10/2018

POWERnews

Customer Magazine

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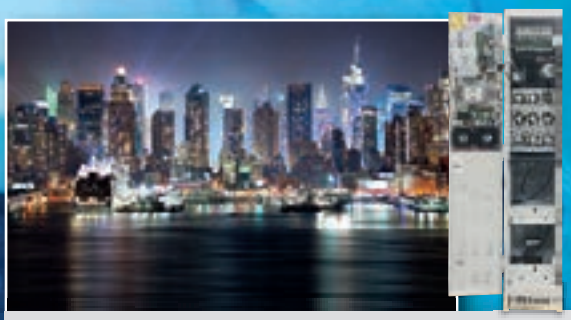

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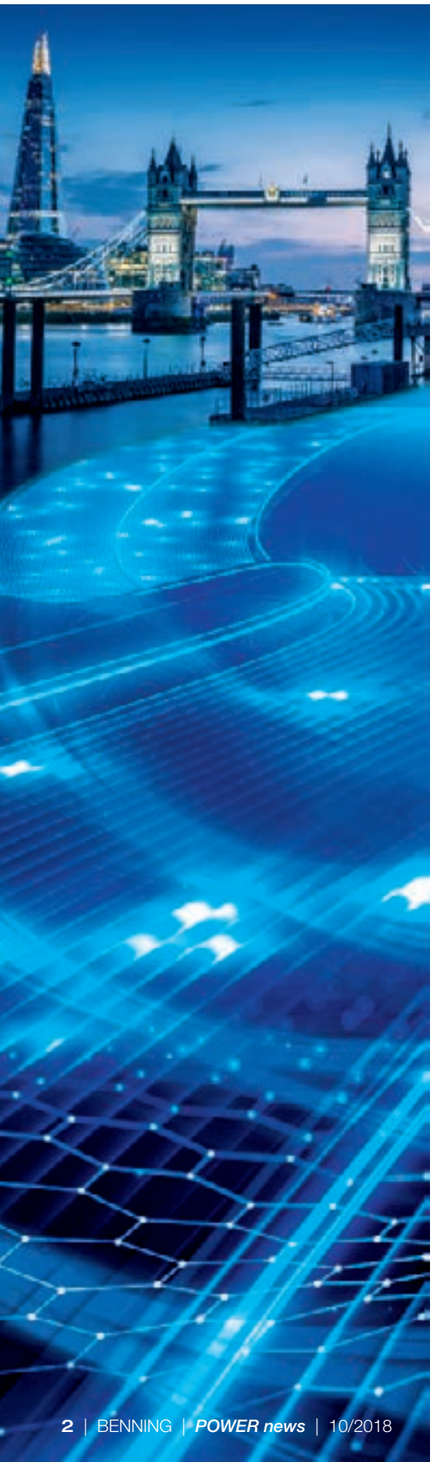

POWER news 10/2018

Editorial

Dear reader,

The UK is planning to build the world's largest battery power supply network, consisting of 45 battery storage systems with a total capacity of more than two gigawatts, helping balance any fluctuations in electricity production and demand, so that a constant and stable power supply is maintained – an important step towards better management of the transition to renewable energy. In parallel with the installation of the battery power supply network, one of the largest networks of rapid-charging stations for electric vehicles will be created. The UK power network will experience additional strain due to the electrification of road vehicles, these storage systems will help by reacting flexibly and compensating for any fluctuations.

BENNING is also committed to making sure that the use of electric cars, trucks and buses becomes central to a smart, resource-conserving urban lifestyle. For this purpose, we have developed the HPC rapid-charging BELATRON modular range whose advantages we will be highlighting in this issue of POWER news.

You can also read about how BENNING uses highly efficient modular power systems to contribute to CO_2 savings and greater efficiency in other areas, e.g. the modernisation of a power station in the UK, and the expansion of the Ukrainian mobile network or the modernisation of the New York metro.

I hope you enjoy reading this issue and look forward to your feedback.

Yours, Stephan Ratermann

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Contents

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Safe power supplies for offshore wind farms

BENNING greatly contributes to energy transition: It supports offshore wind farm projects throughout Europe with secure power supply systems and customised services.

Energy transition is an issue that affects us all. At the UN Climate Change Conference in Paris in 2015, the Assembly adopted a climate agreement that provides for global warming to be limited to at least two degrees and ideally to 1.5 degrees Celsius. At the same time, CO_2 emissions are to be significantly reduced.

To achieve this goal, we want to implement a gradual transition from conventional energy sources to fully renewable ones. This article describes the way the offshore wind industry is contributing to the latest trends and developments and the role of BENNING in this regard.

19" modular rectifier plug-in unit with 4 modules TEBECHOP 3000 HDI and remote monitoring unit MCU 2500

Promotion of wind energy

In addition to the study of sustainable technologies, the promotion of wind energy is of particular importance when it comes to the sustainable implementation of the energy transition.

As the construction of larger wind farms turns out to be fairly complex in rural areas, the focus is placed on the development of Offshore Wind Farms (OWF), which are constructed in coastal areas (e. g. in the North and Baltic Seas, the Irish Sea or the Iberian Atlantic coast) and supply energy to the coast via submarine cables to feed into the general power grid.

For transmission distances of less than 30 kilometres, the principle of alternating current transmission is generally used. For longer distances and high wind farm performance, however, high-voltage direct current (HVDC) transmission is used, as this allows a lower loss of energy and thus more efficient energy transmission.

Increase in capacity

While the first OWF received substantial subsidies from the government, the first projects are currently being implemented without state funding. This is a clear sign that the offshore wind industry has established itself in recent years as a new and strong industrial sector in Europe. →

Especially in Germany, the offshore sector is in the ascendancy. At the end of 2017, a total of 1,196 offshore wind turbines were connected to the grid in 20 OWFs with a total capacity of around 5,387 MW. But that is not all: According to the plan, this figure is to be increased to 10,700 MW by 2025 – and other European countries also wish to follow suit. The Netherlands, for example, plans to expand its offshore capacity from 1,120 MW currently to 7,000 MW by 2030.

Over the past five to ten years, a large number of OWFs have already been built and put into operation – especially in European countries such as Great Britain, France, Germany or the Netherlands. Most of these wind farms have a total capacity ranging between 300 and 700 MW.

A single wind turbine has an average power output of 10 MW and is connected to a central platform (called hub) where all the energy is accumulated and routed to the mainland.

Not only the number of wind turbines, but also their average power has significantly increased to 10 MW. At the same time, the voltage level and thus the use of DC connections has increased – as a result of the larger amounts of energy, some of which are transported over very long distances.

Artificial energy islands

Several European energy companies are currently working on a major project which is significantly contributing to the implementation of the goals of the UN Climate Change Agreement. It consists of several man-made North Sea islands, on which various wind farms are connected to generate electricity for the surrounding countries.
By the year 2027, they should be able to produce sufficient energy to supply approx. 80 million households. There are also central facilities such as accommodation for technical and operational personnel as well as an airport and water port close to these hubs.

Secure power systems

For almost 15 years now, BENNING has proven to be a reliable designer and manufacturer of flexible and, above all, safe power supply systems in the offshore sector. It supplies both rectifier systems and UPS systems with batteries, which are primarily used on offshore platforms where permanent availability of critical loads (e. g. switchgear for high voltage, communication and safety systems) must be ensured by means of uninterruptible power supplies.
BENNING also offers tailor-made solutions for the wind turbines themselves, especially in transition pieces. The systems used here must meet the highest requirements in terms of EMC, vibration and climatic influences.

Customised service

BENNING provides its customers with an experienced team of competent experts whose aim is to maximise the use of power supplied in the offshore wind energy sector in terms of safety and efficiency. BENNING is continually seeking to optimise service performance from planning through to maintenance in a targeted fashion.

