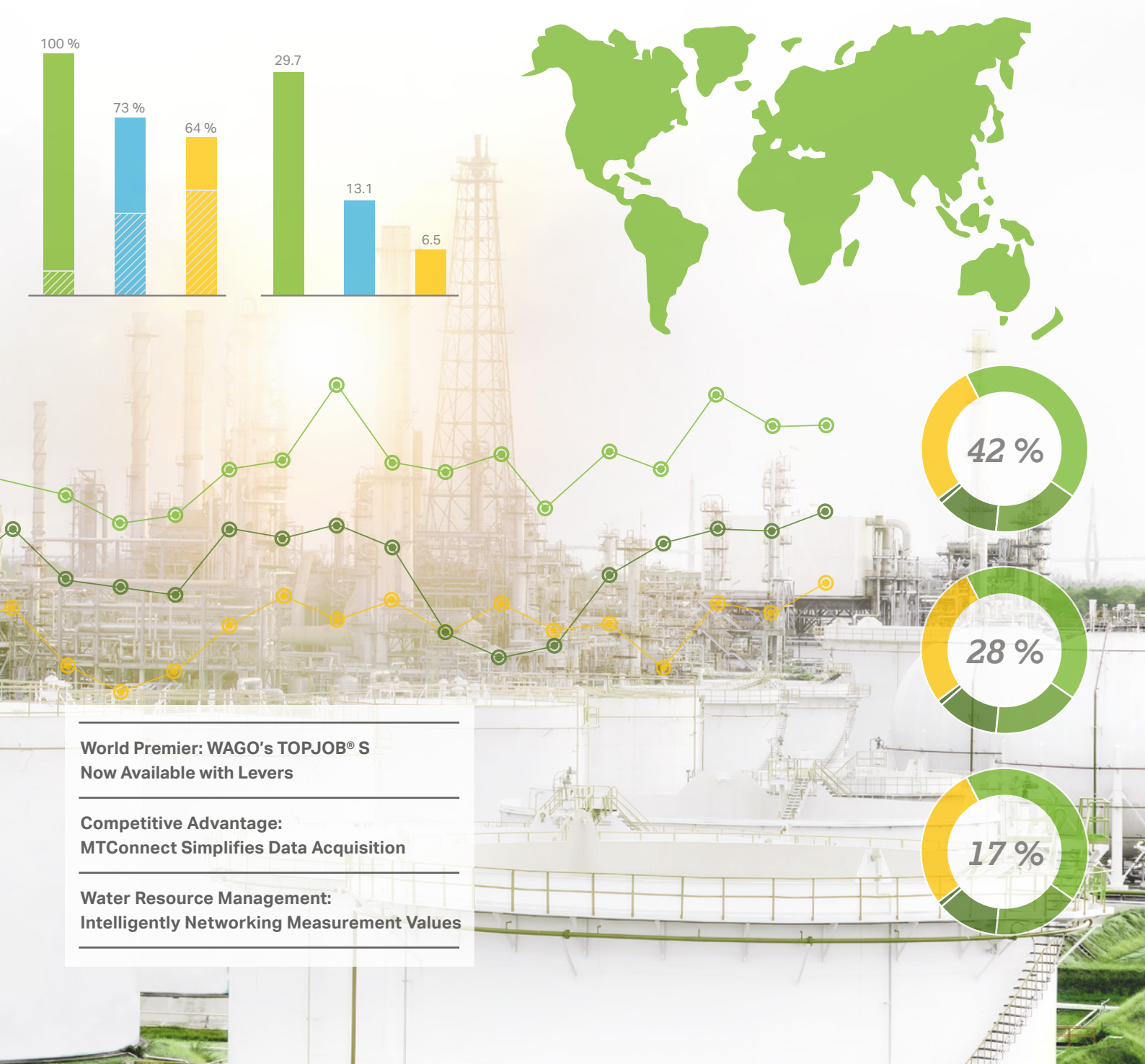
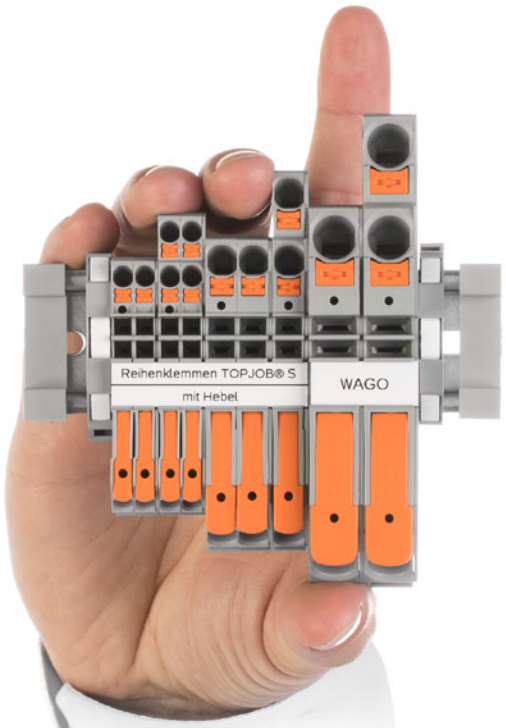
DIRECTPROCESS

Big Data – Data Jumble?

Targeted Data Strategies for Networked Processes





First-Hand Information!

Experience first-hand our innovative electrical interconnection technology – like WAGO's new **Rail-Mount Terminal Block TOPJOB® S with a lever**.

For the professional by the professional!

The Way to Connect!

www.wago.com/topjob-s/en

EDITORIAL
FOCUSING ON THE BIG PICTURE

Dear Reader,

Think back about your last purchase of a bicycle or a smart TV, a pair of sneakers or a car – how much of a role did your rational side play in the decision? According to marketing experts, consumers make 70% of their decisions subconsciously, and while they do consciously determine the remaining 30 %, these are not completely emotionless conclusions. Where do you fall on this scale when selecting options? do you make decisions subconsciously? emotionlessly? rationally? What criteria do you want to be guided by when determining efficient management of your systems?

The increased competitive pressure brought about by globalization and digitization is not letting up. Therefore, one is well advised to have precise knowledge about company assets and methods for obtaining optimal production. This does not, however, require detailed information about the efficiency of individual methods, systems, or machines. Instead, the focus is placed on the entire value added process, which is increasingly influenced by digitized, dynamic developments, and extends from receiving to the finished products and now beyond. Examples include autonomous transport vehicles for delivery of resources within a facility – a reality in the processing industry in order to optimize material flows within systems.

To bring the requisite transparency into the systems in order to derive adjustments, it is necessary to "tap into" the data. Determining which data points are required for establishing key performance indicators (KPIs) certainly represents a major challenge. However, is it valid to collect the knowledge about your processes and systems, and then bow out just before gaining insight into prevailing thought processes and the resulting derivations? Come at the problem using algorithm-based key indicators.

You are probably also facing the conundrum about using internal, facility-specific resources, or trusting external sources available in a cloud. Making a decision that determines the right path for your company – whether to evaluate data using dedicated MES software or "deep learning tools" available through cloud service providers, like Amazon AWS or Microsoft Azure – will set a course that leads into the future. We at WAGO can support you on this path to find solutions. In addition to our controllers and comprehensive I/O system, we offer suitable platforms for recording your data at the field level, or on the shop floor, for processing it, and transmitting to the cloud or MES systems. In addition, our highlights and new offerings in interconnection technology always place you on secure footing when reliable and durable components are needed.

Learn more in this edition of **WAGO DIRECT-PROCESS** about our most recent developments and solutions, or we can offer you personalized advice about our innovations at IFAT in Munich, or in June at ACHEMA in Frankfurt.

Best regards,

Benjamin Böhm

COVER STORY

Big Data – Data Jumble?

Networking and digitizing data is a necessary development to stabilize and increase added value, even in the process industry. Data plays an fundamental role in this. Opinions differ about how to interact with it: the point where operations technology (OT) and information technology (IT) meet represents the contact between different worlds and philosophies. Orientation may be difficult to establish for systems operators, who want to undertake the initial steps towards networked production. This is where small projects can already generate measurable added value.

CONTENTS OF THIS ISSUE

OPINIONS

COVER STORY: BIG DATA – TARGETED STRATEGIES FOR NETWORKED PROCESSES

APPLICATIONS

TECHNOLOGIES

The system, which they named “NiDeEco” and equipped with WAGO automation technology, ensures that the aerobic bacteria have an optimal oxygen supply in the aeration basin at all times.

WAGO Technology Increases Efficiency in Wastewater Treatment

HIGH PRECISION IN THE AERATION BASIN

Using WAGO technology, H2Ortner® GmbH from Passau developed a controller module that gives operators of wastewater treatment plants need-based control of the blowers in their aeration tanks depending on the degree of contamination in the wastewater. This type of control saves electricity, lowers the nitrogen concentration in the discharge and increases operational reliability. Practical experience shows that in many cases, plant operators can recoup the investment through the waiver of the wastewater discharge fees alone.

In any modern wastewater treatment plant, there are team members who work around the clock without vacation time or even payment: these are the bacteria that break down harmful substances in the wastewater in the aeration basin. All that the microorganisms need for their work is oxygen, and in return, they carry out nitrification – the conversion of nitrogenous ammonia into nitrate.

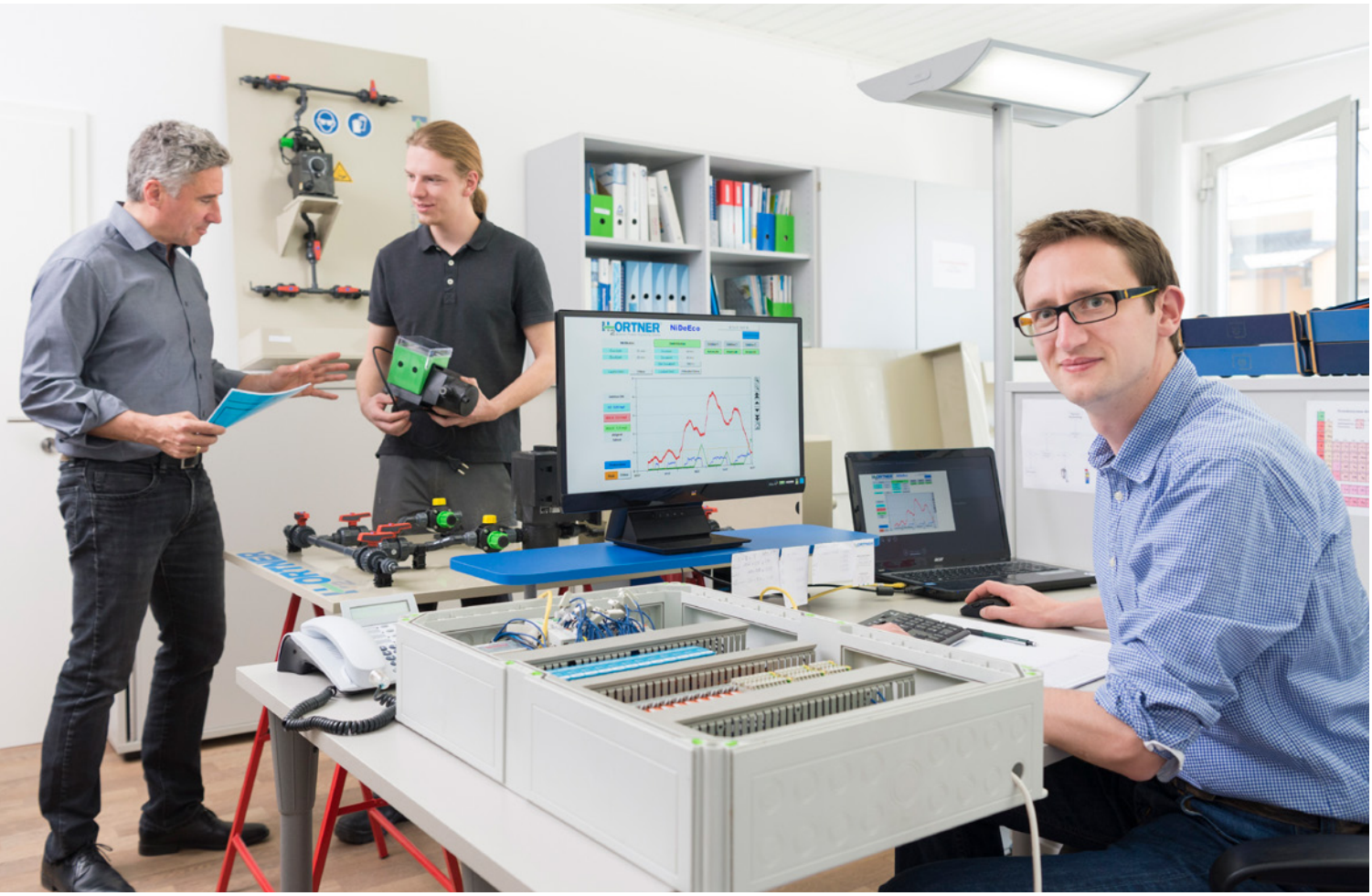
The oxygen is injected into the aeration tanks via blowers. In the case of small and medium-sized wastewater treatment plants, these are usually controlled by a timer – regardless of the actual contamination level in the wastewater influent. This approach also ignores the dynamics of the biological processes in the aeration tank. The operation is usually implemented under that assumption that "more is better." In this case, it is better to aerate a little longer in order to ensure that the required limiting values are actually met. However, since the blowers require a great deal of power, this approach drives up the energy costs. Furthermore, an excess of oxygen impedes the stage following nitrification – denitrification

– in which the nitrates that were generated are then reduced to molecular nitrogen. This means that the discharge values are not as low as they could be. As a result, plant operators often have to pay unnecessarily high wastewater discharge fees.

These are some of the reasons why H2Ortner, wastewater purification experts from Passau, developed a solution for need-based blower control. The system, which they named "NiDeEco" and equipped with WAGO automation technology, ensures that the aerobic bacteria have an optimal oxygen supply in the aeration tank at all times. "Our controller module allows the operators of wastewater treatment plants to lower the nitrogen concentration in their discharge and simultaneously reduce their energy costs," explains CEO Josef Ortner. Furthermore, the system makes it possible to optimize the elimination of phosphorus.

