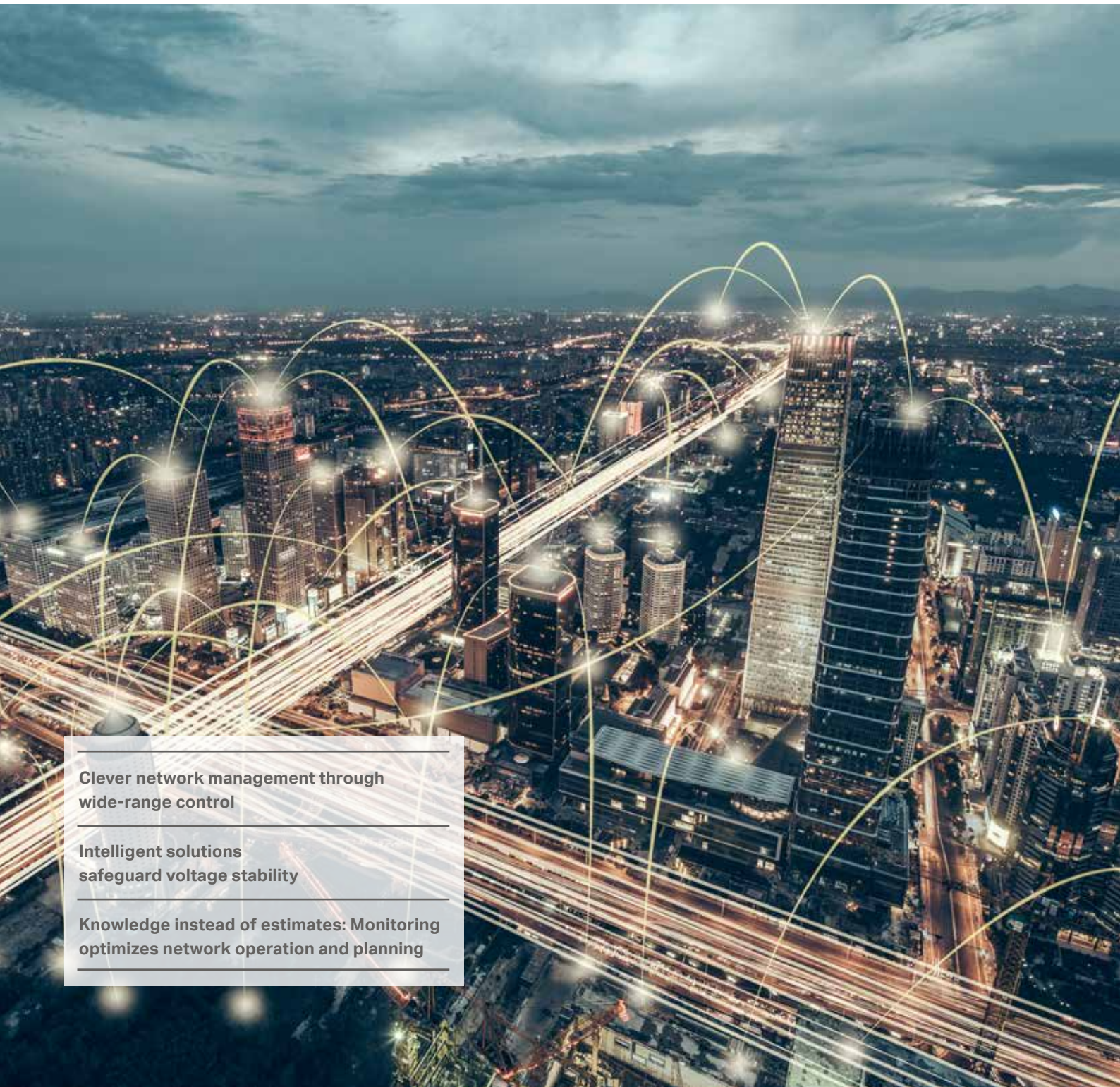
DIRECTENERGY

Orchestrating Distributed Energy Generation

Make Existing Grids Fit for the Future



Clever network management through wide-range control

Intelligent solutions safeguard voltage stability

Knowledge instead of estimates: Monitoring optimizes network operation and planning

It Doesn't Get Any
More Intelligent Than This!

Wide-range control makes the power grid intelligent. WAGO control and measurement technology plays a key role here: On the basis of online measurements, it visualizes bottlenecks in the low voltage network and compensates for them automatically at the same time. This allows network operators to make expensive network expansion significantly more efficient.

Into the Digital Future!

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WAGO

EDITORIAL
MAKING RENEWABLE ENERGIES USEABLE

Dear readers,

The current German government wants to advance the expansion of renewable energies. The goal: By 2030, 65 percent of domestic power demand should be provided through clean energy – that's the political idea anyway.

However, looking carefully at the problems, it's clear that the biggest challenge is not getting enough energy from photovoltaic, wind power or hydroelectric plants, but rather making it actually useable. But the grid expansion continues to be delayed and cost money. However, grid stability and the use of electrical power demand intelligent control today already – this is the only way for distribution system operators to make economically optimal use of the existing grid infrastructure.

But what measures will allow this goal to be achieved – in the short, medium and long term? **WAGO DIRECT**ENERGY addresses this crucial question of the energy industry. We present solutions for smart grid management and voltage stability that have been proven in practice. They all lead to one conclusion: Grid modernization will increase the value of data even further, since grid loads of the future will have nothing in common with the familiar standard load profiles. Data has been driving the energy transition for some time already. The focus of the necessary data collection, transfer and analysis is on making grid capacity transparent and establishing anticipatory load management.

In this connection, the local network stations will play a crucial role in the success of the energy transition – controllable, intelligent and digital – since all the future variables influencing the control loop for voltage and frequency stability in the networks are located near the local network stations. These include increasingly decentralized electrical power generation on the low voltage level and new "disrupters" in the form of e-mobility and energy storage, which also continue to increase.

WAGO is already oriented towards solutions and offers the necessary hardware and software applications. These provide the necessary transparency in the distribution grids – in a way that is scalable and reliable in applications.

Would you like to learn more about our technology? Then get in touch. We hope you enjoy reading.

Ulrich Menzel

COVER STORY

Distributed Energy Generation

Renewable energies are both a blessing and a curse. While helping to counteract climate change, they also drive the grids closer and closer to their load limits. Consumers are becoming energy produces themselves more and more. And the existing grid infrastructure? It's just not made for distributed energy generation – but that can change. Intelligent use of measurement technology, technologies that drive data and data-driven applications can already make it possible to establish and expand efficient generation and load management – in a way that is anticipate and sustainable. And there are three ways that pays off: It makes it possible to set up stable, resistant grids, to absorb the shock of the grid expansion delay but still increase the share of renewable energy used.

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How distributed grid operators direct the energy transition themselves.

Who is actually waving the baton when it comes to "conducting" the orchestra of renewable energies? Politicians like to see themselves as the "conductors" of climate change. But the music is playing somewhere else: in the distribution networks. And they will soon buckle under the strain of increasingly distributed, highly volatile feed-ins. In this scenario, it's up to the distribution network operators themselves to direct the energy transition. How is that possible in a technically efficient and economical way? You'll find out in this volume.

4 billion €

The annual total costs nationwide for stabilizing network interventions could grow to this number after the shutdown of the last nuclear power plants in 2022. (Source: Federal Network Agency)

1,043,300 miles (1,679,000 km)

This is the total length of the electrical circuit of the distribution networks in Germany, which is managed by 883 distribution system operators. (Source: dena)

New Year's Day 2018

On January 1, 2018, at 6 a.m., Germany got its power exclusively from clean energy for the first time – purely in terms of figures, of course. (Source: Federal Network Agency, Smard Platform)

70,000 charging points

For 2020, the Federal Association for Energy and Water Management (Bundesverband der Energie- und Wasserwirtschaft – BDEW) and the German National Platform for Electric Mobility (Nationale Plattform Eletromobilität – NPE) have calculated a demand for about 70,000 publicly accessible charging points and about 7,100 quick charging points. (Source: BDEW)

610 million €

Plant operators' claim for reimbursement for the clean energy not produced for network safety reasons was about 610 million euro in 2017. Consumers paid around 237 million euro more for clean energy not produced than in 2016. (Source: Federal Network Agency)

36 %

The renewables in the electricity sector now cover 36 percent of the consumption and are on a course to break new records. In 2017, wind beat out coal and nuclear power, both of which fell to their lowest levels since 1990, in the electricity mix for the first time. (Source: Agora Energiewende)

According to the German Federal Network Agency, grid stabilization measures cost a record 1.4 billion euros in 2017. However, grid stability is still at risk, due to increasing e-mobility, for example. Although technologies like battery storage systems, sector coupling and virtual power plants contribute to making solar, wind, and hydroelectric power useable, the network managers need data in order to navigate the networks – this is the only way for them to identify and exploit the condition and potential of their networks. Martin Breitenbach from NGN Netzgesellschaft Niederrhein puts it in a nutshell: "We first need to know more about our network in order to be able to make better decisions."