BENNING's extensive service package also includes the Hotline support service for its customers. On request, BENNING also provides employees who specialise in offshore operations for on-site deployment. This ensures continuous operational safety of the wind turbine.
A small but important contribution on the way to the energy transition. □

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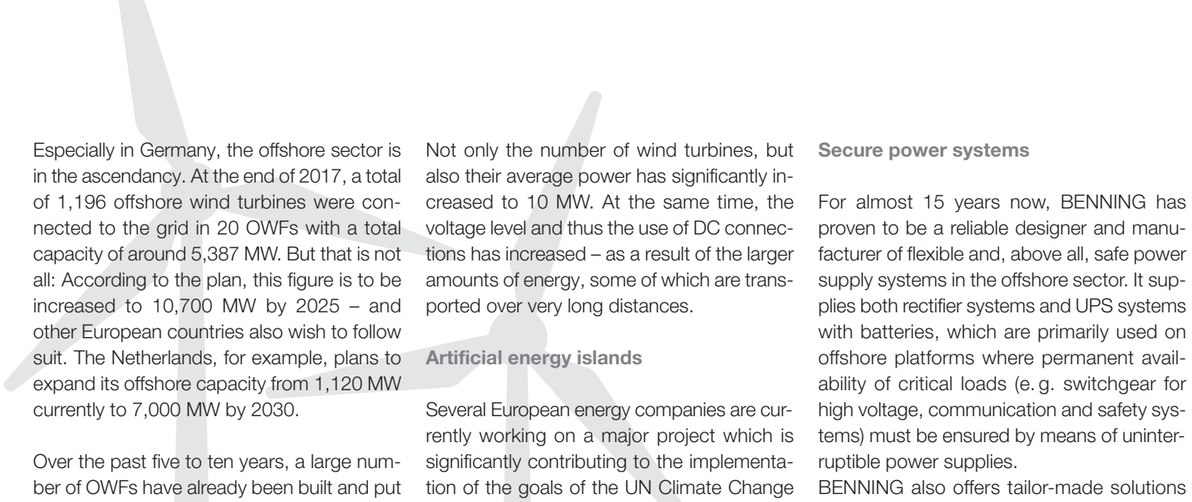


The high wind farm capacities of the artificially constructed energy islands require high-voltage direct current (HVDC) transmission. This ensures a highly efficient and low-loss energy transport over long distances.

Redundant and modular power supply system with rectifier, inverter and DC/DC converter

BENNING

Modular power protection in industrial applications

The principle of modularity provides significant technical and economic benefits in the design and operation of UPS systems.

Modular power protection and conversion technology, particularly in the form of UPSs, has long been used in commercial applications, but take-up in industrial applications has, to date, been relatively slow.

ENERTRONIC modular SE, 40 kW modules

BENNING's UPS system is scalable and can increase in size in line with load requirements

This relatively slow uptake is due, in part, to a limited understanding of the "ilities" ("Availability", "Reliability", "Scalability", "Flexibility" and "Maintainability") commonly associated with modular technology and how the various "ilities" complement each other.

The fourth of five articles within our 'ility' series focuses on flexibility. We will define this in the context of the increasingly important and popular modular technology and discuss how truly flexible systems allow system designers to design power protection systems capable of adapting to the potentially changing needs of a site and/or its critical load.

Flexibility

In previous articles within this series we have defined modularity and discussed how modular UPS systems can be designed to either maximise system availability or minimise total cost of ownership (TCO). We must now consider how we can design a single system that is flexible enough to have the highest availability or lowest TCO with the ability to switch between the two depending upon the prevailing needs of the site/critical load.

Determination of functional characteristics

At the initial design stage of a power protection system, the designer will prioritise the most important aspects of the required system and will most likely compromise on other design aspects. For example, if the load is considered to be business critical the designer will prioritise availability above TCO.

Such prioritisation is not a problem if the needs of the site and/or critical load are guaranteed to never change over the working life of the system (typically 20-25 years), however, we live in an ever-changing world and such guarantees can rarely be given. The danger, therefore, is that a system that was initially designed to meet one set of site/critical load needs may no longer be suitable if the needs of the site/critical load ever change. If this situation ever occurs it may be an expensive problem to correct.

In an ideal world, a system would be designed with the capability to quickly and easily adapt to the prevailing needs of the site and/or critical load.

Such a system could, for example, be increased or decreased in size (see "scalability" article) to optimise TCO or additional modules could be added to it to introduce parallel redundancy (i.e. N+n) if maximised system availability became a requirement.
Finally, it would allow for power capacity to be relocated from system to system if the needs of the critical load(s) across numerous systems ever needed to change.
With the above "ideal world" we can define "flexibility" as a system's ability to adapt to the ever-changing needs of the site/critical load. High levels of system flexibility help designers to "future-proof" their design and below we will consider a practical example to see how the inherent flexibility of rack-mounted modular UPS helped to future-proof a system and thereby provided numerous financial and operational benefits to the system operator.

An example of a highly flexible system design

Let us assume that a pharmaceutical company decides to start up an experimental production line that needs 60 kW of UPS power. Because of its experimental nature, the directors of our fictitious company restrict the project's budget and because it does not have a production line, the UPS system is not "business critical", making TCO a greater consideration than system availability. To meet this design brief a modular UPS system, "rightsized" to the initial critical load by using two 40 kW modules, is installed (see phase 1).

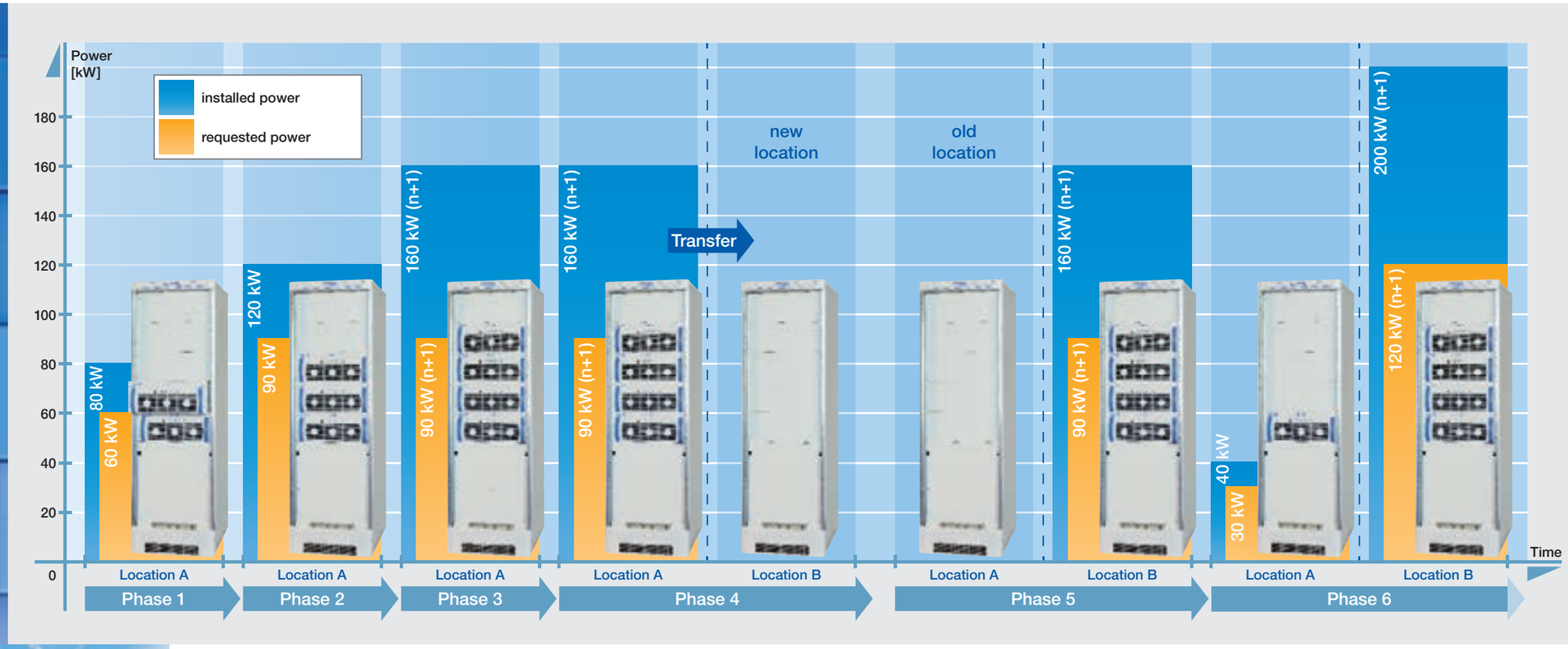
Assuming that the company's experimental production line is an initial success, directors want to see how easily production capacity can be increased on the experimental line, adding 50% capacity to the production line. This increases the production line power requirement by 30 kW from 60 kW to 90 kW. This challenge is overcome by simply adding one additional 40 kW module to the modular UPS system (see phase 2) to accommodate the increased load and still meet the initial design brief of lowest TCO.