Process Dynamics at a Glance

NiDeEco regulates the blowers, and thus controls nitrification and denitrification, as a function of the level of contamination in the wastewater. The current oxygen, ammonia and nitrate values, which are recorded by sensors – either existing or newly installed ones – are the starting point. The data is wirelessly transferred to the controller module, where a software application determines the treatment performance from the sensor data, and then calculates the optimal oxygenation level on this basis. However, the system does not use the individual values; the process is based on curve pro-



Using WAGO technology, the H2Ortner team from Passau developed a controller module that gives operators of wastewater treatment plants need-based control of the blowers in their aeration basins depending on the degree of contamination in the wastewater.

»With its many interfaces, the WAGO controller offers ideal options for communication with different controllers.«

gressions instead. "This allows us to take the dynamics of the processes into account – a great advantage for precise, accurate control of the blowers," explains Ortner. In the process, NiDeEco is able to directly control blowers, and also address higher-level controllers.

The core of the controller module is the WAGO PFC200 Controller. The parameterization and monitoring of the processes is web-based. Employees can access the controller using a standard PC, tablet or smartphone via a secure IP address. That provides flexibility, since they can keep an eye on all values from afar, such as from home. A clearly organized interface allows for fast comprehension of all relevant data. Furthermore, this allows the employees to set all parameters themselves with minimal effort. "Instead of a black box, it was important for us to create a solution that offers our customers independence from individual manufacturers," says Ortner.

The WAGO controller provides additional important advantages. "These include the option to carry out parameterization and visualization directly in the controller module via the IP address, for example. Furthermore, with its many interfaces, the product offers ideal options for communication with different controllers. And don't forget WAGO's excellent price-performance ratio, which really stands out," explains Ortner.

Recouping Investments through the Waiver of the Wastewater Discharge Fees

NiDeEco is already in use in twenty wastewater treatment plants around Germany, mostly small and medium-sized plants. In each case, power consumption has been successfully reduced by at least twenty percent. This significantly relieves the burden on the operators, which can be illustrated using a population equivalent, which describes the capacity of a wastewater treatment plant.

For instance, for a plant designed for a population of 10,000, a 20% reduction means calculated annual savings of at least 17,000 euros. Furthermore, the wastewater discharge fee is waived for the plant operators for three years if they succeed in reducing one of the three relevant discharge values – the nitrogen or phosphorous concentrations, or the chemical oxygen demand – by twenty percent. With the system from H2Ortner, it's generally easy to achieve nitrogen concentration reductions on this order of magnitude. Since the investment costs for the controller module are relatively low, they can be recouped through the waiver of the wastewater discharge fees alone in many cases. "This applies even to plants with a population under 7,000, which have lower wastewater discharge fees," emphasizes Ortner. "Thus, NiDeEco paid for itself from the very first day."

These advantages include an increase in financial security.

The core of the controller module is the WAGO PFC200 Controller.

If the blowers can only be controlled at preset time intervals, then too little oxygen may be available for nitrification at times when there is a very high contaminant concentration in the influent. This is a burden on the environment, which consequently costs the plant operators a great deal of money, since the discharge fees are based on contaminant levels in the discharge.

Customized System Design

The experts at H2Ortner always customize the system to a specific plant based on a careful analysis of the specific technical and economic situation. For example, it is not necessary to install sensors for all values (oxygen, ammonia and nitrate) in every case.

"For a small investment, our customers get a controller system tailored exactly to their requirements," says Ortner.

This lets the plant operators keep their aerobic bacteria in the aeration tank happy at all times – saving energy costs, while increasing operational reliability and improving the water quality in the discharge.

TEXT KAY MILLER | WAGO

PHOTO RALPH DIERMANN

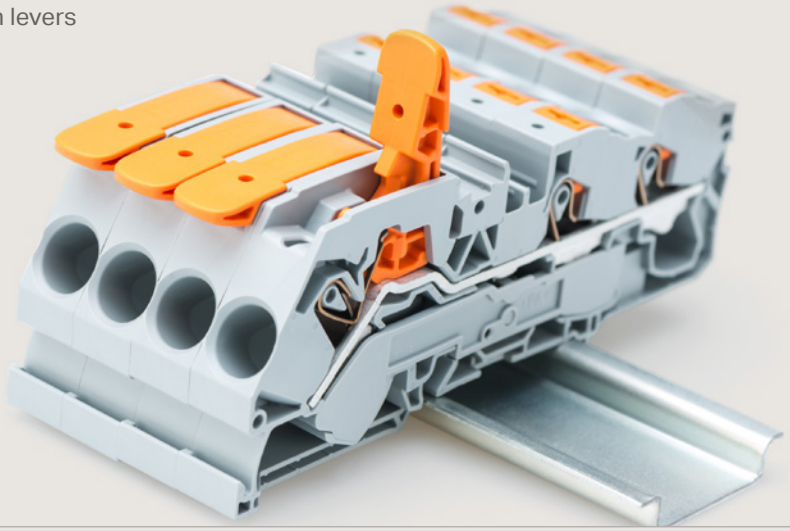
THE MOST INTUITIVE WAYS TO WIRE

WAGO's TOPJOB® S Rail-Mount Terminal Blocks Now Available with Levers

Pull the lever up, insert a conductor, and push the lever back down. The ingeniously simple connection technology that has made WAGO's 221 Series Junction Box Connector a popular all-purpose solution is now available on the DIN-rail – as the newest variant to WAGO's trusted TOPJOB® S Rail-Mount Terminal Block family. Conductors can now be easily connected and disconnected by hand in control cabinets, without requiring tools. The user benefits from the simple and intuitive use, especially for in-the-field wiring: The terminal point is clearly marked by the open lever, which reduces the risk of forgetting terminal points when wiring or incorrectly connecting conductors. In addition, both hands remain free for wiring. These two advantages are already characteristic of the current TOPJOB® S terminal blocks; however, the operating tool still had to be applied separately. This convenience facilitates connecting difficult-to-bend conductors with large cross sections.

WAGO's rail-mount terminal blocks with levers are suitable for all types of conductors: Solid, stranded and fine-stranded conductors. Like the tried-and-tested version of the TOPJOB® S Rail-Mount Terminal Blocks with operating slots, the new lever-equipped blocks feature push-in connection technology. In addition to solid conductors, fine-stranded conductors with gas-tight, crimped ferrules and a cross section of 0.75 mm² (18 AWG) can be directly plugged into the unit – and this now includes the rail-mount terminal blocks with levers. The levers simply remain closed in this case. With side conductor entry, the rail-mount terminal blocks with levers even permit large, difficult-to-bend conductors to be easily connected.

As a first step, WAGO is offering rail-mount terminal blocks with levers in the nominal cross-sections of 2.5 mm² (14 AWG), 6 mm² (10 AWG), and 16 mm² (8 AWG) – and thus primarily for feed-ins in the most common conductor cross-sections. These terminal blocks are available in 2- or 3-conductor variants. The field side of WAGO's rail-mount terminal block is lever-equipped; a push-button or operating slot is available for internal wiring. In the future, lever connection will be extended to other products in WAGO's TOPJOB® S Rail-Mount Terminal Block family.



Targeted Data Strategies for Networked Processes

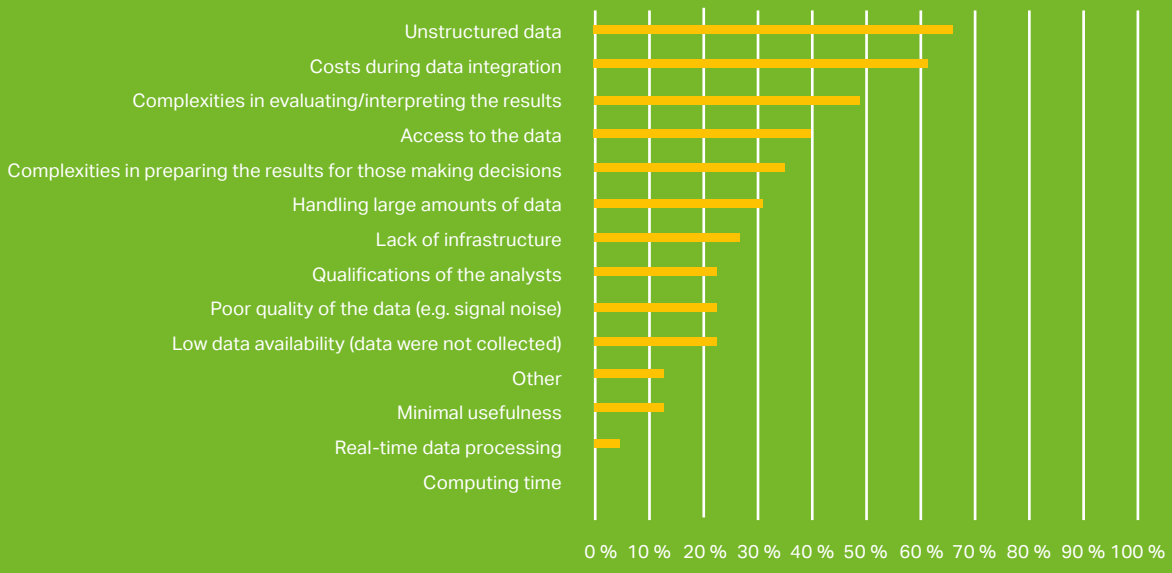
BIG DATA – DATA JUMBLE?

Networking and digitizing data is a necessary development to stabilize and increase added value, even in the process industry. Data plays an fundamental role in this. Opinions differ about how to interact with it: the point where operations technology (OT) and information technology (IT) meet represents the contact between different worlds and philosophies. Orientation may be difficult to establish for systems operators, who want to undertake the initial steps towards networked production. This is where small projects can already generate measurable added value.


42 %
28 %
17 %

Approximately two-thirds of of the 152 NAMUR member companies are convinced that data analysis is always useful for system optimization. So where does big data fail? A survey from the Technical University of Munich provides information about data integration and analysis among NAMUR member companies in process industries:

What problems do you see during data analysis?



(Source: TU Munich)

Data is the key component for the digital transformation. It is fundamental for networking and directing processes in a targeted way. The collection and availability of data from the field level therefore play a key role on the path to the smart factory. It is no coincidence that data acquisition, big data, and analytics appear in every conversation. The more data is collected – runs the common opinion – the more detailed the overview of the assets in production, the better the correlations between added value and the modes of action in existing processes and control circuits. Whoever obtains the most data should thus have an absolutely clear perspective and be able to make reliable predictions, avoid idle times, optimize resources, and increase efficiency.

Data Acquisition – And Then What?

This is, however, quite wrong. Regardless of how promising the view is that big data can exploit enormous potentials in the processing industry, intelligent networking remains quite challenging. In most companies, there are already diverse systems within production that currently collect and transmit data; however, the data is often quite heterogeneous, particularly in the process industry. Data is distributed on diverse systems, available in different formats, and is often stored with insufficient time synchronization or without a definition of the semantics. Many values are still manually read despite digitalization, and this particularly applies to values that have to be retrospectively integrated into the control system, which generates enormous costs.

In short, OT and IT operate using different protocols – both as this applies to communication and also to the application itself. In order to be able to network data together, they must be available in a uniform format, which is a step beyond basic data acquisition. Instead, the focus must be on collecting data in one standardized format so that it can be further processed both easily and quickly. In this context, I/O systems like the WAGO-I/O-SYSTEM 750 provide a good and simple solution. The WAGO I/O system offers three very different advantages:

1. With more than 500 different modules, it has the potential to record practically any signal that occurs at the field level – and this applies

»Unstructured data is the greatest obstacle to employing big data analysis in the process industry.«

Prof. Dr.-Ing. Birgit Vogel-Heuser, Chair of the Institute of Automation and Information Systems at the Technical University of Munich

in particular for signals that are prevalent in the process industry. In addition, there is a robust version, the WAGO-I/O-SYSTEM 750 XTR for extreme environmental conditions and demanding applications. WAGO also offers modules for acquiring signals from Zone 1 or Zone 2 in potentially explosive areas, including those caused by dust or gases. These modules are likewise available in the XTR variant.

2. Because the WAGO-I/O-SYSTEM is modularly constructed, system operators can use the exact modules that they require. Only one module is used for each signal to be recorded. This provides an economical entry into the topic of digitalization and networking, which can be flexibly expanded later.

3. The WAGO-I/O-SYSTEM 750 includes the PFC family of controllers, which are based on Linux and can be used with diverse communication protocols. The PFC is the link between OT and IT – the ability to program an IEC application using a corresponding library and IT technologies, like firewalls and VPN, make it an IoT device. Specifically, the PFC translates the heterogeneous data into a uniform language and translates this problem-free, via various protocols and interfaces, to higher-level systems.

The question as to how the data are obtained from the field level is thus a comparatively small problem on the way to networked production. This assessment is shared by Benjamin Böhm, Global Industry Manager in Market Management Processing and Industry at WAGO. “The actual challenge is not in acquiring the data, but instead in determining which data points are actually necessary to create the key performance indicators.” This includes the corollary, that “recording all of the data, just because I can, does not necessarily gain more transparency in a production process.” Böhm strikes a nerve with this. This is because determining the exact amount of collected data or expertly managing the data thus acquired leads to headaches for many system operators: they worry that they do not have qualified experts who can manage the data glut, or fear that OT and IT are not working together in a targeted way that will actually lead to networked production. Such worries are not baseless. It is precisely

»Those who know from the beginning which data is being collected, can already achieve significant added value using rule-based applications.«

in data handling that different approaches and philosophies are exhibited by IT and OT. The one values better algorithms and more powerful computers, while the other respects bright minds.

Cherry Picking or Hoarding?

Dr. Ralf-Michael Wagner from Siemens provides a possible example, stating that "IT groups take the approach of collecting as much data as possible and then searching for meaningful findings using machine learning algorithms." According to this statement, one does indeed need experts for this. Wagner continues, "If, in contrast, I know from the beginning which data I am collecting, I can already achieve significant added value using rule-based applications." Is the search for buried data treasure thus configured more efficiently by limiting the search area from the outset? Stated another way: Start by looking at one segment, and then expand data acquisition in a targeted direction.

Böhm also finds positives in this approach. "If, with an eye to predictive maintenance, for example, I need to monitor a pump, then I do not need a complex algorithm. For this case, a simple mathematical equation suffices." Very few values need to be recorded in order to maintain the pump in the optimal operating range, or to detect deviations and be able to alleviate them quickly. The pump's characteristic curve is known and the system's characteristic curve can be mapped at relatively low expense. The current operating range of the pump can be defined and deviations from the operating point can be determined by recording input/output pressures and input/output temperatures for the pump, and optionally the output data for the drive. Whether the results of the mathematical equation are then merely sent to the process control system, or to the cloud, is a question for another time, according to Böhm and depends more on the individual challenges facing the system operator. "However, it is essential that I do not just generate a graveyard, where data go to die, in the process control system or in the cloud. Instead, I only provide processed or evaluated data that enable me to draw direct conclusions about the system."

