

Green Power – Fit for the future



Connectivity: BELATRON charger 3–7



A facelift for run-of-river power plants 20–29



International HVDC connection 30–31

Editorial



Dear Reader,

the last few months have given the Earth's climate something of a breather. Emission levels have dropped, whilst previously smog-laden capital cities have become clearly visible once again on satellite images and fishes could be seen enjoying the crystal clear waters of the canals of Venice. Could this mean that one upshot of the pandemic is that it has given the environment a chance? At first glance, that might seem to be the case; but if we want to achieve a sustained effect, there needs to be a marked increase in the investments made in renewable power sources and energy-efficient systems.

The German Government's national climate protection targets are based on the objective outlined in the Paris Agreement: to limit the rise in the temperature of the Earth's atmosphere to an increase on the favourable side of 2°C. This will put us on the road to achieving greenhouse gas emission neutrality by the year 2050. A particular focus is placed on Industry, which is presented with a challenge inasmuch as it is accountable for a share of approximately 46% in the overall levels of consumption of electricity. Digitalisation and the systematic improvement of industrial efficiency in the use of energy are some of the possible means of saving electricity. Whilst efficiency has an important part to play in relation to individual items of industrial plant, we need to consider more than just efficiency if we are to achieve the optimum levels. To that end, we need to include the process cycles that feature most prominently in any given period of operation.

These requirements were incorporated into the development of the new generation of BELATRON chargers. These chargers provide the maximum of energy efficiency and digital connectivity. In this issue, you can read about the major advantages they provide for floor conveyor operators when it comes to saving energy and reducing the overheads for a floor conveyor fleet. You can also find out how sustainable infrastructure projects are boosted by BENNING. For example, in connection with a high-voltage DC connection between the European continent and Great Britain, the benefits of which will include the integration of sustainable energy sources into the European electricity grid. You can find out how the availability of modern interlock systems is ensured thanks to UPS systems which are designed specifically for the railways sector and the way in which run-of-the-river power stations generate sustainable energy with the aid of the products & services of BENNING.

I trust that it will all make enjoyable reading for you – meanwhile, stay safe!

Warmest Regards, Dietmar Papenfort

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The new generation of BELATRON chargers combine efficiency with connectivity

Thanks to process monitoring as the basis for smart energy management, a sustained reduction in the operating costs for a fleet of floor conveyors can be achieved.

Over the last few years, energy costs have grown into a significant component of companies' running costs in terms of production. Here, energy becomes a strategic resource with a significant influence on maintaining international competitiveness. By 2050, we need to have reduced our consumption of primary energy in Germany by 50% relative to the 2008 levels. This is where the German government has placed the objective of a marked increase in the efficiency achieved.

There is particular focus on Industry, which consumes a share of approximately 46% in the overall power consumption. That gives rise to an obligation to improve the whole system

of industrial energy efficiency. For example, in order to secure energy tax concessions, such as the "peak compensation" or a cap on the EEC subsidy, industrial companies have

to come up with proof of a certified environmental management system corresponding to EMAS or an ISO 50001 compliant EMS (energy management system).

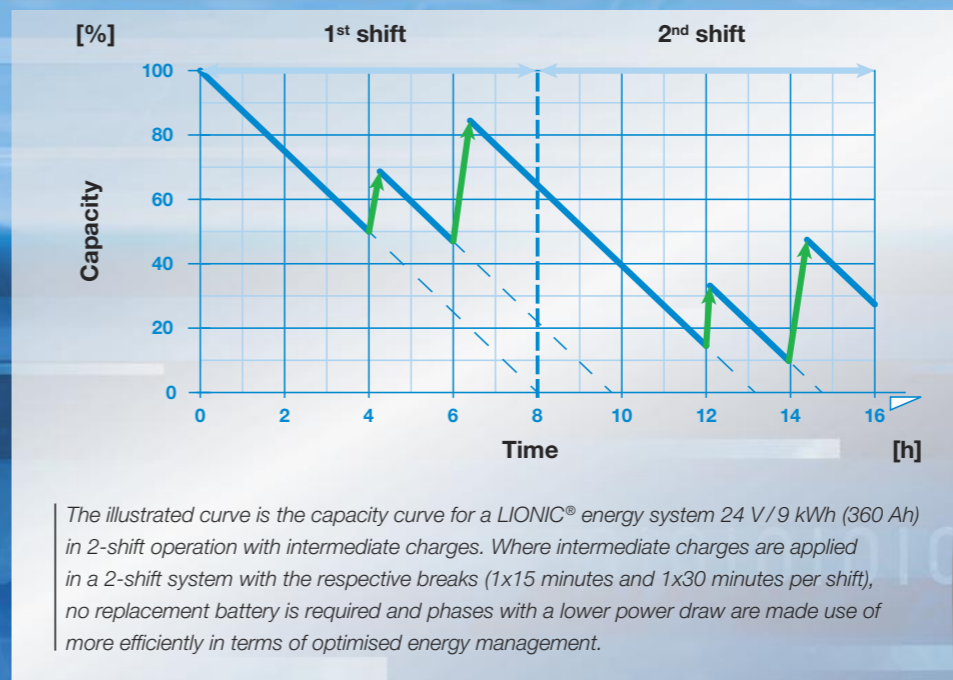
Attaining optimum efficiency

In many cases, companies do not even know where they are using disproportionately high amounts of energy. Consequently, they are generating additional expense unnecessarily. One important factor in assessing this is the level of energy efficiency of individual items of plant. Efficiency in scientific terms can be drawn upon as an indicator. What is harder to analyse is whether the process cycles which determine the operating periods of machines and →





Monitoring and reporting platform: BENNING traction portal, user-friendly interface for displaying a charging station's relevant operating parameters



BELATRON Li+ chargers in the WT 60 casing and the BELATRON WT 7 casing

Current charge values	Final charging values	Settings
LP01 - IPUIa Puls	Record 23	General settings
145 Ah charged	Charge start 11.01.11 01:11:11	Battery
SOC = 92 %	Charging time 08:59:59	History
	Charge stop 16.07.14 08:17:34	BATCOM
	Charging profile LP1 - IPUIa Puls	Service
	Charging temperature 27 C	Back
	Charging current 10.5 A	
	Charging voltage 2.79 V/Z	
	Charge capacity 462 Ah	
	Error no Error	

Status display optimised thanks to large touch screen

items of apparatus are making use of all of the possible scope for optimising efficiency. Consequently, an initial step must be to determine how much energy the company is consuming and at what topographical and chronological points. This is where we turn to energy monitoring. That means logging, monitoring and controlling the consumption figures. For this purpose, the widest range of types of data, such as the consumption of electricity, gas and water; and also the levels of atmospheric humidity and temperature, will be logged from sensors. On the analysis of the information thus obtained, consumption can be actively controlled with the benefit of reducing costs.

Avoiding load peaks

Load peaks or "maximum output levels" which are continuously measured, represent

a substantial component in the cost of electricity for corporate customers. In most cases: high loading peaks are expensive. A load management system based on the information from energy monitoring will continuously adapt itself to ongoing changes in consumption conditions. The extreme differences between high consumption and low consumption will be smoothed out by switching the relevant consumers on or off or just by reducing the power they are receiving. Accordingly, cost-intensive load peaks are avoided. Noticeable downturns in the costs for electrical power will be achieved.

Energy management software uses a range of smart technologies which focus on more than just saving electricity. Examples of their applications include:

- monitoring the consumption of electricity, gas and water

- identifying the main consumers
- reducing load peaks
- detecting faults, and revealing scope for modernisation – with a view to reducing failures and bringing down the costs of servicing.

Predefined standards for the most common applications or individually defined routines will help to achieve rapid, reliable and fault-free process control.

This will crucially depend on precise measurement and seamless logging of structured operating data, such as energy consumption, temperature and operating hours.

Relevance to intra-logistics

In the context of intra-logistics, the charging-up of your fleet of floor conveyors is one of

the most energy intensive concerns in the company. Accordingly, this is a problem area where the use of energy efficient products, products which can also be included in digital workflow processes and management systems, becomes essential. As highlighted by Peter Hoepfner, BENNING's distribution manager for traction, "The digitisation of processes and the Internet of Things (IoT) are increasingly highlighting the significance of connectivity and data exchange". He went on to say "Accordingly, our objective is not merely to supply energy-efficient products, but also to develop apparatus which makes it possible to exchange data in a straightforward, flexible way. For example, this will enable smart networking with energy-management systems. These objectives are fulfilled by our completely upgraded range of BELATRON chargers."