The directors – who are delighted with the performance of the now larger experimental production line, decide to turn it into a real production line and begin serial production of a new drug. This decision now fundamentally changes the design brief of the power protection system because if a power problem causes the production line to be stopped mid-batch, the entire batch must be scrapped, costing the pharmaceutical company tens of thousands of pounds.

The design brief is now to maximise system availability and an additional 40 kW module is added to the modular UPS (see phase 3) to add parallel redundancy and thereby meet the new design brief of maximum availability.

As a result of increasing sales, the pharmaceutical company opens up a new production facility in a town, which is a 30-minute drive away, and decides to move the new drug's production line to the new production facility. The drug production line's modular UPS is only 3 years old and rather than investing in a completely new UPS system the directors decide to relocate it to the new facility. However, the downtime on the production line must be minimised and the time needed to decommission, de-install, physically relocate, re-install and recommission the existing UPS is considered to be too great. →

Modular power protection



The solution is to install and commission an empty modular UPS cabinet at the new production facility (see phase 4).

When the production line is switched off at the old facility, the four UPS modules are then simply switched off, removed from the original modular UPS cabinet, driven by car to the new production facility, fitted into the new modular UPS cabinet and switched back on (see phase 5). Because the new production facility was only a 30-minute drive away, the whole process took less than 90 minutes in total.
The pharmaceutical company now decides to start up another experimental production line on the original site and this line now needs 30 kW of UPS power.
Again, because of its experimental nature, the directors restrict the project's budget and because it not a real production line, and therefore not "business critical", TCO is a greater consideration than system availability.

To meet this design brief a single 40 kW module is fitted into the original modular UPS system cabinet and the whole "experimental production line" cycle starts again (see phase 6).

The above example shows the flexibility of a true modular UPS. In this example, we have seen a simple, cost effective:

- Increase in system capacity
- Conversion from a TCO priority to an availability priority design
- Relocation to new premises
- Reduction in system capacity and conversion back to a TCO priority design

Inbuilt intelligence for true flexibility

The example above needed the pharmaceutical company to make decisions and take physical actions to adapt the system to the changing needs of the site/critical load.
In most cases this is perfectly acceptable, however, there may be occasions when it would be beneficial if the system itself were intelligent enough to make decisions and take automated actions to maximise system availability or minimise TCO.
Of course, such decision-making capability must be user configurable to ensure that the system operator retains ultimate system control, but such inbuilt intelligence will further enhance system flexibility.

Modular systems with modules that have the inbuilt intelligence to be parallel redundant (e.g. N+1) when the size of the load means they can be; or parallel capacity (i.e. N+0) when they need to be, enable automatic, real-time flexibility and ensure that the critical load is always supplied with the highest level of protection possible. This capability automatically maximises system availability.

Reduction of power consumption

Similarly, modular systems with modules that have the inbuilt intelligence to use only the required number of UPS modules necessary to supply power to the critical load by putting "excess" modules into a "sleep mode" enable the system to automatically operate as efficiently as it can whilst ensuring that the critical load continues to receive the required level of protection.

If the critical load increases, a "sleeping" module will automatically be returned to full service and if the critical load decreases further then another module will automatically be sent to "sleep". This capability automatically optimises system TCO.

Conclusion

With industrial power protection systems having a design life of >20 years, one of the greatest challenges faced by system designers is how to future-proof their design by enabling it to adapt to the potentially changing needs of the site and/or critical load.
Rack-mounted modular UPS systems can be quickly and easily reconfigured to allow the power protection system to adapt to site/critical load changes and can prioritise either highest availability or lowest TCO depending upon the prevailing needs of the site/critical load.
Rack-mounted UPS modules with user configurable inbuilt intelligence will automatically further enhance system flexibility without removing ultimate control from the system operator.
The next, and final, article in the "ilities" series will discuss "maintainability" and how selecting the right UPS topology will reduce servicing costs, minimise "local" spare parts holdings and enable rapid "first line" fault rectification, all of which will ultimately maximise system availability and minimise total cost of ownership. □

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Photo: © Oleksandr Ananyev

Photo: © Anatoly Sribny

The rear cabinet series has a 48 V / 216 kW telecommunications system with TEBECHOP 13500 modules consisting of module cabinets, mains supply fields as well as battery and load output fields, including a monitoring system. The front contains the battery system, along with battery connection boxes.

Photo: © Oleksandr Ananyev

Power supply systems and services for the Ukrainian telephone network

BENNING Ukraine has been supplying the Ukrainian telecommunications market with high-efficiency power supplies for energy-saving, reliable operation for over twenty years.

At the beginning of the new millennium, there was a surge in development in the telecommunications market in Ukraine, attributable to the economic progress of the country. This was also reflected in high demand for uninterruptible power supplies for setting up network infrastructures. Despite the high competition in that market sector, many high-profile Ukrainian telecommunication operators chose products and services from BENNING. At that stage, the company had already accrued ten years' experience in the Ukrainian market and nurtured trust from a large number of customers with its bespoke product solutions, high standards of quality and reliable support.

Over 500 DC systems for Vodafone

Vodafone, one of the largest telecommunications network providers in Ukraine, also uses know-how from BENNING for power supplies for 3G and 4G telecommunications systems. The positive experiences since the start of the collaboration have served to underpin the good relationship that continues to exist between the two companies. Since 2005, Vodafone Ukraine has received more than 500 DC systems with associated distribution systems. These conform to the relevant international and regional standards and are perfectly tailored to the strict individual requirements of the Ukrainian telecommunications system, which repeatedly experiences network outages, especially outside major cities.

Virtually all the regions of the Ukrainian Vodafone network are now equipped with BENNING telecommunications power supplies – and Vodafone Ukraine is currently using BENNING solutions for new mobile cell sites that are to be erected. The power supplies delivered are based on SLIMLINE, TEBECHOP 12000 and TEBECHOP 13500 SE series rectifiers. →

... Turnkey Service

Proactive Service – Technical On-Site Service

BENNING power supply system for telecommunication applications

High-efficiency power supplies

BENNING has delivered battery-powered AC and DC power supplies to many mobile phone and landline operators around the world for decades. In recent years, it has made particular investments in the development of high-efficiency power supplies for energy-saving, reliable operation. The latest circuit topologies and state-of-the-art electrical components support a very compact and reliable design of system.

Rectifier series TEBECHOP 13500 SE, 48 V - 250 A (300 A)

INVERTRONIC compact, modular, single phase inverters – 19" Sub-rack with 5 inverters

Power capacities up to several hundred kilowatts are covered, depending on customer requirements and purpose. The modular technology of the power supply systems also provides customers with a quick and easy option for capacity scalability (pay as you grow).

Furthermore, each of the systems has an individually developed DC distribution unit, an online monitoring system (TCP-IP and SNMP protocol), as well as a temperature compensation system for gentler charging of batteries.

Largest system in the Ukraine

The telecommunications system in Kharkiv, a large city in the east of Ukraine, is not only the biggest one in the country with a capacity of 48 V and 14,000 A, it is also one of the biggest in the whole of Europe. It consists of TEBECHOP 13500 rectifier modules, TEBEVERT DSP power inverter modules and four distribution cabinets. These are responsible for the power supply to the entire 3G and 4G network and include both an on-board control system and extensive monitoring and diagnostic functions (remote monitoring) for preventative early detection.