Getting Started at Manageable Expense Levels

There are already various firms that offer complete hardware-software packages specifically those just getting started with data acquisition or predictive maintenance. For example, WAGO

offers an autoscan function, which automatically reads out the structure of the I/O node when the program boots. “In addition, we also provide complete software modules for processing data that is subsequently detected by the I/O system. This is especially the case for standard applications,” adds Böhm. “Tailored adaptations are possible for other applications.”

By using these modules, machine states can be monitored for individual assets, which guarantees that the subsystem operates optimally, or enables predictive maintenance. By deploying small, manageable solutions, companies can take the first steps towards networked production and big data: they can discover the potentials that result from this and gain experience as to how and at which points the expansion of the network would be well-targeted and shows promising results. In the end, this approach – starting with a small solutions – reduces the threshold for embarking on this path.

Cloud Connectivity in the Second Step

That which applies to the management of a single asset likewise applies, in the case of Benjamin Böhm, to managing the entire value added process. This is especially true because one question must be continuously addressed: should the data that were collected in production be made available via the cloud or not. This is another point at which the philosophies of OT and IT diverge. While IT generally follows a path of engaging with a system from the outside and providing external controls, OT conceives of closed system environments. The IT department, which would also like to collect as much data as possible, feels that deep learning tools in the cloud are essential, like Amazon AWS or Microsoft Azure. In contrast, system automation specialists seek to solve specific problems, like system data monitoring or predictive maintenance, using specialized MES tools within their own facility.

“Ultimately, the needs of the customer determine whether the cloud connection is necessary or not; however, before security concerns are deployed to terminate discussions about any type of external networking, a gradual expansion in this direction should be considered,” states Böhm. Data that are initially linked solely to an MES tool can always be transferred to the cloud in a second step – and this can be carried out in an encapsulated format that isolates the data from the path to the company’s internal process control system. However, operators must ensure that the hardware is capable of these demands. Böhm explains, “WAGO’s PFC Controllers have several interfaces that can be used simultaneously. Thus, data acquisition can be carried out in the control system simultaneously with an encrypted communication to the cloud using a different protocol.”

»Ultimately, the needs of the customer determine whether the cloud connection is necessary or not.«

TEXT BENJAMIN BÖHM, EVA KOCH-BANHOLZER | WAGO

FOTO GETTYIMAGES, WAGO

During data acquisition, I/O systems like the WAGO-I/O-SYSTEM 750 can provide a good and simple solution.

Achieving Optimized Manufacturing with WAGO

MTCONNECT: THE SPILE FOR TAPPING INTO SHOP FLOOR DATA

MTConnect is a digital interface that taps, acquires, and collects information, like maple sap is tapped from a tree, and forwards it to analysis software.

As global competition increases, the pressure to create a competitive edge grows with it. One possibility for asserting one's self on the market is to consistently collect, evaluate, and efficiently use data from the manufacturing level in order to optimize production processes, to offer products at lower costs, and to ultimately increase sales.

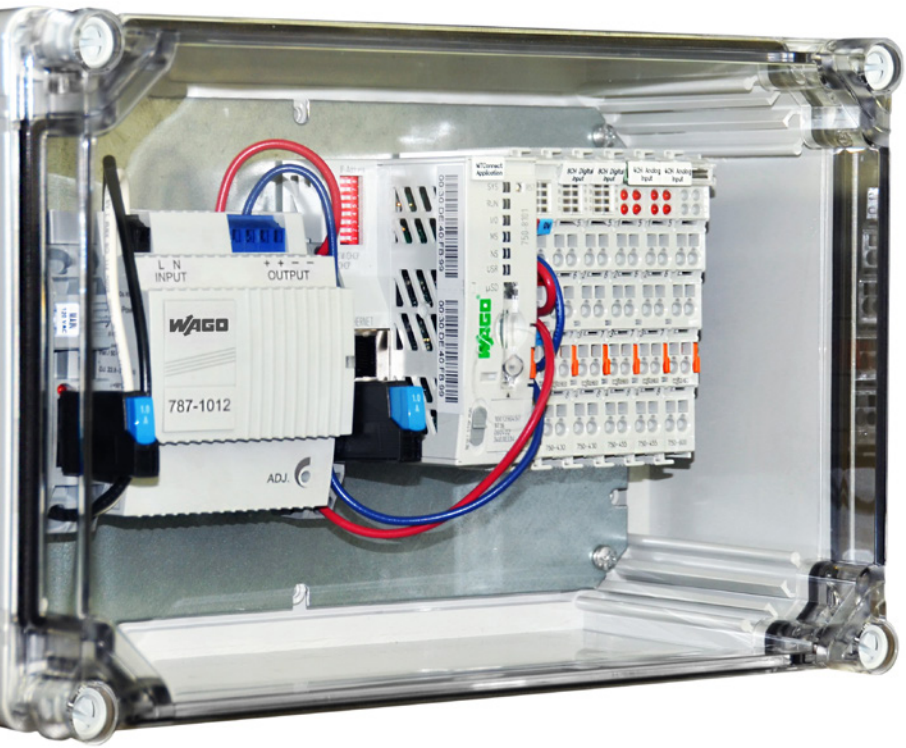
OEE Uncovers Potentials

Machines from the most recent generations are designed to exchange information; thus, they optimize the calculation of the overall equipment effectiveness (OEE) and therefore improve the efficiency of production processes. The problem remains that systems, even those developed a few years ago, still operate as closed units. This means that most of the equipment currently in operation may be equipped with sensors that record temperatures, setpoints and cycle times; however, they lack the ability to forward this valuable data. How can companies bundle the data collected from their different types of machines and convert it into information in order to logically and cost-effectively visualize and optimize operating processes?

Traditional Approaches

Up until now, there were only a few conventional approaches for solving the problem of efficient data exchange, and they were technically complex to implement. For example, if a machine already has a modern, integrated controller, important data can be forwarded via a network following reprogramming. What appears straightforward at the beginning in many areas often ends in frustration: a person with programming skills must be hired to update the controller or to rewrite the program. If the program's documentation is lacking, then the programmer may have to "re-engineer" the code in order to copy the desired data into a memory that the control system can access. This process can be time-consuming and expensive.

Another approach is to fit each machine with an individually-designed control application. If, however, there are several machines in one manufacturing area, or the equipment pool includes systems from multiple manufacturers, then the possibility arises that suitable applications may need to be developed for each one – an enterprise that is linked to high labor costs. It is then additionally necessary to program the control system so that it can extract the data from the respective applications on the machine level. In addition, each application must be maintained and documented. Does this sound cumbersome and tedious? It is indeed – however, there is also another way!



The digital MTConnect interface for WAGO PFC100 Controllers allows networking of machines using the license-free, open-source standard.

Easy. Independent. Efficient.

One universal, standardized machine language – for detecting and processing data from different types of equipment – simplifies the workflow. MTConnect provides this solution: the open-source, license-free standard leverages proven Internet protocols to convert data from manufacturing equipment into a standardized format. The application collects the machine data, translates it into readable measurement data, and thus facilitates remote monitoring about the status and activity of the equipment.

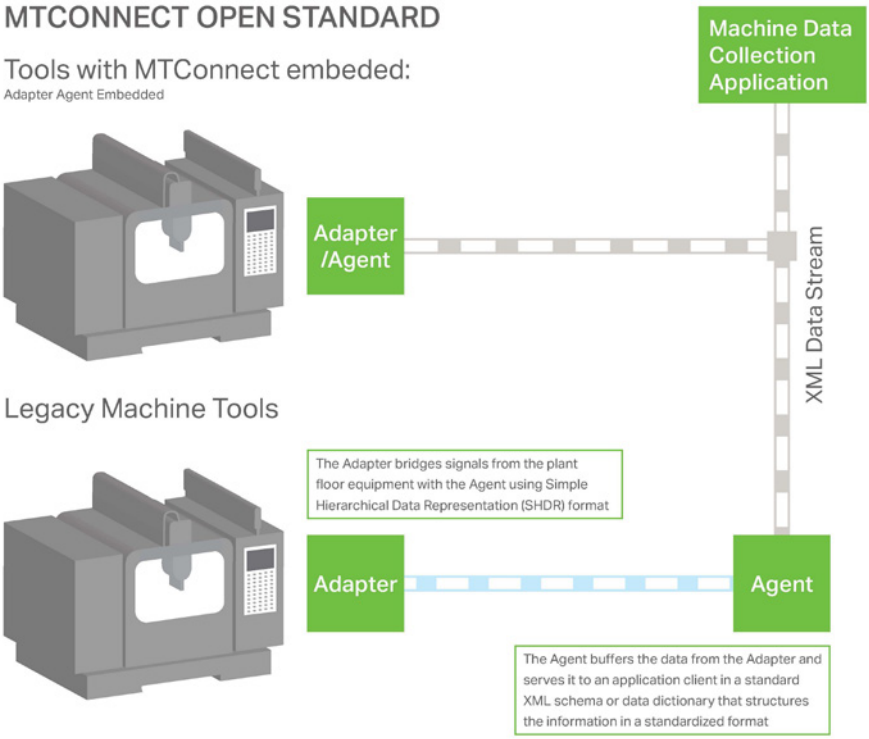
Secure Acquisition, Translation, Presentation

MTConnect is purely a read-only standard. This means that information is securely acquired, transmitted to an application or an MES system per request, and evaluated there. However, no control access to individual machines is possible. The MTConnect standard is based on the HTTP protocol and uses RESTful web services. The digital interface consists of three components: the two specified functional components, application and agent, and the non-specified adapter. The adapter collects machine data, standardizes it and then transfers it to the agent. The agent follows a prescribed XML schema that organizes the data in a standard format, no matter what type of machine is being monitored. The agent buffers the data and forwards it upon request to the application. The application subsequently stores the data in a database and can display it in a way humans can understand. The machine output data is visually displayed in diagrams or tables for engineers and supervisors.

Digital Interface

This method can be illustrated using a metaphor. The machines in a manufacturing area are maple trees, and the operating data is the sap. It is easy to lose your orientation in this "maple forest"; however, the MTConnect technology can help you maintain an overview. The MTConnect adapter and agent can be used like a spile, in that they are tapped into the interior of the tree to allow the sap to flow out. The application is then a combination of the collection bucket and the evaporator, in which the collected sap is boiled to form syrup.

MTConnect can thus be viewed as a universal, digital interface, which can be easily integrated into current equipment without causing process interruptions. It is a standardized platform that "taps", records, and



collects information and forwards it to software for analysis. Continuing with our maple syrup metaphor: MTConnect is integrated as an interface into the tree, and connects the data collection bucket with the application, and then links the application to an HTML website. The website displays how efficient this tree is, in comparison to other trees in the forest. A simple concept, which supports companies with complex machines and processes in easily digitizing their manufacturing environment.

The Result

MTConnect is therefore easy to install and to integrate – so far, so good. However, what about actually using it? As already mentioned, it is decisive for each company, regardless of sector, to create a competitive edge. The technological trend for industrial and manufacturing corporations has been digitalization. It is becoming increasingly important to be able to monitor, adapt, and control every aspect of a manufacturing area in real time. Those who closely monitor their machines can uncover and report a multitude of problems, before expensive failures occur. MTConnect provides specific numbers about the cycle times, and also supports planning and logistics. The digital interface essentially enables companies to visualize and optimize work flows in manufacturing areas in order to reduce costs – an economic use that anyone can support.

The Transition

Many machines are not equipped to connect directly to the MTConnect adapter and agent. However, a solution has been developed for the WAGO-I/O-SYSTEM for enabling a seamless transition to a digitalized manufacturing area. The Linux®-based PFC100 Controller forms the interface with the MTConnect adapter and agent: programming is not necessary. Machine data, like temperature, position, power consumption or motor speeds, can be called up, inputs can be configured using a web browser, and real time analysis can be initiated. Analysis and evaluation software with corresponding MTConnect interfaces, which is currently on the market, then converts the data into comprehensible diagrams or tables. MTConnect provides specific machine data that enables companies to monitor and track overall efficiency in their manufacturing areas. Implementing this tool would thus be the next logical step in optimizing processes, and for easily configuring the transition into the digital future.

TEXT BENJAMIN BÖHM | WAGO

PHOTO ADOBESTOCK, WAGO

In the process industry, demands for system designs with significantly greater production flexibility are steadily rising. The DIMA concept (Decentralized Intelligence for Modular Assemblies), developed by WAGO, gives modular system design a leg up.

Ensuring the future of the German chemical industry.

FEDERAL MINISTRY SUPPORTS MODULAR PROCESSING SYSTEMS

WAGO, together with leading companies in the German chemical industry, applied for funding from the German government – and successfully gained it! By working together, we can make more progress in developing modular automation for process systems.

The chemical industry belongs to one of the economic sectors in Germany, whose products require energy-intensive processes, and where substantial energy savings can still be found in their production methods. In particular, the conversion from batch production to a continuous production method can potentially provide both enormous gains in efficiency and also savings in valuable time, particularly if production can take place on modular systems. These allow the easy exchange of single system modules, which promote flexible adjustments to production capacity.

Working Together toward Energy Efficiency and Accelerated Processes in the Chemical Industry

In the meantime, there are still a few hurdles to overcome; however, these challenges cannot be solved by individual companies.

In the Energy Efficiency and Process Acceleration Initiative (ENPRO), major players in the German chemical industry have joined forces with representatives from system operations, module manufacturing, module automation specialists, system integration specialists, and universities. Their goal is to actively design the future of the German process industry. All participants are willing to share their expertise, in spite of market pressures to compete, because ultimately they are pursuing a much higher, mutual goal: namely ensuring the competitiveness of the German chemical industry on the

global market over the long term. Toward this end, the companies are mutually developing concepts to enable the modular construction of process systems that are intelligent and flexible, which should ultimately increase the resource efficiency of the chemical processes. Because these objectives also address important strategies on the part of the German government, the ENPRO initiative is also supported by the Federal Ministry for Economic Affairs and Energy (BMWI). Explicitly, this Federal Ministry regularly determines which research and development projects will be publicly funded.