BELATRON chargers

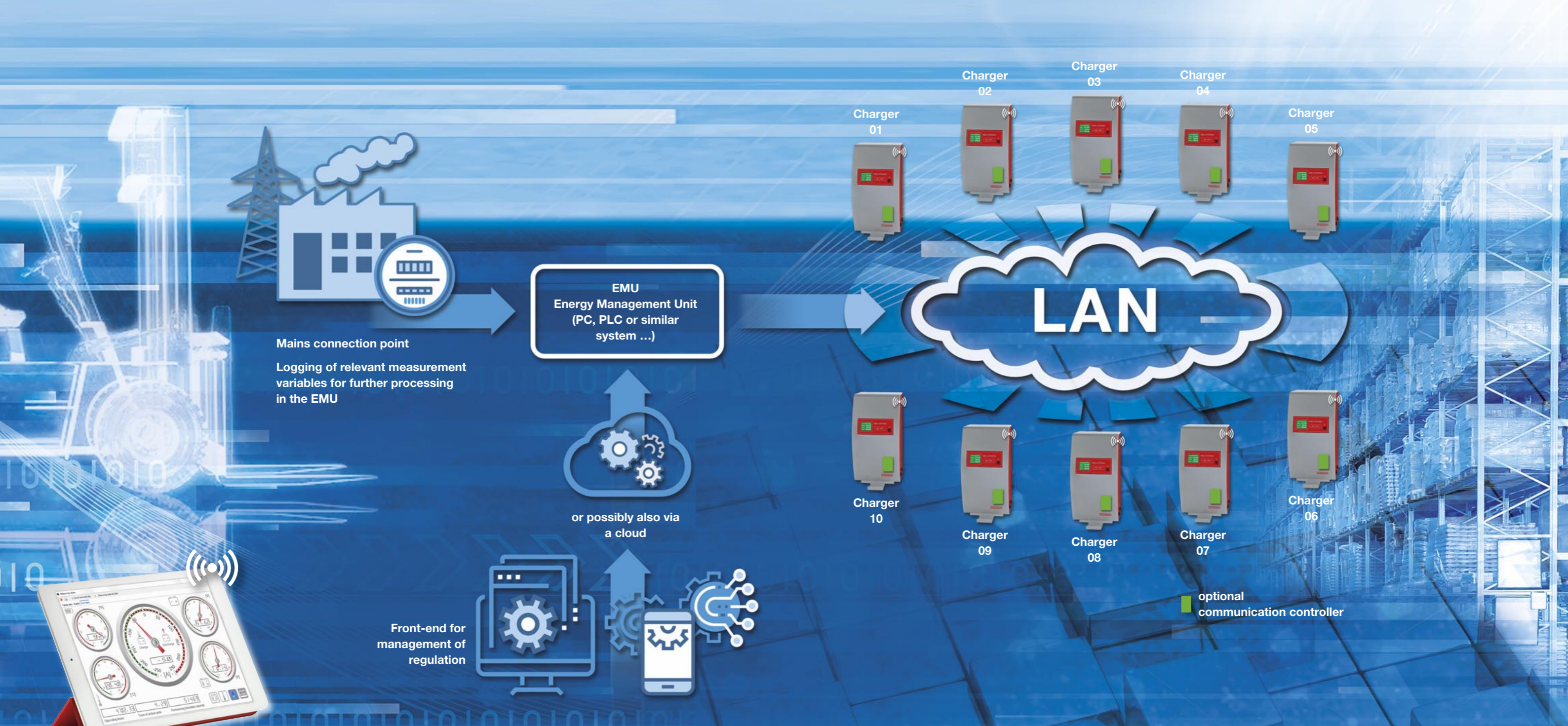
The BELATRON range is supported by the latest generation of future-oriented, energy-efficient charging technology. This equipment has been available as standard since April 2019, in the wake of completing an extensive phase of testing over a broad range of applications. Chargers of as much as 96 V and 300 A are available as standard.

The required grid connection capacity is minimised thanks to the achievement of as much as 96% efficiency together with a cos φ of up to ~1, and this in turn reduces investment, installation & operating costs. Thanks to the sinusoidal power draw and the satisfactory output power factor, there is no need for the reactive current compensation system to be expanded. →

"The value of BELATRON chargers – for our customers – is enhanced thanks to using digital communication solutions. The range of possible applications is expanded, giving rise to enhanced efficiency and extra cost savings."



Peter Hoepfner, Traction Distribution Manager, BENNING



The size of the casing has been almost halved, whilst retaining the same output power. Compact construction makes it possible to achieve a high density of installation in the smallest space. This reduces the space taken up in the charging station. A new addition is the multi-voltage function which makes it possible for the widest range of different batteries to be charged up with just one BELATRON. This ensures additional flexibility in the optimisation of charging processes.

User-friendly data exchange

A big plus point with the new generation of chargers is their high connectivity. Because the data from chargers and batteries can now be continuously transferred to an EMS, you have a clearer idea as to your entire bat-

tery pool's capacity, operating characteristics and condition in general. It's just this transparency which means that companies can operate their charging stations more efficiently and hence more cost-effectively.

Chargers can interact with each other using the option of an interface card, i.e. interfacing with energy management systems. In conjunction with the BATCOM digital+ battery controller, the communications interface provides comprehensive energy data, thus enabling seamless recording of power draw levels.

Important conclusions concerning the charging procedure's energy efficiency and the general condition of your batterie can be drawn thanks to visual display on the EMS. At any time, you can intervene in order to

optimise the situation. For example, choices include future control of charging, individually tailored to the respective battery and/or environmental situation. Processes such as "load shedding" (applied in order to avoid peak loading levels) can be automated in conjunction with LIONIC® lithium energy systems.

The logged charging data can be used as the basis for obtaining further important information, thus enabling early detection of possible defects in your battery.

Availability is maximised

Failures in the charging technology can quickly bring about negative repercussions on the availability of the floor conveyor fleet. Especially if you are not operating with interchangeable batteries. In the worst case, you

suffer production shutdown, because the required goods can no longer be transported. In that event, prompt intervention is absolutely essential. And this is where it helps to have modular technology with output electronics that can be swapped over on site. Accordingly, the MTTR can be kept as short as possible.

With modular-design BELATRON chargers, the system can continue to operate with the remaining modules if an output section fails. On-site service staff will be able to assign master functionality to a different output module. Accordingly, data communication and display to the outside world will still be assured.

Charging can continue, albeit at a reduced level, until the spares arrive.

Conclusion: Efficiency and prevention

At the present time, data reliability is crucial to all energy-technical processes. Reliability increases quality, saves on valuable resources and makes you more competitive. With an EMS, complicated consumer data can be displayed and analysed with a few control clicks. A given company's energy usage becomes transparent, and energy efficiency can be maximised.

But there are further benefits that will prompt a company to include chargers in their digital processes (further to the need to comply with energy-saving regulations, and further to the drive to reduce energy costs). As a rule, there is also the fact that preventive servicing can always be performed more favourably than remedial repairs.

The facility of a display and data availability with the new BELATRON chargers provides the following 2 benefits: (1) Optimisation of the energy consumption required in order to charge up motive power batteries and (2) Maximisation of their availability. Thanks to the fact that recommended preventive actions have been highlighted. ▣

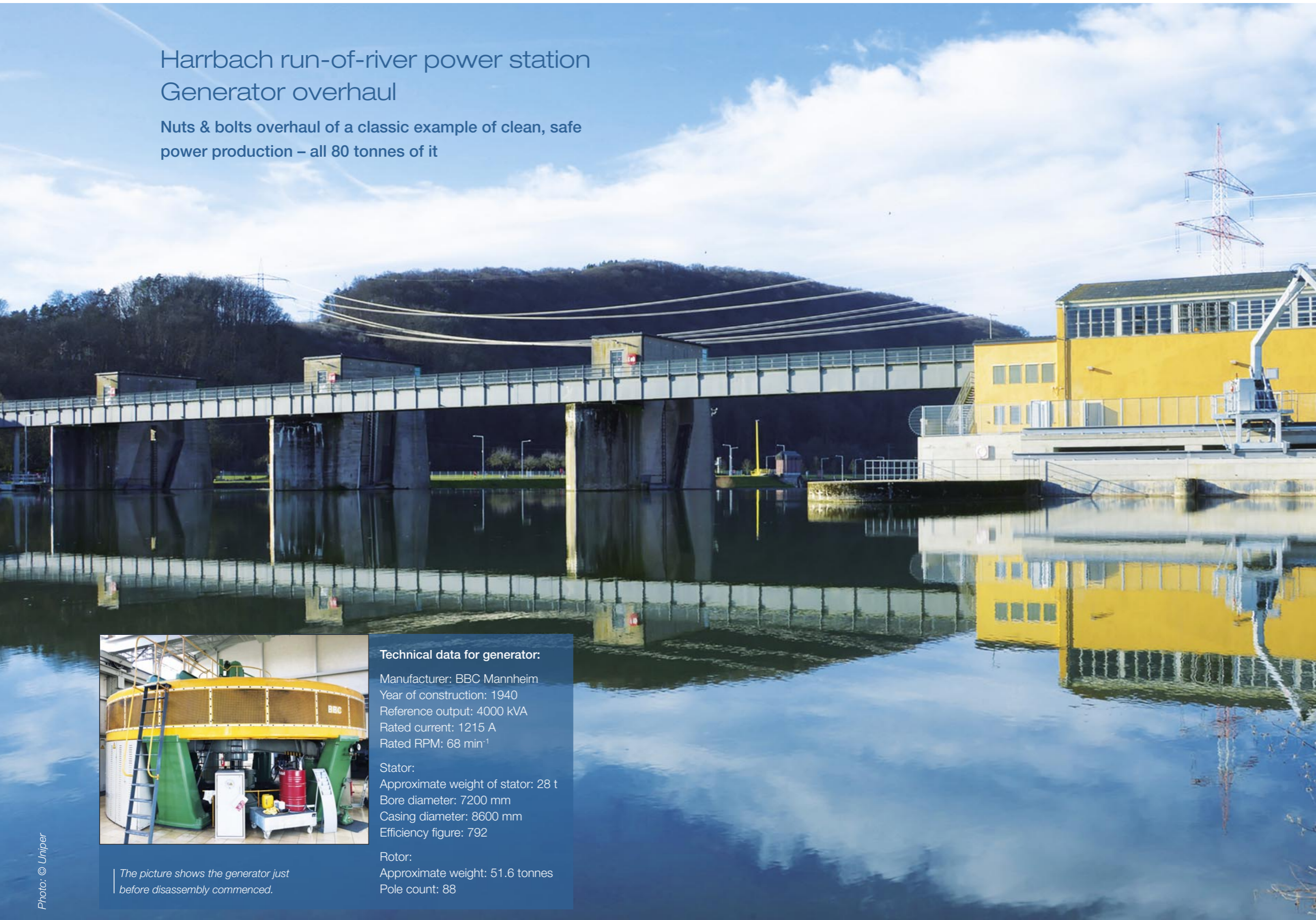
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Scan the QR code for further information

