VOITH

HyCon Automation

The Power Plant's Brain

The enduring vision of hydropower

As others come and go, Voith has been in the hydropower business since the late 19th century. Our impressive experience of hydropower technology puts us in a position to deliver innovative and reliable solutions globally. Whether we design automation systems or turbine-generators with meticulous precision, Voith always bears in mind how the complete power plant works most efficiently – both now and in future.

When it comes to automation technology, Voith supplies tailor-made components and system solutions that breathe the spirit of hydropower. Each component has to be designed in such a way that the whole plant ultimately ensures perfect operation. If you need a complete new turnkey hydropower plant, or a modernization, or even service support, Voith will find a solution for any kind of plant operator.

Customer-oriented solutions

Voith has provided about 40,000 generators and turbines worldwide to date. This experience has tremendous impact on the development of our automation products. Our experts all over the world work together to find optimum customer products. As they are close to local markets at our many locations worldwide, you also can choose from the best ideas the Voith Hydro company network has to offer. In this way we transform your wishes and our ideas into customer benefits such as maximum reliability, top-level efficiency and excellent performance.

We look at things from different angles in order to perfectly create fully fledged automation systems for any kind of hydropower plant. As a result, Voith creates outstanding and sustainable automation products. Our deep hydropower knowledge and decades of experience in building hydropower plants is shaping the future of hydropower.

HyCon – integrated automation systems

HyCon
maximum reliability
top-level efficiency
excellent performance

Control System
Governor
Monitoring & Diagnosis
Optimization
Protection
Excitation

Voith's comprehensive knowledge of plant equipment and processes provides the basis for supplying best-in-class solutions. For our HyCon automation family we provide excellent engineering expertise and experience to select, design and implement a specific automation solution. In this way, HyCon (Hydro Control) is able to promise top-level efficiency, maximum reliability and excellent performance.

Voith's strength is the optimized, integrated overall solution. We plan, build and install complete automation systems for hydropower stations of any type and size. Moreover, we provide services and support throughout the lifecycle of our products.

Complementary products make a single family

The challenge is to integrate automation systems, electrical and mechanical equipment to form a smooth-functioning and reliable power plant. These are our key areas of activity. There are several complementary products of the HyCon family for complete automation systems.

HyCon Control System

We have combined our long-term process know-how and control system expertise to create hydrospecific solutions based on numerous standard modules. HyCon supports a wide range of open interfaces and allows integration of existing components into the control system. It is designed to fulfil very challenging demands in terms of safety and reliability. Starting from an economical all-in-one concept and extending to distributed architectures and redundancy at all levels of the system.

HyCon Governor

Our digital governors provide an outstanding performance in turbine controls by using the best hardware and software available. Voith is a supplier of high and low pressure governor systems depending on turbine type, size and application. So we deliver maximum safety and availability, maximum lifetime, sensitivity and accuracy as well as minimum losses.

HyCon MD Monitoring & Diagnosis

In addition to standard supervision and monitoring functions, which are part of the HyCon control system, these intelligent diagnosis modules help improve the hydro plant's operation, availability and safety. The highly sensitive measuring systems ensure effective condition-based monitoring and maintenance, thereby increasing the lifecycle of rotating machines as well as plant reliability.

HyCon PO Plant Optimization

Intelligent optimization modules can significantly enhance the profitability of a plant by increasing its annual energy output. And by having a well-designed optimization system, operators can reduce operating and maintenance costs. We provide smart solutions for single units, whole plants and even cascades.

HyCon EP Electrical Protection

Electrical protection systems have to limit damages of electrical equipment such as generators, transformers, busbars or substations in the case of overload or fault events. With Voith Hydro electrical protection solutions you can expect proven and durable technology to guarantee maximum supply security. Suppliers benefit from our innovative know-how and can be sure of excellent safety for the entire plant.

HyCon Thyricon Excitation

Thyricon, the Voith Hydro excitation product line, ensures excellence in generator control and fulfills all grid response and stability demands. This modular system can be customized to provide optimized solutions for generators and motors from 0.5 to 800 MVA.

Worldwide partnership in hydropower automation

Voith Hydro is a global partner for solutions concerning all types of hydropower plants. HyCon automation products are available all over the world. In Africa and Asia as well as in Europe and the Americas, Voith Hydro has equipped numerous power stations with automation systems. Wherever you need automation expertise, Voith is nearby.

