# real.times

The Bachmann Customer Magazine 11 | 2022

# RESPONSIBLE PROGRESS

SIMPLY: ACT | CLEAN ENERGY STORAGE SOLUTIONS | MICROGRIDS
AUTONOMOUS SHIPPING | FLEXIBLE VISUALIZATION | MARITIME STANDARDS
M100 I/O SYSTEM: TOUGH WITHOUT COMPROMISE

# Standing still is not an option

I sometimes wonder if our society has forgotten how to think sustainably about the future. It often seems that an investment is no longer worthwhile without an immediate return. This is something I often encounter, especially related to the increasingly urgent need to transition to power generation from renewable energy.

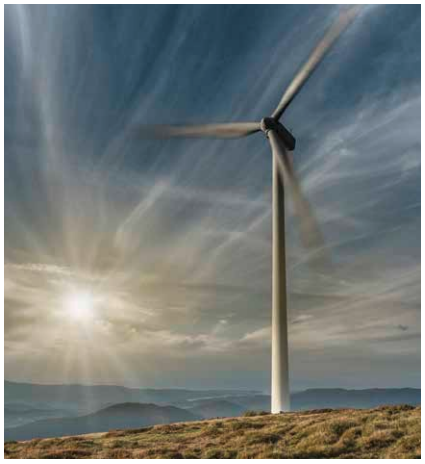
But I'm also pleased to see that things can be different. It is possible to think and act for the long term, without chasing quarterly operating results or doing things that look good short term but are actually detrimental long term. Perhaps that is just the inherent difference between a medium-sized company and an anonymously-owned listed company, where the owners have little connection with the actual operation.

We want to invest in the future, for example in training young people. We do this in-house, specifically with training institutions concerned with the future of our energy supply. In my view, this is a small but necessary step forward and a kick starter for us to achieve ambitious energy transition goals.

Forward momentum, working toward a goal, also entails staying on the path, without diversions. Perseverance, even in the face of a headwind. Staying flexible when we need to change how we do things. We as a company, as well as a community, need to remain alert and ready. For me personally, this is a mindset. For us as a company, it is a permanent process to keep ourselves on track, strengthen our team members, and therefore improve the resilience of our entire organization.

To cut a long story short: progress is not possible without forward momentum. That's why standing still is not an option for us. We are therefore pleased to present some of our commitments and those of our customers in the new issue of real.times. I hope you enjoy reading!

Yours sincerely,



## MAIN THEME



## ENERGY



## MARITIME

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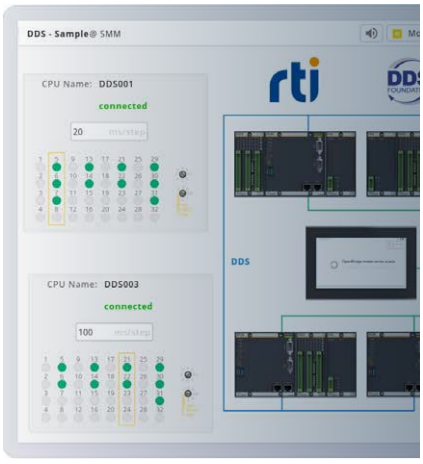



## INDUSTRY



## ENGINEERING



## PRODUCT NEWS



## KNOWLEDGE

Don’t Just Manage – Pioneer

# SIMPLY: ACT

Pandemic, raw materials shortages, components shortages – for many, this sounded (and still sounds) like the prescription for a complete standstill. “We couldn’t have seen it coming”, is the often the excuse. For Bernhard Zangerl, CEO of Bachmann electronic and his team, a standstill was never an option. We talked to him and asked where he hopes to see even more momentum.

**Going above and beyond the call of duty has always been a Bachmann virtue. Does that still hold true?**

Absolutely. We certainly don't wait until someone asks us to do something. Sometimes, you get the feeling that the current challenges are being hailed as an excuse to take a step backwards. Admittedly, it is becoming increasingly difficult to operate in Europe's political and economic environment, and still remain successful internationally. We often have to compete with companies and organizations abroad that are extremely focused on doing the bare minimum to deliver the service value demanded by the market. And nothing more. Of course, we also keep an eye on market demand. Anything else would be fatal. But within our operating framework we often do much more than just deliver a solution.

**How do you deal with this at Bachmann?**

More now than ever, we have to focus on what is useful, on aspects that create value for our customers. And with that, we need to reduce unproductive or unnecessary elements to an absolute minimum. This is an ongoing process. But where we want to develop further, where innovations are required: That's where our real focus lies. That's how we are looking ahead.

And I think this is exactly how times like these make us stronger. This is what you sense when you walk into our company: everyone is pulling in the same direction. We work in an atmosphere of openness and transparency. Even in important committees, balanced discussions are possible face to face, even if they are often very controversial. We make decisions directly and quickly, and everyone gets behind them. Our employees feel that, and this is what makes us successful in challenging times.

**Where does this become visible?**

Well, 2021 was another record year for us, with the best results since the company was founded. Perhaps that stands as proof. But we should be equally proud that even in these 'crazy' times, we were always able to deliver. Many aspects are a question of planning and stockpiling, of course. But what to do when components are no longer available? We could have buried our heads in the sand and said, "Sorry, this is due to the current situation." But we're doing the opposite: we've formed a task force dedicated to precisely this issue, looking for inter-disciplinary solutions and, above all, collaborating. The work is not simply shifted to 'the other side', but the actual question, about how we can get out of this together, is being addressed. Decisions are made at the table. And we expect the same elsewhere in the company, for our employees to make decisions within their areas of responsibility. In my opinion, this makes the organization much more efficient.

And yes, we are in a fast-paced industry. Customers and employees alike are being challenged every day to meet growing demands. That's precisely why we consciously take the time to work together. And this collaboration, in turn, helps us reach our goals faster.

# »We need to get out of our comfort zone.«

**Bernhard Zangerl**
CEO Bachmann electronic

**Do your customers feel this, too?**

Of course. But it's not just a matter of safeguarding the status quo; it's about looking ahead. There are many controller systems on the market. And they are competitive. So, the question arises, why should I choose to work with Bachmann? For us, it's partnership in action. Medium-sized companies work on a handshake, and our customers feel that. Reliability, ability to deliver, and support when it counts. These are our values. And under these conditions, these values have surfaced once again. We have once again become aware of what makes Bachmann special. Where we make the difference.

We receive regular confirmation. A customer who, in the past, prioritized monetary aspects over what really mattered – reliability – returns to us in the current situation. Because all of a sudden it has become apparent that price difference is not nearly as significant as it sometimes appears. In fact, the difference is negligible compared to loss of business when a supplier is unavailable or unable to deliver.

**You mentioned ability to deliver. But this is not possible at any price.**

Component prices on the world market have exploded in recent months, of course. We have to somehow cushion the impact, and think and act for the long term. To achieve this, we also need to pay our bills. Now, you could take advantage of a situation like the one I described earlier. And some organizations may well do so. We could neglect quality and cut back on reliability. But this is precisely our value proposition. This is why you can only tackle such tasks together. And then, at least for a certain time period, you can't just pass on price increases in full, just as you can't keep costs the same on the other side.

**But how long can such a situation be sustained?**

Today, when a crisis appears on the horizon, there is an almost immediate call for governmental aid. The state must do this, the state must do that. But we are the state, we have to respond. Let's assume the crisis continues. A government will not be able to regulate everything in the country, or ensure everything remains equal for everyone. It won't work for long.

It seems to me that nothing works without coercion. Even something that makes intellectual sense, such as the energy transition. Everyone says that of course it needs to happen. Of course, wind and solar power should be expanded. But this enthusiasm comes to an abrupt end when these same supporters are challenged to make changes for themselves.

**So, will we be waiting until change is forced upon us?**

I hope not – Even though it's clear that we should have acted sooner, when the movement was still moderate. But that brings us back to the role of politics. I would like to see more courage from politicians to actively shape the future. Proactively. Sensibly. Unfortunately, politics tends to be more reactive than proactive.

Of course, the media has an important role to play as well. It may well be possible to 'sell' all the 'unpleasant' realities in a more positive light. However, it is the negatives that are always emphasized: Change or die out. No one seems willing to paint a positive picture of the future. We all have the negatives in mind; what will happen to the world if we fail. It will get cold. And dark. But what if our cities no longer stank of exhaust fumes? Or if temperatures dropped to below 25 degrees again at night?

I would like to see more foresight from the multiple lobbying groups, as well as courage to make unpopular decisions. And to do so in a calm, collected manner – one that everyone can understand. But this will only succeed if issues are addressed clearly and directly, rather than bundled up in a tangle of empty words.

**In short: take action?**

Exactly. We have to get out of our comfort zones and put an end to the window dressing. Politicians proclaim major expansion targets, and then everyone applauds. But in the background, laws are being passed to prevent these targets from being met. Take the distance regulations for wind turbines in Germany, for example. Ultimately, this kind of behavior triggers political fatigue, with citizens no longer trusting politicians and struggling to keep track of everything. I think that a new 'momentum' must emerge, from people who can put the whole topic in perspective.

**Where can you, as a company, do something – positive – as a counter measure? Isn't a company always a reflection of our society?**

For many of our employees, especially the younger ones, what we do is important. They ask: What am I working for? Many of them are very concerned about living their personal values and being able to develop. And they attach great importance to sustainability.

This gives us hope, because a change in thinking is taking place. I see the possibility of enough social momentum to make political change possible. But it can no longer be about maintaining power at all costs. The motto should be 'I'll prioritize the environment over my reelection'.

Our society seems to have forgotten that we have to think in a long-term, sustainable way in order for our future selves to benefit. And there are positive connotations; we are creating a new livelihood for ourselves. And that's worth investing in.

**Thank you very much for the interview.**

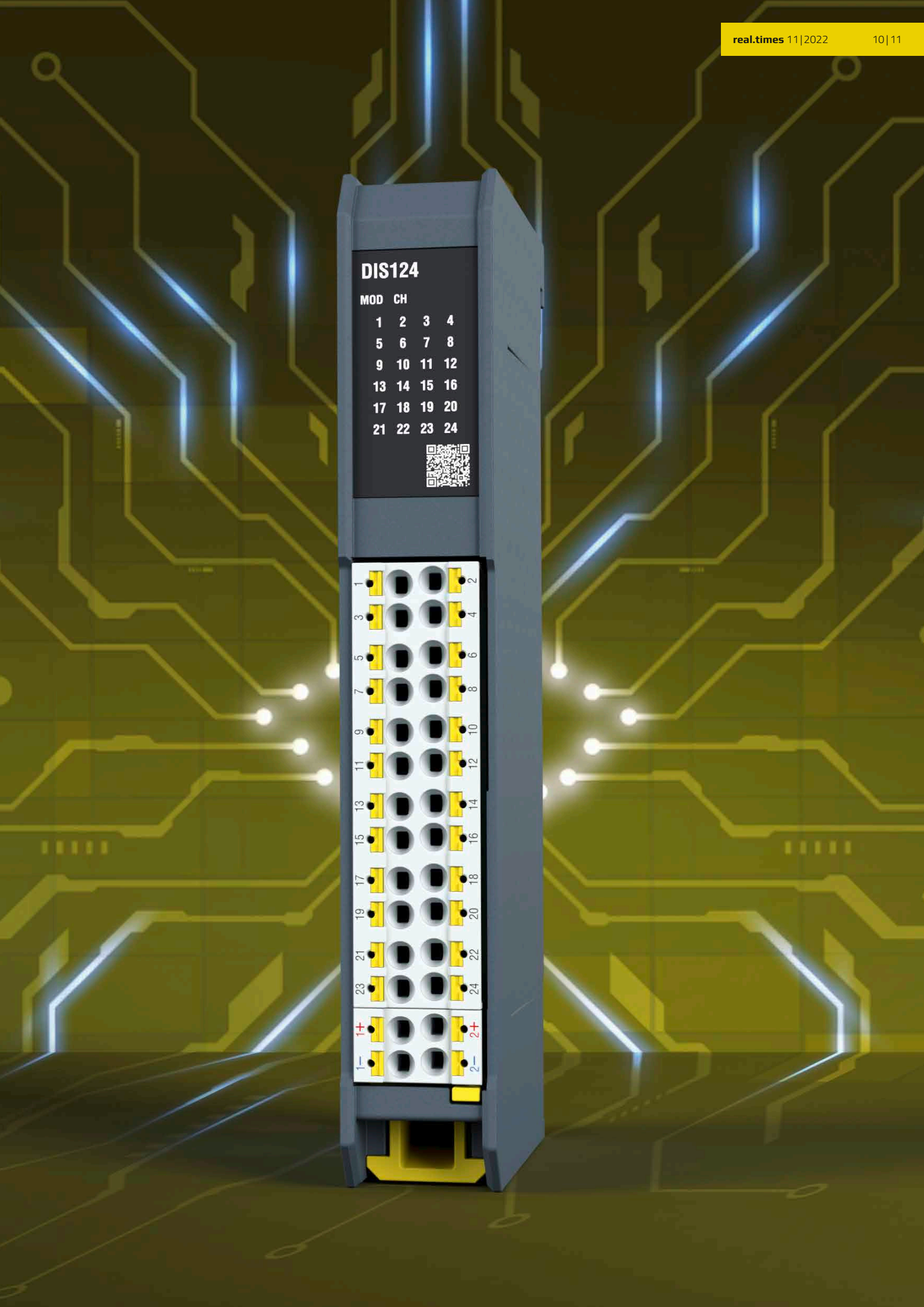
M100 I/O System

# A Master Class in Evolution

## Robust. Flexible. Compact.

**Ideal for decentralized distribution – designed for future-proof automation.**

Find out more from page 55.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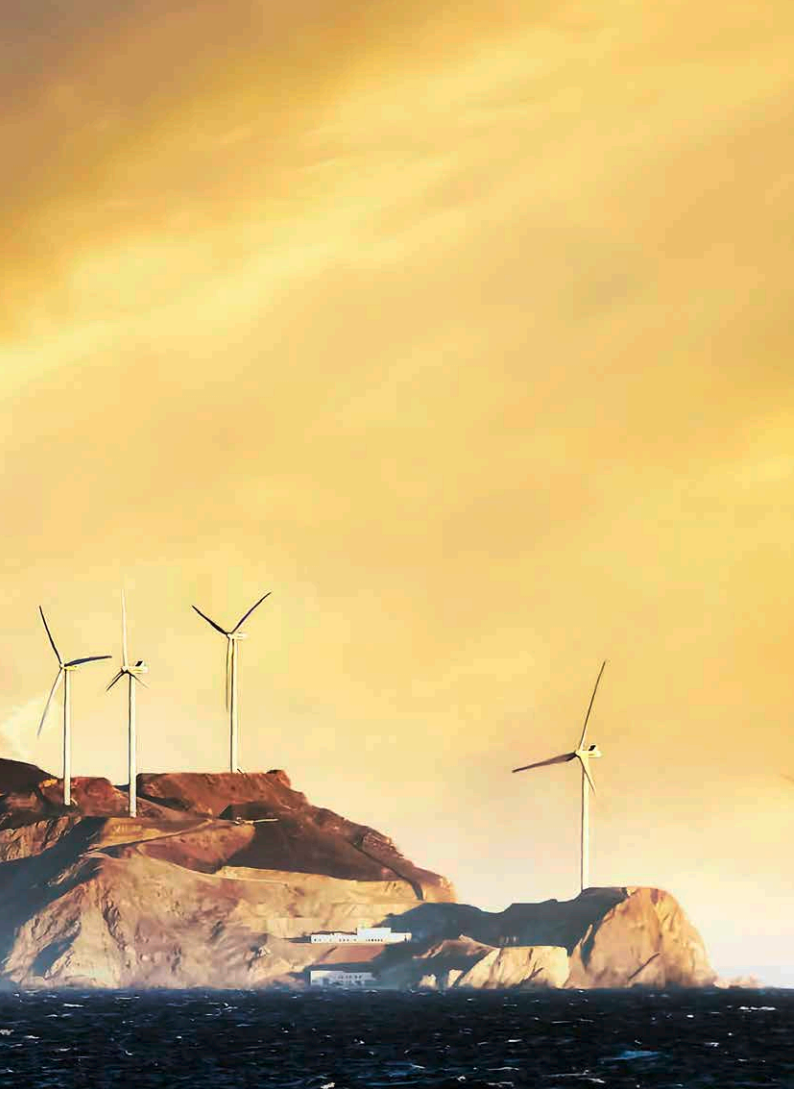
»Medium-sized companies like ours work on a handshake, and our customers feel that.«

Perfectly Tailored Retrofit

# WINDS OF CHANGE BRING HIGHER YIELDS

The operation of older wind turbines is time-consuming and expensive: Unproductive downtimes accumulate due to failures and maintenance work, and replacement components may no longer be available. In addition, access and parameterization options are limited. And so, yields decrease. With Bachmann's proven retrofit solution, producers remain competitive by increasing productivity and extending the service life of the plant.



More than 130,000 turbine controls installed worldwide is testament enough: Bachmann's automation solutions more than meet the diverse requirements of wind energy plants. This also applies to their modular controller retrofit solutions – already a winner of best technological innovation for wind energy plants at the WEU O&M Excellence Awards.

Each turbine retrofit is designed to increase performance and availability, and reduce plant load – extending service life and improving safety. Bachmann's experts consider individual control strategies for each turbine model, behavior in the event of a fault, and the wind farm's operational strategy.

### Higher yields

With a retrofit solution, system speed and pitch can be easily adjusted to current needs via secure, web-based remote access. The yaw system and main shaft brake can also be controlled manually. In the event of balancing requirements from grid operators, the Bachmann solution's definable power setpoints significantly improve the power curve of wind farms, increasing cumulative energy yield and avoiding an entire plant shutdown (see Factbox). In low wind conditions, the intelligent controller also reduces self-consumption, leading to lower operating costs.

### On grid for longer

Automatic self-start routines bring the turbine back online automatically and at record speed after grid disturbances, and a manual plant reset can be carried out remotely.

A turbine retrofit with Bachmann opens up the possibility of condition monitoring for primary components, such as drive trains, gearboxes and rotor blades. Online diagnostics with Weblog, Bachmann's condition monitoring system, supports early-stage damage detection and targeted on-site maintenance scheduling, and extends plant service life. It can also help optimize operational strategies and increase annual energy production. For drivetrain faults, the system's detection rate is a remarkable 99%.

### Precisely-tuned retrofit system

Following inventory and performance measurements of the existing system, we analyze data and communication interfaces and identify initial potential for optimization. This is followed by a controller software implementation, including plant documentation, I/O and event lists, as well as load calculations with Bachmann's Wind Turbine Template (WTT) – based on turbine structures as defined in IEC61400-25. After multiple testing processes – software in the loop (SIL), hardware in the loop (HIL), and real-world conditions, the completed system is installed on site and commissioned.

### Cost-effective, with rapid replacement

As all hardware retrofits and software adjustments are planned and configured in advance, operations are only interrupted for a few days during implementation.