At the end of 2017, it was time: during the 3rd ENPRO meeting, diverse working groups were offered a platform to present research and development projects and to apply for funding from the BMWI. WAGO also participated in this event as a partner in the ORCA project – the efficient orchestration of modular assemblies. ORCA was one of the eight projects that applied for funding from the BMWI.

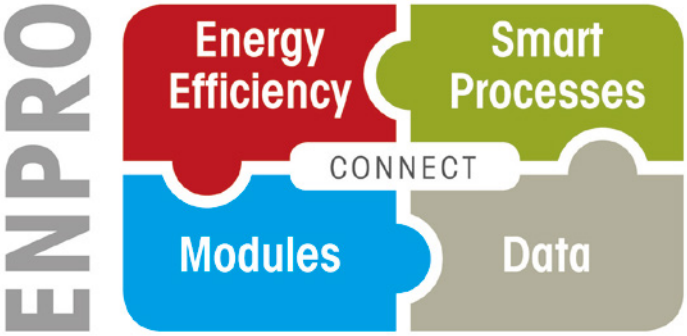
ORCA – Efficiently Orchestrating Modular Assemblies

The goals of the ORCA project are to develop methods, models, and tools for orchestrating assemblies, virtual commissioning of modular systems, and demonstrating their applicability in practice. Specifically, the ORCA project focuses on those aspects that facilitate an automated and complete commissioning of a subsystem that consists of several modules. Therefore, the project team worked on the optimal tailoring of modules, the logical integration of multiple system modules in one higher-level process control system, instrumentation requirements, and security and regulatory issues.

The partners who have joined in collaboration on the ORCA project read like a who's who in the German chemical industry: Evonik and Merck represent system operators and module manufacturers, Samson produces field devices, X-Visual and ABB are software developers, and Siemens and WAGO design automation systems. The team is supplemented by two university partners: the Technical University of Dortmund and the Technical University of Dresden, where Leon Urbas, who introduced the ORCA project during the 3rd ENPRO meeting, is professor for process control technology.

Recommended as a Partner due to DIMA

It is no coincidence that WAGO is standing along side global players in automation technology, like Siemens and ABB, in the ORCA project. As Benjamin Böhm explains with



evident pride, "Since the introduction of the DIMA concept in November 2014, WAGO has made a significant mark in modular automation in the process industry."

WAGO is thus highly regarded as a partner in the ENPRO Initiative, which the company joined in 2017. Böhm began the ORCA project with the premise that, "The experience that we have collected for DIMA could be introduced into the collaboration prior to the competition."

»Since the introduction of the DIMA concept in November 2014, WAGO has made a significant mark in modular automation in the process industry.«

Placing their own economic interests in second place is nothing new for WAGO. In 2014, WAGO published the core of DIMA, the module type package (MTP), making it available for development within the wider community of chemical companies. "The wheels that we would have to turn in order to change the philosophy of automation in the process industry are simply too large for a company like WAGO," explains Böhm. "On the other hand, if we can work together in a consortium, then the entire German economy can profit from this in the future."

BMWI Invests in ORCA

This is an impression that the decision makers at BMWI obviously share, since the intentions and efforts of the ORCA project team were granted particular attention. There is also the speculation that ORCA can uncover new possibilities. Consequently, the Federal Ministry for Economic Affairs and Energy decided to invest public funds in the ORCA project after the presentation at the 3rd ENPRO meeting. ORCA is thus one of four projects to receive support from the German government in the context of ENPRO II. According to Böhm, "We are more than satisfied with the decision. Modular automation in the process industry has thus received the status that is needed in order to thoroughly develop its potential."

TEXT BENJAMIN BÖHM | WAGO

PHOTO WAGO, DECHEMA

Efficient Orchestration of Modular Assemblies (ORCA) – Outline Data

Start of project: July 1, 2017
Duration: 36 months

4-CHANNEL ANALOG MODULE WITH ELECTRICALLY ISOLATED MULTIPOINT INPUTS

A new module joins the WAGO-I/O-SYSTEM 750: The 750-471 4-Channel AI Module features four electrically isolated analog inputs, making it ideal for all applications in which signal acquisition requires high immunity to interference.

Electrically isolating signal inputs is particularly important for areas in which interference may occur, e.g., due to potential differences. Typical examples are found in marine and offshore environments, where potential differences can often occur due to a floating ground for the electrical supply when systems are distributed over great distances. As a result, interference occurring in signal detection can lead to application errors. The new 750-471 Module, now available for the WAGO-I/O-SYSTEM 750, has four electrically isolated analog inputs to prevent this from happening. The resolution of the inputs is 16 bits, which enables implementation of high-precision control and regulation tasks. The channels can be parameterized either as a current input ranging from 0 … 20 mA, 4 … 20 mA, 3.6 … 21 mA (NE43) or ±20 mA, or as a voltage input ranging from 0 … 10 V, ±10 V, and up to the millivolt range of ±200 mV. This makes WAGO's new module very flexible. Depending on the requirements, the user can configure the channels individually and almost any analog sensor can be recorded using this single module.

This saves storage and operational costs. The WAGO-I/O-CHECK commissioning tool and suitable function blocks for WAGO-I/O-PRO and ***e!***COCKPIT are available for programming and configuring the WAGO-I/O-SYSTEM.

The WAGO-I/O-SYSTEM 750 currently consists of more than 500 different modules that allow the user to create the perfect system. With its versatility and flexibility, the system is suitable for industrial, process or building automation, sensitive safety applications, telecontrol or in hazardous areas. International certifications mean that the WAGO-I/O-SYSTEM 750 can be used worldwide within the broadest range of industries.

»USING MODULARIZATION TO ENSURE GERMANY'S COMPETITIVENESS.«

High hurdles are approaching companies in the process industry. Thomas Scherwietes, Manager for EMR Designs and Systems at Evonik and the chair of the 3rd work area "Field devices" at NAMUR, explains how Germany can remain competitive in the future.

In your opinion, what challenges must companies in the process industry overcome in the next few years in order to maintain their competitiveness in Germany?

» **Scherwietes:** Competitiveness in Germany can only be maintained in my opinion if we continue following the path of developing new, high-quality products that can be brought to market in the shortest possible time. Time-to-market is the determining argument. The intriguing question that drives us forward is also the question as to how we approach this challenge, and the guarantee for our success will be the technologies that support us in this endeavor. «

How do you approach these challenges at Evonik – also, or in particular, with a view toward using modern technologies and methods?

» **Scherwietes:** At Evonik, we meet each challenge with a willingness to integrate new technologies and methods directly into our own engineering processes. In particular, the approach of adding modularity to systems could massively alter classic engineering processes. If we could easily configure the automation technology of modular systems so that functional production lines would be generated merely be joining modules together, then we could deliberately design systems that can be set up by operators, and thus without automation specialists. «

How does Evonik define the topic of asset management? Do you consider asset management to be a central component for increasing efficiency in your processes?

» **Scherwietes:** Asset management is defined comprehensively, that is, over the entire asset life cycle at Evonik. Stated another way: asset management is part of our asset life cycle management. It begins when planning a new system and extends continuously through the system use up to and including decommissioning. The goal of all system design is to integrate the elements of the asset life cycle management, ideally at the design stage. This is the only way that we have found, over the long operating time of our systems, to be able to access both the specifications and design data and also to include recurring test data from maintenance management, and thus ultimately the flow of goods from the asset, including both the starting materials for and the products from our systems. So, yes, asset management is an indirect component for increasing the efficiency of our processes. «

Evonik and WAGO have implemented joint projects at various times in the past. In your opinion, what are the greatest advantages of WAGO's solutions?

» **Scherwietes:** In our opinion, the greatest advantage in the WAGO solutions is that the understanding of modular system design is already firmly anchored at

WAGO due to DIMA. WAGO can react very flexibly to demands that result from a highly innovative project that also includes a completely separate automation concept. «

How important is the ORCA project for you personally and for Evonik? And what do you hope to achieve from the joint work on the ENPRO initiative?

» **Scherwietes:** For me, personally, the ORCA project offers the possibility of participating in the development of a new technology, which we can use in the future to bring automation technology closer to the plug & play principle. For Evonik, the ORCA project means that we are getting significantly closer to our objective of scalable systems. The desire for individual products at low lot sizes demands that we be able to adjust our systems to meet new product requirements, ideally within a very short period of time. Regarding our participation in the ENPRO initiative: we hope to be instrumental in laying the foundation for a new technology, which will then quickly and successfully establish itself on the market. The conditions appear positive for this, because representatives from the universities, the manufacturers, and also the process industry are collaborating on the ORCA project. «

In addition to the current actors in the ENPRO initiative, who else do you see as potentially responsible for actively shaping new approaches, like that of modularization?

» **Scherwietes:** In addition to the participants in the ENPRO initiative, I feel that generally all manufacturers of automation technology and those of us who use it are responsible to be receptive to the principles that are being created by the ENPRO initiative, and consequently to actively work for their implementation. Therefore, it is important that the ENPRO initiative creates approaches that find a broad level of acceptance. This is the only way for such approaches to quickly develop into a reliable standard, which in turn is the only reason that it would make economic sense for manufacturers and end users to implement this standard in their own products. In particular, I hope that our package unit manufacturers recognize the advantages of the modularization approach. This would allow us to mutually profit from a standardized interface, via which any package unit module could be adapted quickly, and thus less expensively, into a process system. «

Dipl.-Ing. Thomas Scherwietes studied general electrical engineering at the Ruhr University Bochum with a subsequent focus on control technology and digital signal processing. Starting in 1991, he worked at the former Hartmann & Braun AG as a project leader for various project process control technology projects, including the re-instrumentation of the transalpine pipeline (TAL). He gained international experience through working at Technip. He has been at Evonik since 2007, where he manages the Site Services business unit at the Marl location, focusing on EMR designs and systems. In NAMUR, he coordinates the 3rd work area "field devices" and manages the 1.10 working group "PLC engineering" as the chair.

Wastewater treatment facilities are sensitive systems that require constant conditions to maintain their microorganisms. A harmonized wastewater supply can be realized by combining the throughflow measurement of the wastewater in the sanitary sewers with hydraulic engineering measures, like throttle points.

NIVUS and WAGO have created a simple network organization using a standardized solution.

WATER RESOURCE MANAGEMENT: INTELLIGENTLY NETWORKING MEASUREMENT VALUES

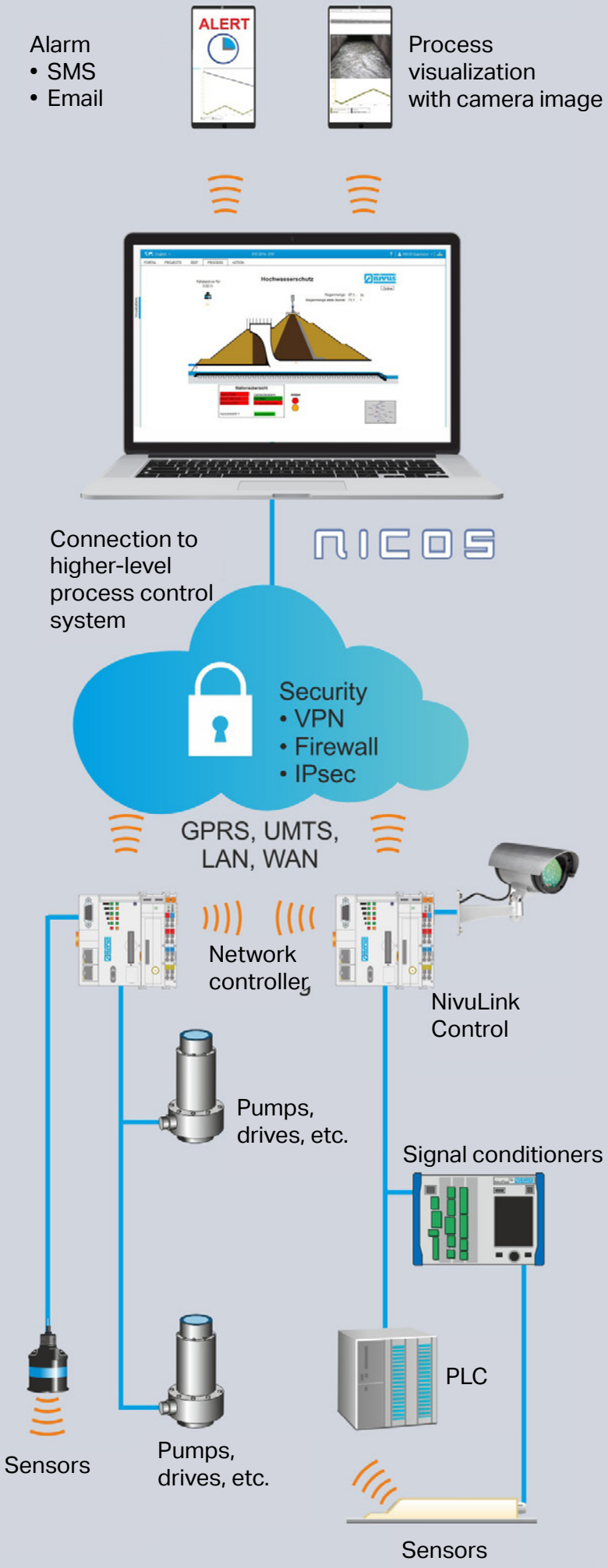
Using the right measurements – it always goes back to that when you are optimizing processes. It often sounds so easy, but it is usually anything but. Using the right measurements means: determining the data that are actually relevant for the process analysis, evaluating the data using suitable mathematical models, and bringing it into a targeted context. If this succeeds, then measures can be derived in the end that have the potential to sustainably increase the efficiency of the process. In wastewater treatment, data is primarily recorded in the sanitary sewer network or at wastewater treatment plants. NIVUS GmbH from Eppingen is among the market leaders in this sector due to their measurement sensors. Together with WAGO, the company developed a solution that links data from geographically distant stations into a network in a comparatively easy way.

Wastewater treatment facilities are sensitive systems that require constant conditions to maintain their microorganisms. In this context, a harmonized supply of wastewater is an essential prerequisite – particularly when considering the volume, concentration and composition of the waste load. This can be implemented by combining the through flow measurements from the wastewater in the sanitary sewers with hydraulic engineering systems, for example, a throttle point.