1 Gilgel Gibe II, Ethiopia

The 420 MW power plant near the Gibe river is Ethiopia's most powerful hydropower station, equipped with a Voith HyCon control system.
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2 Xiaolangdi, China

The large hydropower plant with a capacity of more than 1,800 MW was fitted with new Voith governors.
Page 10

3 Kargi, Turkey

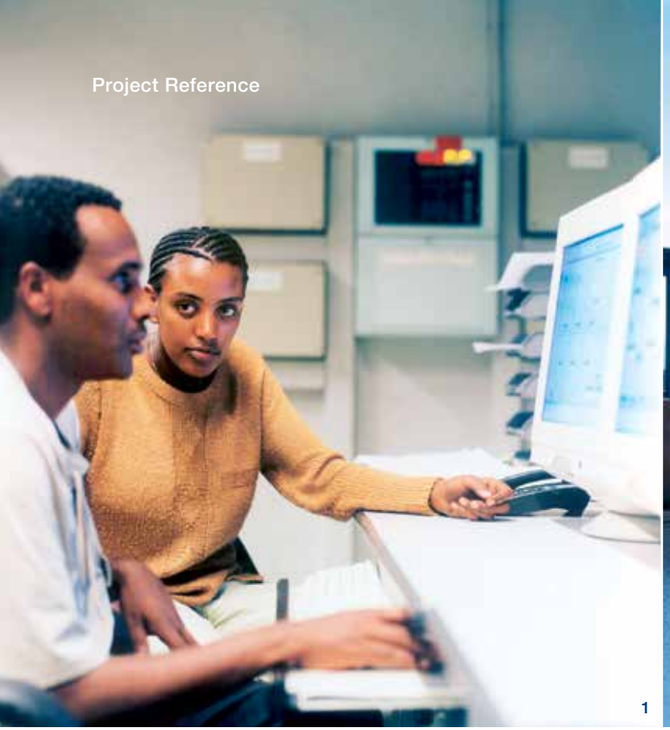
Constructed in 2015, the 102 MW run-of-river power plant will be fed by the Kizilimak river – the country's longest. It is equipped with Voith governor technology and an excitation system.
Page 12

4 Teles Pires, Brazil

The 1,820 MW run-of-river power plant was commissioned in 2015 and supplies 2.7 million households. Voith's monitoring and diagnosis system ensures trouble-free operation.
Page 14

5 Jefferies, USA

The 133 MW storage power plant was built in 1939. This hydroelectric power station of the Santee Cooper utility has the very latest Voith protection system.
Page 16



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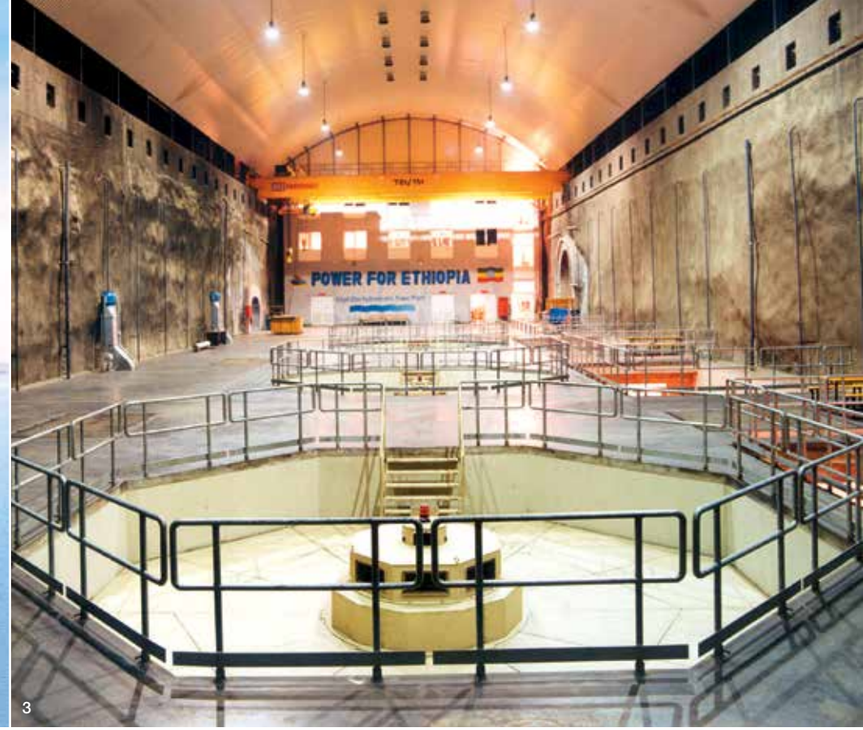