Harrbach run-of-river power station Generator overhaul

Nuts & bolts overhaul of a classic example of clean, safe power production – all 80 tonnes of it



Run-of-river power stations normally feature slow turning synchronous generators with salient pole rotors whereby the shaft is in a vertical arrangement directly above the turbines. “Slow runners” of this type frequently feature rotor diameters in excess of 20 m.

Over the last 120 years, the output available from salient pole machines has been multiplied, thanks to development, by more than 100. The largest machines today run at approximately 750–850 MVA output. In the 1st decades of the 20th century, however, it was the peak of engineering to succeed in achieving an approximate output of 6 MVA from any machine.

The category of umbrella-type alternators to some extent represents a variation of salient pole rotor systems. Generators of this type are only single-bearing, hence more economical to manufacture: the shaft supports not only the turbine rotor but also the generator rotor. Between the generator and the turbine, there is only a guide bearing, such that the construction resembles an umbrella.

In order to service or to repair plant of this size, where rotor diameters come to several metres, the whole system has to be dismantled. The weight and the diameters involved are so large as to preclude the possibility of transporting the whole plant in one.

Clean, safe power generation

Many German run-of-river power stations featured systems of this type and were in operation in the first half of the last century. They still stand as a classic form of sustainable energy sources and are still contributing to the production of clean and safe power generation. →



Technical data for generator:

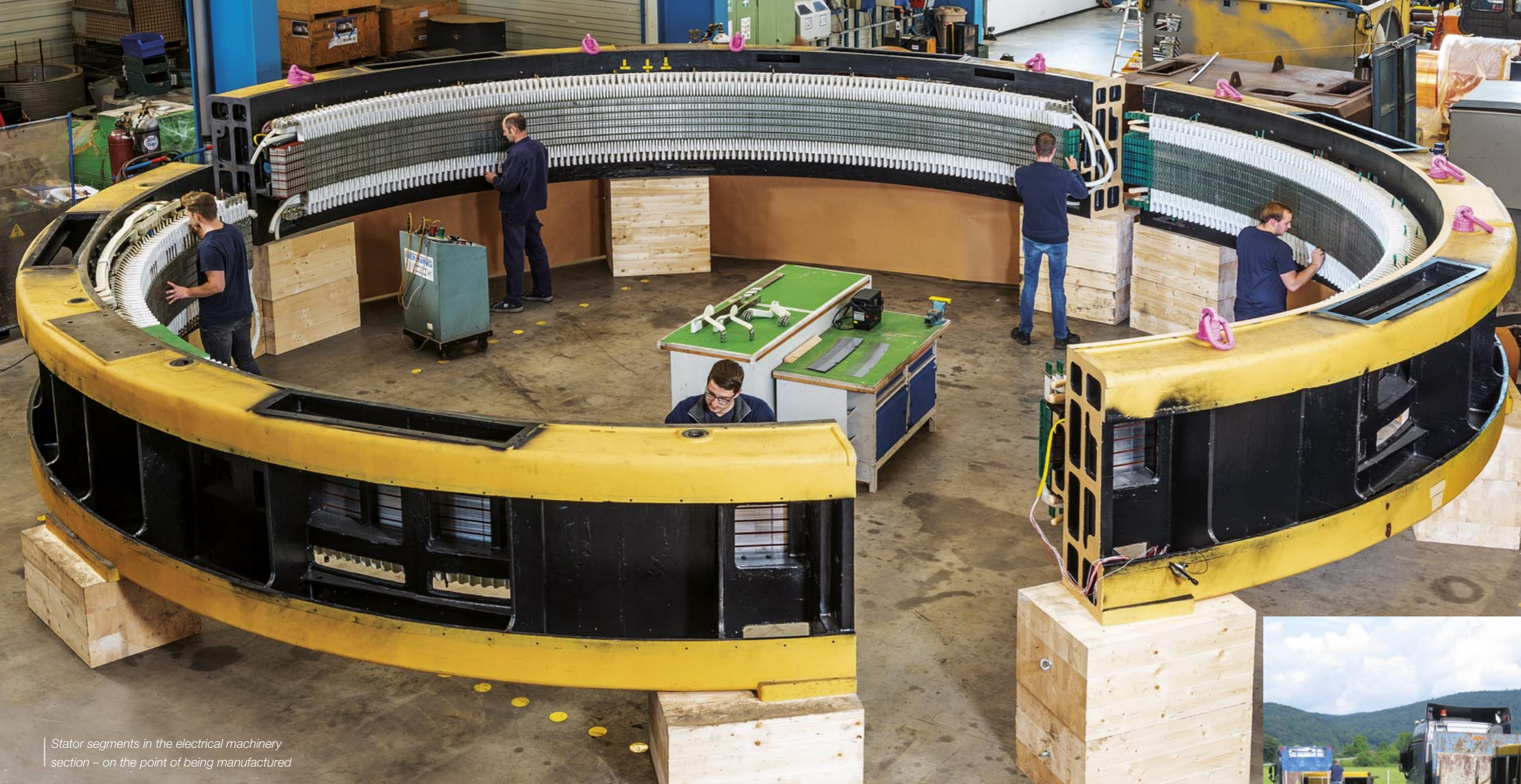
Manufacturer: BBC Mannheim
Year of construction: 1940
Reference output: 4000 kVA
Rated current: 1215 A
Rated RPM: 68 min⁻¹

Stator:
Approximate weight of stator: 28 t
Bore diameter: 7200 mm
Casing diameter: 8600 mm
Efficiency figure: 792

Rotor:
Approximate weight: 51.6 tonnes
Pole count: 88

The picture shows the generator just before disassembly commenced.

Overview of Harrbach run-of-river power station.



Stator segments in the electrical machinery section – on the point of being manufactured



Stator segments 2 and 3 take to the road

One such plant is the Harrbach run-of-river power station that was commissioned in 1940. It is operated by Uniper Wasserkraft GmbH and is located on the River Main, at a point which is 219 km from the source, between the municipal districts of Gmünden and Karlstadt.

The hydroelectric generating set, whose rated output is 4000 kVA, is driven via a tubular turbine. The overall weight of the generator is approximately 80 metric tonnes. Of that weight, the three-part stator on its own, whose 8600 mm diameter is almost as impressive now as it was back in the day, accounts for 28 tonnes.

It was in August 2018 that Uniper decided to overhaul the generator, prompted by the fact of damage to the stator plate laminations combined with unsatisfactory insulation values of the stator and of the rotor.

Let's continue with an account of how the lamination pack, the stator winding and the magnetic field windings were re-insulated.

Cost-effectiveness and know-how: convincing factors

The final contract award was negotiated via an internet auction. Bidders could propose only such repair measures as had been awarded preference during the pre-selection phase where the bidder had put in a convincing bid, highlighting its technical expertise and relevant reference projects on record.

It was judged to be in BENNING's favour that it had already repaired run-of-river generators for other power station operators.

Not only that, but Uniper was also impressed by the excellence of service which it had experienced in connection with the retrofit of the four generators at the Kachlet run-of-river power station (please refer to our previous article in POWER news 04/2015). BENNING shone through in terms of its flexibility: its capacity to achieve what it achieves with no sacrifice in terms of industrial safety or quality and also the increased output achieved from the generators.

The end result was that the online auction that took place on 8 January 2019 saw BENNING being awarded this valuable project by virtue of having put in the most cost-effective bid.

Since the 1930s, BENNING's electrical machinery department (commonly abbreviated to "BeM") has specialised in repairing generators and motors.

The department boasts decades of experience: with references in the building, rebuilding and repairing of electrical machinery for the widest range of sectors.