If the Grid is an Orchestra, Data is the Score

It is essential to replace estimates with real knowledge. This brings the probabilities better in line with reality and allows realistic forecasting. Generation and load management can only be efficient and economical if they are aligned with reality. Such management provides a solid foundation for sensible prioritization of network expansion and planning that are both anticipate and cost-effective – especially with respect to grid stability. However, this first requires transparency about the state of the network. To stick with the orchestral metaphor: Data is the score that the "conductor" of the network needs in order to "conduct" the orchestra of distributed energy generation.

The Demand for Coordination is Growing

But how can such a useful data foundation be established and expanded? The most important data arises where the power is generated – in the low voltage network. It is already being used to allow control of the direct local network stations. Where it gets interesting is when these local network stations completely bundle the data and prepare it intelligently and automatically, and it is used to control the level above them – the medium voltage network. This widens the focus to the networks, and not just that: It enlarges the range of what can be controlled. Therefore, this is also referred to as wide-range control. And this scenario will continue to gain importance. As the Agora Energiewende gGmbH think tank says in its twelve-point discussion paper: "The future will be characterized by closer connections and higher demand for coordination between the voltage levels – and thus also between the transmission and distribution

The future will be characterized by closer connections and a greater need for coordination between the voltage levels.

networks." To achieve this, the communication requirements and interfaces between the transmission and distribution system operators, as well as the control and regulation priorities, must be clearly specified.

Remaining Competitive

When it comes to making the existing network infrastructure stable and future-proof and keeping it competitive, a far-reaching, data-based foundation for communication will be indispensable for every network operator. New technologies that reduce network load can allow them to achieve network transparency, which makes anticipatory network planning possible and shows where exactly the most urgent need for action exists. After all, the energy transition is not just about climate change mitigation – it also concerns internationally competitive power generation, says Patrick Graichen, Director of Agora Energiewende. But that is only possible if the network is "singing the right tune." Time to take up the conductor's baton yourself.

TEXT LINDA BÖGELEIN | WAGO

PHOTO GETTY IMAGES AND PIXABAY

The Background of Network Instability

In the new energy system, the great majority of distributed generation systems are connected directly to the distribution network. A large proportion of the new loads, like electric vehicles, heat pumps and other flexible loads also draw their electricity from the distribution network. Therefore, in contrast to the conventional system, the electricity no longer simply flows "top down" from the transmission network to the distribution network. Instead, there is a "two-way street" in the form of backfeed from the distribution network into the transmission network. In particular, this occurs when more and more electricity generated in the distribution network can no longer be withdrawn by the on-site loads. As a result of the backflows, cities are also supplied by renewable energy plants from the surrounding area, for example.

If bottlenecks in the transmission network arise, control of the systems in the distribution network (flexible generators and loads) is often needed too in order to eliminate these bottlenecks. Furthermore, the new kinds of loads, especially electric vehicles, can lead to new network operation challenges in the distribution network if many often draw power from the network at the same time. When transmission and distribution network operators intervene, it is always necessary to consider the repercussions for the other higher or lower network levels. (Source: Agora Energiewende gGmbH)

Renewable Energy Generation

DIGITIZATION AS THE BASIS OF SECTOR COUPLING

Lars Baumann, Asset Management Team Leader at Avacon Natur (left), and Andreas Klesse, Board Member of Avacon Natur GmbH, explain the function of the WAGO system distribution box.

Sector coupling, digitization and customer orientation – these are the focuses of the energy service provider Avacon Natur. This focus increases the efficiency of the energy systemsand district heating systems and provides demand-driven information. Above all, sector coupling – integrated control for heat, electrical and electromobility – requires digital data collection.

"Digitization is the glue that holds sector coupling together and makes efficient solutions for neighborhoods and districts possible," says Andreas Klesse, Board Member of Avacon Natur GmbH. The company is a subsidiary of the regional energy service provider Avacon AG – itself a part of E.ON – and operates CHP plants, heating networks, heating service systems and a wide range of renewable energy systems in Saxony-Anhalt, Lower Saxony, North Rhine-Westphalia and Hesse. It currently has 80 employees and is on a course for further growth.

The Energy Transition Will Be Driven by Customers

After the first phase of the energy transition, which mostly took place in the electricity sector and focused on the expansion requirements of renewable energies, the second phase will be driven by customers – and their needs are changing. Customers are increasingly becoming prosumers and playing an active role in the energy system. This shifts the challenge from pure energy supply to integrated solutions for heating, electricity and electromobility.

Innovative energy solutions can be implemented especially efficiently for development of new residential and business districts. Such development allows an integrative view of the energy requirements during the planning phase already, which allows the energy supply of a district to be optimized. Nonetheless, Avacon Natur implements these solutions for both new construction and existing districts.

The challenge is coordinating the supply of electricity, as well as heat from CHP plants, photovoltaic plants and other heat producers, with customer demand in the district. This requires precise data to be collected and processed digitally. The system distribution boxes from WAGO that Avacon Natur uses for this purpose are ideal for the data gathering.

Climate-Friendly Energy Solutions

In the Salzwedel metropolitan area, the company is already testing such climate-friendly energy solutions. Avacon Natur operates a complex power generation structure there, with combined heat and power (CHP) plants, photovoltaic systems and power-to-heat plants. A combination of centralized and decentralized heat generation is implemented here successfully. The residents also benefit, since so-called tenant electricity models make cost-optimized power supply possible for them. Furthermore, smaller CHP plants are connected to the Salzwedel district heating grid and provide electricity and heat efficiently in combination with a photovoltaic system. Surplus generated heat is fed into the existing heating network.

Digitization of the Heating Network

Digitization is advancing in existing systems too. The focus here is on increasing the efficiency of the district heating network. Avacon Natur is currently equipping about 100 energy systems with WAGO system distribution boxes for data collection. One of them, in the Bockelsberg district of Lüneburg, supplies heat to Leuphana University and an adjacent residential district and cold air to the main auditorium building of the university for the server rooms and air-conditioning the lecture halls. The Avacon local heating network at this site consists of three sub-networks and is 2 miles (3.3 km) long. It includes 55 transmission stations in the residential neighborhood and

a central heat transfer point for the university. The downstream network on the campus is the responsibility of Leuphana University.

The sub-networks are operated at different flow temperatures. The CHPs installed there are the heart of the heat generation and are supplied with renewable energy in the form of biogas. Digitization of the heating network should allow them to fully exploit their heat/power coupling potential through even more intelligent operation. Running the motors up and down frequently negatively impacts the service life and efficiency. Digitization can fix that too.

Added Value through the Cloud

"If we know what temperatures are effectively present in the network, we can control the CHP plants more efficiently," explains Andreas Klesse. Therefore, Avacon Natur couples the network temperature data to the forecast profiles and the data from the district heating station. Here the WAGO system distribution box collects all the important values such as the heat quantities, flow rates and supply and return temperatures. The motor data of the CHP plants is added to this.

A central component of the specialized WAGO system distribution box is the PFC200 controller. It comprises a power supply, a circuit breaker, 16 digital inputs, four analog inputs, an M-Bus master module and transfer terminals blocks for the sensors and actuators. An SD card slot is also available, making software updates very straightforward, for example.