The retrofit makes the best possible use of existing turbine infrastructure. Existing sensors and actuators remain in use wherever possible. Failure-prone or obsolete components are replaced to ensure many years of continued operations. In addition, new controller modules are subjected to a 48-hour test in advance under the most extreme conditions.

### Absolute independence

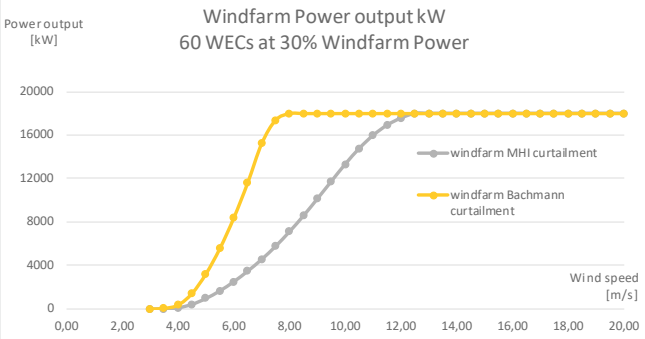
When original parts are no longer available for defective turbine components, controller parameters for any third-party replacements must be reassigned. With existing automation systems from turbine manufacturers, data is not always accessible. With Bachmann's open system, operators have access to all necessary data and are able to make flexible adjustment and optimization decisions.

### Full overview with simple engineering

Wind Power SCADA (WPS), Bachmann's web-based SCADA solution, allows any visualization device to be connected to the automation system – from smartphones, to powerful operator terminals.

The software framework is based on WTT and incorporates communication standards such as OPC UA as well as IEC 61400-25. With its ready-made plant components and numerous integrated functions, developers can quickly implement new control strategies and easily create additional visualization tools. Together with the scalable hardware concept, operators remain securely and profitably connected to the grid over the long term.

## MITSUBISHI MWT-1000A: BETTER PERFORMANCE FOLLOWING RETROFIT

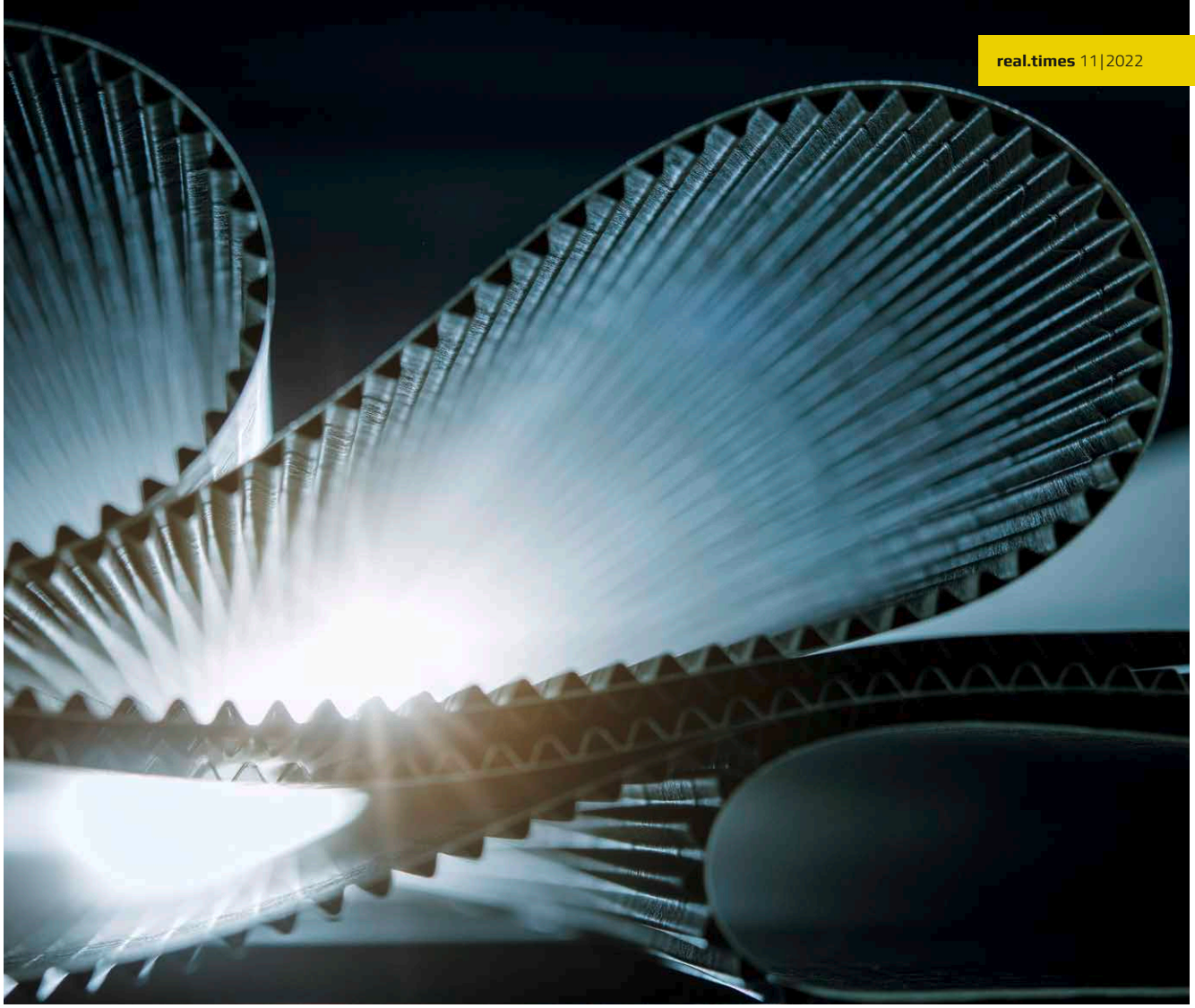



Higher yields thanks to manageable power: The curve shows the power output from sixty MWT-1000A wind turbines as a function of wind speed at 30% of the grid operator's required park output. With the precise individual turbine control provided by Bachmann's retrofit solution (yellow), output remains constant compared to the complete shutdown of 70% of the turbines (gray), even at very low wind speeds. At 30% required park output, electricity production increased by a remarkable 44% with the Bachmann solution, and by 17% at 70% required power.

Bachmann installed and commissioned a retrofit solution at three MWT-1000A plants in just two days. In addition to updated automation, the operator benefited from additional remote visualization, operation and reporting capabilities with WebMI pro and Wind Power SCADA. Live data is aggregated on individually-configurable dashboards, and can be compared with historical data.

The implemented 'Power Boost' improved the power curve and increased annual power production by one percent. Optimized wind tracking by the Bachmann controller increased production by a further one percent.

A power setpoint that can be remotely defined in the event of grid operator curtailment requirements also increased electricity production by up to 4% per year. Compared with shutting down entire plants to reduce park output, precise individual turbine control via the Smart Power Plant Controller ensures that required output can be supplied constantly, even at very low wind speeds. In addition, the Bachmann controller minimizes self-consumption at low wind speeds. Thanks to gradual turbine shutdown, Mitsubishi plants are less heavily loaded compared to previous abrupt shutdowns – which has a positive effect on service life.



Flexible Visualization

# TRANSPARENT AND POWERFUL

IBS Paper Performance Group specializes in improving the performance and energy consumption of paper, board and pulp machines. The company needed a convenient visualization solution for its more than 200 rebuild projects annually worldwide. The solution had to be easily integrated into their customers' numerous different plants, controller systems and process control systems. Therefore, it needed to be both open and adaptable to specific requirements.

### Flexible solutions for a diversified market

The company encounters a diverse range of plant conditions during the course of rebuild projects for its customers worldwide, explains Robert Rauchegger, product manager in the automation division at IBS: "There are a lot of different approaches to automation and production in the industry, which we have to account for in our projects. In some cases, customers want to integrate our products into their own process control system with their own automation. In other cases, for example, there is no central controller system whatsoever." IBS products must therefore harmonize with a wide variety of controller and process control systems.

### Missed opportunities

IBS subsystems were previously operated via a separate panel in the plant. "The functional scope of our previous visualization solution was limited. It was very time consuming to introduce additional functions," explains Rauchegger. As a result, three years ago the company started searching for a convenient and future-proof visualization solution for its customers, one that provided IBS the flexibility and openness required for an extremely broad market: "We wanted to sensibly integrate our individual plants into an overall system, and provide our customers with a standardized and fast interface for plant operation."

### Easy integration into the controller system with atvise®

IBS found the solution with atvise®. The openness of atvise® made it an easy decision for Robert Rauchegger: "The visualization solution's communication is based on OPC UA, so we kill two birds with one stone: On the one hand, customers can easily integrate our plant components into their control system, retrieving and operating them via the web. And secondly, we can very easily adopt process data from every well-known controller system manufacturer."

### Consistent object orientation

When creating the plant visualization, object-oriented engineering proved to be a great help for IBS. Adapting visualization layouts to the respective application is very efficient, according to the product manager: "With atvise®, we define our products as objects and then simply place them where we need them. We only have to adapt the layout to the respective system – the products in the background are the same. That used to be significantly time consuming."

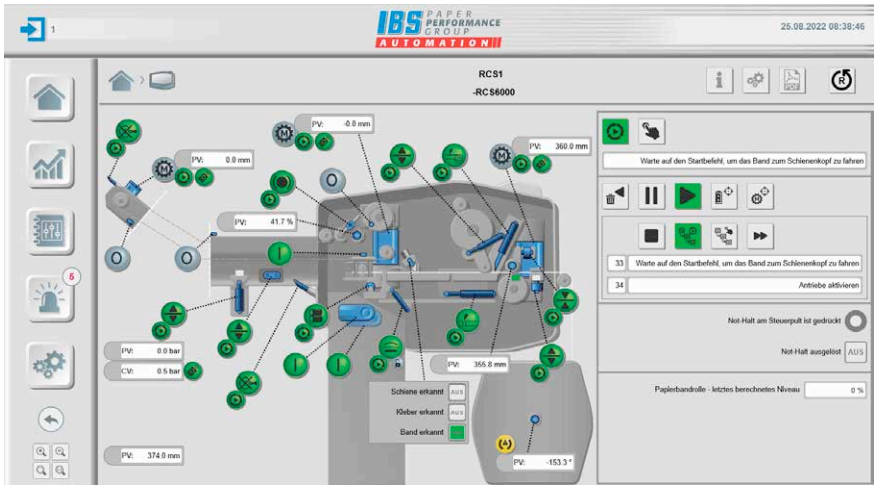
### Individual, wide range of functions

IBS utilizes many atvise® functions and then extends them. Thanks to the open architecture behind atvise®, IBS now has a very wide range of functions available for visualization, says Rauchegger: "atvise® offers us many features that you usually only see in really powerful controller systems – even recipe management. You compile certain recipes in advance, load them onto the control system as required, and use them to influence the product." But the option to export a defined status from every parameter is also a great advantage, he says, which until now was only available from larger control systems.

When customers integrate IBS subsystems into their overall system, important subsystem status information is quickly visible in the overview via

»atvise® is based on OPC UA. The standardized interface makes it very easy for us to integrate our subsystems into various customer systems.«

**Robert Rauchegger**
Product Manager in the Automation Division at IBS




**Full transparency:**
Tooltips provide information about operating equipment identification on site as well as sensor and actuator designations.

IBS headquarter in Teufenbach-Katsch, (Styria/Austria)

alarm symbols. "Our plants can be parameterized directly from the higher-level controller system. Previously, operators had to analyze the operating status on the display directly on site, at the machine," says the visualization expert. In the new visualization, tooltips for individual plant components precisely indicate operating equipment labels on site, as well as sensor and actuator designation. The ability to view electrical system documentation directly from the control system is another valuable feature – for example, circuit diagrams or system-specific user manuals in the appropriate language.

## Remote assistance

It took around a year a half year to develop the functional scope of the new visualization solution before the initial systems were delivered to customers. During this period, the group also expanded its remote service: IBS now simply installs visualization updates for atvise® remotely. In addition, the service-oriented company has always offered remote support for parameterization based on data aggregated by atvise®: "We collect a lot of plant data at our customers' sites and store it locally. Customers can use this data, and we can help remotely with parameterization and highlight any problems we identify," says Rauchegger. For IBS itself, however, it is also important to collect and understand the data accumulated from plant components. This is the only way to keep up with fast-pace development demand and continuously improve products.

With atvise®, the company sees itself well equipped for the future, especially as the paper industry moves toward mobile process operations. "This was one of the reasons why we opted for a solution based purely on web technology. And with atvise® you get a huge range of functions on top of that."

## IBS PAPER PERFORMANCE GROUP

- Headquartered in Teufenbach-Katsch, Styria
- More than 750 employees of the 12 group brands operate at 20 locations worldwide
- A global leader in the optimization of paper, board and pulp machines. IBS products are used in almost all major paper machines around the globe
- The IBS Paper Performance Group has registered over 25 patents

**www.ibs-ppg.com**

Mobile Grid Support

# CLEAN ENERGY STORAGE SOLUTIONS

At SmartGrid, the goal is to accelerate the integration of renewable energy, replacing polluting power generation technologies, such as diesel generators, with innovative and easily-scalable battery energy storage systems.

**A SmartGrid battery energy storage system in a 10 ft container:** A fully charged SmartGrid 500 kWh battery system can provide enough clean electricity for 15 full charge cycles of a small excavator.

The Netherlands-based company was founded in 2019, as an offshoot of Super B Lithium Power, and specializes in the production of high-quality lithium batteries. The concept for container-based battery energy storage systems came about through a project to increase available grid power at the port of Arnhem, Netherlands, using a combination of batteries, wind, and solar energy. The challenge was to develop an energy system capable of providing grid support and stability.

To model the system, SmartGrid teamed up with experts at Controllab, who introduced them to Bachmann's robust hardware and open software platform for PLC systems. Using the expertise gained on the Arnhem port project, the team at SmartGrid decided to further develop the concept of mobile battery storage systems.

### Challenging development

"The aim was to deliver a fully-functional mobile system, capable of providing grid support and delivery, ready for use on the balancing energy market", explains Harry Roewen, CTO of SmartGrid. "And it all had to fit into the smallest possible space."

Achieving this required a combination of various technologies, such as inverter systems and batteries. The developers at SmartGrid also had to ensure that the control logic maintained batteries in good condition for many years. "Proper battery usage: preventing overcharging, under-charging, or even deep charging is not a trivial matter. We had to consider many different parameters," says Roewen. For grid support the team at SmartGrid relied on Bachmann grid measurement and protection modules. The modules provide safe, reliable, and rapid measurements of all relevant values in three-phase electrical networks, as well as several monitoring functions for generator and grid protection. "We are particularly happy with the highly-accurate measurements provided by the grid modules. It is important to know exactly what goes in and out of the system – something we guarantee to our customers", says Michel Bodegraven, Sales Operations Lead at SmartGrid.

A crucial phase in the project was the development of an intuitive and user-friendly graphical user interface, for straightforward system set-up and control. Combining all the required functionalities posed a significant challenge.

### Innovative results

The result of all that hard work is a smart and flexible container-based battery storage system which fits into 10 or 20 ft containers. The modular system allows the flexible addition of inverters and batteries: anything from between a few kilowatt-hours to several megawatt-hours. And containers can also be combined into larger systems – either on the AC side for more power, or on the DC side for more capacity.

### High potential for a variety of industries

Designed according to the highest safety standards, SmartGrid battery storage systems are a robust and reliable source of clean energy. This makes them an ideal solution for many industries aiming for to zero emissions. Many governments have already restricted the use of diesel generators for energy supply, for example, on construction sites and at outdoor events. But SmartGrid products are also well suited to supporting the stability of the existing grid.

Demand for their products is growing rapidly, and along with it, the demand for a number of new features. With this in mind, it was important for SmartGrid to choose the right partner. "Meeting the people at Bachmann and getting to know the company's culture was very important to us", explains Roewen. "We chose Bachmann because we need a sustainable partner to ensure our products stay ahead of the competition."

## SMART GRID B.V.

- Founded in The Netherlands in 2019 as an offshoot of Super B Lithium Power, a manufacturer of lithium batteries
- Part of Koolen Industries, the Dutch clean energy solutions conglomerate
- Develops and builds mobile battery storage systems for clean energy provision

**www.smartgrid.com**

CHP Template

# FULL THROTTLE!

BK³ Energieanlagen GmbH, based in Berlin (Germany), has been building combined heat and power plants for almost twenty years. Updates to grid connection guidelines for low and medium voltage required plant recertification.
For BK³, this was an opportunity to integrate a new controller system – the Bachmann M200 Series. The migration was completed extremely quickly thanks to the Bachmann CHP template.

»The CHP template took most of the work for controller migration out of our hands.«

**Michael Rauchfuß**
Commissioning engineer
BK³ Energieanlagen GmbH

**BK3 ENERGIE-ANLAGEN GMBH**

– Headquarters in Berlin, Germany

– Manufacturing, installation and service of cogeneration units from 50 to 500 kW

**www.bk3-energieanlagen.de**

BK³ Energieanlagen GmbH builds combined heat and power plants that produce between 50 and 500 kW of energy, with a focus on converting sewage gas into electricity. The revised German power generator connection regulations, VDE-AR-N 4105:2018 low-voltage and VDE-AR-N 4110 medium-voltage, require new dynamic and static grid support functions, making it necessary to recertify plants. This was a time-consuming process, with high associated costs, which BK³ tackled together with enertec Kraftwerke GmbH. The company from Mühlhausen in Thuringia also builds CHP units – primarily for converting biogas into electricity.

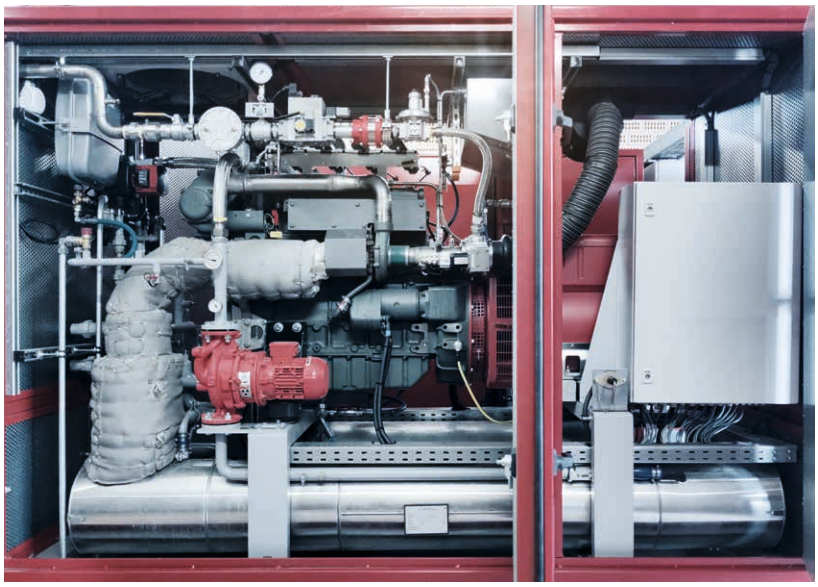
## Controlled migration to the M200 Series

enertec has relied on Bachmann's controller system for its plants for some time and has had a good experience. "The compact controller we were using up to now did not offer the necessary functional performance required by the revised regulations. That's why we decided to migrate our CHP controller to the M200 Series, not least on the recommendation of enertec," explains Michael Rauchfuß, commissioning engineer at BK³.