Tight window of opportunity

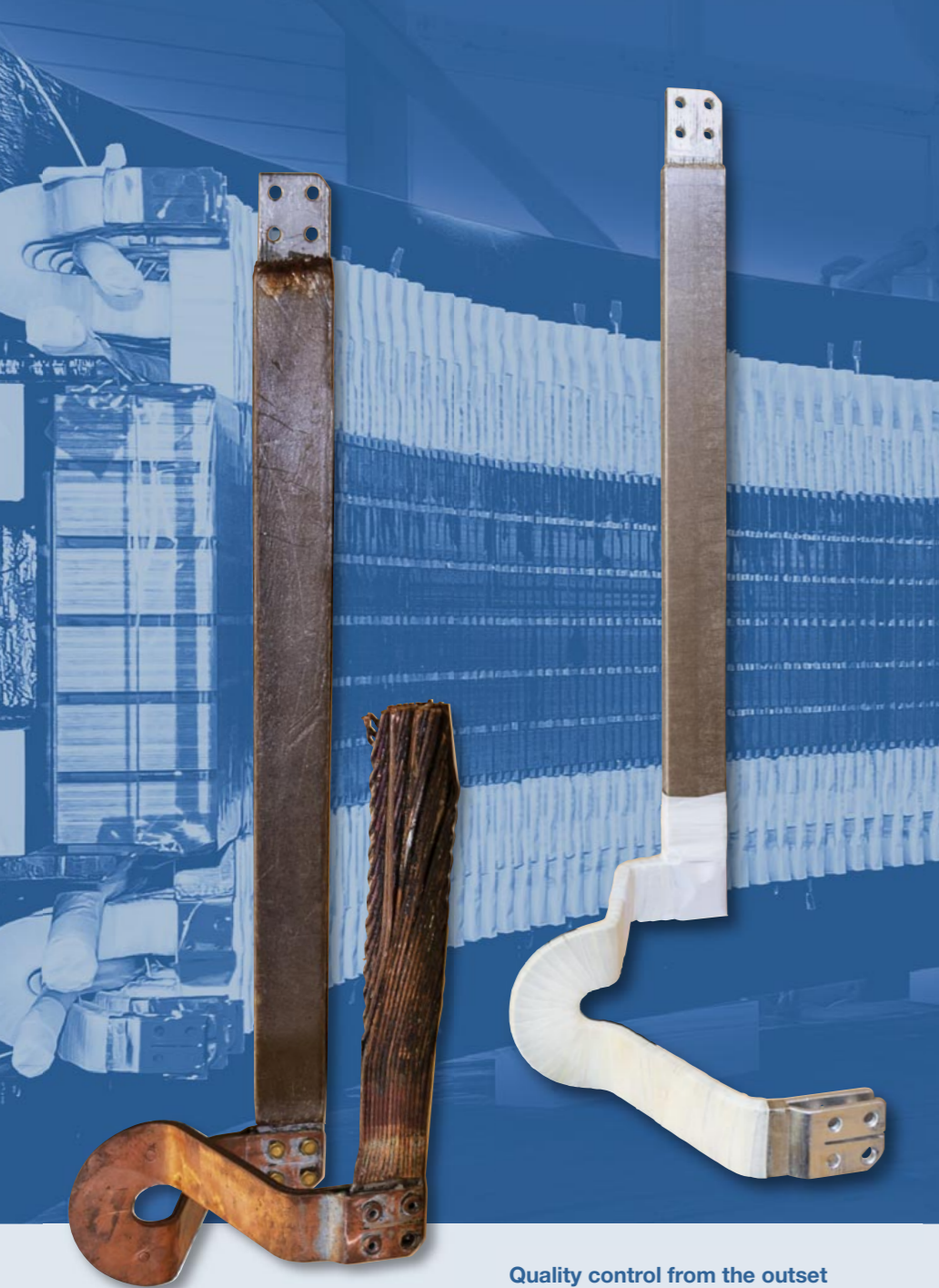
The objective was for the plant to be dismantled, repaired and recommissioned as quickly as possible, so as to restore normal power generation, minimising the period for which no valuable electrical power would be produced.

The window of opportunity was indeed tight, the deadline for disassembly was 10th June

2019. Re-assembly and recommissioning had to be completed no later than by the end of September. The rotor, weighing 52 tonnes, had to be reconditioned within the power station. The work that had to be done to the stator, whose diameter is in excess of 8 m, had to be carried out at BENNING's repair centre in Bocholt.

It was something of a logistical challenge to transport these components, because nobody had ever considered, in the decades that followed the original commissioning of

the power station, the possible value of planning the infrastructure such as to facilitate the eventual need for the generator to be transported. In the meantime, road layouts had been altered, and a new bridge over the railway lines had been constructed. Specifically in order to avoid overloading the railway bridge, the maximum permissible weight of the transporters required extremely precise calculation. On that basis, the loading consignments for the stator, which can be divided up into 3 sections, were distributed over several transport vehicles. →



Old Roebel bar (top left in picture),
new Roebel bar (top right in picture)

Quality control from the outset

BENNING's machinery team had a few quality control measures of their own up their sleeve. Even before they started on the task of dismantling. The machine's origins went back so far that there was little documentation available. This prompted BENNING to start by taking a wide range of measurements on site. Thanks to adopting that precaution, it was possible to assess operating characteristics and to project definitive curves. The temperature curves associated with a range of different operating points was placed on record, with the aid of modern thermography cameras, and certain assessments were entered into on that basis.

As the stator arrived at the repair centre in Bocholt, it was met by a team ready to place further measurements and readings on record. The original winding had to be taken out in order to determine the conductor sizing and the stator plate geometry. They had to completely remove the old stator lamina-



Lamination pack with Roebel bars installed –
shortly before completion of manufacture

tion pack that was also going to be replaced. In parallel with cleaning the ,now completely empty, stator casing and repainting it with base coats, work could now start on manufacturing the set of approximately 24,500 new laminations. Despite the enormous quantity of sheets involved, and the tremendous time pressure in the background, a production tolerance of no more than a few hundredths of a millimetre had to be adhered to. The high requirements associated with the precision sheets that had to be lasered out meant that a suitable new material had to be used.

They succeeded in starting on the process of laminating the new stator pack.

Windings based on Roebel bars

The generator winding exhibited some unusual features. For example, it did not consist of individual bars as electrical conductors, but of a quantity of approximately 800 Roebel bars.

The principle of the Roebel bar was developed as long ago as 1912. The electrical conductor for a Roebel bar is divided up into several parallel sub-conductors.

These sub-conductors are insulated from each other. They are specifically coated and they are made with a twist. The manufacturing procedure is very labour-intensive, and it entails relatively high costs. For that reason, Roebel bars are normally used only when it comes to large-sized electrical machines.

They improve efficiency and enhance the power output.

A customer-specified test program was applied to each of the 792 Roebel bars required for the new winding, before it came to be installed.

As a means of gauging the limits of the system, some of the finished bars were subjected to specific overvoltage tests where the loading was extended to material destruc-

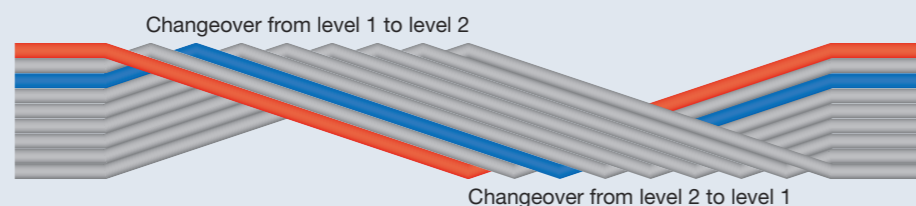
tion, in a procedure to which the customer was specifically invited.

Because the circuitry for the Roebel bars had to be embodied with threaded fasteners, BENNING started by carrying out thermographic investigations. The benefit of this is that it enables the thermal characteristics of the connections to be analysed in the most accurate way possible. Accordingly, it was possible to confirm that no unforeseen transition resistances would arise. →

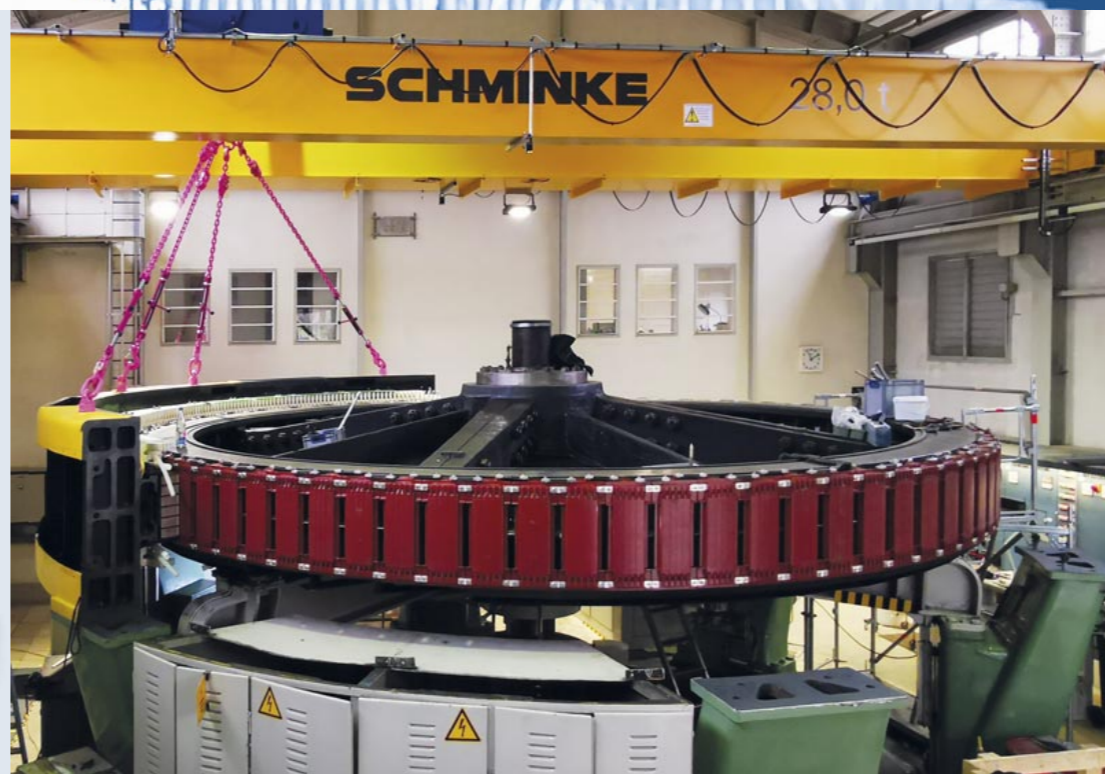
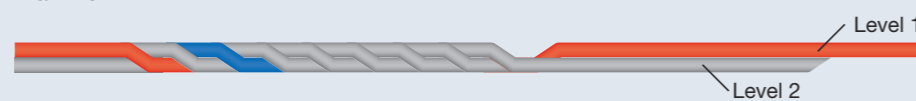
Construction of a Roebel bar