This system distribution box configuration ensures that one piece of hardware meets all the requirements of the various Avacon Natur energy systems. "The WAGO system distribution box made according to our specifications, the Avacon Natur Cloud Box, offers us a tailored solution, which is still scaleable at will," says Lars Baumann, Team Leader of Asset Management at Avacon Natur.

Besides the specialized hardware, WAGO created a CODESYS application on the basis of Avacon Natur's specifications. This allows the connection of M-Bus meters to be configured via the Web interface of the PFC200 and the digital inputs to be configured as pulse counter inputs or fault message inputs. Avacon Natur's team of measurement and control technology experts handles installation and commissioning. Jörn von Hörsten, a member of this team, adds: "The Web interface is enormously practical, especially

The district heating station of the Bockelsberg district heating network in Lüneburg is located right next to the main auditorium building of Leuphana University.

Jörn von Hörsten monitors the measurement and control technology at Avacon Natur.

during commissioning. It provides an immediate overview of how the energy data is sent to the cloud environment."

Programming Freedom, Maximum Security

The industry standard, support for open protocols, fieldbus independence and the flexibility of CODESYS programming freedom were additional points in favor of the WAGO system. "In addition to collecting data through open interfaces, the WAGO system also makes it possible for us to model technical control and regulation functions," says Baumann. "In WAGO, we found a strong partner with which we can collaborate on further development of our projects and the ideal programming for them," emphasizes Klesse.

For the initial data analysis of its energy systems and heating networks, Avacon Natur uses WAGO Cloud Data Control, which is based on the Microsoft Azure cloud computing platform. This allows not only asset management employees at company headquarters, but also the distributed employees throughout the system, to examine the data of all the energy systems at any time. WAGO Cloud Data Control stores all the measurement data and serves as the interface to Avacon Natur's existing energy data management system, which also runs on the MS Azure platform. This energy data management system performs automatic plausibility checks of the meter readings, monitors the efficiency of the energy systems and is used for reporting.

Besides functional aspects, it also illuminates security issues. The hardened firmware and the encryption of all data practically rule out third-party access to the data in the cloud.

Forecast-Based Network Control

In Bockelsberg, Avacon Natur is also conducting a pilot project to test to what degree weather forecasts can increase the efficiency of the heating network. The load profile of the coming day is forecast on the basis of historical load profiles and the weather conditions, and the heat generation is adjusted accordingly. The storage management is optimized in combination with a thermal energy storage system to cap the temporary load peaks – always with the goal of maximizing the cogeneration potential.

However, Avacon is looking even further into the future with the forecast-based method and will also incorporate electricity market data into the optimization process, since such methods are necessary in order to integrate distributed heat generators that fluctuate in time, such as solar thermal collectors and power-to-heat plants or industrial waste heat, into a heating network.

Besides sector coupling in new districts and increasing efficiency in existing systems, Board Member Andreas Klesse also cites a further motivation for digitizing heating networks: This makes is possible to provide certain data to customers. For example, housing companies can handle tenant billing quickly and reliably.

TEXT LARS KÜHN | WAGO

PHOTO DIRK EISERMANN

WAGO IOT CONTROLLERS NOW INCLUDE MICROSOFT AZURE CERTIFICATION

WAGO's PFC100 and PFC200 IoT Controllers are now Microsoft Azure certified. This certification guarantees users that the systems work optimally with the Azure cloud, allowing IoT projects to be implemented easily and securely.

With WAGO Cloud Data Control and the PFC100 and PFC200 IoT Controllers, WAGO offers a solution that links elements from the real and digital worlds. WAGO Cloud Data Control manages and monitors all WAGO Controllers, as well as their applications and data. WAGO's cloud service is hosted by Microsoft Azure; certification ensures smooth communication. The MQTT protocol provides a reliable and secure connection with TLS encryption. Microsoft Azure is highly scalable in terms of computing power, data storage, transactions, availability and security standards. It offers a large number of services and tools to provide an optimal foundation for implementing IoT applications.

The user accesses the cloud service via a Web portal. Typical functions include project, controller and user management, controller status monitoring, alarm functions and email messaging. A dashboard displays texts, tables, diagrams, display elements and command buttons for convenient and intuitive operation. For customized solutions, the REST or OPC UA interface is used, for example, in energy monitoring or predictive maintenance applications. These IoT applications can be quickly and easily implemented using certified controllers and WAGO Cloud Data Control. Of course, the user is not committed to WAGO's cloud solution. The MQTT protocol can also be used with the IoT controllers to create custom solutions using Microsoft Azure.

Microsoft Azure Certified

»WE ARE REPLACING ESTIMATES WITH REAL KNOWLEDGE«

An interview with the two network experts Hans-Werner Leenen and Martin Breitenbach from NGN NETZGESELLSCHAFT NIEDERRHEIN MBH

Martin Breitenbach has the job of introducing new technologies and standards. In this role, he directs the software project with WAGO for NGN. After studying electrical engineering, he also got a masters in energy economics and is considered an expert on the digitization of local network stations.

All of Germany is talking about the energy transition. What are your biggest challenges?

» **Hans-Werner Leenen:** We have to make the right decisions: What comes now? One scenario would be complete electrification of the grids. Perhaps soon we'll no longer want to use fossil fuels for heating and automobiles, but only electricity and water. The electrical grid would then have to handle the entire power supply. That's not possible with the grid as it is today. «

So do we need new grids?

» **Leenen:** Yes, but the demand differs by scenario. In the past, the need for expansion was easy to calculate, since there was only one direction of energy flow in a system dominated by large, centralized power plants. The increase in distributed energy generators and bidirectional energy flows has made it difficult to assess how to design the grids for the future. So we are going in a different direction: We first measure and see what really happens in our network and base our network expansion on that. We are replacing estimates with real knowledge. «

That means monitoring takes priority?

» **Martin Breitenbach:** Definitely. We first need to know more about our network in order to be able to make better decisions. We need to look more closely at the load flows, for example. For instance, we have local network stations that behave normally in the medium voltage ring, but there could be a significant strain on the low voltage infrastructure, since the generation by PV plants is offset by loads within the low voltage network, for example. We can detect that with current transformers and power measurement modules. «

And what can you do with the insights this provides?

» **Breitenbach:** In an initial step, without large investments, we can use these insights to connect grids better in the medium and low voltage ranges and better distribute the prevailing load flows. In the second step, we can better prioritize planning network expansion in line with demand on the basis of information based more on measurements than estimates. «

But the network expansion costs money in any case. Network operators can recoup their investments in new cable through the network charges at the right conditions, but the same is not true of digital measurement systems. But that must make your digitization more difficult, right?

» **Breitenbach:** Indeed – the German Federal Network Agency (BNetzA) doesn't appreciate the investment in intelligence correctly. The Federal Network Agency assumes in part that in the long term, we will increase efficiency through digitization of the network and get our income from that. But the problem is not just the initial investment costs, but also the follow-up costs that intelligent solutions entail. They lead to greater operating expenses, such as wireless communication costs. Qualified personnel is also required to support these intelligent solutions. We are cooperating with WAGO to solve this problem while continuing to advance digitization. Among other things, we have developed commissioning software that allows us to commission a large number of systems more quickly and support them more easily. «

So the Federal Network Agency is providing the wrong incentives?

» **Breitenbach:** In general, I would talk about it in terms of barriers to investment. The appreciation and reimbursement of the investments and expenses by the BNetzA are not the only hurdles. In some cases, investments in measurement, computing and telecommunications technology have been expensive to acquire and costly to operate. Furthermore, handling and sensibly distributing new data is not a trivial problem. And then there are unforeseeable, and thus unplannable, developments, in the areas of the renewable energy plants and electromobility. Therefore, our goal was first to establish a good partnership with WAGO to supply reliable hardware that is scaleable and expandable and features a Linux® platform, allowing us to use software updates to continually meet new challenges we'll face – some of which we can't even foresee yet. «

Barriers to investment, uncertain challenges in the future: Isn't the risk of wasted investment increasing for you?