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1 Monitoring and analysis are always in view.
2 The enormous water reservoir of the Gibe River. About 500 meters above the powerhouse, the water is directed into two steel penstocks.
3 The Pelton runners supplied by Voith allow minimal energy loss when the water jet impacts the runners at a velocity of over 350 kilometers per hour.

Serving Africa's promising rise

Gilgel Gibe II, Ethiopia

Capacity 420 MW

Scope of delivery
Pelton turbines with generators, electrical and mechanical equipment, full automation package

Since 2007, the Ethiopian Electric Power Corporation has run Gilgel Gibe II – Ethiopia's most powerful hydroelectric plant with an installed capacity of 420 MW – in addition to the Gilgel Gibe III project. The project increased the nation's hydro capacity by more than 50 percent. Voith supplied not only four Pelton turbines and generators, but also all the mechanical and electrical equipment.

Gilgel Gibe II uses the water of the older Gilgel Gibe I plant, upstream on the Omo river. A 26-kilometer long tunnel under the Fofa mountains conveys the water to the powerhouse. Finally, shortly before the power plant, the water rushes down about 500 meters through penstocks bifurcating into four distribution pipes, finally feeding the runners of the Pelton turbines. As the water hits the turbines, the entire power plant is now set in motion – a complex interaction of many components starts.

Thanks to Voith Hydro's automation systems at Gilgel Gibe II, the machines work smoothly and highly efficiently. Known for its extremely high reliability, the Voith automation, supplied by our division Voith Hydro in Heidenheim, enables simultaneous operation of various subsystems. As Voith systems control the entire plant, they also integrate tailor-made solutions and ensure secure performance with a high level of flexibility.

Tighten your grip on the power plant – with HyCon control systems

With the state-of-the-art Voith control system HyCon 400 at hand, Gilgel Gibe II operators can manage the plant in a safe and simple manner. Local control with the local control board or remote control via the central control room are two options for operation which guarantee maximum flexibility in power production and maintenance situations. In any situation the HyCon 400 control system ensures that the plant is in a safe state and that the Gilgel Gibe operator has a simple and instant overview of the current status of the plant equipment. In case of plant equipment failure, the sophisticated HyCon 400 alarm system will guide the operator directly to the point of interest, thereby providing maximum assistance that the operator can concentrate on the process and not on how to operate the control system.

Smart integration and smart handling of plant assets was an important issue in the design of the Gilgel Gibe automation solution. This included not only turbine governor and voltage controller, but also electrical and mechanical protection. This is an invaluable advantage for our customers with regard to maintenance and spare part management. As a result, Gilgel Gibe's II control system layout is the all-encompassing system which an operator dreams of.

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"Maximum reliability combined with simple handling and a perfect safety concept – that's the way we delivered it. And on top of this we provided both outstanding quality and maximum flexibility."

Oliver Hesse, former Lead Engineer for the Gilgel II project and Senior Product Manager Automation & Plant, Voith Hydro Heidenheim

1 The Xiaolangdi dam at the Yellow River.
2 Planning discussion during the modernization measures.
3 The Yellow River provides energy, water for irrigation and flood protection.

Keeping high-tech automation updated

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Since the 1990s, China has invested incredibly in new infrastructure and power plants. Even though the country might have the most modern hydropower plant fleet in the world, there is potential for modernization in terms of automation. The 15-year-old Xiao Lang Di plant in the province Henan is a good case in point as Voith Hydro lately delivered a brand new automation. When the Xiao Lang Di hydropower project was first commissioned in 1999, Voith Hydro York from the United States supplied all six 300 MW Francis turbines including ring gates and corresponding controls. So it was only logical to entrust Voith again with modernization of the turbine control system many years down the line, since Voith is a real leader in hydro automation. This time Voith Hydro Shanghai modernized the digital and hydraulic governors and the digital ring gate control and was again able to provide a highly tailor-made and competent solution. As a result, the power station will operate more efficiently and more powerfully for the next few decades.