Side view

Principle of a
Roebel bar



Plan view



What the magnet wheel looked like during the process of rebuilding the 1st stator segment



Photo: © Uniper



Protecting the eel population: sustainability and environmental protection thanks to Uniper

Over the last few years, Europe's population of eels has markedly declined. This is because, in many rivers, their route back to the spawning grounds in the Saragossa sea – in the western Atlantic – has been blocked by hydroelectric power stations.

Consequently, Uniper adopted an approach to protect eels in the context of power station operation. This would not only protect them directly but would also improve their migration experience. An alerting signal is triggered on a fully automated basis by “eel migrators” once the migration process is beginning. Within a few minutes of this alert, hydroelectric plants' control centres can be switched over to “eel saving mode”.

In parallel, it is then necessary to round up the eels, transfer them to generously-sized tanks and transfer them to the Rhine. They are then released and have the best prospects of continuing their migration back to the spawning grounds. That's a journey of several thousand kilometres.

Following the successful completion of further high voltage and partial discharge readings in the works, the 3 stator segments were packed off back to the power station. The components of the generator had to be loaded onto specialised transport trailers with the aid of a mobile crane, if they were to fit into the machine shop.

Once the stator was inside the machine shop, work began on reconditioning it fit for duty in the power station. By now, it had been fitted with freshly insulated pole coils, drawing on modern developments in insulating materials. These assembly works were followed up with quality control procedures. Using assorted testing and measurement methods, a range of installation values was placed on record.

Scope of expectations excelled

The overall project was successfully completed with the generator's recommissioning on 13 December 2019. This was a process

which was completed in no more than 2 days, featuring collaboration with the power station operator on a laborious measurement programme which was constructed from customer requirements, but also took in the BENNING machine team's recommendations. Because the power station itself, with reference to its control system, had been modernised in parallel with the work of overhauling the generator, this was now the time for the redesigned control system to be initiated into harmonised operation with the generator.

Once the installation values had been rechecked, the machine was switched on by the specialists. BENNING also placed partial discharge readings on record. These will serve as reference values down the line, simplifying the tasks entailed whenever the generator is to be assessed. BENNING's machinery department is equipped with the most modern metrology apparatus for this purpose: high-voltage tests can be per-

formed on-site, with the facility for documenting test voltage values of up to 12 kV. Once the no-load curves and the short-circuit values had been noted, initial synchronisation with the grid was carried out. This was a tense moment for all those concerned. They ran the system up to a range of different loading statuses. It transpired that – in respect of every parameter – the generator's oscillation and temperature characteristics provably fulfilled the expectations of BENNING's machine specialists and those of the operators.

Accordingly, commissioning was successfully completed by the end of day 2. Since then, the Harbach run-of-river power station, having placed 80 years of operation on record, has continued making its reliable contribution to sustained, environmentally friendly energy production. Undeniably a very major part in this successful process was contributed in the form of expertise from BENNING's electrical machines department. □



Generator following completion of re-installation at Harbach run-of-river power station

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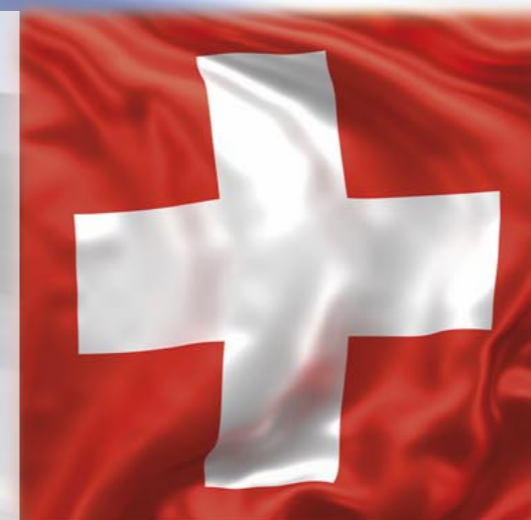


Scan the QR code for further information



Maximum of safety and availability in today's interlock/signal-box systems

BÄR Bahnsicherung AG relies on BENNING's custom-built, modular power supply systems



The next generation of trains is ultra high-speed, energy-efficient and smart. Locomotive drivers are a thing of the past, these trains drive themselves. They will be crossing continents at 400 kmh. The new "Silk Road" China to Europe train project could come to rely on future trains such as these.

A vision such as this will crucially rely on control and safety technology, hand-in-hand with harmonisation of rail traffic worldwide. These aspirations have long been active in Europe. It was in 2019 that the European Rail Agency, originally founded in 2004, came to be awarded official status, with a view to expediting and simplifying the processes that are entailed. There has to be greater safety

and inter-operability. These are key aspects of rail traffic which will be strengthened as the result of the Agency's efforts.

Modernisation is promoted

Switzerland, which is surrounded by EU countries, boasts one of the World's most intensively utilised rail networks. The limits of capacity are being approached in more and more cases in this region. Swiss experts are hoping that the self-driving train system will enable the benefit of a more dense service schedule, since this will enable higher traffic frequency levels. On the other hand, it is not expected that public service operation, i.e. beyond the confines of test tracks, can be achieved this side of the year 2040.

Costs should be reduced thanks to the "Smartrail 4.0" program, in the short-term and mid-term. Safety will be further enhanced and there will be a massive increase in capacity. The existing control, signalling and interlock technology requires modernisation, or better, complete replacement in order to meet the more stringent demands now on the table in terms of profitability, maximum availability and safety.

Cost levels down; safety levels up.

When it comes to clearing out the old interlock systems and replacing them with new ones, infrastructure operators will not be satisfied with the key factors of high reliability and availability. They also require attractive levels of costs in terms of systems and ser-

vice life. With a canny eye on just these requirements, BÄR Bahnsicherung AG has developed the electronic EUROLOCKING® programmable logic control system. SIL 4, the highest safety integrity level under the CENELEC system of standards, is achieved. At the same time, it has been possible to achieve a marked reduction in the costs of investment and operation, whilst preserving high availability and quality.

Operational success

The first EUROLOCKING® systems were installed and commissioned as long ago as the stage of equipping the complex of La-Chaux-de-Fonds (Bellevue station), Montbovon, Châtel-Saint-Denis and Palézieux (all of which are in Switzerland).

EUROLOCKING® systems are of modular construction. This holds many advantages. For one thing, it means that custom solutions can be applied very cost-effectively. Future-proofing is achieved in spades, because these interlock systems are more straightforward to adapt to changes in conditions.

The modular hardware can be expanded or extended entirely according to preference. Changes in software – or expansions to the system at a later date – can be achieved cost-effectively.

Hot-swap functionality and plug & play are amongst the advantageous features provided. Maintenance & repair tasks are simplified, and MTTR (Mean Time To Repair) cycles are completed much more quickly. →



Modular rectifier module, output
24 V - 280 A



Custom solutions

It was at least 4 years ago that BÄR launched its development of the new SIL 4 interlock system. It was not long before it became apparent that equally stringent requirements had to be fulfilled by the power supply system, which was to be protected by the whole interlock system, from suffering power cuts. Once the corresponding evaluation process had been conducted, BÄR opted for collaboration with BENNING. Pride of place went to high product quality and to the supply company's capability in terms of precisely meeting a client's specification. Cost was not the only criterion.

For decades now, the BENNING company has excelled in smart solutions for transforming electrical power into versatile or readily storable energy. BENNING's modular power supply systems offer safety 24/7. They combine the highest levels of cost-effectiveness with maximum reliability and flexibility.

The power supply system which BENNING has designed for the EUROLOCKING® interlock systems is based on a standardised basic module concept. Consequently, it can be adapted to each situation's requirements on an individual, custom basis.

It is not only the interlock system that is covered, it also provides power for the signals, points and crossings that are operated all along the rail routes. A back-up power time of between one and six hours is normally guaranteed.