## 1:1 plus

The Bachmann automation system opened up completely new possibilities compared to the previous compact controller, but also required a change in approach to development at BK³: Where programmers previously had to restrict themselves to the parameterization of software unknown in the source code, the possibility of free programming had now become available. It was clear from the very beginning, however, that the individual functions


**Clear and self-explanatory:**
Operator guidance on the BK³ CHP unit new touchscreen panel.



BK³ builds CHP modules for the common fuels – sewage gas, natural gas, as well as biogas – and also offers solutions for special applications such as associated gas or landfill gas.

and familiar approach to operating the CHP had to be mapped as far as possible on the new controller system. "We did this primarily with service in mind. We wanted to retain as much as possible of what we were used to," says Michael Rauchfuß, describing what was probably his most important requirement for the replacement system. This also created space for completely new projects, for example in plant operation – which now features a touchscreen panel.

## The basis: The CHP template

With the new controller system, BK³ wants to build a baseline for all future implementations: The development of a basic software. This software could then be transferred very easily to various plants, where it would already be executable for basic functions. "Up to now, this has been very annoying. The compact controller's closed nature meant that we practically had to start from scratch again with each plant. Now we can copy and paste individual functions – and it works," Michael Rauchfuß is pleased to report. He also had this experience with the CHP template: "The functions provided for operation, starting, stopping and motor control are very sophisticated. Thanks to this, the first time we commissioned the CHP was very quick," confirms the commissioning engineer. For individual tree groups or special control characteristics, he adapted the template together with Bachmann application engineer Axel Wedderien: "Axel was always available and ready to listen to our concerns. We are very grateful for that."

## Future-proof

For Rauchfuß, the whole project is a great leap forward: "Each system is basically unique – rarely are two identical. It is therefore helpful to be able to use existing software to cover basic functions. In his mind's eye, he sees a future CHP unit that is completely freely configurable on the software side: During commissioning, software is loaded, and then functions and installed components are selected on the display. Following a restart the operator sees only exactly what is required.

The engineer is certain that the Bachmann controller offers him every opportunity to further develop the BK³ CHP units and to implement brand new possibilities for his customers. He has no shortage of ideas, when it comes to plant monitoring, for example: "Our aim is to save resources, time and costs, and thus to make a decisive contribution to the successful energy transition in line with our corporate philosophy."

# OPTIMAL USAGE

The production of stainless steel is energy intensive, yet the consumption of individual plants is difficult to forecast. In order to avoid unforeseen peaks, RWE Supply & Trading GmbH (RWE) has set up a new type of power generation, including a storage facility, at Outokumpu, one of the world's largest producers of stainless steel. Sufficient energy reserves must be available 24 hours a day and deployed without delay. This challenge led RWE to Bachmann.

Energy prices and network charges are major cost drivers in stain-less steel production. When roll stands are operating at high capacity, the plant's electricity demand is particularly high, and the grid operator must be able to provide energy at short notice. With the share of electricity supply from re-newables increasing, this poses a considerable challenge because the volatility of renewable energy leads to variation in avail-able power in the grid. Furthermore, electricity must be purchased during relatively expensive peak times.

### Intelligent energy management

The innovative power generation and storage system consists of a 3.3-megawatt battery storage system coupled to three 1-megawatt gas-powered generators. During peak times, it supplies electricity – "optimized for the energy market," says Viet-Dung Pham, Battery Development Project Manager at RWE Supply & Trading GmbH. "If there is too much or too little renewable energy available on the electricity market, additional power can be fed in or production adjusted accordingly."

### Power demand management on site

Many of the Krefeld-based stainless steel producer's plants run very steadily and therefore have predictable energy requirements. However, for the cold rolling of flat stainless steel products, four large rolling stands are put into opera-tion sporadically, with a startup power alone of 15 to 20 MW. In order to maintain grid-delivered energy below a defined threshold value around the clock, a sophisticated algorithm is required that continuously forecasts the pro-duction plant's consumption, looks for ways to com-pensate, and reacts accordingly by providing electricity from available sources.

Short-term high energy demand can be met by the battery, and longer lasting demand by the gas generators. If neither of these is sufficient, the power supplier can inter-vene in the production process at clearly defined points via the controller system, explains Viet-Dung Pham: "Since the energy consumption is essentially proportional to the rolling speed, the feed rate and with it the energy re-quirement can be throttled if necessary." Although this extends production times for the output quantity, it is unproblematic for the rolling process. Finally, the plant operator is informed by a message on their control panel that the rollers are being throttled.

### Absolute availability

The top priority was 'absolute availability', because the algorithm had to be able to switch energy sources immedi-ately and without delay, explains the project manager. In its search for a controller solution with the correspond-ing functionality, RWE found what it was looking for at Bachmann. Two MC220 processors operating in hot standby as masters serve 12 further redundantly-coupled gate-way processors to control the individual gensets. Real-time communication at RWE takes place via the bluecom

protocol. "This is the ideal topology for us. Parallel CPU operation also makes it possible to update the computing cores securely," says Viet-Dung Pham. "We can adjust the software on one CPU while the second maintains operation. In the event of an error, it is always possible to revert to the previous version."

### Efficient web visualization

RWE implemented the monitoring user interface with Bachmann's atvise® scada. "I was really impressed," Pham confirms. "The engineering was very simple, because the entire catalogue of Bachmann devices is already fully mapped in the supplied libraries, so you can build a functional solution very quickly."

The plant has been running autonomously and unmanned since the beginning of 2022. Operations monitoring is carried out from the control center of a power plant belonging to the RWE Group. Since then, 'MALIBU (Motor Assisted Lithium Ion Battery Unit)', the plant's internal project name, has been reliably preventing peak loads from entering the grid – saving money for the electricity customer.

## RWE SUPPLY & TRADING GMBH

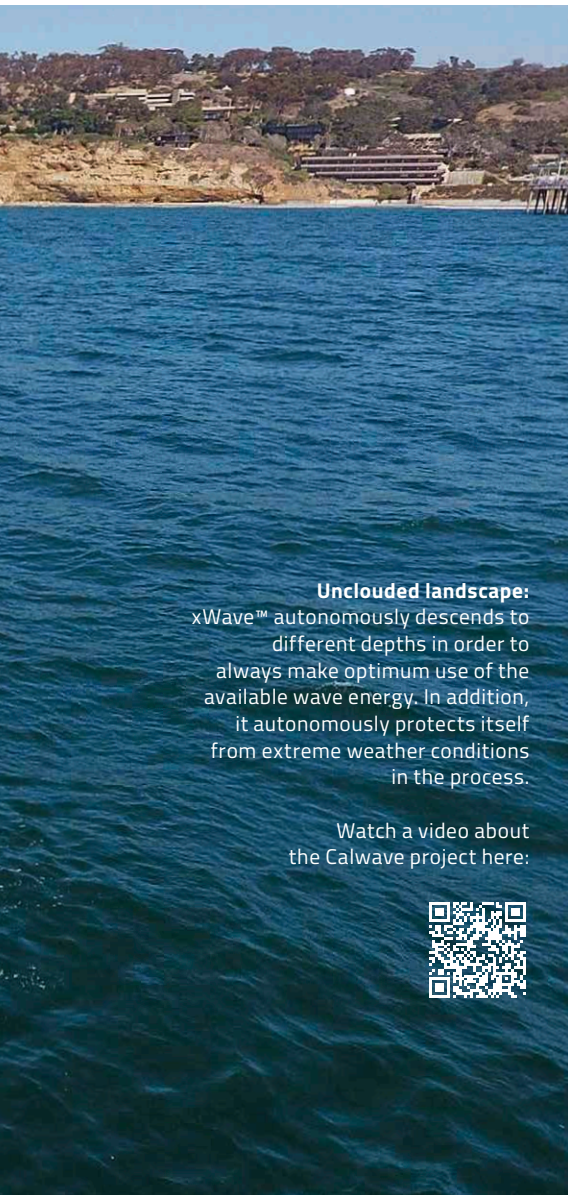
- RWE Supply & Trading is the Interface between RWE and energy markets around the world
- Around 1,600 employees from over 50 different countries trade in (renewable) electricity, (green) gas, raw materials and CO2 emission certificates
- The trading company also ensures commercial optimization in the use of RWE power plants and markets renewable electricity.

**www.rwe.com**

Electricity From Wave Energy

# OCEANS OF POTENTIAL

Wave energy is the world’s largest untapped renewable energy source. CalWave from California wants to change that: The company's goal is to reliably and consistently supply a quarter of the world's energy requirements with energy from ocean waves.
In July 2022, the company completed a highly successful pilot project with its xWave™ system off the coast of San Diego. And for its next prototype, the company is utilizing M-Target for Simulink® for application development, as well as hardware from Bachmann.



**Unclouded landscape:** xWave™ autonomously descends to different depths in order to always make optimum use of the available wave energy. In addition, it autonomously protects itself from extreme weather conditions in the process.

Watch a video about the Calwave project here:

## Huge potential

Ocean waves are packed with hydrokinetic energy: According to the Ocean Energy Council, a wave breaking along a mile of coastline releases up to 35,000 horsepower. But a few miles off shore is where waves have the greatest energy potential. This can be harnessed with wave energy converters anchored to the seabed that convert energy into electricity, then transport it via a cable to coastal regions.

According to the U.S. Energy Information Administration, the annual energy potential along United States coasts is 2.64 trillion kWh. "This means that, in total, about one-third of American electricity demand could be met by wave energy alone," says Thomas Boerner, chief technology officer at CalWave Power Technologies, Inc.

## A perfect addition

Compared to other forms of renewable energy, wave energy is more constant and predictable: "The day-night profile of wave energy looks very similar, there aren't usually any fluctuations correlating with the day-night cycle, and seasonal fluctuations are less significant compared to other renewables," explains Boerner.

Moreover, the production profile of wave energy is counter-cyclical to that of wind and solar. While wind produces the most electricity in the summer months, waves are strongest in winter – making wave energy an ideal complement to existing forms of renewable energy. With its xWave™ system as a wave energy converter (WEC), CalWave aims to maximize this potential.

## Protective water

Back in 2012, CalWave founder Marcus Lehmann became fascinated by wave energy. Inspired by the muddy seabed that effectively absorbs it, he built the first device to convert wave energy into electricity. Experimentation continued with prototypes in the wave tank at the University at Berkley, and the first patents soon followed. After CalWave was founded, the company spent four years working diligently on the system concept. Power electronics, closed-loop control and the drivetrain underwent continuous development. The automation and SCADA system were also consistently tweaked.

The COVID pandemic complicated the procurement, testing and integration of hardware for the first field test. Coordinating the logistics of all involved parties was also a challenge. "Fortunately, thanks to Bachmann, we had extremely short lead times in procuring hardware and software components for the Bachmann automation system. In addition, the Bachmann team went through the automation requirements with us in detail, and advised us on how to assemble the systems in the best possible way. Their support was extremely valuable," says the Chief Technology Officer, looking back at the development period.

But conditions on the deployment site – the open ocean – also presented developers with a challenge: The xWave™ design had to withstand 50-year storms. During strong storms, waves can reach destructive proportions. Withstanding such high forces on the surface would require huge material expenditure. CalWave therefore operates its system entirely underwater, avoiding these potentially damaging waves. In addition, the wave energy converter is equipped with unique load management mechanisms: xWave™ can be lowered or raised relative to the seabed, depending on the immediate wave propagation, to harness wave energy at the ideal absorption depth.

"Such load management mechanisms were specifically integrated into the xWave™ concept right from the start, enabling a highly efficient design and significant cost advantages," Thomas Boerner is pleased to report.

### Maximum performance

Several drivetrains generate electricity from the wave-induced movement of the superstructure relative to the seabed. The goal was to utilize each wave as much as possible. Since the entire platform is below the water's surface, wave energy is utilized over multidimensional degrees of freedom, improving overall efficiency. In addition, the system can also change the geometry of the absorbing body to further optimize the scalable system. "With these mechanisms, we keep not just the drive within an optimal operating range, but the entire unit – very similar to the approach used in wind energy," explains the engineer.

### Successful pilot

In September 2021, half a kilometer off the coast of San Diego, a pilot project kicked off to rigorously test the system under real conditions. It was California's first long-term trial of wave energy usage.

CalWave was keen to keep their system operating autonomously around the clock. "Availability is the most important issue for us," says the CTO, adding, "with the Bachmann controller, we were able to achieve more than 99% total system availability during the 10-month pilot project under real conditions."

No interventions were necessary during the project, he adds. "Our mechanisms for drive control, power optimization and diagnostics proved to be reliable and robust; they worked completely autonomously," explains Boerner. Following the initial six months, CalWave decided to extend the project by an additional four months due to high reliability.

With a rated power of 15 kW, the xWave™ system is controlled with the MC220 processor module via a Bachmann master station, which is connected via FASTBUS to several remote drive substations. Communication to the drives is via EtherCAT. The GM260 network acquisition module quickly and reliably measures the relevant three-phase current variables. Finally, the processor load is cleverly distributed among the CPU's four cores. Boerner is impressed, "Despite complex controls requiring the exchange of more than 1,000 variables between parallel-running application programs, the MC220 CPU system load never exceeded the 50 percent mark, even when using just one of the four available processing cores."

CalWave kept a constant eye on the pilot plant's status: The Scope3 software oscilloscope was used to record and historize system data. Visualization with webMI pro enabled comprehensive plant diagnostics and targeted control of all important parameters, from any location. "Thanks to the 12-hour data sampling of all relevant signals, we were able to track the platform's processes quite easily and without post-processing," Boerner is pleased to report. "Of course, detailed analysis at a high data rate is always possible during post-processing."

### Challenging development conditions

However, the path to the pilot project was demanding from a development perspective, as the CTO emphasizes: "Testing a new type of system with multiple components on a large scale and under controlled conditions is highly complex. There are a great many factors that influence and sometimes reinforce one another. In addition, as much of the system configuration as possible had to be performed onshore, because offshore testing is very expensive. The development and optimization of drivetrain control strategies are good examples of this."

During the testing phase, the team further optimized the dynamic system with extensive simulations. They automatically generated code using M-Target for Simulink®, and were able to load it onto the controller at any point via the network. This was crucial for putting xWave™ through its paces (see article "In focus: model-based development" on page 29).

Another challenge was the complexity of the powertrain and controller system, as well as the signal and data organization. Here, it was an advantage that the Bachmann controller supports programming language C++ in addition to code compiled with Simulink. "This parallelism is already extremely strong. We are yet to find another platform that is so seamlessly integrated. It was very helpful," says Thomas Boerner.

### The development continues

As a next step, CalWave plans to build a 100 kW version of the xWave™ architecture. This is to be operated for two years at PacWave South – the first accredited, grid-connected and approved test facility for wave energy on the open ocean in the USA. From there, 20 megawatts of power will be fed into the mainland's local grid via pre-installed cables.

This time, CalWave also wants to work with a digital twin – a simulation model trained with data from the real system. The control and simulation model will then run in parallel in real time, with

the results from the real system being compared with those of the simulation. "This will allow us to test different control concepts before they are deployed on the real system. This data-driven approach should ultimately enable us to monitor systems that are not equipped with sensors – and also to plan maintenance for the xWave™ predictively," explains Boerner. He expects to be able to accommodate the required computing power in parallel on his MC220 CPU.

The long-term goal is to achieve grid-serving power classes in the range of over one megawatt per system. Even if the drive systems are further scaled for this purpose, the control architecture based on the Bachmann automation system can essentially be adopted 1:1. "To this end, in future we also want to create a farm setup and bundle the units," says Boerner. But platforms with lower nominal power ratings, such as those in the pilot project, also have a role to play in wave power. They could be used in future, for example, as an energy supply for offshore measuring stations.

### CALWAVE POWER TECHNOLOGIES INC.

– Founded in 2014 in Oakland, California

– Employs seven people

– The company aims to harness the power of ocean waves to provide reliable and cost-effective access to sustainably-produced electricity

**https://calwave.energy**

## IN FOCUS: MODEL-BASED DEVELOPMENT

Calwave chose Simulink® for model based development. This allowed them to use a simulation model to precisely investigate the reciprocal influences of the mechanical and electrical components of waves. The necessary control algorithms, signal processing, and state machine were also designed in Simulink® at the same time. This made it possible to fully test the final machine control within the simulation, and to carry out proof of concept even before the first real components were available.

**The architecture makes the difference**

With M-Target for Simulink®, software applications for the Bachmann automation system could subsequently be generated directly from Simulink® and then processed on the Bachmann controller alongside other C++ programs. Within the Simulink® control program, sensor and actuator signals are connected directly via Bachmann hardware blocks. The drivetrain, connected to the mail server trigger via EtherCAT, is also integrated in the Simulink® model.

To maintain flexibility, the Simulink® control program was encapsulated in individual sub-applications. For this purpose, signal acquisition, machine control, the state machine and signal output were encapsulated in separate referenced models and accepted individually. From the M-Target library's referenced models, independent Bachmann software modules were generated and installed on the MC220 CPU using the Model Builder block.