Individual turnkey services

However, central to the service portfolio provided for Vodafone Ukraine are not only product solutions, but also various individual turnkey services. In addition to the development, manufacture, installation and start-up of the systems, this also includes service and maintenance work, as well as training for Vodafone Ukraine service technicians. As BENNING has highly qualified personnel and technical resources, it is in a position to respond quickly at any time to requests from customers from a wide range of sectors and to offer bespoke solutions.

Vodafone Ukraine requires optimum technical solutions and services, and not only for 48 V DC power supplies. As BENNING Elektrotechnik und Elektronik GmbH & Co. KG has developed the state-of-the-art ENERTRONIC Modular SE UPS system, the cooperation will be intensified even further. The new high-tech product was unveiled in Ukraine at Elcom Ukraine 2017, an international trade fair for power engineering, electrical engineering, energy efficiency and automation. □

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Highly efficient, fast-charging module for electric vehicles

With the BELATRON modular series, BENNING provides equipment suppliers and operators of EV charging stations with high-performance charging modules and systems which combine the highest level of system availability with maximum cost-efficiency.

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Photo: © Scharfsinn/Shutterstock.com

The German automotive industry is going to invest around 40 billion euros in e-mobility by 2020. This should make the use of electric vehicles a key feature of a smart, resource-friendly urban lifestyle.

There is a clear need for optimisation, especially with regard to the charging infrastructure. According to a recent study, about 25 percent of all potential car buyers are concerned about not finding an e-charging station in the vicinity if needed.

In particular, the idea of experiencing this on the way to work or on holiday, was unwelcome. Consequently, the installation of fast-charging systems will be the high-priority task in the near future.

The challenge is to design the interfaces between electric vehicles, charging devices and power grids as open systems. This would enable a wide variety of companies to collaborate and jointly develop product modules for a common platform.

A key component in this context is the newly developed BENNING HPC rapid charging module the BELATRON modular. POWER news took the opportunity to discuss this with Reinhard Erfen, Key Account Manager of the E-Mobility Division at BENNING.

Block diagram: combination of rectifier and DC/DC converter in the 19" module (87.5 kW) of the BELATRON modular

PN: Mr. Erfen, could you briefly explain what makes the new BELATRON modular fast charging module stand out?

Erfen: With pleasure. BELATRON modular is a highly efficient modular system for effective installation of DC charging stations.

The three-phase fast charging modules can be flexibly combined and are suitable for charging a wide variety of vehicle types such as cars, trucks and buses.

With the different configurable power ratings (e. g. 150 kW or 350 kW), vehicles with both 400 V and 800 V batteries can be charged efficiently.

19" module (87.5 kW)

PN: Before going into more detail, can you please explain to our readers what are the most important benefits of this new range of devices?

Erfen: Each 87.5 kW module has freely configurable interfaces and is therefore an ideal building block for the installation of charging systems at fuel stations and motorway service areas, for example. The modules are therefore aimed, in particular, at companies that plan and install the charging infrastructures. By opting for charging modules of the BELATRON modular series, they will provide future e-filling station operators with tailored configurations that combine maximum system availability with extremely efficient operation.

PN: With this equipment range, BENNING is entering a completely new market segment. That's a major risk for the company and its potential customers, isn't it?

Erfen: We do not see it that way. For more than 80 years, BENNING products have improved safety and efficiency and contributed to better utilisation of energy resources. Ever since it began, the company has been producing smart solutions for the conversion of electricity into multi-purpose or storable energy. Today, BENNING is known worldwide as a 'quality leader' for reliable smart-efficiency AC and DC power supplies for the telecommunications, power plant technology, medical and IT industries. →

BELATRON modular system cabinet 350 kW / 875 VDC

And it's not really a new market segment for us. BENNING has been supplying chargers for forklift trucks for almost 50 years now. The name BELATRON is synonymous with high-quality, robust and highly efficient charging systems for lead and lithium batteries.

PN: At whom is the newly developed product aimed?

Erfen: With the BELATRON modular series, BENNING is providing equipment suppliers and operators of EV charging stations with high-performance charging modules and systems that are specifically tailored to the extremely high requirements of fast-charging operation. In addition to the cost-efficiency, these also offer maximum operational safety, reliability, energy efficiency as well as easily configurable User Space at the installation site.

Plug & play technology ensures quick and easy exchange of modules

PN: You have mentioned cost-efficiency as a key feature. This becomes evident when you consider the system total operating costs. These include, among other things, the investment costs, the energy costs as well as maintenance and service costs. How does the BELATRON modular meet these requirements exactly?

Erfen: Each 19" power module is standalone and highly efficient. Due to the highest module efficiency of 97% the ongoing operating costs are minimised without compromising the voltage quality.

The power module components consist of a redundant control unit, a three-phase rectifier and a DC/DC converter. Rectifiers and converters are implemented in a 3-level IGBT technology, ensuring low power input distortion and active power factor correction at all times. While the harmonic content of the mains power consumption (THDi) is 3%, the input current is sinusoidal with cos φ of nearly 1.

PN: The module is offered not only as a stand-alone unit, but also as an integrated system in a cabinet housing. To what extent does the system design you develop affect the costs of rented areas or new buildings where the relevant equipment is installed?

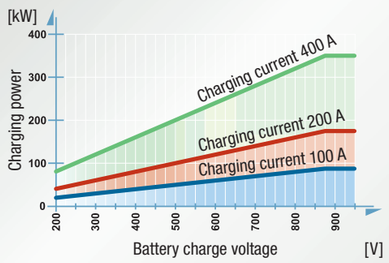
Erfen: The charging system has an output of approx. 729 kW/m². Since the air flow is discharged through the system roof, its installation is extremely space-saving. The systems can be easily placed 'back to back' on a wall or in a corner.

Optionally, a rear ventilation system can be integrated. These possibilities ensure a high degree of flexibility and save a lot of space, which in turn leads to a reduction in costs in terms of rented areas or building investments, for example.

PN: The goal is to achieve a fast charging time of approx. 20 minutes for electric vehicles, which is still relatively long as compared to the refuelling process with conventional fuels. It is the top-priority task of the operator of an EV filling station to ensure that all EV charging stations are available for operation on a permanent basis. How do you meet this requirement for maximum product availability?

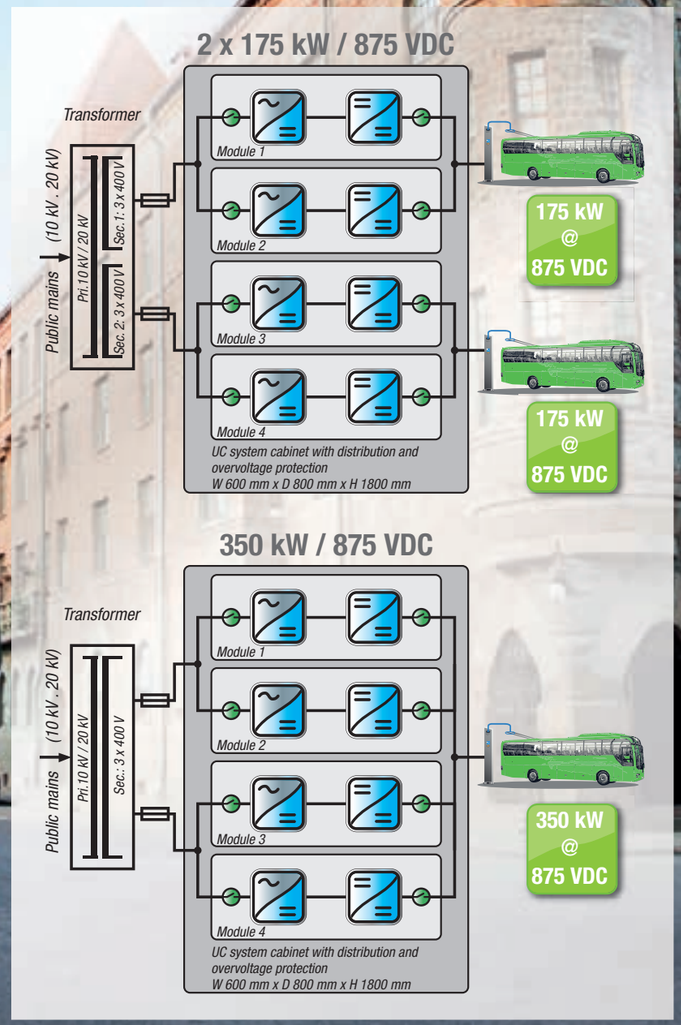
Erfen: In the new BELATRON modular series, BENNING combines the advantages of maximum reliability and shortest repair times (MTTR) in a product that meets the highest requirements regarding the availability and quality of a safe and reliable power supply of EV charging systems.
By using high-quality components and their generous performance rating in the critical path, the design of the BELATRON modular system is optimally adapted to the harsh conditions of rapid charging with high currents and voltages.