» **Breitenbach:** Not at all – except for the regulatory problems, we have largely eliminated our barriers to investment. Because, regardless of what developments may arise, we're sure that we'll need more information from the networks, and the investment here won't be wasted. We can even reduce our ongoing expenses at the same time, since the software allows us parameterize the systems with the mouse, with no need for complicated program code. Furthermore, the data is now prepared within the WAGO controller already so it can be supplied directly to multiple departments of the company right away. This allows various processes like network planning and follow-up questions to be handled more quickly and accurately, so we can work less with assumptions and more with measured values. «

Hans-Werner Leenen is an authorized representative and Head of Asset Management and Planning at NGN. He is also responsible for the Technology and Standards Team.

The power grid of the future will be dynamic and comprise many distributed producers and consumers. How far has this development already advanced in the network of the Netzgesellschaft Niederrhein (NGN)?

» **Leenen:** Quite far, since more energy and more capacity have been fed in than drawn in the rural network territories for years already. Furthermore, the proportion of customer systems operated with cogeneration and power-to-heat modules, for example, is increasing there, as well as in the urban network, and the behavior of the systems is oriented towards the energy market – meaning full offtake, neutral network behavior or maximum feed-in. No conventional profile fits these modes of operation. «

Are electrical vehicle charging stations already putting a strain on the network?

» **Leenen:** So far, use of e-vehicle charging stations has been fairly sporadic, and that's precisely our dilemma: We'd like to get experience with effects they have on the network. What are the charging cycles like – is there an ebb and flow, allowing cables to cool off occasionally, or are we dealing with a continuous full load? We can't tell yet. «

» **Breitenbach:** But in future, electromobility could cause big problems for us. Individual charging stations can already be problematic. But if all electrical vehicles are charged within a brief time window, for example due to exchange-driven price signals, this will put a significant strain on the network. Today's networks do not suffice to meet these challenges. In future as well, it will not be economical to design the networks for the theoretical maximum simultaneous loads. That's why we want to get insight into the network and, in a further step, to establish communication with the participants so in future we can intervene to provide control. The goal is to be able to postpone the loads that arise, such as electric vehicle charging operations, to allow better network utilization over time and avoid temporarily overloads. The software on the WAGO controller allows us to achieve this too. «

A dynamic network requires dynamic reaction. What do you think of wide-range control? This method makes it possible to control all lower-level stations from a central point like the substation.

» **Leenen:** I think it will go in that direction. But we also need to know our network better in order to allow optimal use of wide-range control. I sometimes change up to 200 lower-level stations with one controller. We need to know the points in the network with the highest and lowest voltages. But the highest and lowest values vary with the time of day. For instance, when the sun is shining, the points with photovoltaic systems are under significant strain, and high voltage predominates, but in the evening, when the electric cars are

charging, the voltage is reduced elsewhere. So a certain density of measuring points is necessary. But that doesn't mean that we have to measure at all points. With a certain minimum density of measuring points, we can draw sufficiently precise conclusions about other points in the network that have not been measured and set up wide-range control. «

» **Breitenbach:** Since this won't happen overnight, we want to approach wide-range control iteratively: Before we intervene, we need to first prepare the network for the new method. We can do that as part of maintenance of our local network stations; we can adapt the transformer levels here. If just two local network transformers are configured poorly, this can significant limit the control range for the wide-range control. Unfortunately, we can't achieve this with the current measurement technology – mostly moving iron ammeters with drag indicators. Therefore, the information that the WAGO system supplies is necessary for not only operating, but also preparing wide-range control. «

Are you integrating your modernization concept into the cloud?

» **Breitenbach:** Not yet, and I actually consider the cloud inappropriate for network operation. If data from many critical systems is transferred to the cloud, this centralizes it. But I think it's quite healthy for there to be many supply grid operators all operating different local systems. The more distributed the approaches here are, the more secure our networks are, in my opinion. In contrast, for unidirectional information transfer, we are using cloud solutions in some areas already. I can imaging that this will increase. «

Let's take a look at the future. At some point, you will have optimized your network and strengthened it at the right points. And then perhaps electromobility increases more than planned, and you have to lay new cables again. So even with the best technology, you'll never reach an endpoint, right?

» **Breitenbach:** That's right, electronics and software can only achieve optimizations. The capacity of the lines and transformers represents a limiting factor above a certain point. But thanks to the digitization of our network, we know whether we still have reserves in the network, and if so how many, so we can plan measures in a more targeted way. Furthermore, wide-range control will help us to reduce voltage range problems so we don't need to expand as much. Moreover, it is possible to reduce the strain on the equipment through demand-side management and measures such as optimized reactive power management. «

To summarize in conclusion: What are the immediate advantages for you of using digital technology for network operation and planning?

» **Leenen:** There are three points that help us immediately if we use digital technology:

1. The operations manager can plan the conversion better.
2. The network planner can choose selective expansion over comprehensive expansion.
3. More information makes fault elimination quicker.
4. We can assess CHP and renewable energy plants and charging stations better.
5. We can determine our own profiles. «

NGN NETZGESELLSCHAFT NIEDERRHEIN MBH

NGN is a subsidiary of SWK Stadtwerke Krefeld AG and the network operator for Krefeld, Straelen and Wachtendonk. In Krefeld, NGN is responsible for all electrical grids up to the 110 kV high voltage level and for the medium and low voltage levels in other network territories. In Krefeld, NGN also operators the water, natural gas and district heating networks. NGN has around 350 employees.

Energy Grids

ADDED VALUE FOR NETWORK OPERATORS

No network monitoring without transparency, no planning without monitoring, no network optimization without planning – to automatically compensate for bottlenecks in the low voltage network, distribution network operators need to keep an eye on the networks. The WAGO solution makes network visualization and control on the basis of online measurements easier.

Developing technologies and processes to reduce the strain on networks is a key goal of the energy industry. The latest developments include generation and load management via so-called wide-range control through the medium and low voltage network distribution networks. In the process, the medium voltages in the substations are regulated to keep the voltage within the allowed rage throughout the entire lower-level grid. This allows the maximum amount of renewable energy to be fed in and the voltage range to be maintained simultaneously at all points.

WAGO is among the forces driving this innovative type of network optimization. Substations with WAGO control and measurement technology are an essential component of wide-range control. In this approach, WAGO PFC200 Controllers function as a central data node in the stations: They collect the current values recorded by three-phase power measurement modules in the low voltage network and transfer them to the office network via a secure VPN connection, and if necessary, e.g. if a limit is exceeded, to the network control center via a second VPN connection. This allows the network planning employees to do a better and better job keeping an eye on the network with progress in telecontrol monitoring, to plan proactively and to react quickly in the event of faults.

The Network Becomes Transparent

The network station controller transfers voltage values to an additional WAGO controller in the 110 V substation in parallel. Special easy-to-operate software calculates the current state of the low voltage network on the basis of the measured values from the distant endpoints. The level control in the substations is optimized automatically on the basis of these calculations, reducing the burden on the network management in critical situations. Initial experience shows that the wide-range control can reduce the fluctuations in the network by almost 30 percent.

“Intelligent local network stations allow measurement, control, regulation and remote control and function partially automatically. The next step is now real network control in the low and medium voltage range. Online measurement is not new, but we now use it in a timely fashion to obtain knowledge that has many benefits for network operators,” says WAGO network expert Daniel Wiese. The most important benefit is that wide-range control can help companies reduce high network expansion costs, since, on the one hand, it allows the capacity of existing lines to be fully utilized, and on the other, the network information allows investments to be planned in a more targeted fashion. “Online measurement in the low and medium voltage ranges makes the network transparent. This allows the network operators to easily identify where more or less primary technology is necessary,” says Wiese.