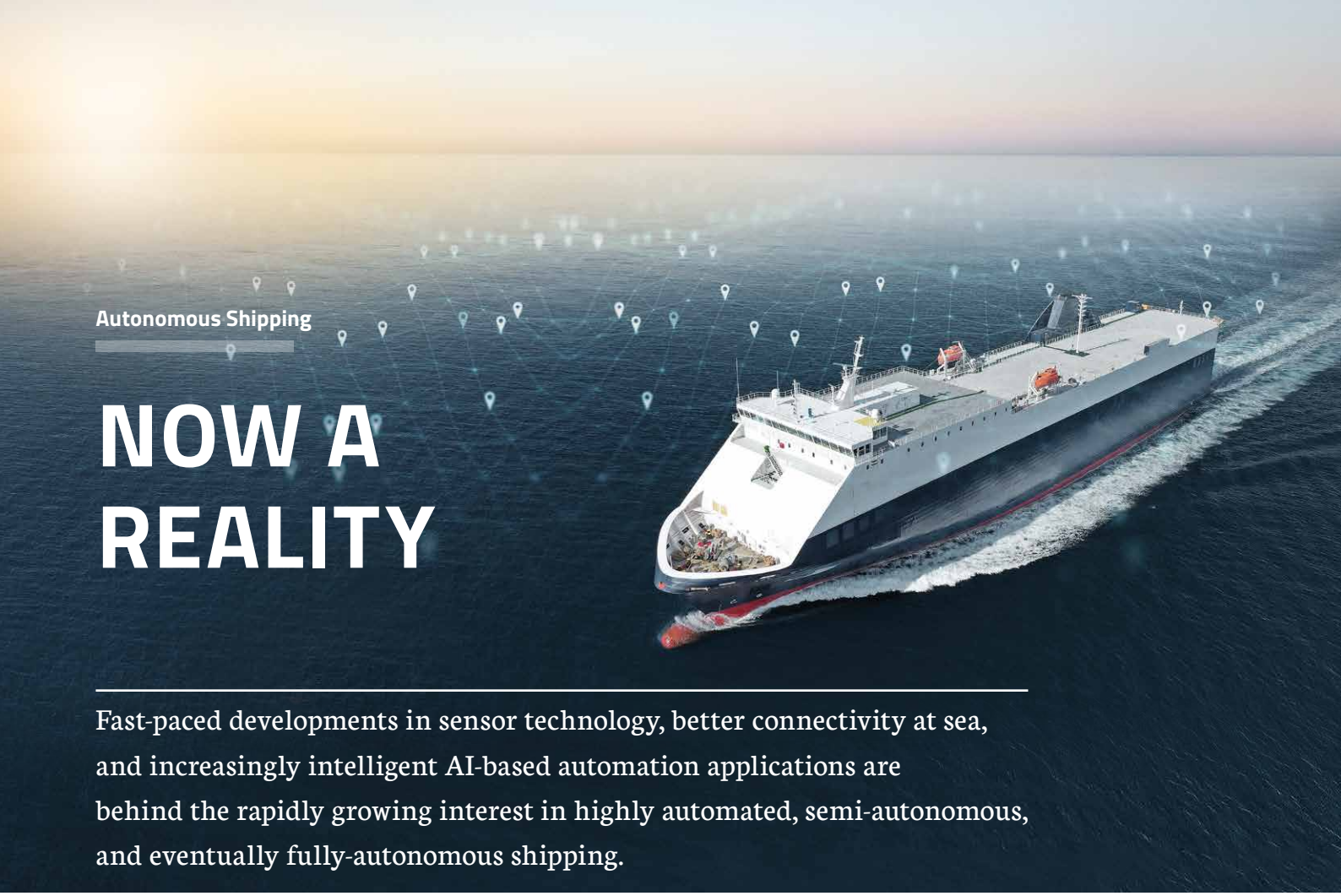
This architecture proved to be a key advantage as the project progressed and during field testing. For example, it allowed CalWave to replace the existing control core with a newer, optimized version by reloading new software. All other software components remained unaffected by the change. Because the control system did not have to be restarted, the plant continued to operate.

**The future in sight**

In future, CalWave will simulate its machine model, which is built with SimScape blocks, on the Bachmann controller in real time. This will allow the model to be processed as a separate software module alongside the rest of the control code on the operating controller.

Among other things, Calwave expects this to provide decisive advantages for its hardware-in-the-loop (HIL) testing. Certain plant components, such as the drivetrain, are built in the real world and connected to the Bachmann automation system via the I/O interface. Non-physical components are simulated by the machine model.

In the next stage of expansion, this setup will be used to create a digital twin on which new controls, predictive maintenance concepts, or virtual sensors can be tested.



Autonomous Shipping

# NOW A REALITY

Fast-paced developments in sensor technology, better connectivity at sea, and increasingly intelligent AI-based automation applications are behind the rapidly growing interest in highly automated, semi-autonomous, and eventually fully-autonomous shipping.

Automation concepts based on machine learning (ML) and artificial intelligence (AI) now facilitate a wide range of applications; some of which are already widespread in the maritime industry. Many ships now sail semi-autonomously with the help of assistance systems, for example, or are controlled remotely from the mainland with sophisticated automation technology.

Depending on the degree of automation, human intervention is only required either for selected tasks or for overall system monitoring.

## Clear benefits

The benefits of these concepts for the maritime industry are obvious. Software-based ship intelligence (AI) can reduce human error and prevent collisions and maritime accidents. In addition, crew and skippers have more time to focus on other tasks. Optimized navigation routes reduce fuel consumption, reducing costs and protecting the environment. AI-based predictive maintenance means that repairs are caried out in good time, reducing downtime to a minimum.

## Sophisticated technology

Semi-autonomous, remote-controlled or autonomous shipping, however, requires the successful combination of multiple components. There are sensors to monitor the ship's condition and surroundings, for instance, and the GPS navigation to determine the ship's exact location at all times. Further key components are the highly complex control algorithms that constantly make decisions based on available data, as well as a visualization system to convey all relevant information to crew both on board and on the land-based virtual bridge. A fail-safe connection between the onboard systems and those onshore is also critical, as well as the real-time exchange of data between systems from a wide range of manufacturers and platforms. The combination of Bachmann's robust and secure controller with Connext® software from Real-Time Innovations (RTI), leading Californian autonomous systems manufacturer, provides the prerequisite for a flexible and fail-safe automation platform for the networking of distributed systems. RTI software supports Data Distribution Service (DDS), an open standard for message exchange with high data connectivity and scalable architecture for real-time applications. Thanks to DDS, all controllers communicate directly with one other in real time. The constant availability of up-to-date information forms the basis of reliable, autonomously-controlled operations.

## Human-machine communication

Despite all this technology, autonomous shipping still requires people. Unfortunately, many automation concepts are still not designed to actively involve people in processes. For example, some can only be switched on or off, while others run in the

background as assistance systems without the captain's awareness. But it is important for crew to understand what a machine is doing and why: This is the only way to ensure that those on deck, or on shore, can effectively monitor ship systems and respond appropriately if required. In addition, certain operations must still be mastered, despite automation, to avoid the loss of process knowledge. Although certain maneuvers can be performed independently by assistance systems, for example, the captain must be able to intervene or take over control at any time. Regular crew training is therefore essential, even as shipping becomes autonomous.

### Feel the ship

Haptic feedback is an emerging trend in the maritime industry and a way to bring man and machine closer together. This technology enables systems and devices to communicate with the operator via touch impulses. Similar to modern cars, assistance systems provide haptic feedback – for steering or speed control, for example. The use of haptic feedback can also ensure that operators retain control of automated operations and, more importantly, can override them. Training becomes more efficient when simulators are equipped with haptic feedback. This intuitive learning method means a significant reduction in training time.

### Exciting future

Highly automated and partially autonomous shipping is already a reality, and current technological developments in the maritime industry are promising. We look forward to the emerging opportunities and challenges over the coming years as we continue on the journey to fully-autonomous shipping.

## HAPTIC FEEDBACK: FORCE FEEDBACK TECHNOLOGY WITH SMART SHIP

Dutch start-up Smart Ship uses the Bachmann controller to implement 'force feedback technologies' in the maritime industry. Custom-built components for ship control, such as throttle, tiller, azimuth and joystick, are connected to an algorithm that provides haptic feedback to ship operators during complex control operations through resistance and vibrations.

### More than just vibration

Familiar to us all, the most basic form of haptic feedback is a vibrating cell phone. But smart-ship technology can do much more: "By using a control handle equipped with haptic feedback, we can transmit many different forces," explains founder Roy Kok. "In addition to vibration, resistance is also an important force. Variable resistance signals that you are approaching or moving away from a target, also allowing us to create virtual walls or 'no-go areas.'"

### Conscious control

For remote ship operation and for supporting decision making in critical situations, it is especially important to quickly create awareness of the current situation. When ship AI alters the speed, for example, the captain feels a vibration at the throttle and can immediately check why this action was taken and whether it was correct. If not, he or she can intervene and override the system. Conversely, the system could apply resistance to the throttle, signaling that increasing speed is not recommended in current sea conditions or levels of visibility.

"Haptic feedback creates an awareness of what a machine is doing, even when visibility is poor or non-existent. And it is precisely this feature that will help us take the step toward fully autonomous shipping," says Roel Kuiper, research and development engineer at Dutch subsea specialist Seatools, and a Smart-Ship consultant.

### Intuitive learning

Smart-Ship also equips training simulators with the same technology. According to Kok, humans respond instinctively to haptic stimuli – which is the reason for its huge potential. "From an early age, humans learn to interact with their environment by experiencing forces. Therefore, using haptic controls in education enables faster and more intuitive learning."

### Guarantee security

Cybersecurity is one of the most important requirements in the development of autonomous shipping. The consequences of targeted disruptive access to a ship control system could be fatal. A well thought-out, multi-layered IT security concept, the use of hardware-based cryptographic methods, and a robust operating system are essential for providing sufficient protection against threats in networked automation. Moreover, end-to-end encryption for communications through SSL renders eavesdropping measures ineffective: All these functionalities are supported by Bachmann hardware, explains Kok. "In addition, Bachmann's controller is powerful enough to run the entire dynamic model in real time – speeding up development as well as testing for new systems, ensuring we continue to provide high quality," concludes Roy Kok.

**www.smart-ship.eu**

Machine Learning

# A DATA-DRIVEN CRYSTAL BALL

Predictive maintenance is not magic: A complex plant consists of a large number of subsystems interacting with one another. Only when every subsystem is functioning correctly can the plant fulfill its purpose. Individual parts are critical: if they fail, the entire plant fails. Predictive maintenance helps to avoid situations such as these and saves considerable costs.

As an example, let us look at a ship: Undetected damage leading to the failure of a crane could leave the entire ship unavailable for a planned task. At the very least, the financial consequences are considerable. But in the worst case, the result is a dangerous situation for both people and the environment. To best avoid this scenario, there are various different maintenance approaches available.

### Maintenance strategy 1: Reactive

Still a common approach to maintenance, repair work is carried out after a failure has occurred, such as exceeding a critical temperature or falling below a minimum oil pressure. An alarm is triggered, and the oil can icon lights up red on the dashboard. However, in this scenario the fault has already occurred and immediate maintenance is required. The warning light is helpful, but it doesn't give service crews any time to plan. The right spare part may not be available, and crew might not be free to perform an immediate repair. The plant is at an unproductive standstill. Reactive maintenance is expensive and insufficient for critical systems.

### Maintenance strategy 2: Preventive

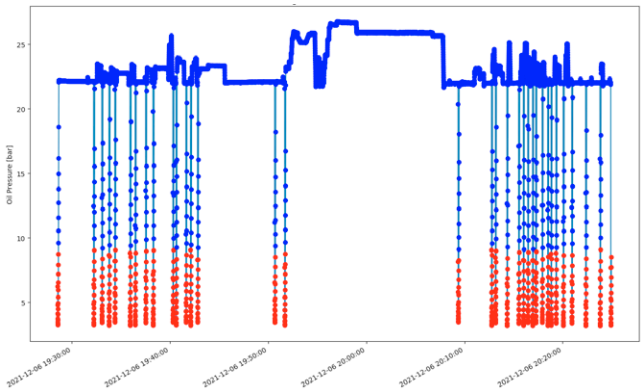
Preventive maintenance strategies try to avoid such situations: Maintenance is performed based on a component's average life expectancy. Sometimes, however, the part is still fully functional at the time of replacement. This wastes money and resources. If, on the other hand, exceptional operating conditions have accelerated aging, the repair window can be missed: The defect occurs, and the system shuts down. Costs in both cases are unnecessarily high. But sometimes critical systems with undetectable fault mechanisms, such as creep or fatigue, require the application of preventive maintenance.

### Maintenance strategy 3: Predictive

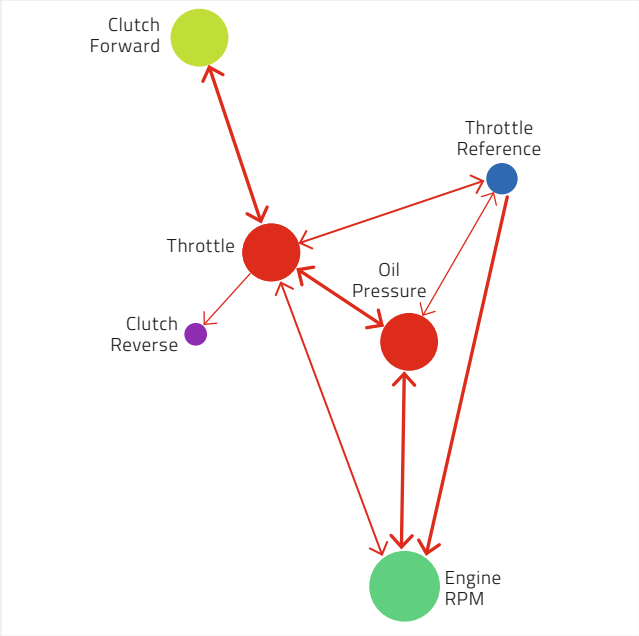
Ideally, maintenance is performed exactly when – and only when – it is actually necessary. This is definitely the most cost-effective approach. With predictive maintenance methods, you know in advance exactly when this point in time will occur, you can plan service and spare parts, avoid failures and reduce unproductive downtime.

### Optimized maintenance

In reality it is necessary to apply a mix of maintenance strategies. These depend on the failure type identified, how far in advance they can be detected, and their criticality to the system. Bachmann's Artificial Intelligence (AI) tool helps engineers to detect multiple types of failure even earlier,




**Data gaps during recording and non-expected operating values (in red):** Bachmann uses graphs such as these to assess the validity of a customer's data. The cleaneddataset then trains the machine learning algorithm.




There are correlations between the individual subsystems on a ship. Thus, from the state of a subsystem, a prediction can be made about the possible availability of the entire ship.

The wider the lines (called "edges"), the greater the dependency of each signal. The larger the diameter of the nodes, the greater the influence of the signals on the overall system.

enabling the application of predictive maintenance to a wider variety of items.

Returning to the above example, now becomes possible to know weeks, or even months, in advance, whether or not the ship will be available for use at a particular time.

### The challenge of realism

Setting alarm thresholds for automatic alerting is tricky. They can vary depending on process conditions. At one point during operation, values may be completely normal, but at another they may indicate a critical anomaly. It takes expertise to distinguish one from the other, and intelligent algorithms that can perform this task during operation for many parallel processes.

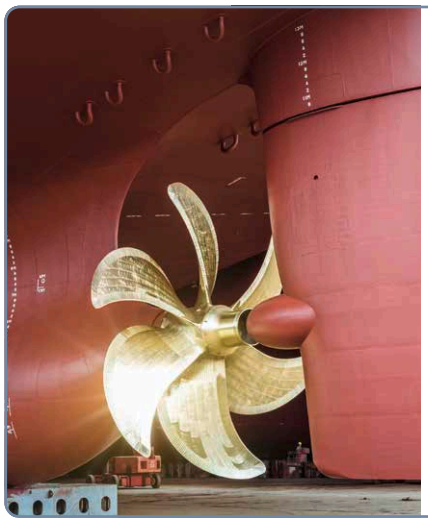
### Searching for clues in the data

Bachmann uses artificial intelligence methods, in this case machine learning, to train fault prediction, opening up new possibilities for predicting the availability of plant components and, subsequently, the entire plant. The first step is to look for patterns in the plant's usually extensive measurement and sensor data that differ from the expected normal state. Statistical methods and graphical representations such as plots or heat maps assist this process. Gaps in the recording or anomalies are thus easily identified. Together with the plant operator and their expertise, these can be evaluated and the data cleaned up.

### No magic

In a further step, corresponding correlations between data are identified, recognizing the influence or interdependency of parameters or subsystems. With this information, neural-network models are trained based on real system data – at a point when it is known to be running fault-free. If these models are overlaid with condition monitoring sensor data, and thus with the current state of the system, intelligent algorithms can be used to identify trends at a very early stage. The better such a system is trained, the more precisely it is possible to predict whether, and for how long, the plant can continue to run under the given conditions – or how much time the maintenance team has to carry out their work.

Ergo: We don't need a crystal ball. In the future, with the right data, advanced analyses and sophisticated, self-training algorithms will perform these tasks. This will make it possible to assess developments in advance, identify potential future damage risks and, if necessary, remedy them in good time. With the right spare parts and tools. From the right service personnel. At the right time.



## SYSTEM VALIDATION WITH AEGIR MARINE

Together with AEGIR Marine, one of the major qualified stern seal & propulsion service providers for seagoing vessels (headquartered in the Netherlands), Bachmann is investigating 17 possible wear scenarios for propulsion propellers. Starting with a fully reconditioned propeller, individual parts such as bearings or seals are replaced by specifically worn parts during a long-term test. In the process, the team is researching at what point, and with which methods, faults can be detected during operation. In this way, algorithms are trained and the quality of prediction further improved.

**Rob de Wit**
Manager Innovation & Business Development
AEGIR Marine

Zero-Emission Shipping

# FUELING ELECTRIFICATION

The Koedood Marine Group in the Netherlands produces EU stage V type-approved diesel engines with ultra-low emissions. Following the development of their modern propulsion systems, the group's R&D department is already working on new approaches for eco-friendly shipping.

Bachmann talked to Sander Roosjen, R&D Manager at Koedood Marine Group, about sustainable propulsion concepts and different energy sources – and what is crucial for these concepts to become reality.

**Sander Roosjen**
R&D Manager,
Koedood Marine Group

**Mr. Roosjen, after the development of the EU Stage V certified engines, which future-proof concepts are you addressing next?**

We are working on different concepts. On the one hand, there is no one solution for all vessels. Additionally, various developments are currently taking place both rapidly and simultaneously.

**Will diesel still play a role?**

We won't get rid of diesel within the next decades. A large number of vessels will still use diesel engines in 2050 – hopefully equipped with exhaust after-treatment technology, of course. The energy requirements are so enormous, that it would be unfeasible to convert the global fleet to zero-emission technology in the near future. Take hydrogen for example: If every large vessel were to use fuel cell technology, then there currently wouldn't be enough renewable energy to create the required volumes of green hydrogen. There are also a lot of both economical and logistical questions to be answered when it comes to hydrogen storage concepts. The hydrogen value-chain is in its infancy and its many facets need to grow collaboratively and at the same rate.

We will need a mix of different energy sources. And we have no crystal ball to predict which will be the main fuel for the maritime industry in future. Therefore, we need to build a flexible foundation in order to make efficient use of future developments.

**What could this foundation look like?**

Our vision for the future is to provide a flexible platform with an electrical drive train. One thing is certain: Ship owners never regret the electrification of a vessel. When you use a power management system together with an electric engine, preferably a permanent magnet engine directly on DC, then you can modularly add or exchange energy-providing units as you go. That's a kind of plug-and-play power combination for your drive line. There are about 120 diesel-electric hybrid vessels equipped with Koedood technology already at sea in Europe. On this basis, you can use a diesel engine with an after-treatment system today, for example, and exchange it with a more future-proof technology such as a methanol-based engine or an ammonia fuel cell system in the future.

**Which energy sources do you use for your current developments?**

One of the new technologies we are focused on is methanol. It is a very potent option, especially for short sea vessels.