“Our governor technology is 100 percent Voith Hydro. We have developed, manufactured and installed these products for many decades. So we have a deep understanding of this technology.”

Ningning Zhao, Automation Engineer, Voith Hydro Shanghai

Total control with Voith governor
Our governors are 100% Voith Hydro, we have designed and manufactured governors for more than 120 years. And we have delivered more than 18,000 governor systems to our customers worldwide, including our highly reliable hydraulic and digital components. As a uniquely experienced manufacturer, we consider these components as crucial to be able to deliver the most flexible, reliable and safe solution a hydropower plant can have. Moreover, the operator has all the flexibility he needs: wide range of redundancy, all operation modes available, speed, flow and pump control, and also remote access control. At the Xiao Lang Di hydropower plant the customer is happy to use the full range of Voith governor technology in order to use the power of water most efficiently.

Xiaolangdi, China

Capacity 1,800 MW

Scope of delivery
1995: 6 x 300 MW Francis turbines with ring gates and controls
2014: refurbishment and modernization of turbine control system

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1 The Kargi power plant will utilize a 75-meter elevation difference in Turkey's longest river, the Kizilirmak.
2 Voith Hydro pole manufacturing and testing facility.

Hydropower for emerging economies

Kargi, Turkey

Capacity 102 MW

Scope of delivery
Francis turbines with generators, electrical and mechanical equipment, full automation package

Turkey is one of the most promising economies on the Eurasian continent: as the demand for energy rises sharply due to rapid economic growth, many utilities have invested in high-tech hydropower. The latest Voith automation technology comes into operation in the Kargi hydropower plant in the north of Turkey, a project of Statkraft's subsidiary Kargi Kizilirmak Enerji Kargi.

With construction having started in 2011, the Kargi hydropower plant on the river Kizilirmak has two turbine-generator units with a total installed capacity of 102 megawatts with an estimated annual production of 470 gigawatt hours. The complex site consists of a dam that is 500 meters long and 13 meters high. Before rushing to the powerhouse, the water passes through an 11.5 kilometer tunnel. The hydropower plant's first encounter with the power of water is the moment when the water touches the two large vertical Francis turbines. This is the key point at which the power is exploited using the very best technology.

An intelligent choice:
Voith's Thyricon™ Excitation System
At Kargi, the customer opted for the outstanding automation systems made by Voith Hydro St. Pölten in Austria. Voith delivered not only all the electromechanical equipment including two superb inlet valves with a diameter of 4 meters but also the complete automation package including control system, electrical protection, optimization and diagnosis, turbine governor and valve control and finally a Thyricon static excitation system.

Voith offers the modular Thyricon™ system for generators and motors in a range of 0.5 to 800 MW – or even more. Within the last five years we have equipped more than 100 generators with all kinds of excitation systems. Consequently, we are deeply immersed in the technology of hydro generators while always bearing in mind how all the hydroelectric components will work with the new solution.

At Kargi, the Thyricon Excitation Systems can respond quickly to the grid, ensuring operation of the machines remains stable. Up-to-date hardware and software enables easy handling of the systems. And the highest safety standards are met by means of a well-integrated controlling system. Status and operation of Thyricon can be monitored locally and remotely. And a choice of static excitation power devices is now part of Kargi: a reliable power converter, excitation transformer, field breaker and power diodes.

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„For me, availability in automation is the most important issue when it comes to operating a profitable hydro power plant. Our HyCon Thyricon excitation systems play a vital role in supporting the grid with a variety of solutions and services driven by engineered reliability, since our focus is always to provide solutions with a clear customer benefit."

Martin Sallfert, Head of Plant Systems at Voith Hydro St. Pölten

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1 The Teles Pires hydroelectric dam on the Teles Pires River.
2 Non-stop monitoring and control of the turbines by means of a Voith monitoring system.