Modernization Instead of New Construction

The effects can already be felt clearly in the low voltage network in particular. The share of photovoltaic generation, as well as heat pumps other electric consumers, is constantly increasing; furthermore, strong growth in electromobility is anticipated in the coming years. “Integrating the charging station infrastructure this will require into the

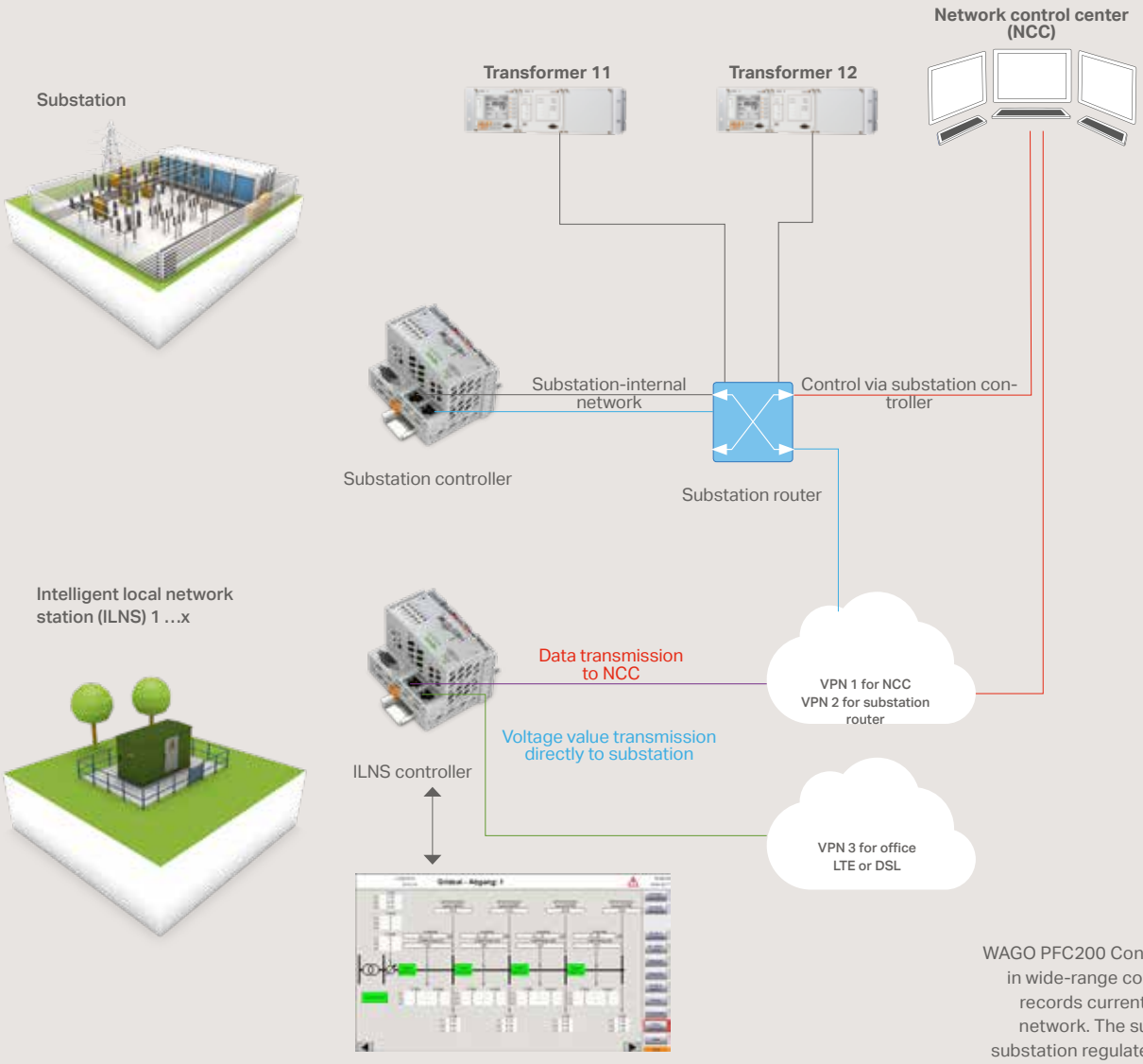
low voltage network will be a huge challenge," says Wiese.

Subsections of the network are already approaching their capacity limits, which shows up in the low voltage range as frequency fluctuations and voltage variations occurring more and more often. The problem: The existing primary technology and the power lines are not prepared for the spread of renewable energies and electric vehicles in many places. They must be adjusted in such a way that grid stability is still guaranteed even with a consistent implementation of the energy transition. The current German government, a coalition of the two parties CDU/CSU and SPD, has clear ideas about how to ensure this in the future: The coalition agreement stipulates that the existing power grids should operate at higher capacity with new technologies and greater digitization, but also with better cooperation between the network operators.

New network codes, which are reflected in the new Technical Connection Rules (TCRs), also require transparency in the grid, so, for example, upstream and downstream network operators can communicate in critical emergency situations in the event of a fault. With network control, network operators would be right on course. "They can create real added value through perspicuous investment in hardware and, in future, through straightforward upgrades of the easy-to-use software," says Wiese.

TEXT DANIEL WIESE

PHOTO WAGO



WAGO PFC200 Controllers play a central role in wide-range control. This ILNS controller records current values in the low voltage network. The substation controller in the substation regulates the medium voltage on the basis of the measured data to keep the voltage within the permissible range throughout the entire lower-level network.

Energy Grids

THE AUTONOMOUS ALPINE CITY

Transparent supply routes and autonomous, automated power and water supply – the Immenstadt public utility company in the Allgäu region relies on these and has done so with WAGO since 2009. Automation and telecontrol technology make this possible and clarify the potential for expansion and savings at the same time.

Over 14,000 residents, 30 square miles (80 km²), all at 2,400 feet (730 m) above sea level. Immenstadt in the Oberallgäu district of Swabia is a tranquil locale. But it would be a mistake to assume that time stands still in this idyllic Alpine town – the Immenstadt public utility company, a municipally owned and operated enterprise, is focusing on sustainable technology for municipal energy management and the distribution of district heating, as well as for the water supply, wastewater management and even flood control.

“The modular WAGO I/O-System simplifies plant control and system monitoring. It improves the energy

A scenic view at the edge of the Alps: The power line from the Diepholz elevated tank of the Bergstätt-Illergruppe water supply station, located 3,500 feet (1,066 m) above sea level, is the only clue as to how much technology lies behind all the supply areas of the Immenstadt public utility company.

management, reduces the calculation effort for the energy supply and makes it possible to integrate remote stations into the network smoothly," says Paul Müller of ETM Elektro- und Systemtechnik in summary. His company is handling the planning on site as the system integrator.

But what specific technical products does this involve? "To be exact, since 2009 we have been using the 750-841/-881 Controllers and the PFC200, as well as the 750-652 Serial Interface," says Paul Müller, listing the products in detail. A total of 45 systems have been equipped with this technology to date: 18 water supply stations, 13 wastewater plants, five systems belonging to the building management of the public utility company, three for flood control measures, five in district heating and one drinking water power plant.

Transparency and Innovation

The biggest advantage of the WAGO controller technology for the Immenstadt public utility company is that every supply route can be monitored and controlled comprehensively and transparently. A central process control system (FlowChief) is used to collect, visualize and archive the data and to forward the error messages for the on-call service.

In addition, the monitoring of the existing systems also simplifies billing for the energy supplied: "The existing M-Bus interface allows all third-party products of the energy meters to be read and the meter values to be stored and processed by them directly in the process control and energy data management systems," explains Paul Müller.

The Immenstadt public utility company is focusing on independence for heat and electricity generation – with renewable energies. The town

generates heat itself with a biomass heating plant. This heating network is monitored with WAGO controllers. The public utility company generates electricity with photovoltaic systems. And hydroelectric power has also been used since the middle of October 2017. The large elevation differences in the supply area and a 55 kilowatt Pelton turbine in the drinking water pipeline should make this possible. This connection of the systems to the public utility company's control center is also implemented with WAGO controllers, says Paul Müller.

Straightforward Expansion to All Utilities

Extending the control to additional utilities and services like the water supply, wastewater, flood control and IT technology was just as straightforward.

Paul Müller explains the procedure: "Integrating the remote stations via the existing network interfaces was straightforward. All programmable logic controllers work autonomously. That means that each of the systems can be controlled and regulated on site with the help of the available information." The technical integration of the remote stations over existing network interfaces is done via DSL, SIM card, microwave transmission and SHDSL extender. The maintenance of the individual remote stations has also been improved with direct programming access over the network with CODESYS.

Flood Risk Even in the Mountains

The elevation of Immenstadt does not in itself protect the town, located in the Oberallgäu region, from flooding, since Immenstadt is located right on the water, namely several rivers like the Konstanzer Ach and the Iller, which flow through the municipal area. Therefore, the flood protection has been modernized too. WAGO controllers are used to monitor and control a weir system and flood control polder.