Charging power characteristics



The characteristics show the linear change of the charging power in relation to the battery charging voltage at different charging currents of 100 A, 200 A and 400 A.

Photo: © Scharfsinn/Shutterstock.com



The block diagrams demonstrate how to use the 87.5 kW modules as a basis to configure different DC charging systems

PN: You mention short repair times. Could you briefly explain how these are achieved?

Erfen: The modular component concept is the basis for a significant reduction in installation and assembly times as well as for more user-friendly and efficient maintenance activities in subsequent operation. All settings and service work can be configured and undertaken from the front.
The 'hot swap' capability allows each module to be replaced in less than ten minutes which equates to a maximum availability of 99.9999%.

PN: You mention quick replacement on site. Is the technical support provided for a large number of scattered locations not a critical factor?

Erfen: BENNING has always invested a great deal of effort in maintaining the highest service standards for its customers. Our customers value the reliable, globally oriented service structure that provides the best possible support for their respective requirements.

In anticipation of future requirements, the service department has been greatly expanded over the past few years. We are talking about Service 4.0 which is offered as a proactive 360° service.

BENNING 360° services encompass reliable maintenance and spare parts management, with individual service contracts, which help safeguard the business and production processes of our customers, as well as prevent potential downtime and ensure long-term cost-efficiency. Thus, our customers are well prepared for the challenges of today and the opportunities of tomorrow.

PN: Mr. Erfen, thank you for the detailed and very interesting conversation. □

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Built to last for a power plant's lifetime

BENNING contracted to supply UPS systems to one of the UK's largest and most energy-efficient fired coal power stations.

Uniper's power station in Ratcliffe-on-Soar is a 2,000MW coal-fired power station, which can meet the electricity needs of approximately two million homes. Commissioned in 1970, the power station has four coal-fired boilers made by Babcock & Wilcox, each of which drives a 500-megawatt (MW) Parsons generator set.
In addition to the plant's enormous capacity, it is also the first power station in the UK to be fitted with Selective Catalytic Reduction technology (SCR), which reduces the emissions of nitrogen oxides through the injection of ammonia directly into the flue gas.

In April 2016, Ratcliffe Power Station's lead electrical engineer contacted BENNING to enquire about a small inverter system. When visiting the site, it became clear that the plant's UPS systems for 'Critical Supplies' required an upgrade.

BENNING was identified as the right partner for this project because of its specialisation in providing robust, industrial-scale modular power solutions.

In contrast to power solutions for the commercial sector, BENNING's industrial grade solutions achieve a prolonged lifetime and higher availability by over-specifying components and developing hardware that is designed to withstand the harsh conditions faced in the environment of industrial-scale applications such as dust, temperature changes or water ingress.

Ratcliffe Power Station appointed BENNING for two contracts and some additional systems:

- The first contract was to replace the old station and coal battery charger systems / rectifiers which support critical power plant systems. The new systems were to include additional capacity and be relocated within the building.
- The second contract was to replace the existing site instrument, computer, measuring, recording and regulating device UPS / inverter/converter systems with a set of modular UPS systems.
- In addition, BENNING won orders to replace multiple smaller emergency lighting systems with modular UPS system designs.

For both large projects, BENNING proposed new redundant systems, incorporating efficient and digitally controlled solutions, which provide a high level of availability, whilst minimising risk and cost in maintaining the equipment.

Project one - 'critical supplies' upgrade

It is crucial for power plants to have back up power systems in place that can start and control their operation if the mains supply is interrupted.
To achieve this most effectively, BENNING designed two rectifier/charger systems for the site's critical supplies. Accordingly, two 1000A, 240VDC station charger systems (A+B) were supplied and installed in the power station and one 400A, 240VDC charger system is installed in the coal plant. The coal plant charger/rectifier, which feeds batteries within the coal plant area of the power station, has a future capability of 400A at 240VAC, which was de-rated at delivery to 200A to match the incoming AC supply. All three systems were designed to use an identical voltage so that they can be coupled if needed during maintenance or in emergency situations, increasing the power plant's high availability level. →

UPS subsystem for instrumentation

... advantages thanks to modularity

Easy module swap due to hot plug technology and automatic module configuration

ENERTRONIC modular SE 40 kW module, developed for the most demanding requirements

The two 1000A, 240VDC station chargers provide the power station with a fully redundant N+N system (A+B), which ensures a high level of availability. The systems, which needed to be positioned in a new location within the building, were not only designed but also manufactured, installed and commissioned by BENNING. One challenge was to correctly position the systems over the cable tunnels, however, the team took all client specifics into consideration, ensuring that the systems were perfectly levelled, aligned and positioned over the cable tunnels in their new location.

Project two - UPS & inverter systems

Following the success of the first "critical supplies" upgrade program contract, BENNING was asked to take part in the bidding process for replacing 13 separate UPS/inverter systems across the entire Ratcliffe-on-Soar site. Most systems were at the end of their life and an appropriate, future-proof replacement needed to be found. During survey visits with Uniper's team, BENNING were able to assess the exact requirements of the site and gain an appreciation of the level of criticality involved. Closely working with the lead engineer throughout, BENNING recommended a modular approach for the new systems. This modular approach is well-established in the commercial sector, when looking at smaller scale data centre UPS systems, for example. However, its advantages have not found their way into industrial environments yet, as these environments require longer UPS lifetimes, greater installed system complexity, and rugged system hardware.
BENNING is the only manufacturer to meet these unique industrial requirements whilst providing a highly functional modular system architecture. Rather than a monobloc system, the UPS is built out of smaller units, or modules, which can simply be added or removed from the larger UPS chassis unit, which has no single point of failure.

Key benefits of BENNING's suggested modular system are:

- Increased availability: Units can be easily added or replaced, as none represent a single point of failure
- Reduced MTTR: It only takes a few minutes to remove or swap modules, all of which can be done whilst the overall system is online and running
- Simple spare holding: Due to their small size, UPS modules can be easily lifted and carried by one person, while spare modules can be stored to facilitate quick replacements
- Modules interchangeable with other systems: Modules can be swapped between systems and spare parts can be kept to a minimum due to their interchangeability
- Expandability and flexibility: The UPS system can grow with power requirements, as modules can simply be added to achieve a higher capacity, giving operators a great deal of flexibility
- UPS black start function allows station to initiate a recovery procedure following an extensive loss of supply

According to Uniper's Lead Engineer Christopher Howe, "BENNING were the only industrial supplier of such modular technology, and this coupled with the flexibility of a modular system, led to the decision to employ BENNING as the partner of choice to deliver this project." According to the loads these supported, these systems were:

- 1 x Station Instrument UPS 30kVA N+N system with N+1 on each side and dual battery strings
- 1 x Coal Plant UPS 20kVA N+1 using station battery set
- 1 x FDG UPS 7.5kVA n+1 using dual battery strings
- 1 x Communications UPS 7.5kVA N+1 using three battery strings
- 1 x IT infrastructure UPS 25kVA N+1 using single battery strings
- 4 x Instrumentation UPS 20kVA using station battery sets
- 4 x Computer UPS 20kVA using battery sets

The fully installed and commissioned station UPS system comprises a dual redundant ENERTRONIC modular SE UPS range, which is a modular, transformerless three-phase output UPS system based on IGBT/MOSFET semiconductor and DSP processor technology. It has been designed to provide the highest level of protected power availability for critical loads within the utilities, oil, gas, transport and other high-demand industries. As previously introduced, the truly modular design means that each ENERTRONIC module contains its own rectifier, inverter, controller and static bypass switch, ensuring that there is no single point of failure within the UPS system. This, coupled with a modular, hot-swappable design ensures a high system MTBF and low MTTR. A manual bypass switch is provided for maintenance purposes. The provided system also included 2 x100% rated 12-15 Year design life VRLA batteries.
Low input harmonic distortion and high efficiency, even at partial load, significantly reduce running costs and environmental impact, while modular design allows for rapid repair and pay as you grow system scalability through the installation of additional parallel connected modules.