Modularity and flexibility

When it comes to re-fitting interlock plant, you often have to allow for interfaces and dependency of peripheral equipment which have expanded as time goes by but, which of course, have not yet been upgraded. For that reason, the system's DC power supply is not based exclusively on 24 volts, but also covers custom voltage levels such as 48, 60, 72, 84 and 96 volts that clients may rely on.



Here's a look inside the new Montbovon interlock system plant during the process of installation. BENNING's EUROLOCKING® power supply system (illustrated in the background) protects the heart of the interlock system, the PLC control system, against grid faults.

Essentially, BENNING's EUROLOCKING® modular power supplies consist of the following:

- an AC connection and distribution section, including input isolation transformers
- a modular, 2N redundant, battery-support 24 V DC supply which is based on the TEBECHOP 3000 HDI robust industrial rectifier. This technology employs A & B rails to protect the core of the interlock system, the PLC control system, against grid faults and failures.
- an ENERTRONIC modular SE AC-UPS system. The UPS system comes with 20kW modules and comprises a modular

*1: ENERTRONIC modular SE RAIL represents an optional choice of UPS catering specifically for typical rail industry needs, since it simultaneously stores power from the public grid (400 V / 230 V / 50 Hz) and from the rail grid (230 V / 16.7 Hz).

battery cabinet. It achieves maximum availability (99.9999%) with n+1 redundancy, hot-swap capability and a low MTTR (Mean Time To Repair). Points motors and signal technology are amongst the consumers equipment served by the triple-stage system, beyond the confines of the interlock system itself.¹

Quality that succeeded in convincing BÄR

An overall system which had BÄR convinced in all areas thanks to quality, maximum safety and the highest availability. The result was that the excellent collaboration that had been



ENERTRONIC modular SE with 20-kVA modules and a modular battery cabinet

enjoyed with BENNING was even further enhanced. Now, power supply systems for interlock upgrade projects are being prepared in Palézieux and in Châtel-St-Denis (both of these are in Switzerland) and in Cochabamba (Bolivia). Five other such projects are already in the planning stage.

It must be realised that we have a long way to go before the vision of intercontinental high-speed goods traffic, based on self-driving trains, actually becomes reality. However, the new, modernised electronic interlock systems, supported by BENNING's safe and reliable EUROLOCKING® power-supplies, constitute a crucial contribution to the sustained and continuous development of rail traffic. At the same time, they are already reducing the energy consumption required in

operating an interlock system, thus contributing to the reduction of our CO₂ burden and lowering the consumption of resources. ■

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BÄR Bahnsicherung reviews its corporate history, going back over 30 years. The company has several sites in Switzerland. From these sites, rail projects for the whole of Switzerland – together with international projects – are worked on.

The majority of private-sector railways in Switzerland, together with SBB, are willing to confirm that they belong to BÄR's client base.

The range of products & services has been continuously expanded since the time of the company's foundation and right up to the present day. Although the project work of Domino interlocks (relay tech) took pride of place at the outset, BÄR is now active in all project phases.

With the aid of more than 100 employees, the Company plans, projects, completes, fits and tests railway safety systems and provides support not only in new builds but also in the context of adaptations to existing rail interchange systems, interlocks, train control and management systems.

Ryburg-Schwörstadt hydro power station

Constructed: 1927 – 1931
Turbine types: 4 Kaplan turbines
Output: 120 MW
Annual production: 760 million kWh
Weir length: 111 m
Weir control gates: each is 24 m wide, 12.5 m high, and up to 140 t in weight

Wyhlen hydro power station

Constructed: 1908 – 1912
Modernised: 1990 – 1994
Turbine types: 6 Straflo and 5 Francis turbines
Output: 38.5 MW
Annual production: 255 million kWh
Weir length: 212 m
Weir control gates: each is 20 m wide, 9 m high, approx 100 t in weight

History meets modern engineering

A facelift assuring the future operation of equipment in run-of-river power plants at Ryburg-Schwörstadt and Wyhlen for coming decades.

Modular, cycled power-supply and converter technologies have already been successfully utilised for several years now, in various market segments, such as in IT, in automation and in the field of telecoms. In these market segments, the

engineers in charge have taken the bold step of migrating to innovative power-supply systems – promoting their introduction to industry. The need to provide for critical-function business processes in a reliable way is

fully realised, thanks to the advantages of this technology, which includes high availability, flexibility, simple maintenance and optimised efficiency. Consequently, this was a logical step to take, based on limitless configuration options. →



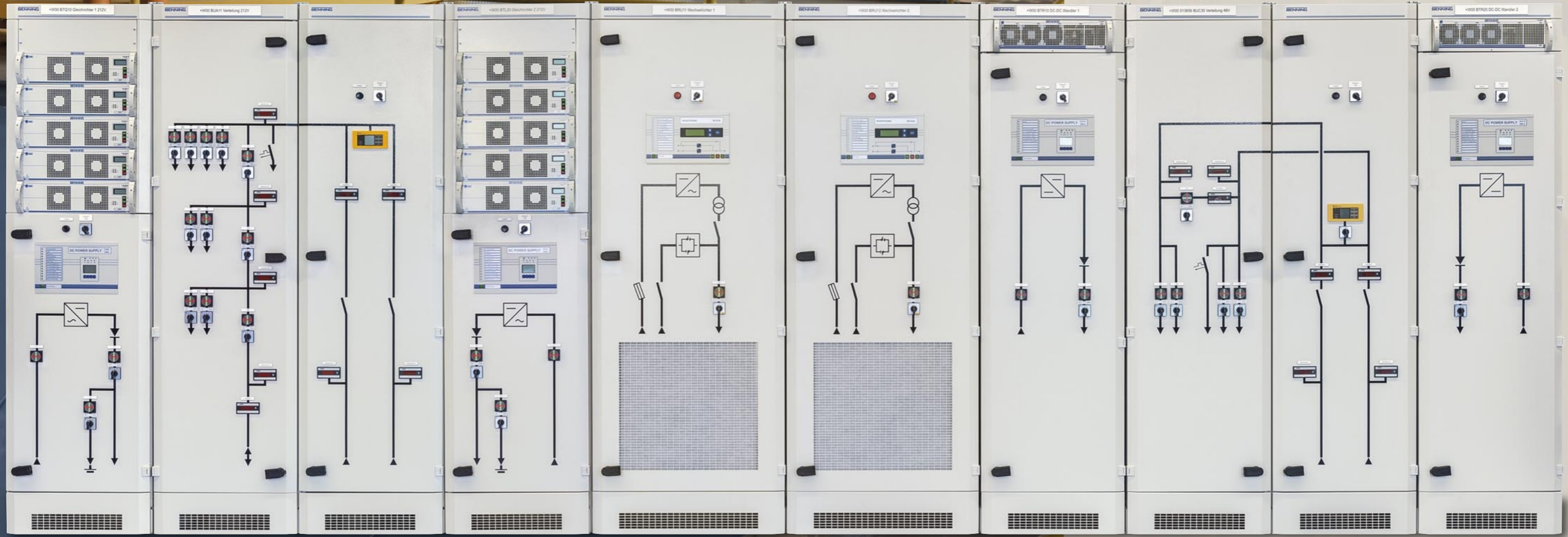
“Because BENNING produces both thyristor technology and also highly modern, cycled plant in a modular design, we had an impartial position in terms of cost and technology, when it came to advising the operator.”



Claus Kirmaier,
Director of Southern Branch of
BENNING

In conventional industrial applications, it has taken a very long time for this modern technology to establish itself. In particular, the power station sector, which is rather conservative in its approach, has been dominated by long-inherited thyristor technology. Until recently, that is. The operators of the types of power station we are concerned with have applied, and are still applying, their own versions of technical

which were written decades ago, are based on the thyristor technology that was prevalent when those specifications were introduced. Consequently, there has been a time-lag in the introduction of modern system designs and in the process of innovative technologies penetrating this sector of industry. It's taken this long. The project we're describing here is an impressive illustration of a power station opera-



Highly integrated power supply system with redundancy, to provide secure supply of power to turbine buildings at Wyhlen hydro power station

principles for the purpose of supplying the power station's "own power requirements". The corresponding specifications, most of tor's change in attitude towards innovative, modular power supply systems – once given cost-neutral, competent technical advice. →



View of generator shop at Wyhlen river-run hydro power station.

Photo: © BENNING / Claus Kirmaier

Energiedienst Holding AG, based in Laufenburg, Switzerland are the owners and operators of the power stations. They started work at the beginning of 2019 on the initial planning for the modernisation and replacement of the on-site power supply systems for their fully automated run-of-river hydro power stations in Wyhlen and in Ryburg-Schwörstadt, where the plant managers are responsible for power supply.

Highest priority goes to availability

In this context, it's a maximum priority to have an on-site power supply, that is reliable, to cover the power station's crucial operating re-

quirements. A seamless data logging record over a wide range of measurement points provides the basis for all open-loop and closed-loop interventions over a massive range of parts internal to the power station, most crucially including its generators. At that stage, it was more than 25 years ago that the power supply systems of these power stations, which had been commissioned between 1908 and 1931 in the Hochrhein (literally: "Upper Rhine") region, had last been modernised. Accordingly, it was extremely likely that something would fail within the next few years. It's essential for the Wyhlen power station to have a reliable power supply for the Francis

machinery which is employed, when required, to back up the more recent Straflo turbines. Any failure in the supply of power could lead, in the worst case, and that also goes for the Ryburg-Schwörstadt power station, to serious damage to these irreplaceable, historic generators which have been producing so much power output for so many decades.