As of recently, a system of two weirs is controlled autonomously with WAGO PLCs: "When the Iller exceeds a certain level, one weir is triggered and the water floods the polders in a targeted way. A second weir then controls and limits the drainage of the water from the flood control polder through a stream to at most 2,600 gallons (10 cubic meters) per minute," explains Paul Müller. All data for visualization, logging and alerts is transferred to the control system via a mobile router.

Automation from an Environmental Perspective

Besides the automation of all supply areas, environmental issues also play a special role in the overall modernization of the public utility company. According to the current energy report of the City of Immenstadt, between 1995 and 2015 alone, it was possible to cut CO_2-emissions in half, from about 4,000 metric tons to 2,000.

A large portion of the heat energy demand is already covered by a biomass heating plant. Through continual expansion of the district heating network, more and more municipal buildings should be converted to a sustainable heat supply. But the demand is growing in the private sector as well. Therefore, the modernization is focusing particularly on the stability, but also the flexibility, of the automation of the supply.

In addition, the greatest potential for greenhouse gas reduction lies in improving the energy efficiency of buildings. Communal energy management has been introduced in the City of Immenstadt for this purpose. Energy controlling helps to monitor consumption and identify weaknesses – this process is especially precise and reliable with the help of programmable logic controllers (PLCs) from WAGO, emphasizes Müller.

The team looks over the successful project implementation (from left to right): Paul Müller, ETM CEO and System Integrator, Patrick Dauser from Elektro Bentele, the company handling the installation, and WAGO system advisor Torben Schüler (WAGO Munich).

A Project Becomes a Partnership

The cooperation with WAGO for most of the past decade started serendipitously: In 2009, the technology that had been used till that point was discontinued, so the search for a new vendor began.

After intensive research and comparison of various vendors, the Immenstadt public utility company chose WAGO. According to them, what was decisive was the relevance of a variety of interfaces with a view to unlimited extensibility of the CODESYS programming interface, as well as the connectivity of the network protocols for communication with third-party vendors.

“At the end, it was simply a matter of having a scalable system that can be extended for different requirements. The WAGO products were and are able to do make a valuable contribution in this regard. Besides that, their optimal price–performance ratio continues to be a decisive factor,” says Müller, summarizing the decision criteria that justified and continue to maintain the cooperation between the Immenstadt public utility company and WAGO.

TEXT ULRICH MENZEL | WAGO

PHOTO WAGO

The water supply is safeguarded by several elevated tank at various altitude levels. This gate valve in the elevated drinking water tank pumps and distributes the drinking water.

Energy Grids

INTELLIGENT SOLUTIONS FOR THE POWER GRID

Some lightning strikes reach currents over 100,000 amperes, or even higher. The voltage often reaches of millions of volts or more. Without sufficient lightning and overvoltage protection, electrical devices, systems and equipment can sustain significant damage even during minor storms.

Maintaining the voltage: That is the highest priority for the lightning protection expert DEHN, even with significant load flow fluctuations and lightning strikes. That's why WAGO relies on DEHN components for equipping location network stations with control technology. The benefit for customers: perfectly tailored solutions, as well as increased efficiency and reliability – both technical and financial.

Dark clouds are gathering on the horizon; a quiet of rumbling of thunder can be heard in the distance. Then the first lightning strikes flicker in the sky – and suddenly the storm erupts. Several hundred thousand thunderstorms a year occur in Germany, with up to two million lightning strikes.

Some of them reach currents over 100,000 amperes, or even higher. The voltage often reaches of millions of volts or more. Without sufficient lightning and overvoltage protection, electrical devices, systems and equipment can sustain significant damage even during minor storms.

The Energy Transition Increases the Need for Protection

Distribution system operators have not had to worry about their over 600,000 local network stations around Germany, since there are simply no electronics installed there that could be endangered by a lightning strike. The energy transition is now changing that: The volatile feed-in to the distribution grids is increasing, and the fluctuations

The WAGO controller makes it possible to integrate DEHN's lightning protection solutions into the network operator's control system. "That is a great advantage for predictive maintenance," says Tobias Kerschensteiner, Business Development Manager at DEHN.

of the load flows are becoming ever greater, as are the associated voltage fluctuations.

It is crucial to upgrade location network stations: with "intelligent" electronic components such as communication and telecontrol technology, controllable local network transformers and longitudinal voltage regulators or remote controllable load break switches and circuit breakers on the medium voltage level. Tools like these help the network operators keep the power grid stable.

The crux of the matter is that the more electrotechnical equipment and devices that are installed in the local network stations, and the more complex and interconnected the local power supply becomes, the greater the risk is of damage due to lightning. As the interface between the medium and low voltage network, the local network stations are especially at risk in this regard.

Lightning striking the equipment or in its immediate vicinity is not the only danger; the interference pulses can also be transferred through the incoming supply lines. Depending on the soil conditions and other factors, the hazard radius can extend up to one and a quarter miles (two kilometers) around where the lightning strikes.

Maximum Safety in the Smallest Package

In many of the local network stations that are already equipped with intelligent technology, WAGO controllers organize the communication between the individual primary components. The measurement, control, regulation and telecontrol technology from WAGO allows network operators to react automatically to voltage fluctuations or other deviations. Thus WAGO helps companies ensure the highest reliability and quality of the supply at all times despite significant feed-in and load flow variation.

But what about lightning strikes? To guarantee the network operators safe, fault-free operation of the controllers for this as well, WAGO has brought in an experienced partner for overvoltage protection: DEHN from Neumarkt in the Upper Palatinate, a family company with about 1,800 employees worldwide that has developed and produced lightning and overvoltage protection solutions for over a hundred years.

DEHN's philosophy is to produce nearly all the required components itself. The company also tests the protective effect of the products in its laboratory before they ship. "That gives customers the greatest possible safety," explains Tobias Kerschensteiner, Business Development Manager at DEHN.

Besides surge suppression devices for energy technology, WAGO also uses products from this partner that are specially tailored to wireless applications for device and antenna interfaces with coaxial connection technology. Together they offer protection that safely discharges voltage spikes before they can damage the controllers. The DIN-rail mounting of the DEHN surge arrester saves space and helps WAGO design very compact solutions.

Predictive Maintenance Increases Efficiency and Reliability

The WAGO controller makes it possible to integrate DEHN's protection solutions into the network operator's control system. "That is a great advantage with respect to predictive maintenance," says Kerschensteiner. "It allows network operators to check from the control room whether the overvoltage protection is functioning properly." Technicians only have to visit the plant if a problem actually exists there or could exist within a foreseeable amount of time.

Thus companies can forego routine on-site checks. This is a big win for the network operators, since many of them do not even have enough qualified employees to handle such tasks. "Remote access to the operating data makes the maintenance of the protective equipment very efficient without compromising safety," explains Kerschensteiner.

Since October 2016, the products have met the applicable standards VDE 0100-443 and VDE 0100-534. These set new requirements on the protection of electrical equipment and systems against overvoltages that can be caused by atmospheric effects or switching operations.

»Together with WAGO, we can offer network operators tailored solutions.«

From a Product Supplier to a Solution Supplier

However, the optimal form of a protection concept depends heavily on the local conditions. Therefore, Kerschensteiner emphasizes, customers are not served with standard products, but rather receive individual advising. "Together with WAGO, we can offer network operators tailored solutions," adds the DEHN expert.

This strategy is advantageous for customers, since they run technical equipment like local network stations for very long periods. Kerschensteiner summarizes their aspiration: "DEHN and WAGO offer more than just products – we are solution providers!"

TEXT DANIEL WIESE | WAGO

PHOTO RALPH DIERMANN, FOTOLIA

Energy Storage Systems

THE TAILORED LARGE BATTERY STORAGE SYSTEM

With a scalable hybrid energy storage system of lead acid and lithium ion batteries, the battery expert HOPPECKE from Brilon is allowing new flexibility in power supply.

Hardly a sound can be heard, only the air-conditioning fans turning slowly. It's hard to believe that the within the inconspicuous container runs one of the most innovative and robust energy storage systems currently available on the market. "We have confirmed the feasibility of the systems, and our expectations have been exceeded," says Matthias Büter, Product Manager and Project Director of HOPPECKE Batterien GmbH & CO. KG from Brilon.