If the individual measuring stations of the hydraulic engineering systems are networked within a sewer system, then the data, that are obtained here, are available in real time at the control center of the wastewater treatment plant. By using the target-actual performance comparison of the process data from the wastewater treatment facility, the optimal supply of wastewater can be determined using mathematical calculations and the plant can be operated in the most optimal state. When calculating the necessary measures, the time delay must also be considered that exists between setting the changes, and the point when the effects of said changes are generated. Controlling the process is thus carried out long before the load arrives at the wastewater treatment plant or even its peripheral areas. At the same time, an important contribution to surface water management can be achieved by the targeted control of throttle points and other hydraulic engineering systems. In this context, NIVUS discusses an integrated process control system which forms the basis for developments in the direction of water 4.0.

Optimally Controlled Processes

Buffer storage points, for example, underground stormwater retaining basins in the sanitary sewer network for the water management area, must also be efficiently regulated. They can fill completely during heavy rain events and, as the rain tapers off, can provide a quantity of water with a low contamination load that is optimal for biological processes at the treatment facility.



The "NivuLink Control" can be programmed using a localized programming sequence for complex calculating and control tasks. The controller supports all digital, analog and specialty I/O modules found within the 750/753 Series in addition to network and fieldbus interfaces. Data transmission is carried out via the wireless network and/or ETHERNET interfaces, depending on the controller version.

For this purpose, the discharge vents of these reservoirs can be adjusted, as needed, based on the intelligent aggregated system. This is used to create harmonized purification processes that lead to good discharge values at increased energy efficiency.

Standardized Solution, Complex Application

In the majority of the numerous applications used in water and wastewater treatment technology, the focus is on recurring applications. Therefore, NIVUS and WAGO developed a standardized technology. The WAGO-I/O-SYSTEM 750 with a PFC200 thereby takes on the central task of a maintenance-free IoT gateway in the substations. As the "NivuLink-Control", it ensures the connections between sensors, actuators, and the main control center. NIVUS thus unites the automation of the centralized processing facility with the monitoring of decentrally distributed processing areas. The resulting advantages are obvious: "There is one central operational guidance down to the lowest levels. Monitoring and controlling the distributed stations is centrally carried out. The centralized visualization of system parts facilitates a fast overview and an efficient monitoring and control of distributed systems," explains Martin Müller, Marketing Manager at NIVUS.

Easily Link in Decentralized Stations

The controllers that are decentrally installed in the aggregated system control both the process and also simultaneously monitor the system. Thus, a pump station can be both linked to and controlled at the central control panel using the PFC200, and continuous system monitoring can also be carried out. In this way, for example, signs of wear or blockages can be identified and alleviated early. With more than 500 function modules, the WAGO-I/O-SYSTEM 750 provides the hardware platform for linking various sensors, measuring technologies and also drives. This allows the process values to be recorded in a targeted way at the substations and then evaluated.

There is a good reason that Martin Müller designates the PFC200 as the "remote brain that links the compiled sensor information with the control system – and we ideally provide both the

sensors and the control system." This system solution provides an overview at all times into the the aggregated wastewater treatment facility. This reduces personnel expenses for monitoring and maintenance of the system, while increasing operational safety at the same time.

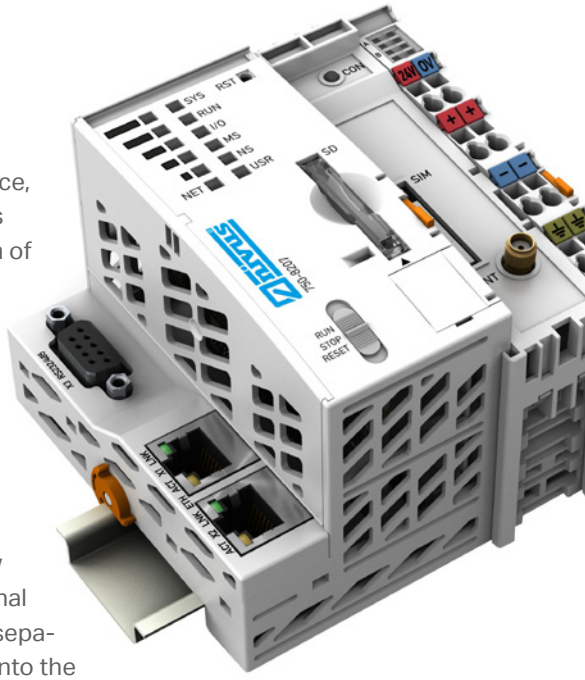
"By using process values measured at the substations, targeted conclusions can be drawn about the state of the system as a whole. ,The system solution using NICOS and the PFC200, or 'NivuLink Control', represents an important step towards predictive maintenance for the operators," emphasizes Kay Miller, Global Industry Manager Water at WAGO. The general openness of the WAGO-I/O-SYSTEM 750 smooths the path for collecting highly varied analysis values, signal types or data formats using suitable I/O modules, processing the data in the controller, and then forwarding it to the control center as a bundled data packet using TCP/IP

No Limits to the Connections

In addition, the many interfaces included in the WAGO-I/O-SYSTEM 750 facilitate communication with adjacent machines and system components. Both analog and digital outputs as well as bus technologies are available for controlling actuators. The measured value memory in the device can be easily expanded using SD cards. Connections to higher-level systems can be established in the traditional way using current data lines, or wirelessly using the 3G version of the PFC200. "By expanding the PFC200 to the 'NivuLink Control', NIVUS has created a solution that can be used independent of local network availability or specific SIM cards. They thus offer a choice between server-based and cloud-based applications," explains Miller. The "NivuLink Control", based on the PFC200, is characterized by minimal data volumes, which thus reduces costs for data transmission. Alarm and trigger functions accelerate processes in predefined scenarios. Integrated security features, like OVPN, IPsec, or TLS are used to ensure transmission security. Therefore, the "NivuLink Control" also complies with the requirements for cybersecurity for critical infrastructure applications.

Conclusion

According to NIVUS' experience, control system manufacturers previously solved the problem of geographic distribution of systems by using heterogeneous system levels. "These do not satisfy the requirements for complex, technical subsystems – at least not in a single step," explains Müller. They relied on "remote terminal units" (RTUs) with low levels of automation for external stations, and then combined separately-designed subsystems into the higher-level network control system in a second step. Müller continues, "With the 'NivuLink Control', we provide a single intelligent solution for completely networking sensor-based measuring systems – from a single supplier, in a single step."



A compact controller for PLC systems that supports network and fieldbus interfaces: the "NivuLink Control".

TEXT MARTIN MÜLLER | NIVUS
KAY MILLER | WAGO
PHOTO WAGO, NIVUS

About NIVUS

The NIVUS Group is a leading developer, producer and supplier of measurement technology and process control systems for water resources management. The company has developed fill-level and flow-through technology for 50 years, and continues to develop application-oriented measuring systems. Their solutions are characterized by a practical approach to consulting. The company is located in Eppingen and is active internationally with nine subsidiaries and more than 40 distributors.

Quintex has relied on WAGO for ex modules for ten years.

HAND IN HAND FOR EX PROTECTION

Celebrating several years of collaboration for safe explosion protection: Frank Sünkel, Technical Marketing Consultant at WAGO (left) and Klaus Weiter, Product Manager Ex at Quintex.

Ex protection is among the topics that system manufacturers and operators do not like to discuss in detail, due to its extreme complexity. This is not the case for Quintex! Ex protection is their "daily bread." The highly-specialized company provides installation-ready junction boxes for ex zones, which solve this vexing problem for system manufacturers and operators. Housings built by Quintex always include WAGO rail-mount terminal blocks and the WAGO-I/O-SYSTEM 750.

The topic of explosion protection originated in mining. This was a dangerous profession up until the second half of the nineteenth century. In the meantime, explosion protection has also spread to other industries. Common examples include the chemical industry, the production of crude oil or natural gas, the food industry, and in biogas systems. Basically, anywhere that gases and dusts are generated that create a "dangerous explosive atmosphere" when combined with oxygen. If ignition, caused by a hot surface or an electrical spark is applied to these mixtures, then the situation that must be prevented under all circumstances can quickly occur: an explosion, which usually has the potential to directly injure one or more people.

Explosion Protection is a Matter of Trust

"Explosion protection is characterized by trust. To express it clearly: people's lives are at stake," explains Gisbert Schmahl. He speaks from experience as the technical managing director at Quintex, a company that is quite familiar with explosion protection. Founded ten years ago, Quintex is now a mid-sized company specializing in ex terminal boxes, ex controllers and components, ex heat tracing, ex cable lead-throughs, and ex overpressure controllers. Quintex solutions are suitable for use in ex zones 1, 2, 21 and 22, and are certified according to international specifications like ATEX, IECEx, and EAC. According to product manager, Klaus Weiter, customers for the company based in Lauda-Königshofen near Würzburg include both equipment and systems designers as well as end customers, that is, system operators. "We do not offer standardized solutions. Instead, our technology extends from lot size 1 up to tailored series manufacturing." In order for Quintex to be able to competitively provide these individual customer requests, the company has learned to skillfully combine components that have already been proven in industrial applications.

Ready-to-Connect Solutions Designed for Ex Zones

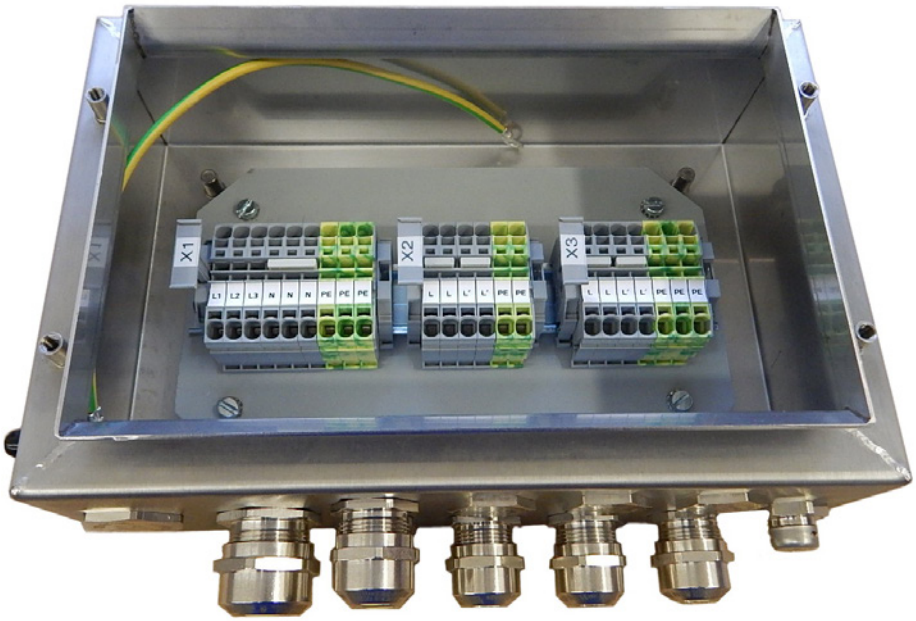
Housing solutions from Quintex, like polyester housings made from fiberglass reinforced plastics or stainless steel 1.4404/316L, have proven their use in harsh environments one-thousand times over. This is, in particular, because aggressive chemical substances or mechanical loads have hardly any effect on them. Silicon seals in the covers seal cleanly and durably, and thus protect the installation and control technology in the interiors. When it comes to populating their boxes, Quintex has relied on the WAGO's portfolio of solutions for ex and non-ex areas for more than ten years.

Ex and Non-Ex from a Single Source

CAGE CLAMP® connection technology from WAGO both saves time during wiring and also ensures a safe connection, even in particularly harsh environments, because the contacting is always spark-free. In addition, the program offers maximum freedom in economically implementing ex and non-ex applications from one system. For example, the WAGO-I/O-SYSTEM 750 assumes the central functions within the vital measuring and control technology in a biogas system.

»We do not offer standardized solutions. Instead, our technology extends from lot size 1 up to tailored series manufacturing.«

While components without ex protection remain powered off following an alarm from the safety technology, systems with corresponding ATEX intrinsic protection continue operation. However, these two worlds need not be implemented using separate automation systems because the WAGO-I/O-SYSTEM 750 allows for the operation of ex and non-ex bus modules in a single node.



Stainless steel housings have proven themselves under the harshest conditions and in hygienic areas as terminal/junction boxes and for on-site control points. The housings from Quintex always include WAGO rail-mount terminal blocks and the WAGO-I/O-SYSTEM 750.

Regardless of how functional the hardware sounds, this is only part of the market solution that Quintex offers, according to Gisbert Schmal. "Customers expect more from system integrators than just a solution off the shelf; they require individual systems that are tailored to their specific interests," he explains. "We do not provide individual devices. We sell functions and tailored solutions – including the optimal coordination of the WAGO technology integrated into the terminal boxes, design coordination at the beginning of projects, the necessary clarification of details, and all required releases and documents."

Before It Explodes: When It's on Fire

By using components from WAGO, and due to the close contact with the connection technology specialists from Minden, Quintex is able to supply its customers with pre-built connection technology and connection-ready terminal boxes and heat tracers within a very short time frame. "If it is a rush job, we can complete it within three days of receipt of the order in our express manufacturing," states Klaus Weiter, Product Manager, with pride. The fast delivery times are among Quintex' unique selling points. However, this requires sound judgement when selecting vendors. "As a system integrator, we are always responsible to our customers for the actions of our vendors. We must be able to rely on them one-hundred percent," adds Gisbert Schmahl, who has declared himself more than satisfied with the collaboration of Quintex with WAGO.

TEXT KLAUS WEITER | QUINTEX
KAY MILLER | WAGO
PHOTO QUINTEX

About Quintex

Founded in 2007, Quintex has become a specialist in installation-ready junction boxes for ex zones in their ten years of existence. The company, headquartered in Laud-Königshofen in Baden-Württemberg, with 50 employees and 2500 square meters of production space, has established itself successfully and enduringly on the market. Their portfolio focuses on heat tracing and explosion protection.

WAGO-I/O-SYSTEM 750 XTR: TWELVE NEW EXTREME POSSIBILITIES

WAGO expands its XTR portfolio to include 12 new I/O modules. XTR stands for: Extreme. This is WAGO's I/O system for extreme applications that place exceedingly high demands on temperature and vibration resistance, as well as immunity to impulse voltages and electromagnetic interference. These new XTR modules are primarily used in the control and distribution cabinets of outdoor applications, mobile systems (such as trains and streetcars), as well as in the renewable energy and process industries.