We are looking into methanol as a dual-fuel solution, primarily for the retrofit of inland marine vessels. It is the customers that want diesel as a backup, because the logistics and refueling possibilities with methanol are not yet consolidated. This solution can run 100 percent on diesel, and almost 100 percent on methanol. With normal loads, we can substitute diesel for methanol up to a rate of 97 %. The remaining diesel is only required for initial ignition.

We use a Bachmann controller for the normal operation of the engine and alarm systems. It is easy to couple with the technology we developed for the EU Stage V engine and also supports our machine learning und predictive maintenance ambitions.

Another technology we are working on is hydrogen fuel cells. Together with Nedstack, we are building marine-certified

300 kV systems. The data collection is very encompassing: We use pressure and temperature sensors in almost every piece of piping.

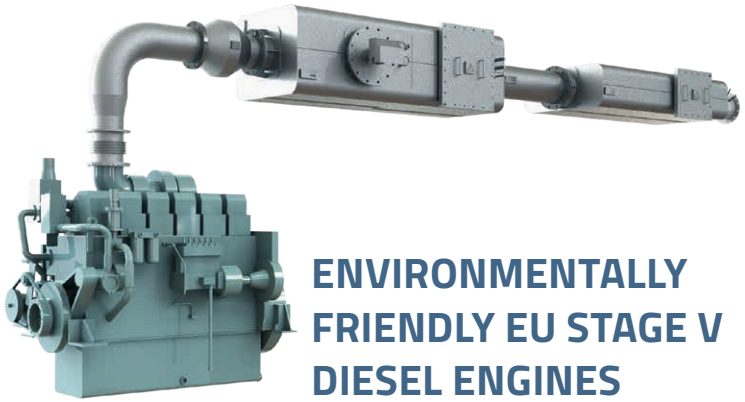
**This sounds like a complex development. How do you stay efficient in this process?**

We actually developed the control system separately from the Piping & Instrumentation Diagram by creating a digital twin. First, we worked out the control system on a conceptual scale in MATLAB® to control all the parameters and fine-tune the system. And then, we put sensors on the model to check it was operating within the desired boundaries.

With the Bachmann automation system, it was very simple to transfer this digital twin to an actual PLC automation platform. Connecting the IOs from the field site to the right points in the model was as easy as sending an email. So in the end, everything was fixed and tested in the digital twin, we just needed to confirm it in the field. This provided a great parallelization in the engineering process. I think it saved us about two or three months of programming work compared to a serial process.

The fuel cell system will be field-tested by the end of this year. By Christmas, the first fully zero-emission inland maritime vessel will set sail here in the Netherlands – on Hydrogen.

**Thanks for the interview.**



## ENVIRONMENTALLY FRIENDLY EU STAGE V DIESEL ENGINES

The Koedood Marine Group of companies specialize in diesel engines and exhaust after-treatment systems, among other things. Together with Mitsubishi, the scientific institute TNO, and the type-approval authority RDW, Koedood developed KEES – the Koedood Engine & Emission System. The combination of diesel engine and after-treatment system is EU Stage V certified. With its low fuel consumption and emissions, KEES sets new standards in eco-friendly shipping.

According to Sander Roosjen, R&D Manager of Koedood, the combination of engine and after-treatment system required a large amount of automation, sensor, and actuation technology. In addition, the software needed to fulfill various requirements to comply with EU Stage V legislation.

Therefore, a robust, marine-certified, and very flexible engine automation platform was required. "It was important for us that this platform is able to grow with the wave of digitalization that we see. Therefore, we worked together with Bachmann not only during the selection and testing phase of the automation system, but also discussed the further development of new digital technologies we want to apply in our EU Stage V platform," said the R&D Manager.

One of Koedood und Bachmann's next co-developments is a remote platform, called 'fleet manager', to visualize every parameter and alarm from the range of vessel engines in the field. For Sander Roosjen, this will be the first step towards big data, enabling novel technologies such as machine learning and predictive maintenance.

One of the first applications of the Stage V engine are so-called River Drones, 10 semi-autonomous vessels, which are controlled from the shore in Antwerp. The 106-meter-long ships are each equipped with two Koedood Stage V engines, two 360-degree rotatable all-electric EQUADRIVE® pod drives, and one bow thruster from Verhaar Omega. Engine, pod drives, and bow thrusters are all controlled by a Bachmann automation system.

# »Virtual reality helps us to succeed in the real world.«

# THE WORLD TURNED UPSIDE DOWN

The popular atvise® scada solution now supports cloud-based central data collection and evaluation - replacing the atvise® portal environment. The multi-client capable, cyber-secure solution reliably secures data even in the event of long-term communication failure on the open ocean.

### Onboard cybersecurity

When atvise® scada is implemented as a cloud server solution, onboard controllers communicate with the server as clients via OPC UA. This offers a major security advantage: Dynamic IP addresses ensure that onboard controllers are no longer vulnerable to attack. The public network can be used for exchange between clients and server, and a VPN connection is no longer necessary.

### Seamless recording

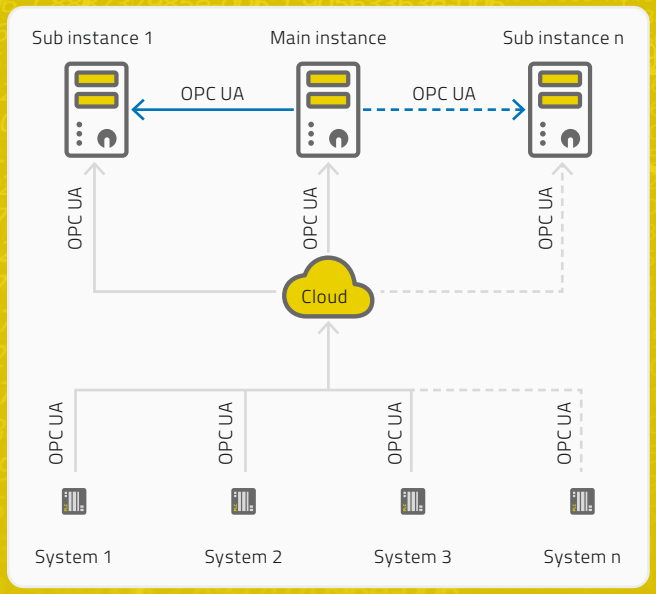
During long voyages, it is extremely difficult to ensure an uninterrupted internet connection. Onboard Bachmann controllers reliably store application-related data in the respective circular buffer. As soon as a connection to the server is re-established, a complete data history is sent to atvise® scada via the cloud. Depending on the sampling rate and available memory, even months-long interruptions to the internet connection can be bridged without data loss. All related data converges at a central point in the cloud, simplifying onboard process analysis. An additional onboard main client handles data backup for all individual controls when required.

### Secure user management

atvise® scada's multi-client capability allows access to information to be clearly defined based on role. If, for example, different forwarding companies charter ships from the same shipping company, each forwarding company can only access data on the shipping company's server for the ships they have chartered. Access can also be defined for individual ship components. For example, a service technician only has access to data for the specific propeller unit being serviced.

### No limits

Connection via OPC UA ensures data from third-party controllers can also be stored and evaluated in atvise® scada: The cloud solution is infinitely scalable. If server-side resources become limited, then storage can be easily expanded with additional sub-instances.

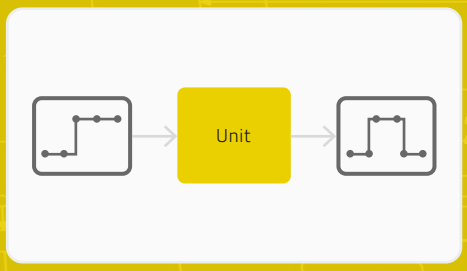



Onboard client controls exchange data with atvise® scada via the cloud. If the connection is interrupted, all data is stored in full for days, weeks or months. The server resources can be expanded as required.

Numerical Simulation

# TARGETED SIMULATION

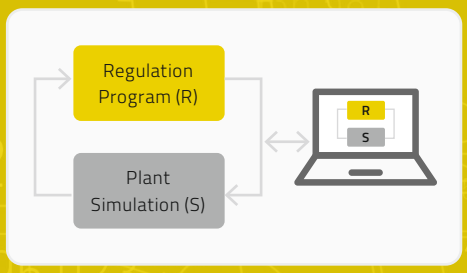
When it comes to machines and plants, it is often complex regulation and control concepts that provide a technological advantage. In many cases, however, these concepts contain several, sometimes contradictory, control objectives. Numerical simulation helps maintain an overview and determine appropriate machine behavior. The method applied depends on the stage of development.




## Unit testing

Clearly-defined functions and components provide the foundations of user programs. Their behavior is verified via unit testing. An input sequence is applied to the component and the results are evaluated.

**Objectives:**
- Verification of individual components
- Ensure that only verified individual components are used in the application
- Function validation – including for possible future adjustments



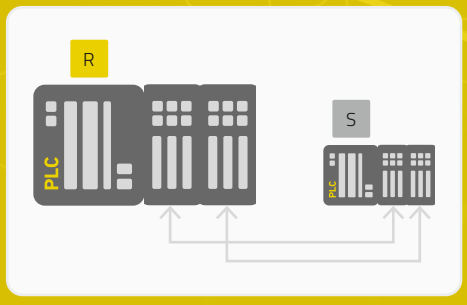

## Software-in-the-loop testing (SIL)

The control and regulation program is tested in a simulation on an engineering PC.

**Objectives:**
- Verification of successful program build processes
- Verification of application functionality in all operating states

## Hardware-related testing

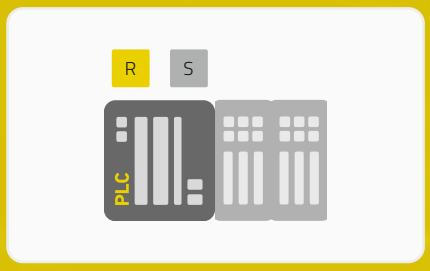
Applications are run as target hardware on an Bachmann controller. Final test setup depends on the testing objectives:




### 1. Hardware-in-the-loop testing (HIL) with two M200 systems

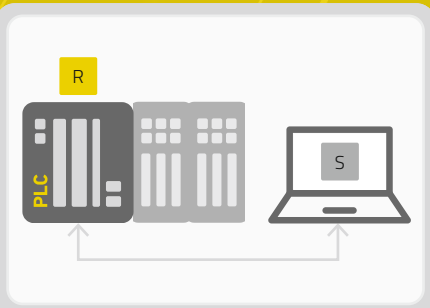
The M200 target hardware communicates with the external system for plant simulation via its I/O interfaces. This system, implemented by a second Bachmann controller, enables hard real-time with high I/O channel count flexibility.

**Objectives:**
- Verification that the application has been successfully embedded in the machine's automation system
- Verification of CPU load, memory usage and real-time behavior of system control for all potential operating conditions




**2. Common M200 control**
For testing individual sub-applications, a simple plant simulation is installed as a separate software module on the M200 target controller.

**Objectives:**
– Test interactions between individual sub-applications (e.g. control program and higher-level operational management); here the configuration differs from that of the overall system
– Verification of program modifications by providing a simple test infrastructure at developer workstations




**New: Co-Simulation**
Parts of the plant simulation are executed on an engineering PC. A Simulink® model, executed in real time via the new M-Target SimConnect interface, can be coupled with the M200 target controller with just a few clicks.

**Objectives:**
– Extend plant simulation to include components that can only be simulated on an engineering PC
– Easy integration of prepared dynamic simulation models when source code is unavailable



# A STANDARDIZED FUTURE

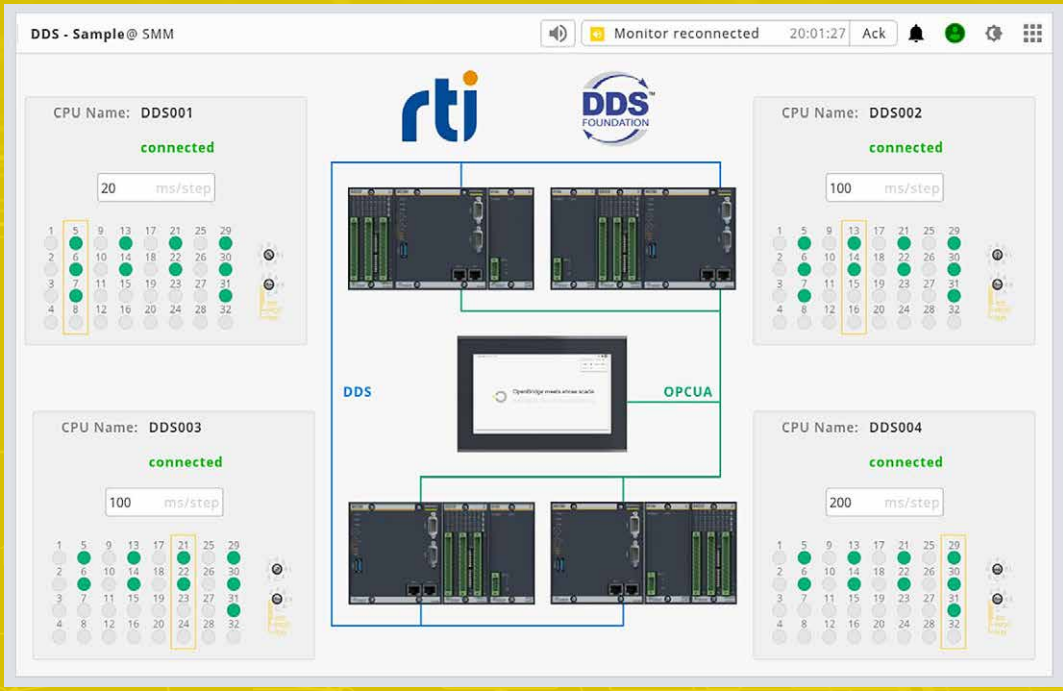
Bachmann supports the Module Type Package (MTP) description format, the OpenBridge design framework, the Data Distribution Service (DDS) middleware protocol and the J1939 network protocol - ensuring the simple, fast and reliable development of future-proof automation solutions for the maritime industry.

**New engineering standards**

Today's shipbuilding industry is facing a paradox, explains Ronald Epskamp, Business Unit Manager Maritime at Bachmann: "While modularity is increasing in the structural aspects of shipbuilding, the use of modular software is still in its infancy." Following the development of new engineering standards together with leading manufacturers in the maritime sector, this is now set to change.

**Simple integration**

The MTP description format standardizes the interface between systems and control level. This ensures that manufacturers of subsystems such as thrusters, gearboxes or separators are easily able to make application visualization objects and interfaces available to SCADA. "With MTP, ship equipment can be visualized and operated immediately following import into atvise® scada, according to manufacturer specifications," explains Dirk Knollmann, Key Account Manager Sales Maritime DACH at Bachmann. This not only saves time and costs in automation system engineering and commissioning, but also improves safety through




The clearly arranged OpenBridge interface shows four controllers connected via the Data Distribution Service (DDS). With DDS, all controllers communicate in real time and directly with one another without a broker or master. The constant availability of up-to-date data is the basis of reliable, autonomous operations. Without a master control, the system has no 'single point of failure'.

the use of modules that have been pre-tested by the manufacturer. In addition, standardized communication with MTP allows new systems from other suppliers to be retrofitted and integrated with ease.

**Intuitive operation**

The development of safe and efficient maritime workplaces continues to be driven by the open-source design guide OpenBridge. Clear and consistent design, as well as reusable components, support the cross-fleet design of simple user interfaces with intuitive interactions. With numerous OpenBrige elements in atvise® scada, the screen interface can be designed with widgets during system runtime, and then adapted to user needs – reducing workload on the bridge. The uniform look and feel also reduces the adjustment period for crew when transferring to a new ship.

**Autonomous systems**

The Bachmann controller supports Connext® software from Real-Time Innovations (RTI), the largest software framework provider for autonomous systems. The software is based on the Data Distribution Service (DDS) – an open standard for message exchange, which features high data connectivity and scalable architecture for real-time applications. This allows secure and reliable connectivity with real-time data exchange, regardless of manufacturer or platform. The collaboration provides the foundation of future application areas such as autonomous shipping.

**Standardized network communication**

The Bachmann J1939SRV software module for the Bachmann controller facilitates the monitoring and control of diesel engines with CAN-based standards J1939, ISOBUS and NMEA 2000. Triggered or cyclically-transmitted data can be accessed in Bachmann's SolutionCenter, or in a visualization system, without any additional programming effort.

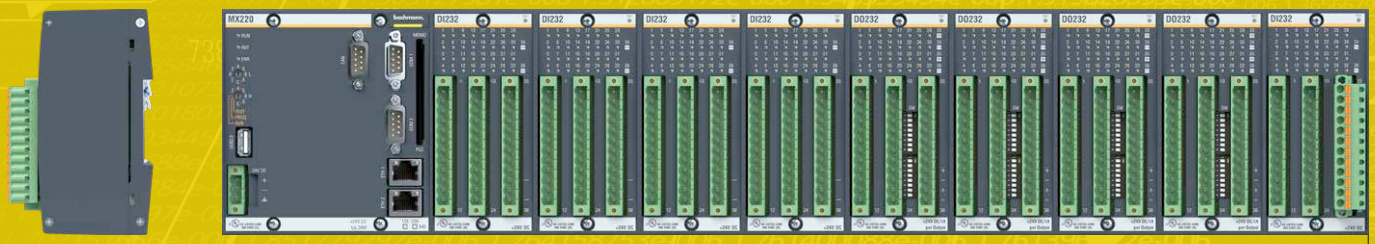
Bachmann is committed to the development and support of upcoming industry standards – to further promote the simple development, rapid commissioning and reliable integration of automation solutions for the maritime industry.

M100 Series

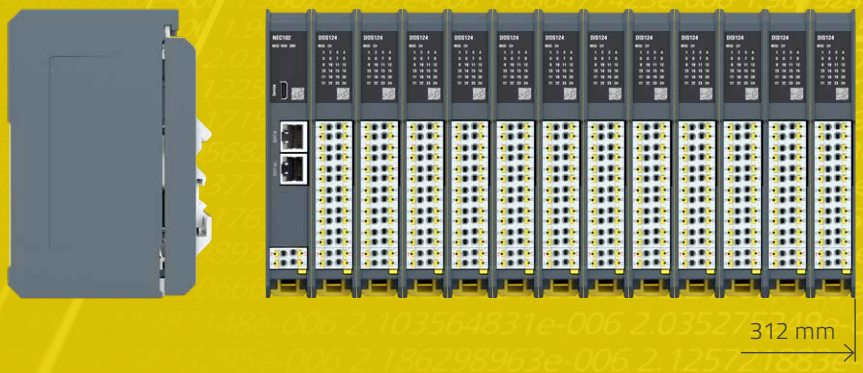
# SLIM AND STRONG

Bringing decentralized periphery into new dimensions: With the launch of the M100, Bachmann delivers an I/O system which, thanks to its uncompromising robustness, fits perfectly into the Bachmann portfolio. But not only that - the M100's compact dimensions also open up completely new possibilities for machine and plant builders.