In June 2019, in order to avoid production shutdown and all of the entailed consequential costs in the run-of-river hydro power stations, a corresponding outsourcing specification was published. The investment plan embraced by the Energiedienst company, as the operator, was to secure continued power

station operation even in the event of a grid failure. The objectives included achieving remote, 24/7 monitored and automated, and hence cost-optimised, operation for its power stations.

Planning and expert assessment

Also in June 2019, there was the first onsite meeting to review local conditions. Considerations that required discussion included looking at the ways & means of updating the "state of the art" systems in place at the time.

This was followed up by refining the outsourcing specification, in July 2019, with a range

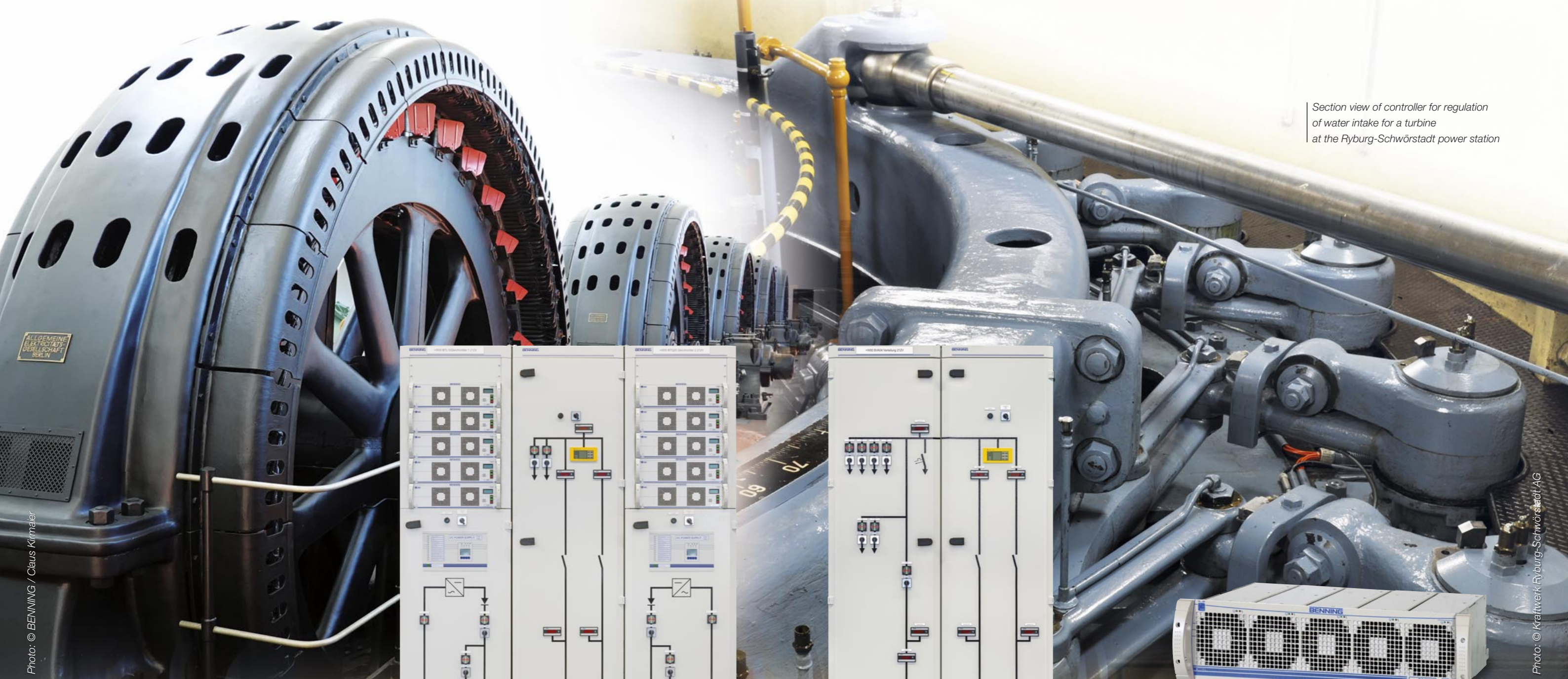
of questions from potential providers, and these questions themselves would allow the client to assess the pros and cons of modern, cycled technology as compared with the specified conventional, thyristor-based equipment.

BENNING had already submitted an initial quote by the end of July 2019. There were, in fact, two quotes.

Because although the planning engineers were already convinced that the specified requirements could be better fulfilled using modern, cycled technology, a further alternative was also duly submitted to cover the

thyristor equipment that had been specified in the first place. Because BENNING's product catalogue also includes conventional technology, alongside the modular cycled units it promotes, the power station operator received the valuable option of benefitting from advice that was inherently cost-neutral and technology-neutral.

The next step was to have a comprehensive comparison and assessment of the respective types of equipment taking account of all of the relevant criteria. They considered not only maximum availability but also user-friendliness and all of the cost-related issues. The Energiedienst company was insistent on →

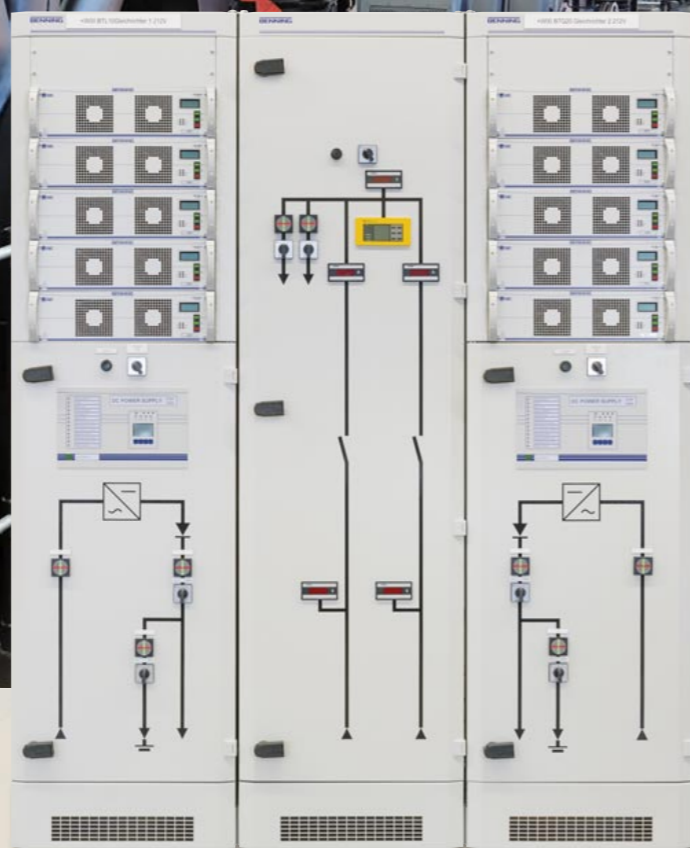


Section view of controller for regulation of water intake for a turbine at the Ryburg-Schwörstadt power station

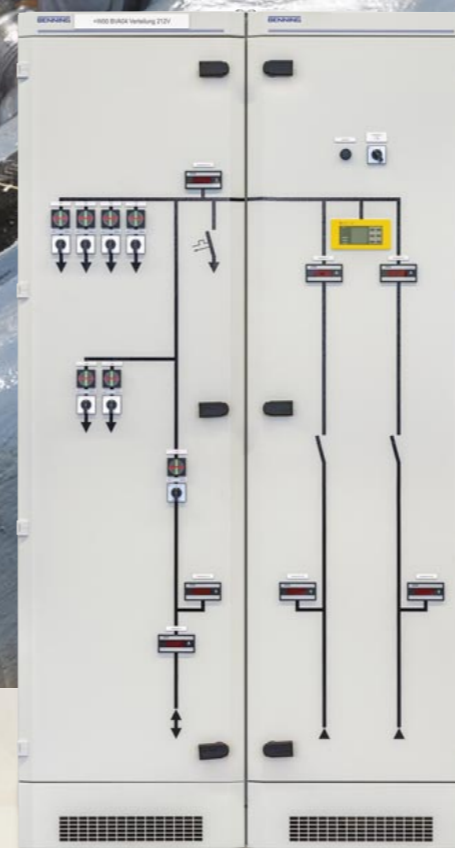
Photo: © BENNING / Claus Klimmer

Photo: © Kraftwerk Ryburg-Schwörstadt AG

Power supply system for 40-megawatt switching system



Distribution with power-feed redundancy to protect energy supply for the Francis turbine shed at the Wyhlen power station



19" DC/DC converter module with five TEBECHOP modules, 3000 IDC



maximum sustainability of entire power supply system in terms of environmental protection and ecology.

Inspired by the advantages

Ultimately, the customers found that they were inspired by the advantages of the highly modern and modular technology that was available. Accordingly, the order for the project on the Wyhlen run-of-river power station was awarded in December 2019, whilst the go-ahead for the Ryburg-Schwörstadt power station was awarded in January 2020. The operators' decision was swayed not only by the maximised availability obtained thanks

to the systems' being designed with N+1-redundancy. There was more than that in the balance; Energiedienst appreciated the substantial operational advantages inherent in using standardised components over a number of different power station sites.