BENNING completed the positioning, installation and SAT/commissioning of all of the remaining UPS systems within the completion target of November 2017. ◻

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Energy Technology List Certification for the ENERTRONIC modular SE

The modular UPS systems in the ENERTRONIC modular SE range developed by BENNING have received a commendation for their particularly high energy efficiency.

"We are proud to be included in the ETL. This is evidence that we offer our customers highly efficient product solutions that contribute to a reduction of ongoing operating costs and lower CO_2 emissions."

David Whitlow, Managing Director
BENNING UK

For more than 80 years, BENNING products have stood for maximum security, efficiency and optimised resource utilisation.

The company has now received a special commendation for its efforts – the inclusion of the ENERTRONIC modular SE UPS systems in the Energy Technology List (ETL) for Enhanced Capital Allowances (ECA). This is official confirmation of the particularly high energy efficiency of this BENNING UPS range.

ENERTRONIC modular SE, 40 kW Module IT Series

The ETL certificate has been awarded by Carbon Trust, an organisation founded by the British government for the reduction of greenhouse gases.

The ECA system supports companies in investing in energy-efficient equipment and machinery which allows them to receive financial benefits. Tax exemptions enable the total cost of the new asset or machine to be offset against the taxable profit for the full financial year in which the purchase was made.

Maximum Energy Efficiency

The energy optimisation mode, selectable and configurable by the user, automatically minimises the total cost of ownership (TCO) while maximising system availability.

An intelligent algorithm determines the number of modules required for safe operation and switches all other modules to hibernation mode. System efficiency is maximised by making the latter available only when they are really needed, e.g. when there is a load increase. Therefore, the system has the capability to automatically maintain the highest system availability, while ensuring the lowest operating costs.

Combined with the repair and maintenance benefits of true "hot swap" modularity, through which a whole UPS module can be replaced in just a few minutes, this results in a UPS system with 99.9999% availability.

Minimising Operating Costs

Thanks to the "pay as you grow" scalability and very high operating efficiency, even at partial load, the actual operating costs of the ENERTRONIC modular series are kept to a minimum, without compromising on network quality. Every UPS module therefore represents a highly efficient, serial online UPS (VFI-SS-111).
The supply of the critical load via the rectifier and inverter of the ENERTRONIC modular SE also eliminates all voltage and frequency fluctuations of the national grid and thus secures the operation of loads sensitive to interference.

If maximum profitability and energy efficiency are of greater importance than the voltage and frequency quality, it is possible to operate in "Super Efficiency Mode". This allows the supply of the load to be achieved via the static bypass, as long as the voltage and/or frequency of the supplying network lie within the preset tolerance ranges.

As soon as one of these values leaves its range, automatic and uninterrupted switching into double conversion operation takes place. At the same time, the load receives complete protection against harmful network influences. ◻

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IABG certification for earthquake safety in the maximum danger zone

The UC-HE cabinet system specifically developed for use in seismic areas has been certified by Industrieanlagen-Betriebsgesellschaft mbH. This is testament to the excellent design work created on PC-based simulation technology.

An individual configurable UC-HE cabinet system by BENNING

The need to consider earthquake risks is almost everywhere. Currently, more than 2.7 billion people live in an earthquake-prone area. If you take a look at the earthquake zone map, you will see that many densely populated cities such as Los Angeles, Shanghai, Tokyo, Lima or Istanbul are located in seismogenic zones. In this case, we are talking about Category 4 hazard zones, based on US UBC standard classification. If a major earthquake occurs in one of these regions, it can cause severe damage to buildings, infrastructure or technical plant - affecting, among other things, transport, industry, healthcare system or energy supply.

On average, large earthquakes with a magnitude of 6.0 and higher occur about three times a week - nearly 100 earthquakes a year cause structural damage, according to recent statistics from the National Earthquake Information Centre (NEIC). This unpredictability makes it necessary to protect electrical equipment by using UPS systems for bridging any power outages and network failures, for example.

But how are the UPS and power plants protected against the impact of an earthquake?

Highest safety standards

The highest safety standards must be met, although a classification into different priority levels is also necessary. The failure of the telecommunications system, for example, poses a much lower risk than a blackout of the pump system that supplies the cooling circuits.

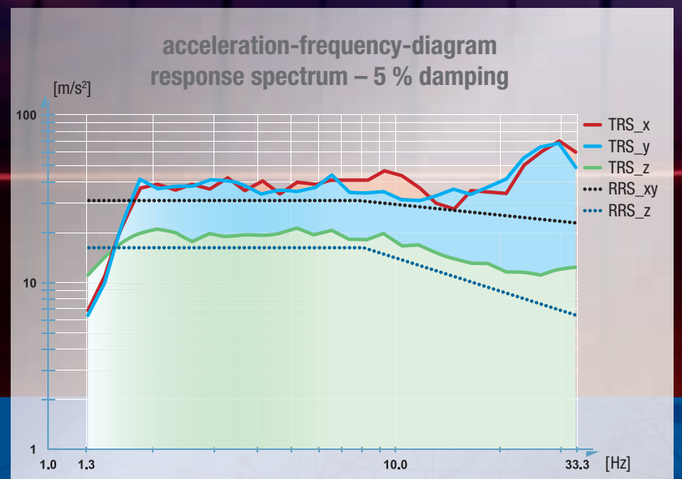
In order to meet the variety of high demands, BENNING has developed an individually configurable cabinet system that can be perfectly adapted to the different earthquake categories and safety requirements. It is available in the following versions: UC (Standard), UC-LE (Light Earthquake Resistant), UC-ME (Middle Earthquake Resistant) and UC-HE (Heavy Earthquake Resistant).

In comparison to conventional designs that seek to achieve the necessary earthquake resistance of housing through high rigidity, the new UC cabinet variants are characterised by a cutting-edge approach. This approach and the use of high strength steel allow a structure to perform well-defined movements without weakening the cabinet system. A construction method that has also found its way into the automotive sector, for example. →

... certified by IABG

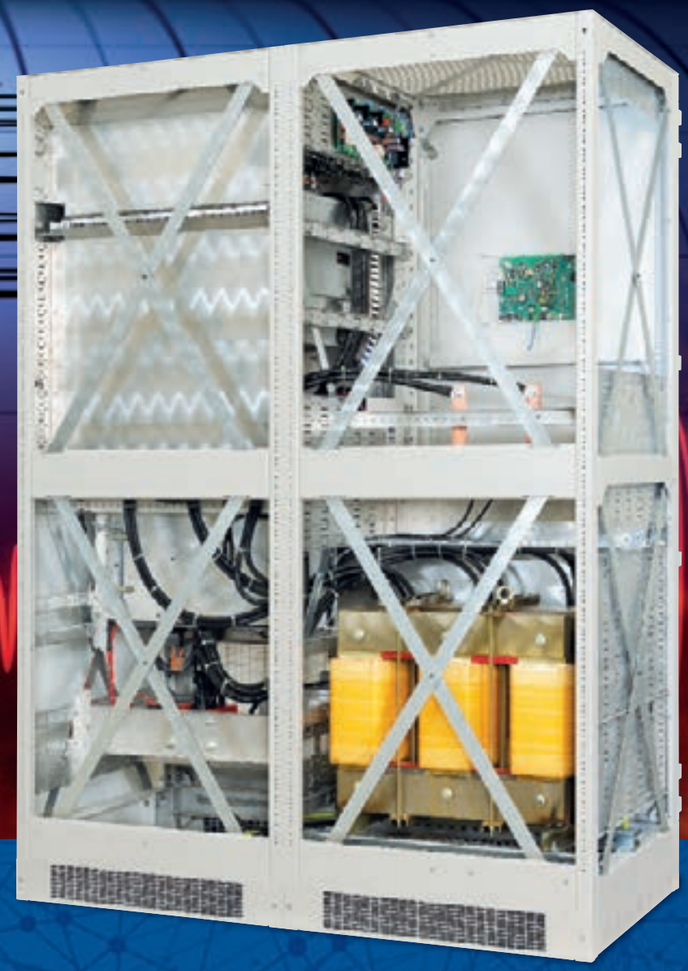
Photo: © IABG

Seismic verification, vibration test and certification by IABG



TRS = transmissed response spectrum (x-axis, y-axis, z-axis)
RRS = required response spectrum (xy-axis, z-axis)