## M200




## M100




**The M100 sets new standards:**
144 digital inputs and 144 digital outputs with a width of just 312 mm.

In a world where automation has always required a choice between durability and compactness, the M100 from Bachmann provides the answer: 24 digital or 12 analog inputs/outputs that require a module width of just 24 millimeters. With a focus on maximum availability and stability, the system makes no compromises despite its small size. Each module, packaged in an EMC-proof metal housing, withstands shock, vibration, extreme temperatures and condensation – everything you have come to expect from Bachmann automation systems over the previous decades. Never before seen, the M100's high density of functions is possible due to state-of-the-art technology and a sophisticated thermal design. The hous-

ings do not even require ventilation slots, eliminating the risk of production- or maintenance-related dirt or particles contaminating the system.

**Built to withstand the elements**

Modular machine concepts significantly reduce the cost of variants. The decentralized positioning of I/O stations also reduces wiring effort, and therefore costs. With the M100 I/O system, up to 744 digital or 372 analog channels per station can be positioned cost-effectively in the smallest possible space. For the first release, Bachmann has utilized EtherCAT as a standardized, real-time capable fieldbus. Subsequent releases will also enable the use of other communication standards to connect with the M100 I/O system. Thanks to the M100's IP40-compliant design and mounting concept, stations can be mounted directly on or in the machine, either on a DIN rail or with screw fixings. Individual modules are also screwed into place, remaining stable even under considerable vibration or impact loads.

**State-of-the-art technology**

Bachmann adopted the most up-to-date approaches when designing the hardware platform: System architectures, processors, logic, and signal interfaces are based on the newest technologies and provide a backbone for minimal power loss, ultra-fast data transmission and next-generation IT security. Secure Boot initialization prevents any compromise to fieldbus hardware, and enables the secure integration of remote I/O stations into the automation network.

The internal, active module bus is designed for a data throughput of 50 Mbit/s per module, making it a long-term solution for data-intensive applications. With big data in mind, the M100 provides machine builders with a solid foundation for future applications, such as predictive maintenance.

**Best-laid signals**

Signal connectivity has also undergone a major redevelopment: cables connect directly to the module at push-in, spring-loaded terminals, and the fully-removable connector allows the control cabinet to be prewired without electronics. All contact elements are generously dimensioned for UL-compliant wiring and are locked to prevent vibration. A separate test connection also enables convenient signal measurement. The I/O modules are available for multi-conductor connection technology (2-, 3- and 4-wire).

**Next-level engineering**

Project planning takes place in the familiar SolutionCenter – but with completely updated usability: "When it came to the M100 I/O system's user configuration, we decided to start from scratch and came up with a completely new approach," says Daniel Pfeifer, Technology Director at Bachmann electronic.

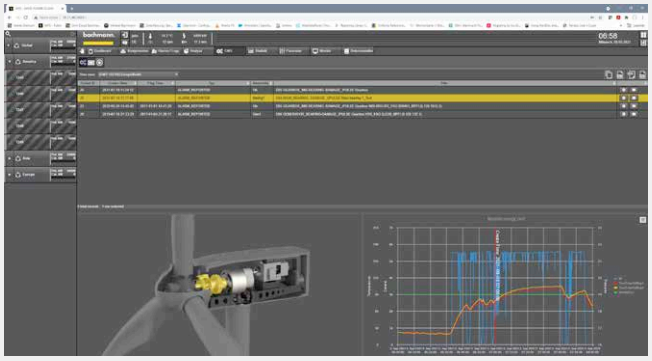
It goes without saying that M100 units are fully compliant with all relevant standards. This makes them particularly suited for demanding applications in challenging environments, such as on maritime vessels. M100 delivers robustness and high availability, everything you expect from Bachmann. And with the slimmest dimensions to date.

W100
W100

»One intelligent portfolio for countless applications.«

# WIND POWER SCADA: USABILITY UPGRADE

Wind Power SCADA is well-established among operators as a reliable solution for the analysis, monitoring and control of wind farms. The newest version offers easily-importable turbine objects, freely-composable dashboards, and other useful features that once again significantly improve the user-friendliness of this SCADA solution for wind power.



If the condition monitoring system triggers a ticket, then WPS automatically displays relevant incident data thanks to preselected variables. These variables are flexible and can be customized by the user.

Predefined and user-definable widgets enable a highly flexible display of required information. With the live button, operators can quickly switch between live and historical views for individual widgets.

### Simple integration

The integration of different turbine types from different suppliers into Wind Power SCADA (WPS) has been greatly simplified thanks to a generic turbine configuration. In accordance with IEC 61400-25, the turbine object's entire data model is automatically generated and can be uploaded to SCADA without manual intervention. All ready-made WPS functions are included.

### Fully customizable

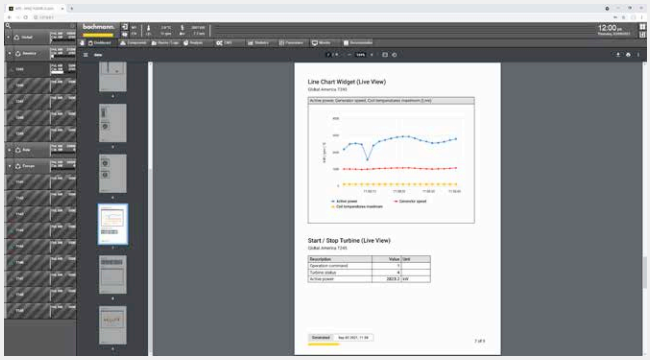
Following the integration of wind farm turbines, the dashboard can be compiled as desired with predefined and self-parameterizable widgets. Inserting widgets into the dashboard is now more efficient thanks to a preview of the most important information. Info widgets are filled completely automatically and without manual intervention. User-defined widgets can be populated with desired variables with a simple drag and drop.

The display is highly flexible: Values can be displayed as diagrams, tables or a thermometer in the case of a temperature. Analysis is further simplified with helpful functions, such as a collective online trend display that includes data from multiple plants.

### Effortless diagnostics

For the first time, WPS can now display condition monitoring data, including CMS Weblog Server tickets as well as live ISO sensor values. The aggregation of live data, events, and high-resolution and precise historical data from the Bachmann controller provides further insights about the condition of operating equipment.

Existing tickets are easily identifiable as icons on the dashboard's corresponding widgets. Bachmann has predefined a topic-dependent selection of important variables. When an operator clicks on a ticket, historical data specific to that ticket is displayed automatically. Of course, the selection of variables can be customized as required.



Customizable reports are available as PDFs at the touch of a button.

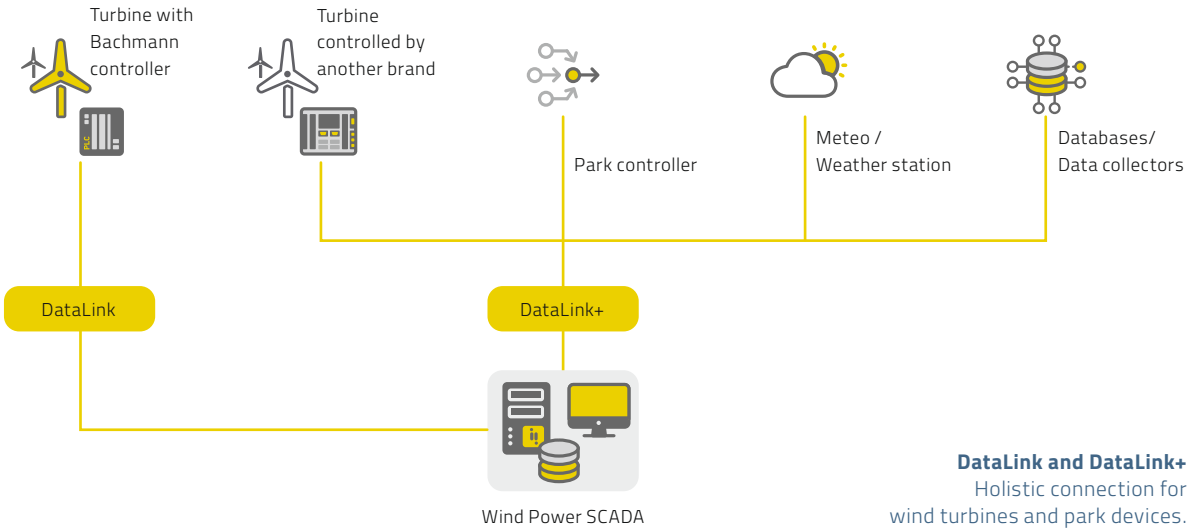
### Automatic reporting

Also new to Wind Power SCADA is a directly integrated, powerful reporting engine. Using the dashboard, composite PDF reports containing historical data, as well as live values, can be created at the click of a mouse. In addition to generating a one-off report, reports can be generated automatically according to a predefined time schedule.

## NEXT STEP: FULL CONTROL INDEPENDENT OF HARDWARE PROVIDER

"DataLink+" will deliver a universal gateway to Wind Power SCADA. Combining the "DataLink" software with either a Bachmann processor module or as "DataLink+" installation on a server or terminal, enables an equal interface and easy integration in Bachmann Wind Power SCADA. Operators with wind turbines from different suppliers can take advantage of WPS for their entire wind farm.

The management and control of all operating devices in the same SCADA environment significantly reduces maintenance effort and system costs. Without needing to collect data from different systems and databases, data analysis becomes much more efficient. By the use of "DataLink", all events and historical data are buffered over a period of up to two weeks and prevents data loss. The latest security standards and access rights management also minimize the risk of cyber attacks.




**DataLink and DataLink+**
Holistic connection for wind turbines and park devices.

Would you like to experience Wind Power SCADA live?
We would be happy to show you our impressive demo environment.
Contact us! info@bachmann.info

# THE ART OF VISUALIZATION: NINE REASONS TO CHOOSE atvise®

For those who take 'digitization in automation' seriously, the atvise® visualization system from Bachmann is the only viable option. In stark contrast to the rigid automation pyramid structures still in widespread use, the atvise® architecture offers total freedom when it comes to both design and definition.

Increasing plant complexity and an ever-higher degree of automation require forward-looking technologies. This is the only way to effectively monitor and control the processes of tomorrow. Thanks to their generic structure, atvise® HMI and SCADA solutions fit in perfectly with all application areas and industries.

There are at least nine reasons to depend on atvise®:

1

**OPC UA at the core**
atvise® is implemented based on OPC UA, which enables standardized, vertical, object-oriented work across all levels of the automation pyramid. atvise® always acts as both server and client, ensuring the best possible performance in industrial data handling. Alarms and historical data can also be synchronized seamlessly across multiple levels – without manual intervention.

2

**Comprehensive portfolio**
atvise® always provides a full range of functions on all supported platforms – for both low-end and high-end hardware. The supported portfolio ranges from simple IoT edge devices to cloud-based HMI and SCADA solutions.

3

**Straightforward licensing**
With a practical, transparent licensing model, atvise® offers maximum freedom when it comes to implementation. Counting data points and separate client licensing are now things of the past.

4

**Unrestricted implementation**
atvise® solutions can be expanded at any time. Current standards create a foundation for highly interoperable and future-proof visualizations. The open platform offers users huge freedom in design: standard components can be modified at any time and custom HTML components can be created with the engineering tool. And there are no obstacles to employing the latest front-end frameworks.

**Pure-web technology**
Visualizations with atvise® are designed to be completely flexible. They are based on modern web standards, rely on vector graphics and are customizable. Any end device with a web browser can become a SCADA client, without any installation effort or additional licensing costs.

5

**Independent integration**
atvise® supports Windows and Linux operating systems as well as ARM processor architectures. Performance is fully scalable – from the smallest IoT device to SCADA servers with several million data points.

6

**Save time with online engineering**
atvise® is built on online multi-user engineering that is fully graphically supported. This means that project changes can be made during runtime without wait- or downtime, without interrupting current processes, and without data loss caused by restarts. The project server can be accessed by several users simultaneously, reducing time to market.

7

**Rapid installation and updates**
A single server installation without client licenses provides installations and updates in minutes without additional configuration or installation.

8

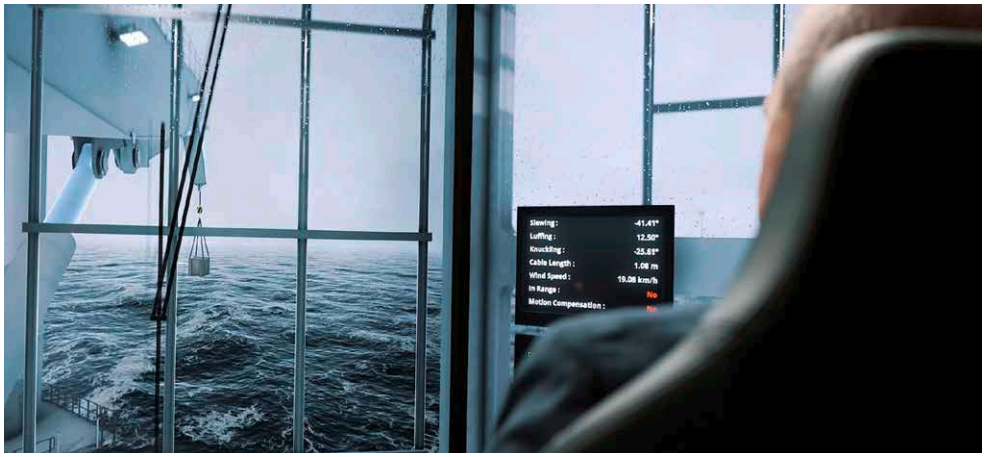
**Added operator value**
Powerful web visualizations with touch-optimized object catalogs offer clear and fluid touch gestures on mobile devices.

9

Interested?
We would be happy to show you the art of visualization.
Please contact us. visutec@bachmann.info

# DIGITAL TWINS: ILLUSION OR MAGICAL TECHNOLOGY?

When it comes to the technological developments of the future, it is impossible to avoid the term "digital twins". Just a buzzword? Not at all. Maritime industry thought leaders are already using digital twins to develop solutions faster, improve safety and optimize usability. Here we provide an insight into current applications of this promising technology, made possible with Bachmann hardware.




During the Digital Twins seminar, industry experts were able to experience digital twins live and in practical applications. The Rotterdam seminar was organized by Bachmann and partner companies and took place in June 2022.

### Controllab: Virtual reality

With the help of game engines, Controllab software simulates the behavior of high-tech offshore and operating equipment in elaborately-designed virtual 3D worlds. Following extensive hardware-in-the-loop testing, the control and design of robots, motion-compensated landing bridges, cranes, and many other applications are perfected with digital twins before being transferred to real world applications.

### MARIN Zero Emission Lab: Digital and Physical Reproduction

The Maritime Research Institute Netherlands (MARIN) conducts hydrodynamic and nautical research together with industry. As well as studies using wave generators in water tanks, MARIN also uses digital twins to model a variety of mechanical, electrical, control and hydrodynamic processes in its Zero Emission Lab. Among other things, the institute is researching the impact of alternative fuels and new energy storage concepts on overall ship design. Existing control strategies are also tested virtually for their suitability in different wave conditions. If necessary, MARIN constructs a real-world model ship to validate results in a water tank.

### VSE Industrial Automation: Quick commissioning

VSE conducts process automation and optimization in a wide variety of sectors. Together with Controllab, the company equipped an existing towing carriage at the Hydraulics Laboratory in Antwerp (Belgium) with a new controller system to track the movements of a model ship in a towing tank. The accuracy of the steering, safety and control systems could be extensively tested with the digital twin without removing the towing carriage from service.

It was also possible to model extreme conditions normally only encountered in the event of a disaster. Thanks to the simulation, damage due to undesired controller behavior could be prevented. Commissioning was completed within one week – an enormous difference from the six weeks required without a digital twin.

### MSA Service: A transparent past

MSA-Service supports its customers in the wind and maritime industries with customized electrotechnical solutions for their automation projects. The company uses digital twins to look back in time: MSA-Service's Multiped software collects a huge amount of existing ship data and uses it to create a digital model. With this, specialists analyze possible causes of past incidents and then derive measures to improve future developments.

# THINKING & ACTING AHEAD

Structural monitoring promotes safety and maximizes value.

Wind turbines must reliably produce clean electricity for 20 years or more, at times under extreme wind and climatic conditions, and, most important of all, they must do so safely. Onshore German turbines are increasingly being positioned in densely populated areas, close to roads and residential areas. If a turbine were to collapse, or if components became detached, then not only would significant economic loss entail – human lives could also be at risk. The call to monitor structures with Structural Health Monitoring (SHM) is becoming increasingly louder. And its widespread introduction makes perfect sense.

Rotor blades more than 100 m long, total height of over 250 m, rated capacity of more than 12 MW – and the end is not in sight: on average, wind turbines are becoming ten percent larger every two years. However, this increases demand on the structure and materials, which have to withstand massive loads.

## Growing risk

Supply chains for materials have been disrupted and the search for alternatives is on. At the same time, to reduce both mass and costs, there are increasing attempts to use alternative materials: Carbon rotor blades are replacing fiberglass, and hybrid towers –prefabricated steel tower segments with a concrete base – are under construction. There is also a trend towards constructing much softer towers. With this type of design, however, operational resonances must be avoided at all costs. Moreover, materials savings may make the structure more fragile as safety margins are reduced.

This increases the complexity of plant control, as well as the required measurement and control technology. After all, the reliable prevention of unfavorable operating conditions, by means of an intelligent control system, must be possible. Therefore, there is much to be said for the expansion of measurement and control technology. Intelligent control strategies and concepts can reduce loads – enabling the use of leaner components. The bottom line is that the potential for cost savings through lower material usage is significant.

Of course, the risks associated with wind turbine construction are nothing new: rotor blades sometimes break, towers sometimes collapse. The only difference is that structural loads, and the associated potential hazards, are increasing as turbines get bigger. And the effects of such a catastrophe would be significantly more serious.

### Risks – or maybe not?

After the standard twenty-year operating period, the question arises as to what condition the wind turbine structure is in. Could its license be extended in order to remain in operation for another five or ten years? If so, this would massively improve ROI, and also help bridge the existing expansion gap when it comes to achieving energy transition targets. But this requires reliable data on whether turbines have actually experienced the loads for which they were originally designed.

### Accident causes serious concern

In September 2021, a dramatic event made headlines: One of Germany's tallest onshore wind turbines collapsed after only a minimal period of operation. Fortunately, no one was injured, but damage to the turbine was considerable. However, lost income following the shutdown of every identical turbine for safety reasons far exceeded the cost of the initial damage. Some years earlier, the nacelle of an offshore wind turbine fell into the sea. And, likewise, every similar turbine was shut down for safety reasons – abruptly removing the output equivalent to a nuclear power plant from the grid. The question arose: Could an event like this have been foreseen?