The inherent simplicity of immediate response from in-house engineers, with hot plug/swap capability and the employed automatic module configuration feature, also helped to influence the decision.

Accordingly, duty staff will have an easier job thanks to the plants being managed in a closed-loop control, with greatly simplified handling of components in the event of any

fault arising, but also with regard to handling and transporting of any components.

As far as the industrial department was concerned, it was of crucial value to have 100% integration into the infrastructure on the power station side, together with equipment automation.

The solution to this objective turned out to be surprisingly straightforward. Thanks to the versatile configuration of the modular power supply systems' data interfaces, all of the historically entailed range of interfaces in the power station's control technology exhibited versatility and comprehensiveness of control in operation.

Product diversity, but still "tailor-made"

As a globally established manufacturer of AC and DC power supply systems, BENNING has very high product diversity and is able to develop and apply individual, custom solutions at short notice. This means that the customer always receives the solution that is ideal for him – in technical terms and according to design criteria.

In the context of this project, for example, not only were the thyristor units (originally specified by the planner) for the required 220 VDC and 48 VDC voltage levels replaced by cycled modules of the most modern design; also, thanks to BENNING's expert recommenda-

tion, the power stations did not receive the addition of the conventional 48 VDC rectifiers but only the modular type 3000 IDC DC/DC converters that were based on 220 VDC on the input side. Thanks to using these modular 19 inch systems, it was possible to achieve a great reduction in the energy loss caused by the voltage step down. These DC/DC converters simultaneously provide (even in the event of a grid failure) a 48 VDC power supply which remains constant at all times, specifically for the legacy Francis generators, which are quite sensitive.

The scope of supply also includes highly automated distribution with a wide range of mo-

torised power circuit breaker which enable the power stations to be controlled remotely from the central console. The capability of on/off switching for individual power station sections and also the fact that they can be coupled, is not only important for normal operation but also enables the optimum emergency mode if a supply issue arises, such as a comprehensive blackout. When an emergency supply issue does arise, the energy stored in the battery systems that come supplied as standard by BENNING as system components will then provide the reserve power required in order to guarantee fully uninterrupted operation of all items of plant in the event of a grid failure. At the same time, the accumulators in →



Energiedienst Holding AG
 The head office of Energiedienst Holding AG is in Laufenburg, Switzerland.
 The sites where power stations in the Hochrhein region are located include Wyhlen and Ryburg-Schwörstadt.

Energiedienst operates a total of 21 hydro power stations, some larger, some smaller, and also collaborates with its subsidiary – ED Netze GmbH – as the grid operator.

“Thanks to our partnership with BENNING, we have the facility to team up with a reliable service provider which can boast the ideal product portfolio.”



Marco Gerspach,
 Engineer in energy management (B. Eng.)
 Power station engineering,
 Energiedienst



Thanks to motorised output switching in the distribution systems supplied by BENNING, there's fully automated management of operations from the control console at all of the power stations' system-related voltage levels

220 V rectifier system in the transformer house – facility for coupling to the generators, at the Wyhlen hydro power station

Distribution of consumers – Francis generators

the power stations make it possible to carry out a “black start”. In the event of a comprehensive grid failure or in the event of a simultaneous power station shutdown, the regulation of the weir could carry on with battery power for only a short bridging period. In order to be able to monitor the flow of water through the control gates at all times, however, it's essential for these components to have the necessary power supply at all times. In the first instance, the “start-up power” required in order to initiate fully-independent

island mode can be drawn from the battery systems; and once the mighty turbines are spinning, the corresponding power is of course available as a by-product. In BENNING's capacity as the system partner for Energiedienst, it also provided the installation service – in addition to manufacture. The scope of services includes an assessment for grid and selectivity, extraction of old systems, transporting the new equipment to site, installation, cabling and commissioning.

BENNING's expertly trained staff are able to provide support with “AuS” (corresponds to Working Live) issues. Appropriately trained staff can ensure that any power station's consumers that must be kept running are switched over, without interruption, to the newly installed plant systems.

Conclusion:
 The customer's decision to select modern, modular power-supply systems was greatly

influenced by the opportunity to receive cost-neutral, credible, competent information on the advantages and the benefits of this solution as compared with conventional monobloc systems. Together with the opportunity to ask whatever questions they needed.

Energiedienst's much trusted partnership with BENNING meant they had the facility to work with a reliable service provider who can offer the comprehensive product portfolio to fully satisfy all of the clients requirements. Efficient

manufacture and a smoothly completed installation are assured, thanks to the decades of experience and expertise in the field of hardware design, quality management and installation planning.

This will be completed with commissioning – planned for July 2020.

And this is how the Energiedienst's run-of-river hydro power stations at Wyhlen and Ryburg-Schwörstadt are going to continue to

provide a reliable supply of power, around the clock, making a major contribution to the move towards sustainable energy. □

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Maximum protection for international HVDC connection



BENNING used a redundant power supply system to ensure the uninterrupted operation of the high-voltage direct current (HVDC) connection "Nemo Link".

The high-voltage direct current connection "Nemo Link" is intended to ensure that the power grid of GB is connected with the Belgian grid. It is a 140 km long connection via an undersea cable across the North Sea. The objective of the project is to provide increased energy security for both countries. Secondly the NEMO Link is designed to encourage the integration of renewable energies into the European energy system. With this international power exchange, the variability of regional production can be smoothed out.

Bi-directional HVDC undersea connection

The end point in Belgium is the industrial area of Herdersbrug, a district of Bruges. On the UK side, the connection terminates on the site of Richborough power station, which was decommissioned and demolished in 2012, near the town of Sandwich in Kent. The backbone of the transmission system is two undersea cables, which operate in a symmetrical monopole configuration, each at a high voltage potential with respect to ground in opposite polarity, with a DC voltage of ± 400 kV. The maximum transmission power is 1 GW. The design and supply of the power converter stations and transformers required for its operation were supplied by a consortium of Siemens AG (Germany),

Siemens Transmission and Distribution Ltd (Manchester, UK) and Siemens Belgium.

Experienced industrial partner

To secure the system against grid disturbances or failures, Siemens looked for a partner with appropriate experience of supplying highly reliable power supplies and UPS systems into industrial applications. Consequently in August 2016 an inquiry was sent to BENNING, who have a long-standing successful global partnership with Siemens and who had demonstrated their low risk and reliability as a supplier through their excellent support in the Western Link HVDC project.

The design phase was completed between August 2016 and February 2017, where the final system design and commercial terms were agreed. A technically compliant and highly reliable solution with a long service life and low total cost of ownership was developed in accordance to the individual requirements and requested specifications of the customer. In February 2017 Siemens placed an order for the manufacture of the desired dual power supplies and UPS systems.

Maximum availability

The structure of the system designed by Siemens and implemented by BENNING is



TEBECHOP 13500 SE,
19" plug-in rectifier,
output 110 V - 110 A

INVERTRONIC,
inverter, output 15 kVA

ENERTRONIC I 3-3,
industrial UPS systems,
160 kVA - 384 V DC bus voltage

2n + 1 redundant. Two industrial UPS systems of the ENERTRONIC I 3-3 series are used (160 kVA / 384 V DC bus voltage), two modular rectifier systems in n + 1 redundancy design (each based on five modules of the type TEBECHOP 13500 SE / 110 A) and two industrial inverters of the type INVERTRONIC I (15 kVA). In addition, there are two battery banks which can supply the loads with electricity for a maximum bridging time of six hours. The redundant system design guarantees maximum availability of all connected critical loads.

The rectifier and inverter systems are used to supply the control and safety systems on site. At the same time, the UPS systems secure the motors of the HVDC converter water cooling system against a power failure and bridges the period until the back-up diesel generator has started up. The UPS bypass

transformer is specifically designed to cope with the high currents produced when starting the motors. If a failure of the UPS system occurred here, the water cooling system would also fail. A total failure of the power supply system would lead to the site systems being unavailable which would lead to an interruption of the HVDC connection.

Permanent customer contact

The entire production period was 21 weeks. The delivery at the Belgian location took place in July 2017, and at the British site in November 2017. BENNING UK was responsible for managing the project, working in support of Siemens in Manchester. BENNING UK was in constant personal contact with the customer, which has always been the central basis for building successful relationships within BENNING group.

The power supply system was commissioned in August 2018 and in the meantime the commissioning of the entire HVDC system has also been completed.

Other HVDC projects

In addition, BENNING was awarded the contract for the power supply systems for Cobracable HVDC link, an interconnector between the Netherlands and Denmark, Aachen Liège Electricity Grid Overlay (ALEGrO) the first electricity interconnector between Germany and Belgium as well as Eleclink HVDC Link which will connect the power grids of France and Great Britain through the operational tunnel of Eurotunnel. "We see this as confirmation of our professional work and as an incentive for future projects," says David Whitlow, Managing Director at BENNING UK.

Efficient transfer – maximum reliability

Together with HVDC Plus technology from Siemens, the BENNING power supplies and UPS systems ensure the permanent and efficient transfer of electricity over a distance of about 140 kilometres. Both companies therefore make a significant contribution to sustaining an undisrupted supply of power to European households on both sides of the Channel as reliably as possible. □

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