Example construction earthquake cabinet UC-HE H 2200 x W 800 x D 800 mm



UPS-System ENERTRONIC I in seismic design UC-HE H 2200 x W 800 x D 800 mm

Specific simulation options

The cabinet system development process has also changed. The method used in the past was to first produce drawn constructions as test objects and then to expose them to extensive tests. If the expected assumptions were not confirmed, the engineers would repeat the process chain (Design > Construction > Tests) until the target was achieved.

An integral part of the state-of-the-art construction processes at BENNING, however, is computer-aided development with specific simulation options, which are carried out before the actual hardware tests. This makes the development process significantly shorter and more efficient.

BENNING has also developed a simulation tool which can determine the cabinet requirements prior to the construction stage in order to select a suitable cabinet.

Finite element method

Computer-aided simulations are used to check the load limits using structural and dynamic calculations based on the finite element method (FEM). This results in a standard-compliant analysis and calculation of the deformations or stresses of a cabinet frame during the construction. In addition, physical properties of the cabinet system can be visualised, and potential weaknesses can be precisely located for targeted optimisation measures.

Stringent requirements fulfilled

The construction of a test housing and the verification of the calculations in the company's own environmental laboratory do not take place until the simulation process has been successfully completed. Here, so-called vibrating tables are used, which mimic the vibrations and shock loads caused by an earthquake.
In addition to its own test results, BENNING has had the current UC-HE cabinet design certified by a recognised testing laboratory, the IABG (Industrieanlagen- Betriebsgesellschaft mbH), with the result that this construction exceeds all normative requirements in terms of earthquake resistance, even in the worst-case scenario.

Maximum cost-efficiency

Another decisive advantage arises from the fact that all four cabinet system versions developed by BENNING are based on the same design principle. Suppose, for example, that in earthquake zone 2, a rectifier system in UC-ME design is used to secure the telecommunications system. At the same time, the rectifier system, which supplies the pumps of the internal cooling circuit, ensures maximum safety and therefore chooses an housing certified to the highest earthquake categories for this area. In this way, both power supply systems used are provided with the optimal protection that complies with the cost-efficiency and safety requirements. On the other hand, this provides for easy and quick maintenance because the base frame of the cabinet construction as well as the arrangement of the power and functional elements are identical in both systems. The only thing which is different is the system casing, i.e. the enclosure. Due to this technical and functional analogy, a technician can find his/her way around a servicing task faster. This provides the highest level of safety with maximum cost-efficiency.

Seismic switchgear terminology

The damping characteristic of a switching device limits the overall gain that it experiences during resonance. Suppose, for example, that two cabinets are identical in design, assembly, and weight, but one cabinet has a welded structure and the other has a bolted structure. During an earthquake, the structural elements in the bolted housing move relative to each other, causing friction and noise, such that the seismic energy dissipates much faster than in the welded housing. The bolted cabinet will thus dampen the energy faster than the welded one, thus reducing the time required to build up seismic response. The damping properties of a system are indicative of the system's ability to dissipate earthquake energy. Without attenuation, the resonance gain of the equipment increases without resonance. The higher the attenuation factor of the device, the lower its response curves. ◻

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Photo © WSW Wuppertaler Stadtwerke GmbH.

Historical wheel set of the Kaiserwagen

Original design: Rotor and field coil from 1900

Data capture in BEM test bay

Reduction of headway

WSW Mobil GmbH aims to replace all 27 old vehicles with 31 new vehicles by spring 2019. These should achieve a higher average speed thereby reducing the rush hour headway from three to two minutes.

As in the case with the power increase, the requirements for the mains voltage have also changed: All new vehicles and the historic Kaiserwagen are no longer designed for a mains voltage of 600 V, but, rather, for 750 V DC.

Historical running gear, disassembled for data capture

New Drive Motors for historical Kaiserwagen

BENNING carried out a rotor-stator re-build on the historic Kaiserwagen of the Wuppertal suspension railway to ensure that it can continue to be used for round trips and festivities in the future.

The Wuppertal suspension railway is considered one of the longest engineering landmarks in the world. On the route of a 13.3-kilometre long railway system, it transports around 70,000 passengers a day through the capital of Bergisches Land. A special highlight is a ride in the nostalgic ambience of the historic Kaiserwagen. Kaiser Wilhelm II and his wife Auguste Viktoria made the inaugural trip through the Wupper Valley in 1900 - about two and a half years after the start of construction of the suspension railway.

To date, the Kaiserwagen has been preserved for posterity, surviving the two world wars as well as several generations of older cars. In addition to the regular transportation services, it is not only used for round trips, but also as a venue for birthdays, anniversaries or weddings, for example.
To ensure that 'the good parlour of Wuppertal', as the historic car is commonly called, is also available for rides and festivities in the future, it must be adapted to meet the increased mains voltage requirement of the new generation of cars.

Historically, the Kaiserwagen has been powered by four 25 kW series motors using 600 V DC, whilst the new 'Generation 15' vehicle series will only use 750 V DC mains voltage for the three-phase asynchronous motors, to allow a headway of only two minutes (see info box at top right).

Adaptation to the new operating system

To ensure that the engines of the Kaiserwagen can be adapted to the voltage requirements of the new operating system, a new rotor-stator configuration needed to be implemented. As part of the modernisation, this represents a particularly complex and costly process, which can only be professionally fulfilled by very few companies.
How and where does one start if no technical documents are available, only an outdated, albeit functional, sample frame, which was used back in 1900 to support the suspension railway?

A challenge facing the BENNING electrical machines (BeM) department, who developed and implemented the appropriate solution strategies using its technical know-how and extensive experience in the repair, construction and reconstruction of electric motors. The customer was WSW Mobil GmbH as the operator of the Wuppertal suspension railway.

Rotor-stator configuration

As part of the rotor-stator configuration, following successful assembly of the sample rack on BENNING's own test station, →

all relevant parameters could be recorded, which were possible on the basis of the large wheel/small wheel tooth calculations. This enabled the generation of the operating characteristics at a rated voltage of 600 V DC. This was followed by the coupling of the frame with a drive motor to ensure idle run by the use of a generator. The values measured were then used to re-design the drive motors at a rated voltage of 750 V DC.

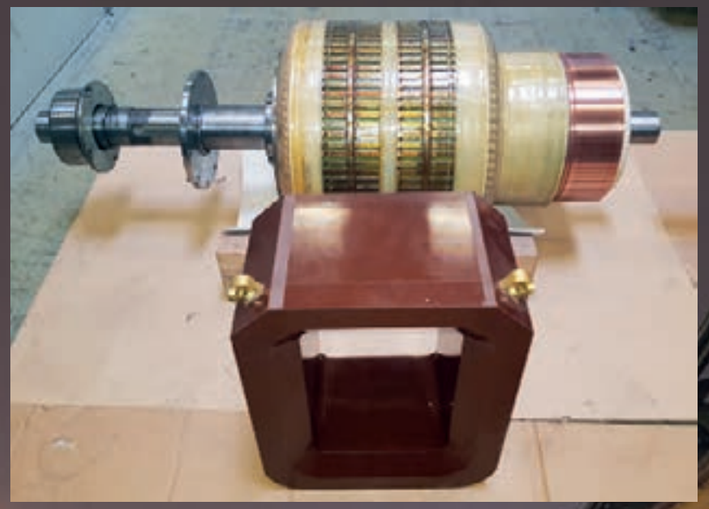
Disassembly of the windings

Following the disassembly of the DC motor, the stator and rotor windings were split into their individual components. The stator winding comprises two main pole coils, which were removed from the stator core and accurately measured. Both the number of windings and the conductor cross sections have been recorded and, among other things, used as a basis for the re-design of the operating voltage.