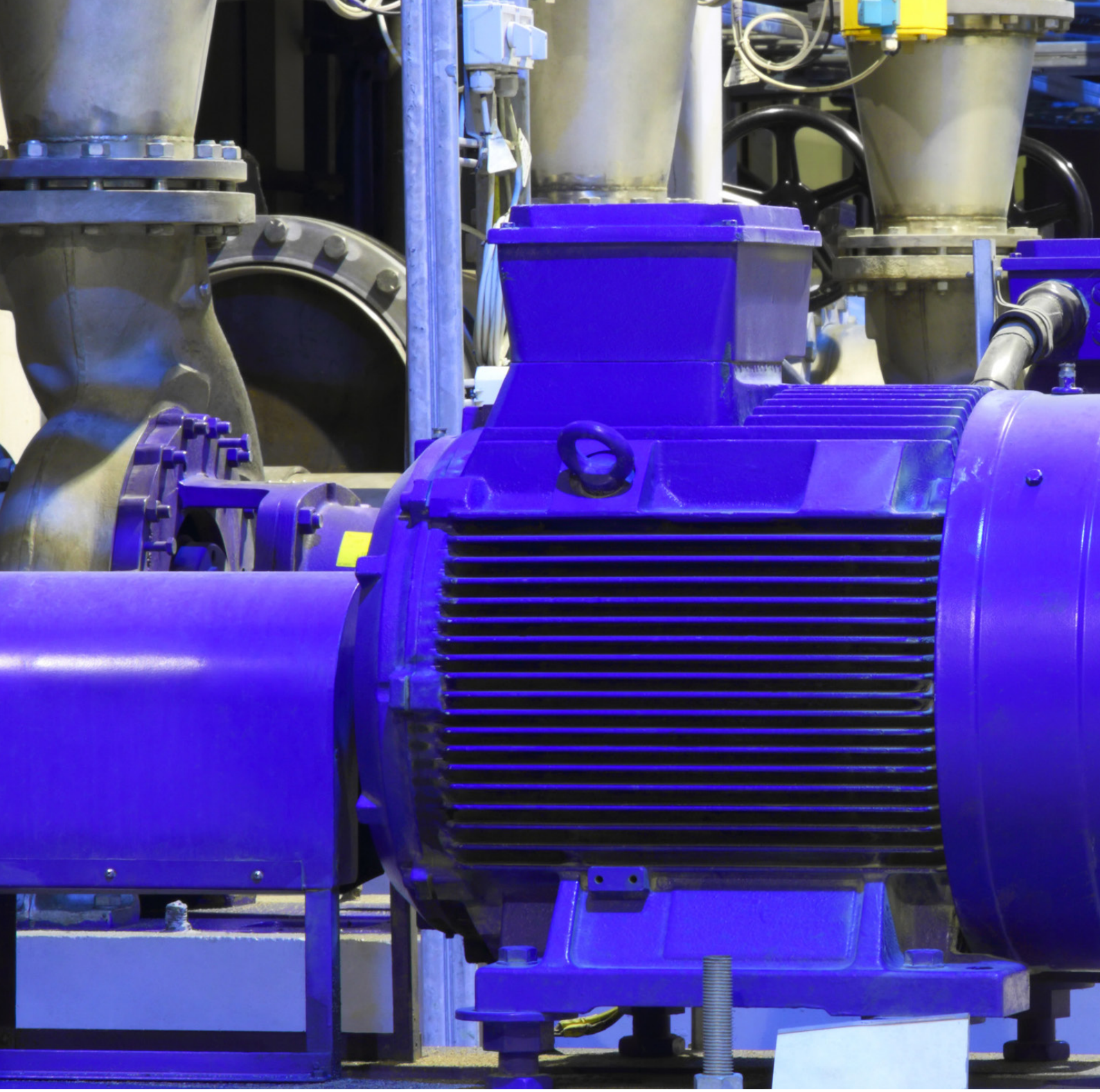
The twelve modules joining WAGO's 750 XTR I/O System include new analog/digital inputs and outputs, function and technology modules, modules with CAN communication capability, as well as supply and segment modules. As with all members of the XTR family, these new modules are engineered to work reliably, are fail-safe and provide a long service life in extreme environments.

Advantages for the Automation and Heavy Industries:

- New possible solutions for applications
- using module functions such as counter, SSI, incremental encoder, CAN gateway, power supply with fuse holder
- Compliance with railway system requirements
- Universal connection possibilities for conductors up to 2.5 mm² (14 AWG)

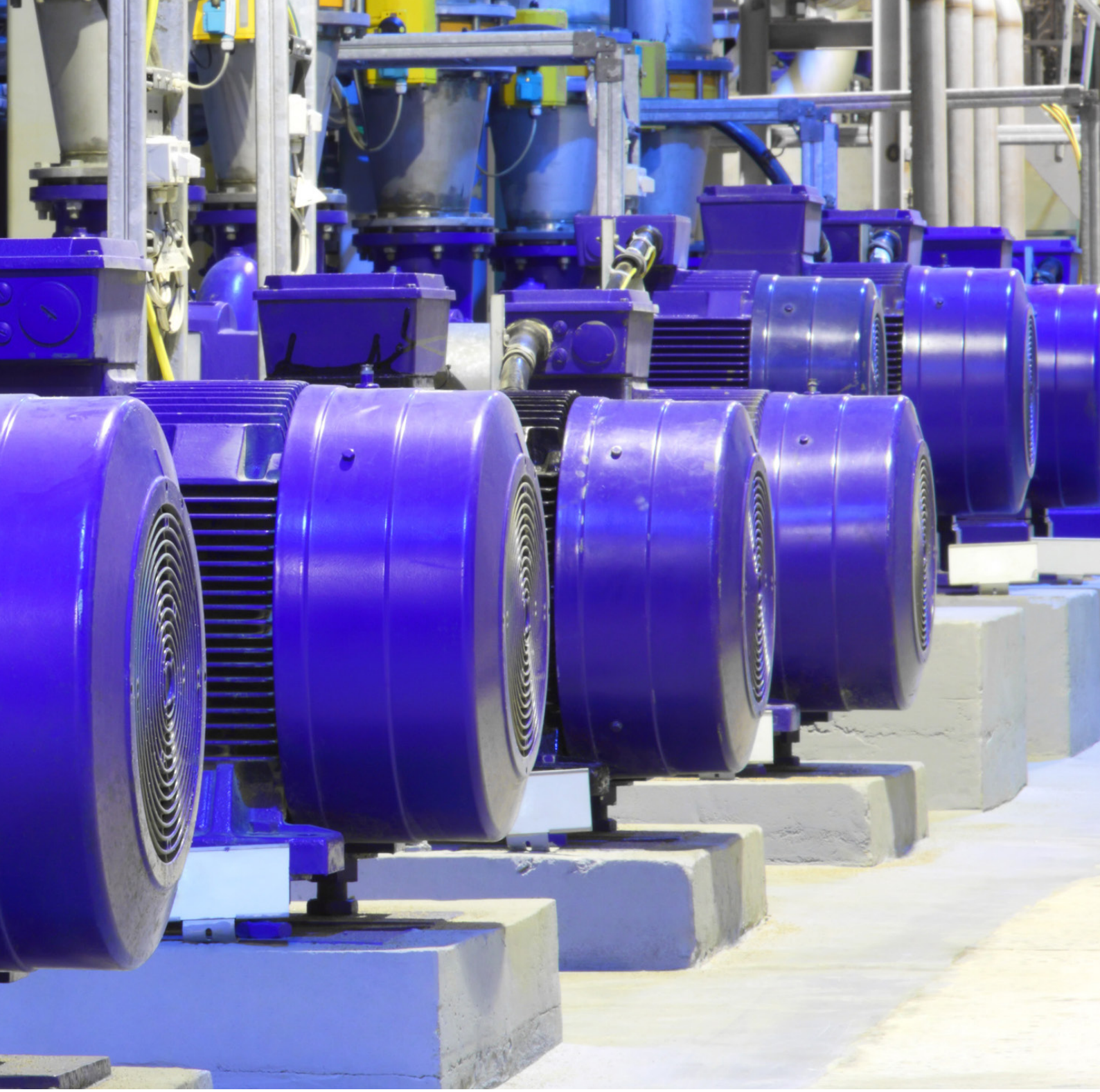
When the Going Gets Tough

The 12 new modules seamlessly integrate into the WAGO-I/O-SYSTEM 750 XTR, which performs in an extended temperature range of -40 to +70°C without additional air conditioning. System vibration resistance also defies acceleration forces up to 5g. With its immunity to impulse voltages and electromagnetic interference, the system is also a great fit with medium-voltage systems.



Application software facilitates software engineering, servicing and maintenance.

STANDARDIZED PUMP CONTROL REDUCES SOFTWARE ENGINEERING TIME



During the design of pump stations in wastewater treatment, the top priority is to equip the pumps with sufficient output. This is the only means for reliably transporting wastewater the way that gravity would. Regardless of the advances offered by technology over the decades, nothing has altered this core task.

Yet, while the function has remained the same, the execution has changed over time. And this has led to extremely heterogeneous plant structures that can complicate servicing. Solutions that support current technology and maintenance are particularly in demand during modernization work. As a result of these demands, WAGO has developed application software for pump controls in which even the smallest details receive consideration.

In Germany, pump stations are among the oldest public infrastructure, next to streets and railway bridges. Some pumping stations that have carried out their tasks for more than 100 years have been converted into cultural centers or

By using variable operating parameters, it is possible to largely protect pump systems from contamination, for example, fat deposits.

even museums. Advances in technology can be potentially read from a pump station: where gas motors functioned as drives a century ago, pumps are now driven by electricity and largely operated by automation technology. The development of new types of impellers and sensors have led to significantly higher outputs and efficiencies as well as improved possibilities for monitoring. However, the modernization and automation of pump stations has grown organically over the decades, and this is precisely the origin of the extremely heterogeneous automation structures that we currently find in pumping stations. It is especially common in large wastewater treatment facilities, where the operators may run 70 pump stations that include pumps or motors from three different manufacturers that are in turn regulated by three or four different control systems.

»The pump control can thus be universally used and reliably ensures that the system is networked into the entire drinking water or wastewater operation.«

Modernization as an Opportunity

Over the course of modernization, the opportunity presents itself to standardize the hardware and software in pumping stations, because while the motor and other mechanical parts are generally retained during refurbishing, the sensors, electronics, and automation are replaced. However, because most operators convert their pumping stations in stages, and not all at once, this is often not the case. Instead, the system operators bundle up to 20 pumps into a batch for which modernization bids are tendered. Even if the operator intends to use the modernization to convert the pumps to one system, in that the tender specifies which hardware should be used during the renovations, there is still no certainty that the software installed on the devices will be programmed in a similar, standardized fashion – not least because every application engineer or programmer writes their software code differently. In the worst case scenario for operators, the maintenance expenses can be as high as those for modernization, because the service technicians have to examine the programming for each controller separately in order to search for potential errors during maintenance or servicing.

Standardized Control Due to Carefully Thought-Out Application Software

In order to reduce these expenses, WAGO developed application software for controlling pumps that combines basic functions for recurring tasks with a large degree of freedom for setting individual parameters. Project-specific variants of the software need only be configured, and not programmed. This significantly reduces software engineering costs. The hardware base for the application software is the WAGO-I/O-SYSTEM 750, which can easily link in systems that developed heterogeneously, due to its more than 500 different I/O modules and numerous interfaces. The pump control can thus be universally used and reliably ensures that the system is networked into the entire drinking water or wastewater operation.
The application software is designed for pump stations with two to six pumps with different outputs. Based on the experience that WAGO has gained over numerous projects in wastewater treatment facilities, it meets the exact demands that typically occur during pump operation: load management, corrosion protection, and securing redundant operations.

Redundant Operation

Different types of pumps are generally provided in pumping stations to further ensure the availability of the station in the case of interruptions or during maintenance work. These include base-load pumps, peak-load pumps, rest drainage pumps and reserve pumps. However, the additional pumps within a facility may be used for more than peak loads or redundant operation. In addition, they should run in regular timed intervals to prevent operational interruptions. Otherwise, operational errors are inevitable, because pumps that remain motionless are subject to dirt loads, connections can be seized by corrosion, or mechanical components can clog.

The different uses for pumps can be correspondingly defined using the application software from WAGO. If a reserve function is configured for one of the pumps, the WAGO controller ensures that this assignment is changed after every operating cycle so that the affected pumps are still regularly operated. In addition, the application monitors the pump runtimes and starts them automatically after a long period of inactivity for a set time to prevent corrosion.

Load Spike Prevention

When the pumps are switched on, they should not all start up at once, if possible, but rather sequentially in order to prevent unnecessary loading on the electrical network. The WAGO controller supports this with a start-up delay. A second pump of the same type is therefore only started up after the first pump has operated for a predefined time period. The length of this time period depends on the individual application and on the effective load management on site – and can therefore be easily parameterized in the pump controller. This minimizes loads on the electrical network and likewise contributes to emergency power operation when using generators.

Pumps can be customized with the aid of the ***e!****COCKPIT* engineering tool, which is integrated in the PFC200 and PFC100 Controllers for the WAGO-I/O-SYSTEM 750.

Flexible Level Switching

By using changing operating parameters, it is also possible to largely protect pump systems from contamination, like fat deposits, that are a serious problem for operators when they accumulate on the walls of the pump shaft. Fats from households or gastronomic companies are discharged to the sewer system and float to the top of the water surface in the pump shaft. Because the water level is held at the same level in the pump shaft by the pump, the fat floating on the water has the best conditions for settling in the pump shaft. This process is further promoted if the fats are already in a lipophilic phase. The layer faces inward, threatens to clog the sump pump, and can only be mechanically removed. To prevent this process from occurring – or at least to delay it, the switch on and off points of the pumps are configured to be flexible. The settings can be customized with the aid of the ***e!****COCKPIT* engineering tool, which is integrated in the PFC200 and PFC100 Controllers for the WAGO-I/O-SYSTEM 750. If this is implemented, then the actual switching point randomly falls slightly above or below the specified water height in the sump. This varies the water level in the pump shaft and better distributes the fat deposits.

Everything at a Glance

With a view toward ease of operations, an intuitively usable, web-based visualization is included in the new, standardized WAGO application software for pump stations. The pumps can be monitored and controlled both from the control center and also directly on site using a touch panel connected to the controller. Users can freely select how the pumps should be identified for the purpose of the assignments. The pump control, programmed using IEC 61131-3 standardized languages, merely provides general functional frameworks for controlling up to six different pumps of different types. The details of the control program are part of the individualized customer design.