### New value, old components

All modern wind turbines are equipped with drivetrain vibration monitoring – a proven method for avoiding catastrophic failures in rotating components. However, structural monitoring is crucial for the prevention of consequential damage, as described above. And because precise structural knowledge would also provide the basis for potential service life extension, Structural Health Monitoring (SHM) and, ultimately, Health and Usage Monitoring Systems (HUMS) are increasingly attracting the attention of operators and investors.

HUMS systems record and collect (operational) data and analyze it from different perspectives. This opens up the potential to increase a plant's availability and performance, and reduce costs, as well as the benefits previously described. This includes, for example, Condition-Based Maintenance (CBM).

Bachmann Monitoring has developed algorithms and artificial intelligence methods for deriving such added value. These are founded on existing data, for example from the plant's condition monitoring system, as well as measurement data from special sensors that detect structural vibrations (Factbox: '3D MEMS acceleration sensor').

### Life time extension

Structural Health Monitoring provides the information required to assess structural integrity. However, it also helps to reduce fatigue stresses by avoiding unfavorable operating situations that exert stress on the structure. One example being situations that would cause resonances identical to a turbine tower's natural frequency. Thus, it not only improves the safety of a facility – it also reduces maintenance costs.

With SHM, it's possible to extend operating permits beyond the planned period of operation based on the actual condition of the plant. And that's cash in your pocket.

## 3D MEMS ACCELEROMETER

The 3D MEMS (Micro Electronic Mechanical Systems) accelerometer is a triaxial accelerometer and an important component for the detection of structural vibrations in the Bachmann Condition Monitoring System.

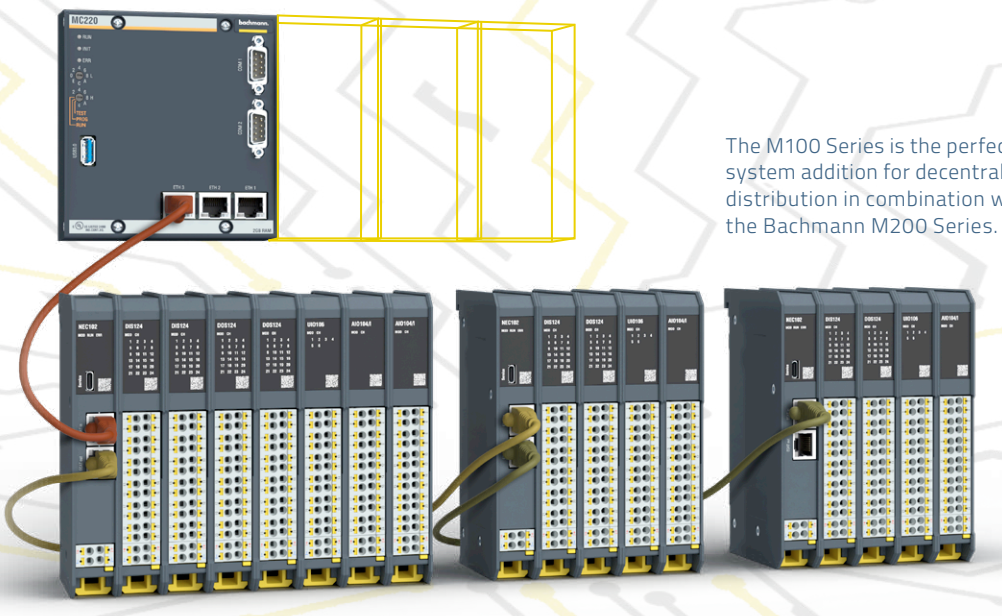
The sensor has high sensitivity and low noise. It also enables simultaneous acceleration measurement in three mutually-perpendicular axes. Signals are used to assess rotor blade imbalances (mass and aerodynamics), monitor structural condition, and evaluate the natural frequency of towers.

M100 I/O System

# TOUGH WITHOUT COMPROMISE

Bachmann stands for robust and powerful automation solutions, properties that are further proven by the capabilities of the M100 Series.

Founded on the Bachmann quality guarantee, our aim was to develop a system extension to optimally deliver a modular machine concept, utilize the latest technology, and ensure maximum availability. The M100 Series comprises a wide portfolio of relevant modules for decentralized signal acquisition, processing and output. Remote units are securely connected to the controller via standardized, real-time-capable fieldbus couplers.




The M100 Series is the perfect system addition for decentralized distribution in combination with the Bachmann M200 Series.


**With its metal housing, the design is highly compact, extremely robust and packed with functions:**
M100 Series – Minimize breakdowns caused by operating conditions and guarantee high-efficiency operational performance over the long run.

**The variable fieldbus connection is prepared for every important communication standard, such as EtherCAT and CAN:**
M100 Series – Minimal engineering and installation costs with an agile, secure communication architecture.

**The completely new hardware architecture and a system design based on the highest security standards are built for the long term:**
M100 Series – Ensure the best possible future for your system with impressive performance, state-of-the-art technology, and a variety of expansion options.

# FEATURES

### Environmental robustness

– Bolted mounting on stable and torsion-free backplane
– High-quality protection against penetrating dirt and moisture on all sides
– High shock and vibration resistance
– Operating temperature range from -30 °C to 70 °C
– Condensation-resistant "Extended Climate Range" variants
– EMC-protected metal housing

### Next-level architecture

– Latest technology in hardware components, logic and signal interfaces
– Multicore controller with dedicated network control units for higher throughput and clock rate
– Next-level security with TLS chip, secure boot and fast encryption/decryption

### All in one

– State-of-the-art ASIC and FPGA technology allows the integration of several different functions in the same hardware design; this reduces development, testing, and machine and system servicing costs

### Performance

– Delivers top-level automation with large reserves for future applications
– Extremely high data throughput for big data analysis and predictive maintenance applications
– Instantaneous module-to-module communication

### Separate potential groups

– Circuit decoupling in case of faults allows partial operation
– Easier troubleshooting in the event of a fault
– High operational security and reliability

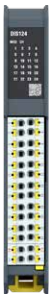
### Potential bridges

– Tool-free, extremely quick assembly without wiring effort delivers time and cost savings

# PRODUCT PORTFOLIO

### Node Adapter EtherCAT

NEC102 – robust link to the M200 Series with powerful performance and integrated station power supply.



### Digital I/O Modules

DIS1xx / DOS1xx / DOH108 – modules with 8, 12 or 24 channels with single and multi-conductor connection. High-performing and integrated functions such as counters, time stamping or pulse modulation.

### Universal I/O Modules

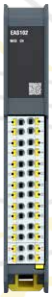
UIO106 – input and output module for all common analog and digital signals, with channel-by-channel configuration.

### Analog I/O Modules

AIM112 / AIO112 offer great compactness with 12 analog channels per module. AIO104/I equipped with interference protection thanks to channel-by-channel isolation.

### Accessories

– Backplanes with varying numbers of slots (BPS1xx / BPR1xx – 4 to 32 Slots)
– Accessories such as connectors, potential bridges, etc.



### Counting and Position Encoding Modules

EII102 – up to 6 independent counters or two A/B/Z encoders.

EAS102 – capture two absolute positions via SSI protocol.

# READY TO EVOLVE – A PARADIGM SHIFT IN ENGINEERING

Engineering for the M100 has also evolved. For example, the future configurator can automatically determine the appropriate module combination from the desired channel functionality and required number of channels.

**The result:**

– High flexibility in the ongoing development process of plants and machines, as well as easy handling during commissioning
– Fast and convenient configuration in SolutionCenter including fieldbus and network configuration
– Faster channel adaptation to new hardware combinations
– Mapping of I/O process data to “Unified Fieldbus Model”, and therefore easy integration into existing software projects
– Fieldbus-independent configuration for future bus systems

»We claim to deliver permanent system availability, so our focus is always on the secure combination of state-of-the-art technology with robustness.«

**Daniel Pfeifer**
Director Technology at Bachmann electronic

»Pioneers, thought leaders, creatives, investigators, visionaries – Science is so beautifully diverse.«

Insights into Bachmann

# ONE STEP AHEAD. AT LEAST.

The Bachmann competence center for visualization:
Not only is Eisenstadt the capital of the Austrian province of Burgenland; it is also home to the Bachmann Group's competence center for operating, monitoring and supervisory technologies. The driving force behind the Eisenstadt team is to further advance the development of generic visualization and control center solutions.

Sheltered by the densely wooded ridges of the Leitha Mountains, the lush surroundings of Eisenstadt, close to Lake Neusiedl, are bursting with ripening grapes, apricots, peaches and almonds. But peaches aren't the only thing that ripen here; state-of-the-art automation concepts are also bearing fruit: "Here, we have plenty of room to develop our passion for connecting people and technology in the best way possible," says Florian Blümel, Team Leader Sales & Automation at Bachmann Visutec GmbH, describing the high standards the team sets itself.

### Passion as a driving force

Collecting experience, thinking ahead, looking to the future, being inspired, trying new things, and acting courageously: these are the values ingrained into the site's approximately 35 employees. According to Blümel, this also includes continuously setting new, forward-looking trends for the entire automation sector: "As a technology leader and pioneer in the use of OPC UA and web technology, we are challenged to constantly evolve, and to find solutions today that will realize the needs of our customers tomorrow."

### Big data behind the framework

An entire floor of the Kasernenstraße building, in Eisenstadt, is dedicated exclusively to the continuous further development of HMI and SCADA solutions. For Detlef Sommer, Head of R&D at Bachmann Visutec GmbH, it is clear that data volumes are continuing to increase. The greatest challenge for a SCADA system is to provide relevant data to the right user quickly and precisely, and the system must also be able to cope with larges influxes of data at any given time. The site's numerous developers are supported by a portfolio of modern tools. Ultimately, the aim is to ensure function and compatibility on Windows and Linux platforms, as well as ease of installation from the smallest single-board computer to atvise® cloud applications. "Impossible without a high level of automation during development, up-to-date development processes and sound testing support," says Sommer.

### Complex yet reliable visualization

Visualizations must operate 'everywhere, without interruption'. To this end, it is necessary to master every browser on every platform. These are the central requirements for developers who, in addition to the constant expansion of symbol libraries, are concerned with further developing sophisticated WebSocket-based communication. After all, this is the key to establishing interactive communication between the user's

browser and server. In addition to the best possible usability, IT security is a top priority for developers. Here, Bachmann meets the highest standards, a fact recently demonstrated by a penetration and vulnerability test of the atvise® web application and underlying web server, carried out by an independent specialist body: Based on the OWASP test catalog with 89 application-relevant tests, 85 received a 'passed' rating. This corresponds to a fulfillment degree of 96%. Florian Bogner, CEO of Bee IT Security, who audited the software, confirms: "During the security audit, it became clear that security was a particular focus throughout the development of atvise®. We saw this in its sophisticated rights management, for example, as well as the implementation of self-protective data rate limitations."

### A room full of hardware

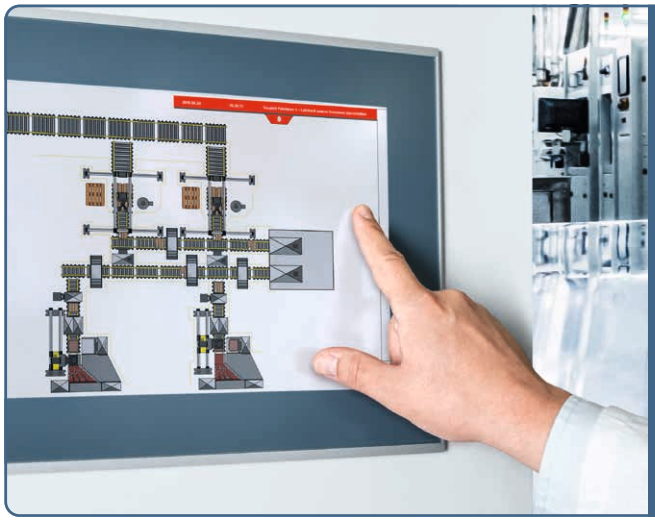
Software compatibility is one thing. But to ensure that atvise® can also be installed on any hardware, one room of the Eisenstadt building is dedicated to the employment of multiple devices from a wide range of platforms, in addition to countless virtual test environments. Here, the integration and long-term availability of applications are put through their paces. A tool chain developed specifically for this purpose simulates complete, realistic SCADA projects, including all associated peripherals, thus enabling automated performance analysis. "Every software release goes through it. This is how we ensure that computing power is applied in the right places, and that the visualization's performance is not impaired at any crucial points despite an expansion of its functions," explains Detlef Sommer.

### Customer applications at the heart

"Every company is unique. That's why we work with each customer on an individual basis," says Florian Blümel. Fast, competent and, above all, personal support is therefore Bachmann's top priority. It is not just a matter of providing the right technologies, he adds, but also bringing the right people together. "This is what allows us to achieve optimal results together, creating a sustainable basis for genuine win-win relationships," explains the team leader. If the customer lacks appropriate resources, then Bachmann is on hand to offer support with application development. Of course, there are plenty of product training sessions and webinars, and their popularity is growing. "It is not unusual for well over a hundred people from across continents to take part in these sessions," says Blümel.

### Innovating into action

Proximity to applications and customers, collecting ideas – and implementing them. This is the simple recipe for success among the employees at the Bachmann Visualization Competence Center. It comes as no surprise that they have been working on AI methods for data evaluation and augmented reality for some time now. And these are just two of the stepping stones en route to the visualizations of the future. atvise® users are always one step ahead. At least.



## OPERATOR TERMINALS – READY-TO-USE

The multitouch-capable operator terminals of the OT product series offer a combination of modern technology, flexibility, long-term availability and modern design.

The installation is individually adaptable to customer requirements and is pre-configured and pre-licensed ex works with atvise® for efficient commissioning.
As a single source solution, everything comes prepared to deliver a smooth web visualization.


Shipbuilding Fairs

# AT LAST

Singapore, Norway, Germany, Spain, the Netherlands and Greece – it was one shipbuilding fair after another almost monthly throughout 2022.
And Bachmann had a lot to show.

"At last, face-to-face discussions and real meetings," says Ronald Epskamp, Head of the Maritime Business Unit, happily. "The previous two years were characterized almost exclusively by online meetings, but this year we were finally able to proudly present our innovations live and hands-on."

## Modern drive and energy concepts

In Singapore back in March, for example, Bachmann demonstrated the world's first hybrid tugboat controller system, jointly developed with Invertek, which is already in use. Open-source design elements for modern alarm monitoring and navigation interfaces in atvise® scada's OpenBridge library, designed by the Oslo School of Architecture and Design (AHO), were presented in Oslo in April. At the 7th Schiff&Hafen conference Maritime 4.0 in May, together with TU Hamburg, Bachmann delivered insights on the efficient and flexible realization of future energy concepts on maritime vessels.

## Autonomous vessels

June's Electric & Hybrid Marine in Amsterdam provided another opportunity to experience and discuss the Bachmann technologies paving the way to autonomous shipping: "At our seventh visit, we met many visitors interested in a high-availability energy management system, secure connection to an autonomous vessel, reliable navigation, as well as access to maintenance information and IT security solutions," explains Ronald Epskamp. "In addition, we were able to demonstrate the interesting haptic control units from our partner SmartShip, and thereby show how autonomous shipping can be achieved step by step."

## Digital Twins

Together with partners Controllab, VSE and MSA Services, we hosted the seminar "Digital Twins: Magical technology or just an illusion?" in Rotterdam in June. With speakers from leading organizations and a high number of attendees, we provided a platform to address this question and to report on the latest developments related to this popular topic.

Finally, Hamburg's SMM in September presented another impressive highlight: A 1:10 scale model of the sailing catamaran DreamcatcherOne. Created by engineer Dr. Bodo Hasubek, the catamaran impressed with its 3-meter-high mast and 2.7 m² sail, as well as 360° rotatable drives and a vector control implemented on the Bachmann automation system.

## As one fair ends, another begins

The innovation well is full to the brim once again; Bachmann's team is back in the starting blocks. Korea (Kormarine), the Netherlands (Electric & Hybrid Marine, Europort, Offshore Energy), Singapore (Sea Asia), Indonesia (IME) and Norway (Nor-Shipping): See you in 2023!

Bachmann Training Center

# BINDT ACCREDITED TRAINING CENTER FOR CONDITION MONITORING



**David Futter**
As a committee member of the BINDT vibration analysis expert working group since 2004 and a Category 4 Vibration Analyst since 2006, David led the establishment of the training program within Bachmann Monitoring.

**British Institute of Non-Destructive Testing (BINDT)**

- The professional institute for all those engaged in non-destructive testing and condition monitoring.
- Promotion of the advancement of the science and practice of non-destructive testing (NDT), condition monitoring (CM), diagnostic engineering
- Leading the way towards standardization throughout the whole of Europe

**www.bindt.org**

BINDT THE BRITISH INSTITUTE OF NON-DESTRUCTIVE TESTING
APPROVED TRAINING ORGANISATION

High-quality and globally recognized training: Bachmann's Condition Monitoring training center in Rudolstadt, Germany has been accredited as an Approved Training Organization by the British Institute of Non-Destructive Testing (BINDT). The approval confirms that the training is carried out in conformance with ISO 18436, the International Standard for the qualification of Condition Monitoring practitioners, and opens the door to Personnel Certification.

"The reason why we sought this approval was to offer our customers high quality and globally recognized condition monitoring training – in our case for vibration analysis – which then offers the possibility for delegates to achieve certification as Condition Monitoring Practitioners through PCN, BINDT's Personnel Certification Service", David Futter, BINDT Approved Training Coordinator at Bachmann Monitoring GmbH, explains.

### Benefit from industry knowledge

One big advantage of the Condition Monitoring training program at Bachmann Monitoring is that courses have been enriched to better meet the needs of the wind industry. "We follow the curriculum of the ISO-Standard, which requires training in the application of vibration analysis to any sort of rotating machine, but we have picked additional examples and case studies specific to wind turbines, for practitioners in the wind industry", David Futter clarifies.

### All in one place

The training center provides vibration analysis training for categories 1, 2, and 3 of the ISO Standard as well as acting as a BINDT examination center for certification as a Vibration Analyst for the chosen category.

Participants can expect an intense, week-long course including demonstrations using a vibration model, practical examples, and case studies, to support their learning of the underlying theory. The week closes with the examination for Personnel Certification in Non-Destructive Testing (PCN) on site at Bachmann Monitoring. The exams are conducted by BINDT, which issues a certificate of qualification to the participants. A certificate issued under the scheme indicates conformance to the international standard and competence to undertake Condition Monitoring through Vibration Analysis at the specified category level.

More information and registration.

# SMALL GRID, HUGE IMPACT

The increasing share of electricity from renewable energy sources poses major challenges for existing power grids. Meeting growing demand will require a paradigm shift: Energy supply structure must evolve from a centralized, unidirectional system to one that is decentralized and bidirectional. Decentralized grid topologies, such as microgrids, have a significant part to play in this evolution.

Power generation from wind and solar is subject to strong fluctuations and does not align with consumer demand for energy. To avoid overloading the grid, grid operators are having to intervene more and more frequently, reducing renewable electricity production or shutting it down completely. This is due to the high costs associated with the temporary connection and disconnection of conventional generators.