Particularly detailed measurements, especially with regard to the steel binding, had to be taken for the rotor winding. Made of magnetisable steel wire, this protects the rotor winding from centrifugal damage. It must be mounted with precisely the same number of windings and cross section on the modified rotor, which was newly constructed for the operating voltage of 750 V DC. Even slight deviations can lead to problems with the commutation, which would jeopardise faultless operation of the GL engine.
The rotor coils were removed from the rotor laminations and the key figures were recorded. Due to the increase in voltage an adjustment of the winding and cross-sectional ratios were required. In designing the rotor, the Mordey circuit was installed, which had to be mirrored with the new voltage ratio.

With a higher voltage one needs a higher number of windings and a smaller cross-section of the copper conductors. This means that the rotor lamination packet constructively requires more grooves and an adapted groove geometry while maintaining the groove, tooth head and frontal dispersion. The new collector was fitted with the necessary slats, adapted to the new rotor design.

After determining the dynamo sheet quality, a new rotor was produced, which was identical to the original one, but with a modified rotor core made of dynamo sheet of the original quality. In addition, there was a new collector with identical dimensions, but greater number of lamellae. The stator was left in its original condition for further use. The original version was retained to restore the same ratio in the GL engine. The main pole coils were produced with new conductor dimensions and new number of windings and then cast in a resin mould with the original dimensions and then installed in the stator.



Newly designed ready-to-install rotor, newly designed field coil in moulded resin

Mordey circuit, mirrored to the new mains voltage 750 V DC

Custom-made production of the new configuration for installation in the bogie – the new rotor and the new coil on the left, as compared to the removed historical design on the right

Rotor winding before vacuum impregnation with visible steel straps

Rotor coils with new geometry

The rotor coils had to be adapted to the new geometry and installed with the new conductor dimensions (including modified winding and switching step) in the rotor. The steel drum made of magnetizable steel wire was applied and soldered – the rotor was vacuum-impregnated with impregnating resin of the heat category H. The running surface of the rotor collector also had to be turned, milled and deburred.

Balancing was followed by the assembly of the GL engine and the testing of the neutral zone. The engine was tested in the test field, as in the case of the input measurement, however using 750 V DC. The load characteristics produced in that case proved to be approximately consistent with the original characteristics of the input measurement at 600 V DC. Thus, was documented that the GL engine at 750 V DC has the same output as before at 600 V DC.
Another quality criterion in this context is the spark-free motor operation on the collector, as well as the tests successfully carried out by the Association of Electrical Engineering, Electronics and Information Technology (VDE).

At the beginning of 2016, the GL engine for the rotor-stator configuration was delivered to BENNING. The bid was made in June 2016 and the final acceptance in April 2018.

Eleven cars already in operation

In addition to the modernisation of the historic Kaiserwagen, eleven vehicles of the 1970 series have already been replaced (as of May 2018) by the cars of the new model series.

According to estimates by the WSW, the replacement of all 31 cars is expected to be completed in the spring of 2019. Only then is it possible to change the operating system of the suspension railway to a higher power and to implement the expected headway of two minutes. ◻

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Increased safety for one of the world's largest underground networks

With a combination of individual product solutions and engineering services, BENNING contributes to making New York's rail traffic safer and more efficient.

Slim Power System with 3000 HD Rectifier (9kW @ 48V DC) and HDi DC Converters (3kW @ 24V DC) for installation into restricted space locations for Public Safety Radio Systems

With more than seven million journeys per day, New York City operates the largest public transport infrastructure in the USA. The Metro, one of the world's largest rapid transit systems, plays a decisive role in this. With its 472 stations, 36 train lines, and 1370 kilometres (850 miles) long rail system, it makes up a large part of the urban transportation network. It also includes a rapid transit line in the city district of Staten Island and a bus network.

Security of operational activities

The main task of the public transportation authority is to ensure safe and trouble-free movement of people throughout the city 24 hours a day. Therefore, the complex transportation infrastructure has to be permanently monitored for schedule, security and maintenance.
An essential prerequisite for this is the continuous functioning of their communication system over different networks. It enables monitoring, control and coordination of the entire railway system. Here, current traffic movements and technical systems along the route are monitored for their function, passengers are notified of operating delays, stations are monitored for safety and the railway staff are provided with vital, real time data (e. g. with regard to the rail condition). This results in a constant exchange of information, whose continuous operation has the highest priority.
The following functions are supported system-wide: public address (PA) system consisting of microphones, speakers and amplifiers; customer information systems and signs; a bus and police radio network and CCTV video surveillance systems all being carried over their ATM (Asynchronous Transfer Mode) and SONET (Synchronous Optical Network) fiber optic network. When combined together, this results in a very complex and sensitive system that requires maximum security and critical availability.
If a complete, or even partial, power outage occurs, e. g. due to a network failure, this can not only have a catastrophic impact on operational processes, but, in the worst-case scenario, also the potential safety of passengers and railway personnel. To avoid this worse-case scenario, highly available and reliable power supplies to support the system are essential. These have to work continuously in a highly demanding harsh environment, but must also be designed to meet the specific and bespoke requirements of the public transportation services.

Multi-Cabinet Power System with 3000 HD Rectifiers (672A @ 48V DC) and three independent DSP Inverters (12.5kVA @ 120VAC each) providing backup to the Fiber Network, CCTV, and PA Systems.

Exchange of knowledge

Searching for a partner who would provide both, tailored product solutions and the associated engineering expertise, the cooperation with BENNING was formed approximately ten years ago. Engineers and designers of both companies are in constant contact to bring their ideas, requirements and solutions together and coordinate them in the most effective solutions.
BENNING received its first order in 2005 for the installation of Phase II of the ATM network for a large portion of the subway system. Since completion of the ATM project, a large number of projects have been deployed throughout their rail network, in cooperation with the client's development and design teams.
BENNING power systems are currently in use at more than 600 different locations throughout New York city – including reliable power systems for the bus and police radio networks. The following product families have been deployed in the power systems: the TEBECHOP 3000 HD and SLIMLINE SE (48 V range) rectifiers, TEBECHOP 3000 HD converters, DSP and INVERTRONIC modular 3 Phase inverters, and UPS systems of the ENERTRONIC modular series.

Protection against heat and dust

The extremely harsh conditions near the subway tracks are a particular challenge. Many rooms in which the power supply systems are integrated have ambient temperatures of approx. 95 - 104 F° and a high concentration of corrosive steel dust resulting from the frequent braking of the trains. The systems produced and used by BENNING are designed in such a way that they can withstand these environmental challenges without any reduction in their functionality.

Furthermore, the height, width and weight of the systems require flexibility so that they can be adapted to the spatial requirements of the site installation. This means also that special methods of delivery, e. g. via a staircase or a manhole in the street, can be undertaken without any problems.

Further railway projects in the USA

The reputation that BENNING has earned in Ney York City has also paved the way for many other rail projects in the USA – for example in Philadelphia and Washington (see POWER news 9/2017).
Again, in these projects, the combination of customized product solutions and services (turnkey services, maintenance and repair) play a key role in ensuring the smooth and continuous operation of railway and communication systems, as well as making rail transport mobility considerably safer, more efficient and more modern. ◻

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BENNING

Fairs, events and exhibitions
2018

ENERGETAB
11/09 – 13/09 in Bielsko-Biala/Poland

InnoTrans
18/09 – 21/09 in Berlin/Germany

Petrochymia
19/09 – 20/09 in Martigues/France

GET Nord
22/11 – 24/11 in Hamburg/Germany

Electrical networks of Russia
04/12 – 07/12 in Moscow/Russia

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