Energy storage systems are playing an increasingly important role in meeting the challenges of the energy transition. They stabilize the power grid and support medium-sized and large industrial plants in absorbing the shock of their energy demand and saving on infrastructure investments.

Storage systems can do even more: They make it possible to optimize energy consumption even with self-produced wind or solar power, provide power for electric charging stations and ensure an uninterrupted power supply. "Our 'sun | systemizer scalecube' large storage system allows all these challenges to be met economically," explains Büter.

Lead and Lithium in a Sensible Combination

The HOPPECKE innovation has an essential advantage: It is modularly scaleable, so it can be adapted to any application. The example on the plant premises can take in and discharge up to 1.5 megawatts of electric power. This power is divided among three battery units with a total energy content of about 2,600 kilowatt-hours: Two units consist of a total of two times 416 serially connected, maintenance-free lead cells from HOPPECKE of the grid|power VR M 2V 600Ah type.

Another battery unit has been implemented with 2,560 lithium ion cells that are connected into individual modules. "The lithium ion battery is the real workhorse for the application, since it is more cycle-proof than the two lead batteries. The lead units form the backup," explains Büter. All the technology is housed in two containers that are specially protected against weather.

Smoothing load peaks, optimizing self-supply, charging electric vehicles – HOPPECKE from Brilon has developed a large storage system that supports small and medium-sized companies in optimizing their power supply.

The WAGO PFC200 Controllers play a central role in HOPPECKE's energy storage system: They determine the state of charge of the batteries and provide the information that is necessary for efficient operation of the storage system.

One standard-sized container accommodates the lithium unit and another, somewhat larger one the lead units. Within the containers, the batteries and accumulators are stacked neatly in specially developed racks. In order to be able use as many lead cells as possible and thus achieve the highest possible energy density of the area while taking up at little space as possible and meeting safety requirements, the two middle rack rows of the four total can be shifted electrically. This creates a 60 centimeter wide maintenance passageway between the two rows at the press of a button.

Data Backup with the Cloud

The hybrid system brings with it a valuable added benefit: "The storage system is able to provide temporary electricity as primary control power. The requirements for this are especially strict," explains Büter. The full primary control power must be available within 30 seconds so fluctuations in the power grid can be compensated quickly.

For this purpose, it is necessary to make all network-relevant data available. This is the only way for all participants – the local network operator, the trader who sells the feed-in or feed-out power of the system to the electricity exchange and the HOPPECKE service department – to make optimal use of the power bank. "We met this challenge with the support of WAGO," says Project Director Büter.

The result even goes a good bit beyond what is necessary. "The idea was to be able to query, not just the state of charge of the lead units, but each individual lead cell. We simply want to show what is possible," says Büter. Furthermore, all cell voltages and temperatures are recorded in real time, and the historical data is stored in the WAGO Cloud Data Control. The essential advantage of the cloud solution is the possibility of site-independent access to the data.

Sensors, in connection with eight-channel analog input modules from WAGO (750-459), record the voltage and current values on each lead cell. A WAGO fieldbus coupler (750-532) that records the data is installed on each of the 52 racks. The 52 devices are connected to each other via Ethernet cables and pass the data on the the WAGO PFC200 controller through this channel.

"It was an immense advantage that we were able to use customized logic on the WAGO controller," explains Büter, because HOPPECKE developed its own algorithm to determine the state of charge from the recorded voltage and current values and

programmed this onto the controller. Besides the state of charge, the temperature is determined on every eighth lead cell. This too is handled by eight-channel input modules from WAGO (750-451). "All this together yields a monitoring system for lead batteries such as lithium ion batteries provide inherently as part of their battery management system," explains Büter.

Energy Management with the PFC200

In the lithium unit, a PFC200 gets the required information on the state of charge, temperature and other relevant data directly from the battery management system of the batteries via their MODBUS interface. Another PFC200 monitors and controls the DC converter. In terms of performance, a single controller would suffice for the entire power bank.

The reason for equipping each section with its own controller is the modular concept. "For example, if customers don't need the converter, we can simply omit it and sill know that the system's communication concept will function reliably. The system's power and energy content can also be customized," explains Büter.

Finally, the fourth and final PFC200 serves as the central monitoring and control unit that receives all the data from the entire system. This also includes information on the air-conditioning with which the containers are equipped. The data is processed graphically and converted into a visualization. All participants – network operators, power traders and the local authorities – get all the necessary information sent to them in real time through innovative interface management or displayed in the visualization created by HOPPECKE. "The modular large battery storage system corresponds in every detail to our philosophy of offering the customer the perfect solution for every problem," says Büter. The system may work quietly and inconspicuously, but it is hardly the runt of the litter.

TEXT ANDREAS GRABOSCH | WAGO

PHOTO JENS SUNDHEIM

The power, size or composition of the individual components – the battery specialist HOPPECKE can fabricate the "sun | systemizer scalecube" according to the customer's exact specifications.

36 lithium ion battery packs, stacked to form a black wall: The local network operator, Allgäuer Überlandwerke, uses a total of five of these large batteries spread throughout the greater Kempten area to ensure the stability of the distribution network.

Energy Storage Systems

INTELLIGENT CONTROL OF A BATTERY SWARM

The “SchwarmSpeicher Allgäu” swarm battery system stabilizes the low voltage network in and around the Bavarian town of Kempten. For monitoring and controlling the distributed storage systems, egrid, the specialist for intelligent distribution grids, relies on WAGO controllers, due to flexibility, reliability and service quality.

The concrete box the size of a garage, located among multi-family units, tennis courts and swimming pools to the west of Kempten, could be a conventional local network transformer station. But what’s hiding behind the metal door is neither a transformer nor a medium voltage switchgear, but 36 lithium ion battery packs, stacked to form a black wall – one of five large batteries spread throughout the greater Kempten area that the local network operator, AllgäuNetz, uses to ensure the stability of the distribution network.

And that is necessary, since, as in many other regions, the low voltage network in Kempten and the surrounding areas has come under significant pressure in recent years. The reason: the significant increase in feed-in of electricity from renewable energies. A clear example is the number of days on which electricity on the medium voltage level was fed back: Until a few years ago, this was very rare, but since 2017 it has already occurred more than a hundred times.

Intelligent Network Hardening

But now, instead of laying new lines at great cost, the network operator has decided to invest primarily in intelligent measures for hardening the existing grid – above all in a system of distributed storage batteries. This battery system supports the local grid with sophisticated algorithms, as well as communication, measurement and control technology from WAGO. The batteries, each with a capacity 500 kilowatts, were installed specifically where a great deal of electricity is fed into the grid and withdrawn again with a time delay.

The swarm storage system, christened “SchwarmSpeicher Allgäu,” went online at the end of 2017. The design, planning and operation of the battery system were handled by egrid applications & consulting GmbH, a joint venture of Allgäuer Überlandwerke and Siemens specializing in consulting services related to the design of intelligent distribution networks.

The concrete box the size of a garage, located in the west of Kempten, has the effect of a conventional local network transformer station. Behind the metal door hide storage batteries instead of transformers or medium voltage switchgears.

For management of the swarm storage system, egrid relies on multi-purpose operation. This makes it possible to exploit different earnings sources. "The most important function of the system is to supply primary control power. We usually support the local network with this too," explains egrid Managing Director Bernhard Rindt. Furthermore, the storage systems occasionally absorb peaks that arise during grid use. The battery packs also serve as an emergency power system. This allows the network operator to invest less money in procuring and operating diesel generator sets, which normally handle this.

With the right energy management framework, even more operating modes will be possible in the future – for example in the context of "Demand Side Management" (DMS) or providing reactive power.

Better Together

Why did egrid create a system of storage batteries with intelligent control instead of installing isolated large batteries? "The swarm storage system offers a series of advantages right away. For example, it is much easier to keep the individual batteries at the optimal state of charge of forty to sixty percent. To do this, the system preferentially activates whichever battery is right at the upper or lower limit of this range," explains Rindt. Furthermore, it is easier to get a handle on the heat build-up of the batteries in the system, which extends their lifespan. And last but not least, the availability increases: If one of the battery packs is no longer working properly, or maintenance work needs to be performed, the four remaining storage systems can make up the capacity shortfall.