This includes specific demands for system availability. More than ever, demands for system availability are prompting operators and service companies to consider new maintenance strategies and to introduce effective measures. Conventional maintenance approaches, like reactive or even preventative maintenance, are changing over time in the direction of predictive maintenance according to Industry 4.0. With this software solution, WAGO provides a foundation that is a reliable statement about what is coming. Key data like phase currents, throughflow values, pressure, temperature, and cos phi, as well as load and alarm management are the foundation for operating a more predictive maintenance. At the same time, the standardized software solution reduces operator investments in different software packages and recurring updates, as well as training for service employees.

TEXT KAY MILLER | WAGO

PHOTO ADOBESTOCK, WAGO

In order to equip pumps with sufficient output, WAGO has developed application software for pump controls in which even the smallest details receive consideration.

Integrating Decentralized Suppliers

BALANCING ENERGY FROM THE REFINERY

The Viennese energy supplier, VERBUND Solutions GmbH, combines decentralized electrical producers and consumers for marketing to the balancing energy market in their virtual power plant, the VERBUND Power Pool. One of these decentralized producers is OMV, an integrated oil and gas company. The exchange of process data is carried out using telecontrol technology from WAGO.

High quality gas is not the only thing produced in the Viennese OMV refinery. Unusable residues also accumulate, which are used on site for energy production.

Providing electricity is a complex business that presents technical and logistical challenges to power suppliers, because production and consumption must be constantly maintained in balance so that the electrical supply system does not tip into failure. Electrical companies therefore have to ensure that there is always sufficient electricity in the system and that the network remains stable, despite fluctuating and unpredictable consumption.

There are national balancing energy markets to guarantee a constant frequency of 50 Hz in the electrical network, which can fluctuate during supply peaks or outages at power plants. Balancing energy represents a type of energy reserve that can be physically tapped for the short term and thus prevents a collapse of the electrical network by stabilizing the frequency back to 50 Hz. Austria defines primary, secondary, and tertiary balancing reserves according to whether the required energy is to be provided by the producer within a few seconds, or within five or ten minutes.

Pan-European Balancing Energy Market

In addition to classic power generators, the balancing energy market enables loads and consumers in industrial fields the opportunity to maintain stability in the electrical system through reductions/increases in electrical production and activation/deactivation of loads, following successful prequalification. In Austria, the oil and gas company OMV used this chance and prequalified as a supplier of tertiary balancing energy three years ago.

The oil and gas company OMV covers the electrical needs of their refinery in Vienna from their own CHPs. Excess electricity has recently been sold on the balancing energy market.

"We operate two combined heat and power plants at our refinery in Vienna-Schwechat, which supply the entire petrochemical facility with electricity. We combust unusable residues from gasoline and diesel production, natural gas, residual gas, and mixed gas," explains Alexander Radauer, Procurist for Operations for the OMV refinery in Schwechat, and adds, "the capacity of our CHPs essentially functions to cover our own use. The production byproducts that we convert to electricity do not accumulate predictably, and can only be provisionally stored. The opening of the balancing energy market for industrial systems offered us the possibility of selling our excess electricity."

After a year of collaboration with the Slovenian energy supplier, GEN-I, OMV now cooperates with VERBUND Solutions GmbH in the context of the VERBUND Power Pool. If excess capacity is present, the oil and gas company can activate up to 15 megawatts for the short-term balancing reserve. Radauer explains, "We only provide the asset. Selling to the balancing energy market is carried out by the Power Pool."

OMV's asset is one of many that feed current into the electrical network during frequency fluctuations, or draw down during excesses. To simplify marketing of both decentralized electrical producers and consumers, VERBUND Solutions combines the decentralized energy systems and consumers into so-called virtual power plants. "As a balancing reserve supplier, this has many advantages for us: we can collect decentralized producers and consumers into an aggregated whole in one virtual power plant. Then, we can sell the bundled, individual participants to the balancing energy market," explains Bertram Weiss, Product Manager at VERBUND Solutions.

Control Box as System Core

A control box, located in the respective power plant, functions as a communication interface between producers, consumers, and retailers. The core is a WAGO PFC200 Controller. "At a command from the virtual power plant, the WAGO controller collects the desired power plant data, such as deliverability status and available output, and returns this information in bundled form. In the reverse direction, the PFC200 accepts commands for output provision and transmits them to the control center of the CHP. "Power plant specific interfaces originally consisted of several digital and analog signals. After modifications, the information is currently transmitted using serial two-wire bussystems, Modbus RTU," explains Martin Kluchert from WAGO.

The communication between the virtual power plant and the WAGO controller is carried out using a fixed telephone network and is encrypted via a VPN tunnel. In the case of the OMV-VERBUND cooperation, the oil and gas company transmits around 25 data points to the network operator,

who returns around ten data points to their decentralized electrical suppliers. The WAGO controller converts commands and information to Modbus RTU in order to communicate with the process command system at OMV. "The process command system reports the query to the power plant operator, both on a user interface and with an acoustic signal, at which point the operator supplies excess capacity to the network by manually spinning up the turbines. OMV, as a supplier of tertiary balancing energy, is obligated to achieve the target value within ten minutes," explains Bernhard Vogel. He maintains the CHP control technology at the OMV refinery in Schwechat. A direct and automated access via the control box into the power plant controller is not necessary, due to the long run-up time; however, one is planned for their future entry into providing primary reserves, for which the run-up time is a few seconds.

"The high operational reliability, ease of operation, expandability, and the multitude of supported interfaces all support choosing WAGO controllers," says Jakob Fölser, the contact person for technical connections in virtual power plants at VERBUND Solutions. He adds, "the pre-assembled control boxes allow us to expand a virtual power plant at any time, and without programming expenses for the decentralized energy suppliers. This helps to save time and money."

Communication Interface Controller

"Small, decentralized power plants often lack uniform controllers, and instead have hardware inputs and outputs. Thus, for example, digital outputs report operating states, like faults, maintenance, or availability. Analog signals are used to exchange currently available outputs, or requested outputs. However, bussystems, like MODBUS or PROFIBUS are also commonly found," states Kluchert from WAGO. The WAGO controller establishes communication interfaces between interfaces specific to a power plant, and the control system for the virtual power plant. The connection to the network operator is then carried out using various standardized telecontrol protocols. In Europe, this is usually IEC 60870 or IEC 61850, depending on system type.

Additional specifications, like VHPready, are also included with the WAGO controllers. This new industry standard, introduced by WAGO, defines operating conditions, operating properties, and data points so precisely that any system can be integrated into a VHPready network without additional software programming. "Security technology, from firewalls to VPN clients, is integrated into the controllers to help protect critical infrastructures. And the linking of small, remote power plants into one virtual power plant is quite simple using the integrated GSM modem," adds Kluchert.

VERBUND Solutions already uses the VHPready standard in additional control boxes, and thus connects several small power plants into its virtual power plant. WAGO offers a complete, yet expandable application for this, which enables VERBUND Solutions to quickly and flexibly link power plants using graphic-supported configuration, and to consider individual desires while doing so. The modular WAGO-I/O-SYSTEM, which is provided in pre-wired boxes, also supports this process and secures a long system availability due to its extreme robustness.

TEXT MARTIN KLUCHERT | WAGO

PHOTO OMV

The Process Industry Faces the Digital Transition

THE CLOUD FOR SMART PROCESSES

Providing, collecting, evaluating and using data: In addition to the PFC100 and PFC200 IoT Controllers, WAGO is expanding its digital performance portfolio with the new WAGO Cloud Data Control capability – a forward-looking method for enabling equipment and systems in a chemical facility to function more efficiently.

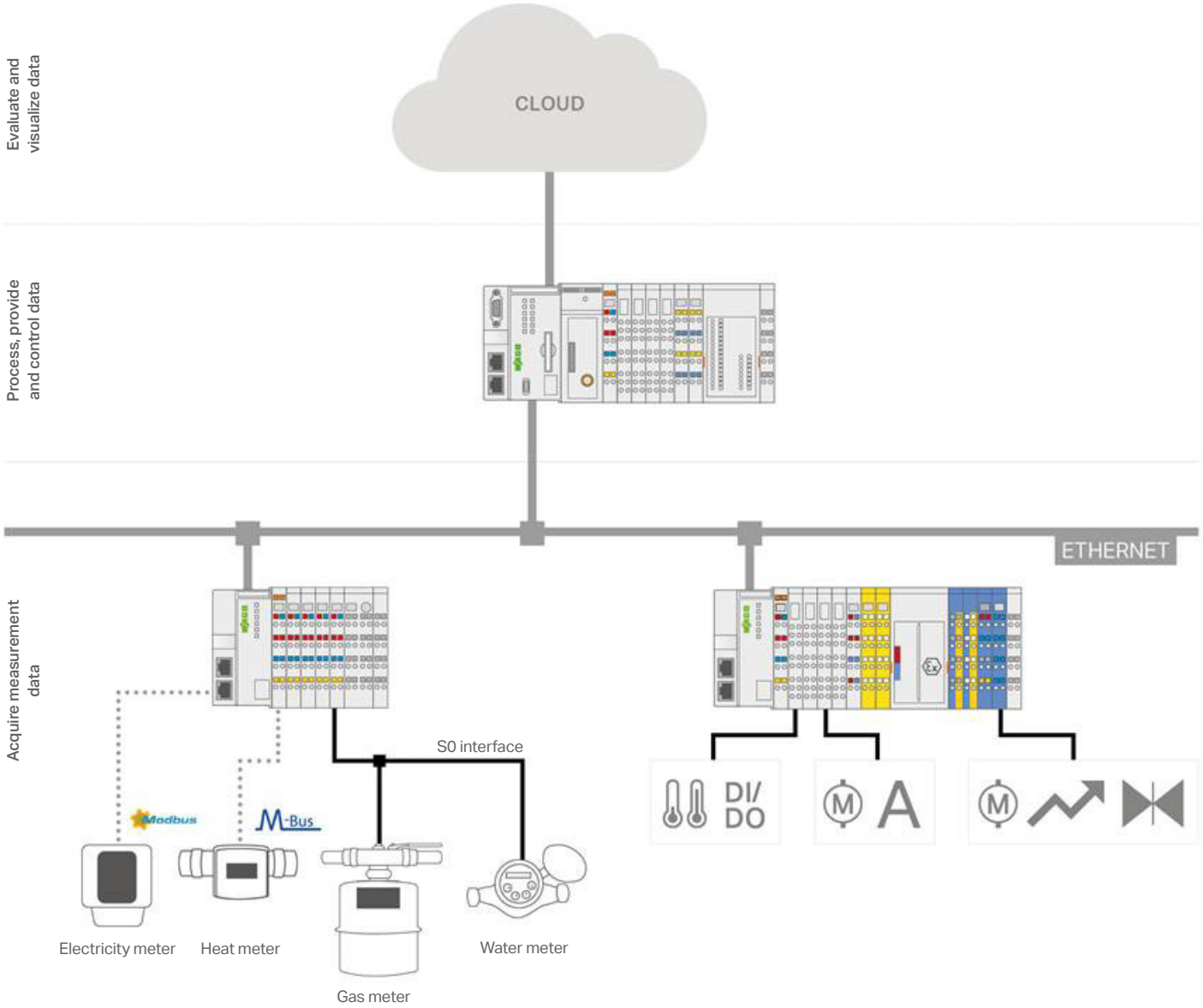
The trend toward digitalization has placed challenges before the chemical-pharmaceutical industry: individualized products, faster product cycles, higher levels of product diversity – all of which demands more flexibility during manufacturing at lower costs. The solution? Is not easy, but it is clever: the smart factory provides many answers to digital questions about the future.

Prerequisites include transparent information about processes, performance and quality. Although a huge amount of data is being collected in industrial processes, this data is usually spread across different systems that are often incompatible. This makes it extremely difficult to network systems and processes. By using cloud communication, new opportunities for networking arise for the process industry, in particular with a view towards required system availability and the optimization of processes. In addition, manufacturing islands must be able to communicate vertically past factory walls to the cloud, so that, supervisors have access to current data across multiple production facilities as needed.

Flexible Access to Process-Relevant Data

WAGO has dealt extensively with these requirements and can offer specific approaches to solutions for system operators in the process industry. These are based on technologies that are available today and offer measurable added value to the users. WAGO Cloud Data Control, which manages and monitors all WAGO PFC Controllers as well as their applications and data, is included among the most recent approaches. A Web portal serves as a user interface for the cloud service hosted by Microsoft Azure. Customers have access to functions – like project, controller, and user management, controller status monitoring, alarm functions, and email messaging – through this gateway.

The requirements for a smart factory are only satisfied when systems and processes are networked and manufacturing islands can communicate beyond factory walls into the cloud.



A dashboard displays texts, tables, diagrams, display elements and command buttons for seamless and intuitive operation. For customized solutions, the REST or OPC UA interface is used, for example, in energy monitoring and predictive maintenance applications. These enable users to recognize disruptions and to initiate repairs before faults lead to serious damage and cause production stoppages.

A Cloud Solution in Just a Few Steps

Both the WAGO-I/O-SYSTEM 750 and 750 XTR connect to field devices, and a PFC Controller sends data to the Cloud Data Control – the newest PFC generation is IoT-ready following a simple upgrade.By programming an IEC application with the corresponding library, the controllers can be transformed into IoT devices in just a few simple steps. Following this, status information such as Run/Stop, connection status, device information, and variables defined in the IEC program can be transmitted to the cloud and visualized.

The IoT controllers communicate with the Cloud Data Control via an encrypted MQTT protocol. The cloud connection data is configured via Web-Based Management (WBM). Libraries for CODESYS V2.3 and ***e!****COCKPIT* are also included in the scope of delivery. The variables that will be transferred to the cloud can be defined using the IEC program. This means that sensitive data does not leave the company.

Thus, the WAGO PFC100 and PFC200 Controllers form the platform that links elements from the real and digital worlds. They also offer a variety of interfaces, forming the perfect foundation for an IoT gateway. These modular and scalable controllers collect every field signal, communicate in all industrial protocols, and even enable cloud connection to sensors and actuators that themselves have no Web interface.

Data can be securely transmitted from the field level to the cloud via the MQTT interface.

Secure Protection from Hackers

The ability to view process data from anywhere in the world – it sounds practical, but is it secure? Cyber security is an important topic at WAGO. WAGO's PFC100 and PFC200 Controllers comply with the highest security standards, as they both encrypt data via onboard SSL/TLS 1.2 security protocols, and also securely transmit data to higher-level systems via VPN tunnel. They are characterized by a cross-platform real-time Linux® system, which has been available for a long time as an open-source operating system that can be scaled, updated and supports tools such as Rsync. This allows them to be used as secure gateways.