### Decentralized, flexible and sustainable

Microgrids are small, geographically-contained power grids in which electricity is generated from (mostly) renewable energy sources, locally distributed and directly consumed. At the same time, energy storage systems provide temporary storage of surplus electricity on site, relieving the public grid. The local proximity between generators and consumers also minimizes power transmission losses, improving the efficiency of generated power.

Unlike smart grids, microgrids can be operated both grid-connected and off-grid. In off-grid island mode, microgrids ensure a self-sufficient power supply for a particular time period. In grid-connected mode, surplus is fed into a connected grid to cover peak loads, for example, and electricity can be withdrawn whenever demand rises.

### Intelligent and secure

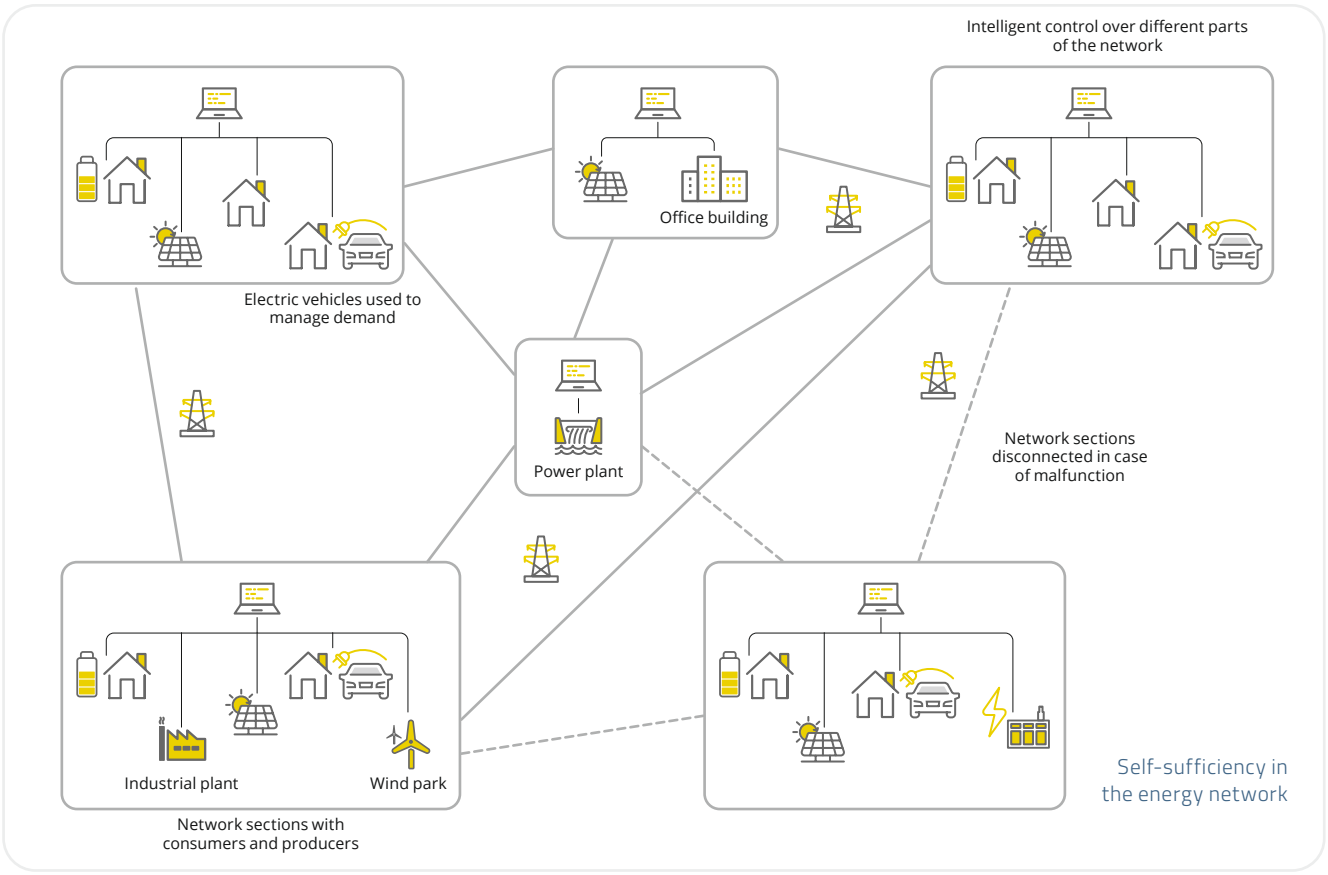
Smart grid components and controls ensure that the microgrid's energy balance and grid frequency remain stable. If the connected grid experiences a power outage, the microgrid will be disconnected, ensuring power supply to connected consumers for a certain period of time.

### Reliable energy management

The challenges for microgrid operators lie in maintaining grid stability, managing bidirectional electricity flow, and processing large amounts of data. Bachmann's automation solutions provide coordinated building blocks for successful and reliable energy management. Bachmann's highly accurate grid measurement and protection systems ensure precise measurement, monitoring and synchronization. Direct integration into the automation system eliminates the need for communication with external devices. Grid information such as frequency, power quality, voltage, current and power can be processed in real time in dedicated applications.

### Open communication

The Bachmann controller system supports a wide range of existing norms and standards and can be




expanded flexibly thanks to its open software platform. Telecontrol protocols that are required internationally for energy technology can be installed and configured as a software solution without effort. This enables communication and data exchange with systems from different manufacturers.

## All regulated

With the Smart Power Plant Controller software module, Bachmann provides a VDE-AR-N 4110/4120 certified park controller. This ensures efficient operation, legal compliance, a stable grid, and compliance with required grid quality. In addition to the requirements for active and reactive power control, in accordance with the VDE directive, the park controller also offers higher-level functionalities such as primary control, clustering and prioritization.

## Integrated security

The increasing complexity of power grids also increases vulnerability to cyberattacks or misconfigurations. A multi-level IT security concept is essential to provide the best possible protection against production downtime. Automation solutions from Bachmann therefore provide extensive security functions out of the box. The 5-stage concept includes, among other things, tap-proof data transmission through encrypted network connections; flexible and configurable authenticated access control; a hardened operating system with detailed access logs, as well as backup and recovery mechanisms.

## Future independence

Microgrids are decentralized energy systems. They offer consumers independence, and also serve to stabilize the power grid. Efficient, sustainable and secure operation demands intelligent solutions. Bachmann has the answers.

Find out more on our website.

Offshore Wind Energy

# REALITY CHECK

Ambitious offshore expansion targets in Germany: The country aims to increase offshore wind capacity to 30 gigawatts by 2030. Some say it's ambitious, others call it impossible. How realistic is this target? We did a quick fact check.

Offshore wind energy is an important strategic part of Germany's energy and climate policy. This is why offshore expansion targets are to be raised once again, according to the coalition agreement of Germany's 24th government. The previously-announced target of installed capacity of 15 gigawatts in 2030 will be doubled to 30 gigawatts, and the expansion target will increase to 40 gigawatts by 2035, and 70 gigawatts by 2045. This is an enormous increase, especially considering that only about 8 gigawatts are currently installed, and not a single new turbine was built in German waters in 2021.

**Production capacity?**

Following major success in 2017, regulatory standstill in Germany led to the industry cutting around 40,000 jobs. Plants were closed, and production capacities reduced or relocated. As a result, the German value chain as a whole has significant gaps. Getting back on track will be a mammoth undertaking.

In addition, new generations of wind turbines, with outputs of 10 megawatts or more, require enormous capacities in the heavy casting industry. Rotor hubs, shafts and machine carriers have huge dimensions and unit weights. But foundries are among the most energy-intensive of production companies – and they are currently facing quite different challenges, such as meeting their own emissions and energy reduction targets.

Not forgetting the massive rotor blade dimensions: At over 100 meters long and with a unit weight of over 50 tons, they pose an enormous logistical challenge.

**Legislation?**

Gaps in the value chain are an obstacle that should not be underestimated. Even more significant, however, are the appropriate regulatory framework conditions and rapid approval procedures that offer security for manufacturers as well as investors. Here, too, there is a need for action.

**Operating personnel?**

Probably the biggest challenge will be recruiting the necessary personnel for offshore operations. Work at sea is extremely physically demanding, and at the same time requires a broad range of technical qualifications and skills. In short, applicants must be qualified, athletic, sure-footed and seaworthy.

When it comes to employees, operators are already struggling to find resources to manage the 8 gigawatts of capacity currently installed. So how can the growing number of installations be operated safely without sufficient personnel?

**Information: Timely, relevant, secure**

Operators need information to produce electricity efficiently, keep their plants optimally connected to the grid, and ensure security. This is why permanent monitoring and assessment of plant condition is so important. Starting up the plant just for this purpose is resource-intensive. Bachmann has the answer: Wind power plants equipped with appropriate sensor technology and measuring systems, providing operational and conditional data for important elements at all times, in full compliance with IT security.

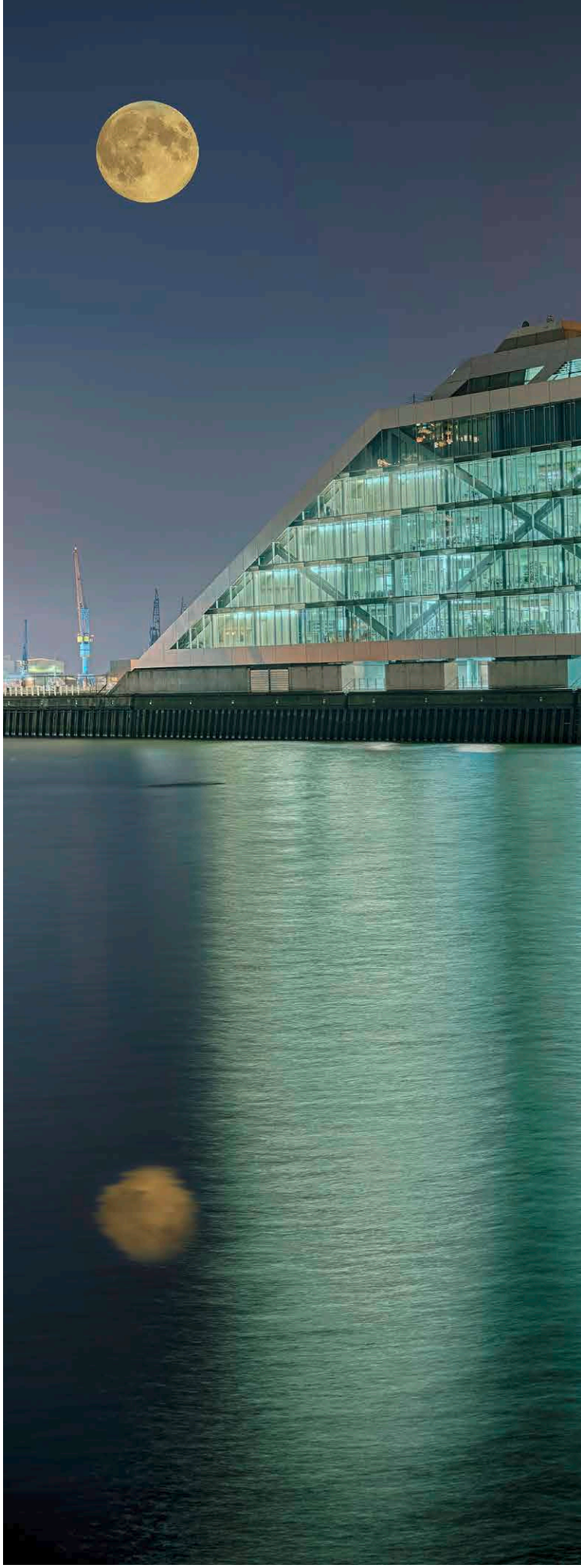
And without requiring a service team on site. Unusual operating conditions or deteriorations in the condition of monitored components, such as those on the drive-train, rotor blades, nacelle or tower, can be assessed remotely and, if necessary, appropriate measures initiated. Knowledge about actual wear conditions, or changes in the condition of relevant components, also prevents unplanned downtime. Spare parts can be ordered in good time; particularly important in the current geopolitical climate. Lead times for a rotor bearing, for example, are between eight and twelve months – at least. At the same time, maintenance windows can be conveniently scheduled, tasks can be combined and, in the long term, service calls reduced. This not only reduces costs considerably, but above all saves operating teams valuable time.

It has not been necessary to equip every turbine in a wind farm with its own structural health monitoring system for a long time now. Using intelligent algorithms, artificial intelligence methods and digital twin modeling with corresponding turbines, Bachmann can draw conclusions for other turbines of the same type, forming an overall picture based on comparative data from a small proportion of turbines. This reduces the cost of such systems significantly. In addition, appropriately-equipped wind turbines also provide information that can be used to make forecasts for safe operation, which can extend long beyond the original intended operating time. If this is successful, then operators generate a significantly higher ROI.

### Highly ambitious

The German government's targets are certainly ambitious. And it will be a challenge for the industry to supply volumes on the required scale. Experts believe it can succeed if stakeholders act cohesively. This will require rapid planning and approval processes, as well as investment incentives for industry to achieve the large volumes required. And ultimately, you have to find sufficient personnel to run the operation. Bachmann is building a bridge for the latter today – with intelligent monitoring systems that enable the monitoring of a large number of plants with minimum resources, keeping them safely connected to the grid.

Further information on on our website.




Interview

# KEEPING A FINGER ON THE PULSE

Cooperation with research institutions: At the Institute for Electrical Power Engineering, Hamburg University of Technology, research is underway into providing efficient solutions that meet the challenges of energy technology. The institute's real-time simulation laboratory has depended on Bachmann technology for several years. Close cooperation between young scientists and industry experts from the automation developer helps ensure that today's research projects result in relevant solutions for tomorrow's problems.

Bachmann spoke to Christoph Klie about plans for a dedicated training center in collaboration with the automation specialists.

»Students are prepared for the industrial world in the best possible way through cooperation with industrial partners. This helps to combat the shortage of skilled workers.«

**Christoph Klie, M.Sc.**
Research Assistant at the Institute of Electrical Power Engineering, Hamburg University of Technology.

**Mr. Klie, the Institute of Electrical Power Engineering works closely with Bachmann as an industrial partner. How did this come about?**

We work very intensively with Simulink and MATLAB in our program. Bachmann solutions enable us to implement complex control algorithms very easily. With M-Target for Simulink®, hardware is perfectly integrated into the simulation: In just a few minutes we can put together a simulation model, export it, and everything runs exactly as it should – with total stability. We can even adjust the parameters during runtime without having to rewrite the program. This is a real time-saver for us. With our previous solution, we needed about half a day to execute simulations.

For this reason, we also insisted that our 'Power Hardware-in-the-loop' simulation lab had to be equipped with Bachmann hardware. We have been using these products for many years now, and not once have we had a case where we needed support because something didn't work. That's also why we enjoy working closely with the company's technologies and specialists during student projects.

**What are the teaching benefits of the collaboration?**

Students benefit from a practical application of their studies – and from the industry know-how they acquire from close cooperation.

One example was a student project to develop a SCADA system for the visualization of our laboratory and to control our devices. We approached Bachmann and were immediately assigned a contact person whom we could reach at any time. We met once a week to develop the system. The result was incredible. We didn't dream that this would produce such an impressive system. The students thought the project was brilliant, they had a lot of fun and learned a lot.

Another project that demonstrated the added value of working with industry was a final thesis on the simulation of protection technology. In that case, overcurrent protection was implemented on a Bachmann controller, which was then measured with an industry-standard protection device test system. You can't get any closer to real-life application within a university context. Through such collaborations, students gain practical experience that they don't get from lectures. This is a great addition to their studies.

**And how does the university itself benefit?**

We have to come up with something that gets students excited about our research topics and projects, so putting things into practice is an essential and very interesting component of an electrical engineering degree – in addition to studying theoretical concepts.

Industry collaboration also ensures we don't stray too far from reality in our research. If we were to only work theoretically, then we could develop every solution under the sun. But what use would they be if we didn't account for the barriers to actually realizing solutions and making them feasible? Input from our industry partners always brings us back down to earth. (grins)

But there are also benefits for industry: Students are prepared for the industrial world in the best possible way, helping to combat the prevailing shortage of skilled workers.

**What are you currently working on?**

We are currently working on a large collaborative project called SuSy, looking into DC power supply on maritime vessels (see Factbox). Our students are developing a mobile measurement and automation center, among other things. It features a Bachmann controller and grid measurement module in a robust casing. The idea is to let the unit generate a large data set over multiple weeks, which we can then evaluate and use. However, the unit will also be used to simulate passenger user behavior, and to switch energy consumers on and off based on stored profiles.

Because we are working with direct current, one challenge in the SuSy project is the issue of grounding. Studying grounding concepts can be very dangerous. Bachmann controllers help us to switch loads on and off safely and from a distance.

Likewise, during the course of this project, we are setting up a motor test bench to simulate rotating loads. As an example, the Bachmann controller allows us to easily simulate the behavior of a ship's air conditioning unit.

**Are there any ideas for future joint projects?**

There will certainly be more joint research projects. One potential idea would be to test communicative system standards, their further development and then application.

We already have some concrete plans: The student project internship to develop the SCADA system was so successful that we have decided to establish a small training center, together with Bachmann, to make our courses even more practical and relevant. There are still so many possibilities in the field of communication, electrical energy system control, or even safety in electrical energy networks. In future, we would like to carry out these student projects regularly with the support of the automation specialists.

**Thank you very much for the interview.**

## SUSY (SUSTAINABLE DC SYSTEMS)

As part of joint project SuSy, the Technical University of Hamburg is researching ways to increase the distribution efficiency and absorption capacity for renewable energy on ships.

To this end, the university is recreating large ship systems in real-time simulations in its 'Direct Current Investigation Environment', part of the 'Power Hardware-in-the-Loop' simulation laboratory, equipped with Bachmann hardware.

Instead of coupling AC and DC grids, the project uses both a unipolar and a bipolar DC grid for the entire vessel. This provides various advantages: renewable energies generating direct current could be integrated directly into the grid. Motor load converters could be connected directly to the grid with their DC link. This common DC link would mean that primary machines would no longer have to be synchronized with the grid, and could therefore always operate at the optimal operating point. Energy from electrical machines in braking mode could be used to charge batteries via a virtual DC link.

The project is also investigating the control of various ship components: Largely isolated and decentrally-controlled power islands would minimize power exchange between islands. Even in the event of the loss of an entire fire compartment, ship operations could be maintained and the ship returned safely to port.

The project team is also looking into the efficient use of heat waste. If electricity is generated from the ship's fuel cells, these could be positioned adjacent to the kitchen, for example. Heat generated in the process could then be utilized over the shortest possible distances. Furthermore, the effects of harmonics, caused by the numerous energy consumers coupled to the grid via converters, can also be analyzed.

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