The individual plants are monitored and controlled from a control room that is staffed around the clock. Both negative and positive control energy are provided automatically according to the frequency deviations, which are measured on site. However, egrid has also implemented additional control algorithms to ensure that the batteries are kept at the optimal state of charge by exploiting degrees of freedom. If the storage systems are to be used for capping peak loads in the grid, the system is operated from the control center in an alternative operating mode.

Reliable Business Culture and Flexible Technology

Whether control energy, grid peak reduction or other applications: WAGO controllers guarantee reliable communication between the individual system components. WAGO has been on board with egrid projects for some years. "Among other things, we like WAGO's long-term orientation in product development," says Rindt. "Many large companies are constantly moving on to the next big thing. And they withdraw from a market segment again quickly if things don't go as planned

»WAGO combines Linux® with CODESYS Runtime and the possibility of adding our own source code on top. Hardly any other vendor offers such flexibility.«

there. In contrast, in our experience, WAGO maintains a very different culture." This also includes the manufacturer's service orientation: "We've always gotten the right support from WAGO very quickly," emphasizes Rindt.

Besides this, technical considerations also favor WAGO products. "WAGO's open source strategy suits us very well," explains the egrid director. With Linux® as the base operating system for the controllers, the smart grid specialist is able to react to new requirements quickly and without great expense. "WAGO combines Linux® with CODESYS Runtime and the possibility of adding our own source code on top. Hardly any other vendor offers such flexibility," says Rindt with conviction. Every now and then, the technical and functional requirements for a battery system change after installation. "Because, for example, a network operator might want to have access to additional information on the status of the batteries after the fact. With WAGO, we can meet such requests very easily – we just need to add a few lines of code."

TEXT ULRICH MENZEL | WAGO

PHOTO RALPH DIERMANN, EGRID APPLICATIONS & CONSULTING GMBH

Bernhard Rindt, Managing Director of egrid applications & consulting GmbH, explains the management of the swarm storage system. "Multi-purpose operation allows us to exploit different earnings sources." However, the most important function of the system is to supply primary control energy. "We usually support the local grid with this too."

CAUTION: BAT CROSSING

The goals of a wind power operator are to optimize switch-off times and increase earnings. Where winged animals rule the skies, it has been necessary to reckon with costly downtimes – but Senvion is showing how to change that. With the help of WAGO, the wind turbine manufacturer offers operators the possibility of reacting even more flexibly to changes, for example: bat conservation.

Date information, wind speeds, temperatures: What functions as the basis for the weather forecast is really a kind of flight plan – for bats. "All this information is required in order to be able to make reliable statements about the activities of bats," explains WAGO engineer Nino Flottmann. But for what purpose?
The short answer: animal protection.

The Forest Becomes a Wind Power Zone

The background is that, from a purely legal point of view, forests too have become a substantial zone for wind energy. This was unthinkable at the start of the era of wind power, simply for nature conservation reasons and due to technical hurdles. But the targets of energy and climate policy need to be met. That's why only five percent of the about 26,000 wind turbines in Germany are located in forests – but there is a trend towards more.

However, these wind turbines must share the space with the forest dwellers. In the turbines, which are current up to 200 meters high, the nacelles extend far above the forest canopy, and

»Adaptable algorithms allow us to react quickly, flexibly and straightforwardly to changing conditions.«

Jochen Poitzsch, Senior SCADA Engineer
at the wind turbine manufacturer Senvion.

the ends of the enormous rotor blades move significantly above the treetops. However, they reach so far down that they cross the airspace of bats, since most of the 25 native species prefer trees as their habitat.

Bats on a Collision Course

"We have to and want to avoid injures to bats on our wind turbines," says Jochen Poitzsch, Senior SCADA Engineer at Senvion, a wind turbine manufacturer that has already installed more then 7,800 onshore and offshore turbines. Not only collisions with the rotor blades are deadly for the bats – even the air turbulence represents a danger.

The only way to protect the bats is to switch the wind turbines off temporarily – the Federal Immissions Control Act (BImSchG), the most important set of environmental protection regulations, requires this. The federal states implement this in their wind power ordinances. However, this protection requirement applies not only to turbines in forests, but to all onshore sites. In particular, the common pipistrelle bat and the large noctule bat, which are on the red list of endangered species, can be found in unforested areas too.

"When certain temporal and meteorological conditions under which bats are active are met at the location of the wind turbine, it is necessary to switch them off. But the operators have a natural interest in minimizing the downtimes of their systems. Every kilowatt hour counts," explains Poitzsch, the expert for Supervisory Control and Data Acquisition (SCADA).

Flexible Algorithm Instead of Sensors

In this area of tension, WAGO controllers offer a way out: Instead of always putting wind turbines in idle mode under certain conditions in general, a programmable logic controller (PLC) from WAGO helps to adapt the switch-off times to every individual site, optimizing them.

There are quite practical reasons for having an external controller handle this. "That statutory developments are very dynamic; the requirements are constantly changing and also differ by federal state," explains Jochen Poitzsch. The alternative would have been updating the SCADA controllers of the wind turbines for every change to the requirements – too time-consuming, Senvion decided.

Therefore, the solution that has been developed now works as follows: “The decision to switch off is not made on the basis of costly sensors that detect the actual presence of bats,” explains WAGO engineer Nino Flottmann. Instead, it is based on a flexible algorithm that takes numerous scientifically determined factors into account such as sunrise and sunset, temperature, wind speed, precipitation and others. The scientific factors trace back to the WINDBAT research initiative, which investigates the risk of bat collisions with onshore wind turbines. As part of its investigations, this research group also developed the “ProBat” software tool, which can be used to calculate bat-friendly operating algorithms for wind turbines. This tool also forms the basis for the solution used at Senvion.

“We then apply local weather data directly from the SCADA system of the wind turbine,” adds Flottmann. That is no problem, thanks to the open interfaces of the WAGO PLC. Nino Flottmann parameterized all the other data through the Web interface. If all the switch-off conditions are met, the SCADA system of the wind turbine receives the stop command from the WAGO controller, and the rotors come to a standstill quickly.

All switch-offs, including the current states of the system, are stored in a file and sent to the plant operator monthly. The system status can be queried at any time through the Simple Network Management Protocol (SNMP). If the legal requirements change, the operator can bring the controllers up-to-date without significant time and effort: The operator changes the default values in the algorithm accordingly and stores the file on an SD card or online. As soon as this data has been loaded onto the WAGO controller, the new values are applied automatically.

Optimizing Switch-Off Times

Senvion has now equipped about 100 wind turbines in Germany with the more flexible controller, and the project is far from over. First of all, the application is currently being internationalized and prepared for Europe-wide launch. Secondly, this technical solution is not limited to just bats: It can also be used for bird protection.

However, it is difficult to determine how much this controller improves the annual return of a wind turbine. “Nonetheless, it is clear that the switch-off times are optimized,” says Jochen Poitzsch in summary, since the adaptable algorithms allow wind turbine operators to react quickly, flexibly and straightforwardly to changing conditions.

TEXT HEIKO TAUTOR | WAGO

PHOTO GETTYIMAGES

Jochen Poitzsch is a “Senior SCADA Engineer” at the wind turbine manufacturer Senvion.

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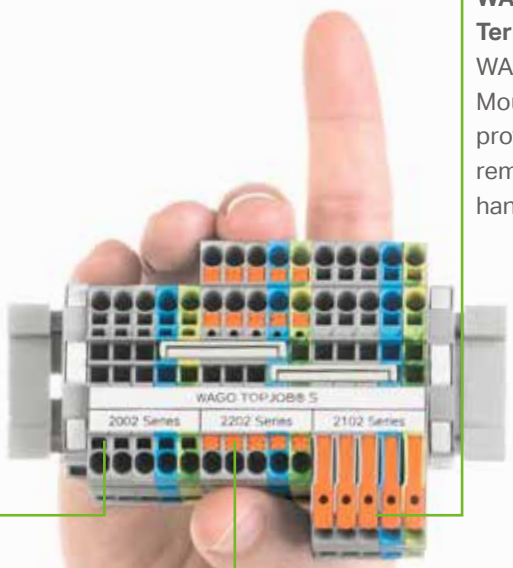

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