The Linux® foundation supports essential security protocols and ensures that these will be constantly refined thanks to the large Linux® community. WAGO devices therefore support IT security by design: all IT security mechanisms are integrated into the controller and cannot be disconnected by third-party access.

With M&M Software from St. Georgen as a member of the WAGO Group, the Minden-based company also has a close and integrated partner for developing industrial and technical software solutions. M&M collaborates closely with Microsoft on digital topics, like the cloud and the Internet of things, to implement corresponding solutions, primarily using Microsoft Azure.
The cloud computing platform is highly scalable and provides a detailed overview of computing power, data storage, transactions, availability and security standards. It offers a quickly growing number of services and tools to provide an optimal foundation for implementing solutions tailored to specific applications for users in the process automation sector.

However, customers are also not limited to Microsoft Azure. The WAGO Controllers can transmit the data, according to desire or requirement, to other platforms, like Amazon Web Services or IBM Bluemix. Connections to third-party solutions are also feasible due to the standardized MQTT protocol.

TEXT BENJAMIN BÖHM | WAGO

FOTO GETTYIMAGES, WAGO

WAGO Cloud Data Control is provisionally available for free as a beta version at **www.cloud.wago.com**.

Following an upgrade, the most recent PFC generation is IoT-ready.

Energy Management in the Chemical Industry

EFFICIENTLY MANAGED

The chemical industry consumes a lot of energy. WAGO demonstrates how companies can easily achieve savings by using intelligent data acquisition and modular automation technology.

The chemical-pharmaceutical industry is becoming more innovative and efficient. According to information from the German Chemical Industry Association (VCI), the sector reduced its energy consumption in Europe by 26% between 1990 and 2015, while production rose by 85% during the same period.

Despite these improvements, the chemical industry is still among the largest industrial consumers of energy. Their proportion of total consumption of fuel and electricity was around 19% of all European

industrial usage in 2015. Even though companies have already implemented many efficiency measures, experts still see potential energy savings, particularly during the distillation process, in the mechanical energy required for motors and machines, and in heating.

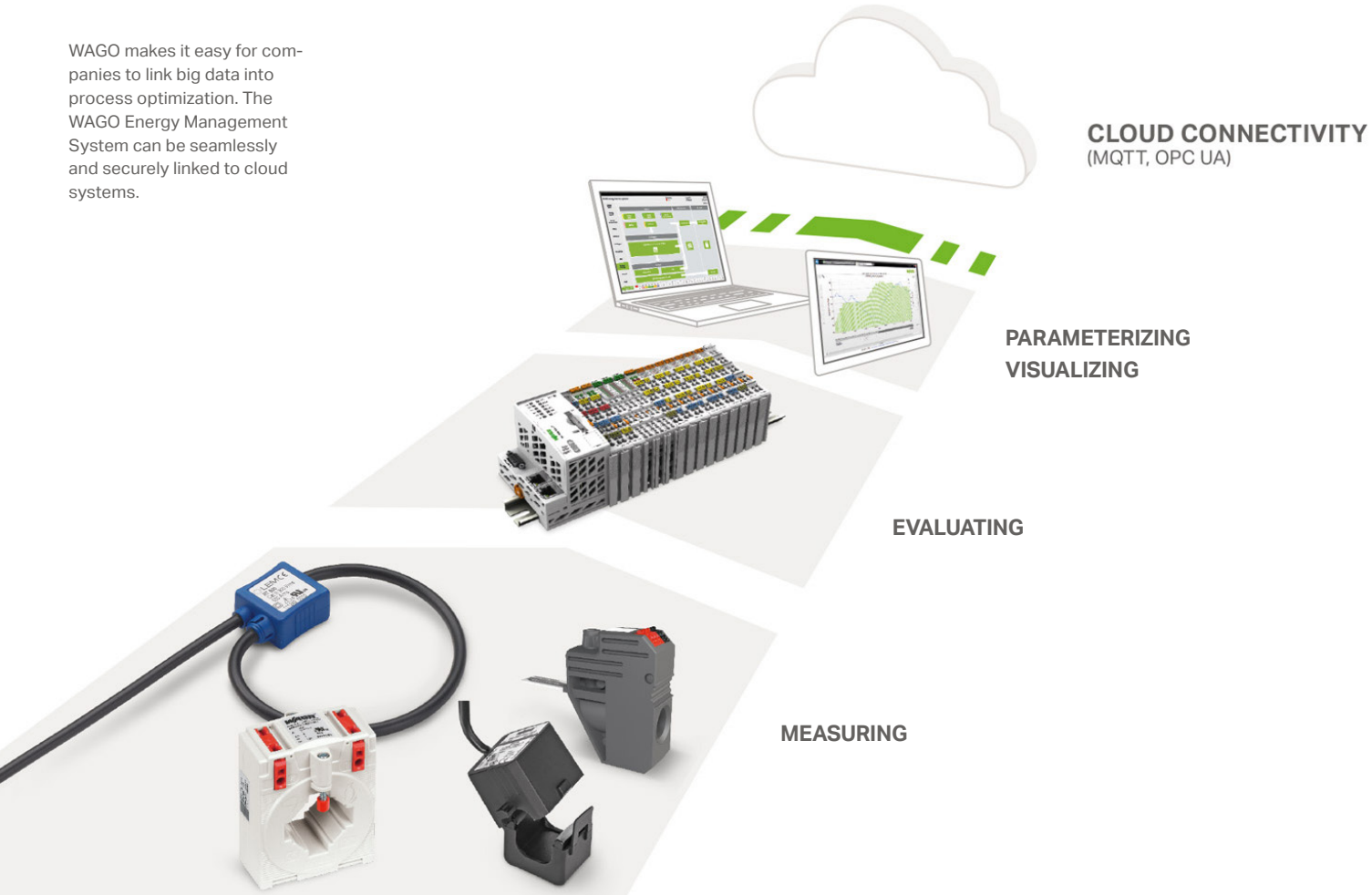
Modular automation technology using an open system architecture, like the WAGO-I/O-SYSTEM 750, can help companies exploit additional possibilities. Complicated measuring technology is not necessary to increase energy and resource efficiency. By using WAGO's energy management system, all process variables and energy consumption values can be recorded using one system. Due to the modularity of the I/O system, companies can individually assemble their data acquisition systems and expand them at any time – precisely as they need.

One System for All Requirements

WAGO relies on an open and flexible system for measurement data acquisition. All data are collected using the WAGO PFC200 Controller and the WAGO-I/O-SYSTEM 750, which can connect to any sensor or signal conditioner. This allows for the operation of different scenarios. System operators, who already use their own energy management software, can easily increase the depth of their measurement points by adding the WAGO solution.

Companies that are just starting out in energy management can also find a suitable solution. The sensors connected via the WAGO controller can be parameterized via the integrated "Energy Data Management"

WAGO makes it easy for companies to link big data into process optimization. The WAGO Energy Management System can be seamlessly and securely linked to cloud systems.



parameterization software, which requires no programming knowledge. Furthermore, the software allows for the visualization of measuring points in clear display formats that show both historical data or data collected as often as every second. This allows companies to quickly and easily discover potential savings and achieve transparency in their energy consumption.

Due to its flexible data acquisition structure, the WAGO-I/O-SYSTEM 750 is also a suitable platform for asset management, including permanent system monitoring.
The PFC200 Controller is used as a gateway for access to the systems. Decentralized systems can also be monitored using telecontrol technology or a PFC200 with integrated wireless modem.

Sensors at the field level can be connected to the Internet using the PFC200, and their data can additionally be made accessible in the cloud, for example. By analyzing operating states, faults can be detected quickly and failures can be avoided by influencing the process via the cloud. In addition, future systems can be optimally designed using asset management.

I/O systems offer seamless communication to MES or the cloud, and thus enable secured access to systems from any location. Individual software interfaces can be integrated into the open Linux® architecture of the WAGO controllers, for example, based on OPC-UA servers. Other communication protocols can also be used with the open architecture. Due to the integrated

MQTT software interface, every WAGO controller is already an IoT controller with cloud connectivity.

Anticipating Maintenance

The cloud facilitates additional applications, like alarms, condition monitoring and predictive maintenance. Software and intelligent systems analyze energy and process data to project critical states or necessary maintenance.
The user determines whether the WAGO controller sends the data to major cloud providers, like Microsoft Azure or Amazon Web Services. Links to third-party solutions can also be quickly implemented due to the integrated MQTT protocol.

WAGO has seriously considered cyber security, particularly in this context, because if cybercriminals manage to manipulate processes via the Internet, then companies can face heavy losses. With WAGO, you are protected from cyber attacks. "Security by Design" – IT security integrated from the outset in the form of layer-based security architecture – ensures that data thieves will not be able to gain access to the Linux® controller. Communication between the controller and the cloud is encrypted and implemented via the MQTT protocol.
You can also define the variables to be transferred to the cloud – this way, sensitive data does not leave the company.

TEXT LUKAS DÖKEL | WAGO
PHOTO WAGO

Greenhouse gas emissions in Europe have dropped by 18% between 1990 and 2012.

At the same time, the proportion of renewable energy has increased by 14%.

By 2030,

the emissions of greenhouse gases in the EU should be reduced by 40% with respect to 1990, and the energy efficiency should be increased by 30%.

2015

was the year in which the energy intensity, i.e. the energy consumption in the chemical and pharmaceutical sectors per unit produced, was already 59.7% lower than in 1990.

In the chemical industry, production has risen by 85%, while the use of fossil fuels and other energy resources has fallen by 26%.

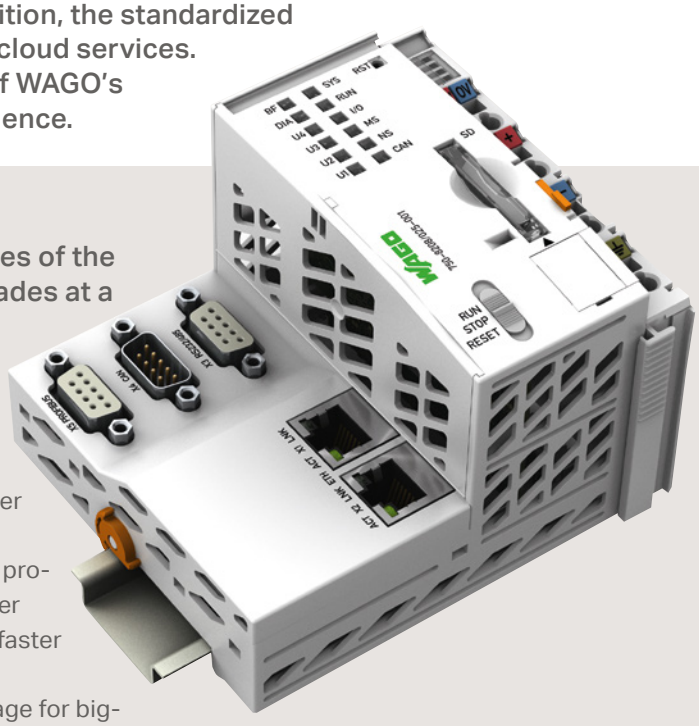
The demand for gaseous and liquid energy sources sank between 1990 and 2015 by 34% and 29% respectively.

The use of renewable energies over the same time has declined by 40%. Electrical consumption is also down by 14%.

(Source: Association of the Chemical Industry)

UPGRADE: EVEN GREATER PERFORMANCE FOR THE PFC200 CONTROLLER

WAGO is increasing the performance of the PFC200 Controller with a hardware upgrade, beginning in mid-2018. The performance increase results from the higher pulse frequency of the processor and the larger memory. In addition, the standardized MQTT protocol ensures seamless connection to web and cloud services. The hardware upgrade is accompanied by a new release of WAGO's *e!*COCKPIT Software v1.4 for greater engineering convenience.



With this upgrade, all of the diverse controllers within the PFC200 Series – along with their various interfaces – provide even more options for sustainable solutions in system and mechanical engineering, as well as manufacturing and process technology. Developed with an eye on cybersecurity, SSL/TLS 1.2, SSH, VPN and a firewall come standard.

Greater performance results from:

- A faster CPU
- Larger RAM and flash memory
- Improved processing of larger data volumes

Save Time and Money

The new Version 1.4 of WAGO's ***e!***COCKPIT Engineering Software offers a Python interface that enables automatic loading of applications onto the controller, for example. The "Static Analysis" and "Profiler" expansions, available separately, improve the evaluation of program code, so that inconsistencies or bottlenecks in execution can be found more quickly. Users of ***e!***COCKPIT v1.4 will benefit immediately from software modules offered in the 3S Online Store, which is conveniently integrated into the ***e!***COCKPIT user interface. ***e!***COCKPIT v1.4 is available in the first quarter of 2018.

Top Advantages of the PFC200 Upgrades at a Glance:

- More RAM memory for improved processing of larger data volumes
- More powerful processor for faster programs and faster processing
- Improved storage for bigger applications due to larger flash memory
- MQTT protocol as standard connection to WAGO cloud solutions, Amazon Web Services, Microsoft Azure or IBM Bluemix
- ***e!***COCKPIT version upgrade for greater engineering convenience
- Data can be recorded in parallel and transmitted to the cloud using MQTT or OPC UA.

Watertight.
Even in the cloud!

IT security for systems in water resource management: WAGO's PFC100 and PFC200 Controllers encrypt information directly in the controller and subsequently transmit the data securely to the cloud – the optimum protection for critical infrastructure applications.

This is the digital future!

www.wago.com/global/cybersecurity

WAGO

Site Notice
WAGO DIRECTPROCESS, May 2018
Editor: Alberto Alonso Malo
(responsible editor)
Phone: +49 571/887-49669
Fax: +49 571/887-849669

Contact: Alberto Alonso Malo.
We assume no liability for unsolicited manuscripts and photos.
WAGO DIRECTPROCESS appears at irregular intervals.

WAGO Kontakttechnik GmbH & Co. KG
Postfach 2880 · 32385 Minden
Hansastrasse 27 · 32423 Minden
info@WAGO.com
www.WAGO.com

Headquarters	+49 571/ 887 - 0
Sales	+49 571/ 887 - 222
Orders	+49 571/ 887 - 44 333
Fax	+49 571/ 887 - 844 169

0888-0203/0118-6901 – WAGO DIRECT PROCESS 1/18 US – 05/2018- Printed in Germany – Subject to changes