Paving the way to South America's future

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Large, modern and reliable: Brazil's Teles Pires hydropower plant provides electricity for about 2.7 million families in the border region of the Mato Grosso and Pará states. With such rapid development, the utility Companhia Hidrelétrica Teles Pires relies on experienced partners like Voith. As part of the Brazilian Growth Acceleration Program, the Teles Pires hydropower plant with 1.82 GW rated power was built quickly and fitted with the latest technology. Voith Hydro in São Paulo was the technical leader in the consortium and provided a wide range of hydropower equipment including the control system HyCon 400, HyCon MD Monitoring & Diagnosis, the static excitation system Thyricon 600 and the mechanical and electrical Balance of Plant components.

"The product family HyCon is the epitome of reliability and experience. It's fundamental to shape the future of automation in the field of hydropower."

Marcus Hofmann, Automation Engineering Manager, Voith Hydro São Paulo

Protecting smooth and efficient operation

Having combined engineering and manufacturing expertise, Voith was able to deliver and install equipment to meet the electricity demands for a maximum of time at minimum cost.

At Teles Pires the HyCon MD monitoring, analysis and diagnosis solution makes an essential contribution to carefree operation. A precondition for smooth running of the machines in Teles Pires is the establishment of a good combination of control, protection and monitoring system: It identifies the power station's individual conditions, recognizes possible damage in advance and signals scheduled maintenance. These sensitive instruments of the HyCon system compile specific parameters in order to provide individualized information about Teles Pires' operation. The system's high adaptation to tailor-made plants and its reliability is characteristic for Voith solutions, too. In this way, HyCon MD is entirely oriented towards the well-being of your power station.

Teles Pires, Brazil

Capacity 1,820 MW

Scope of delivery
Generators, electrical and mechanical equipment, full automation package including control system, electrical protection, telecommunication, monitoring and diagnosis system

Copyright: Jefferies Generating Station – Santee Cooper Moncks Corner, SC Photo by Jim Huff

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1 Jefferies Dam is a cultural feature in Berkeley County, South Carolina.
2 Voith Hydro compact automation system solution.

Next era of automation technology

Jefferies, USA

Capacity 133 MW

Scope of delivery
Refurbishment of turbines and generators including a full automation package

Jefferies went into operation in 1942 and was the first state-owned hydropower plant in the US. Now, the power station in South Carolina's Moncks Corner was ripe for a modernization. Voith played its role as an expert and experienced partner of the Santee Cooper utility Santee Cooper.

The brain of any hydropower plant is its automation system. It controls and steers all the processes in a complex and reliable way. As far as the Jefferies hydropower plant is concerned, the five power units needed complete modernization in order to operate this station as efficiently as possible.

HyCon EP –
Electrical Protection
Voith's electrical protection solutions help guard the electrical equipment such as generators, main or auxiliary transformers from damage caused by electrical faults. With HyCon EP we provide reliable concepts for main protection and back-up protection for all kind of protection requirements and electrical layouts of the plant. So HyCon EP is based on the importance of the generator and not only on the power of the plant.

Voith provides tailor-made solutions depending on plant layout and taking into consideration a minimum number of components to optimize reliability and spare handling. HyCon EP is an optimally configured protection system as we have the complete electrical design and simulation expertise.

Moreover, at Jeffries Voith offers the whole range of services and expertise an operator needs: getting a quick survey of the plant's weak spots, offering a cost-efficient and clear modernization plan and sending out the best staff to fix it at the customer's site.

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"The most sophisticated automation systems have to reliably serve the plant – and ultimately the customer should be in a position to operate the station with ease."

Darryl Stevenson, Director Automation and Plant Engineering, Voith Hydro York

Make the best of your plant

As you consider your hydropower plant as an important asset, we help you increase the station‘s value and the value it generates. To avoid technical failures or even standstill, Voith HyService™ teams support you globally and locally. We are able to offer fully-fledged service packages: tailor-made diagnosis, optimization and modernization as well as repairs and spare parts. Our schemes ensure continuous plant operation over many decades.

Raise your operation value
Every plant operator looks for the most economical plan to run his machines. To raise the operation value, Voith Hydro can deliver HyCon Optimization Packages that increase the efficiency of your power unit, your plant or even your cascade. These solutions work for the whole lifetime of the asset and generate value from one day to the next, for example by taking the real boundary conditions of operation into consideration.

Additional benefit for you
However, once in a while intense operation can result in abrasion and worn-out parts. If your system has to stop, our service experts put it back online quickly, of course. With comprehensive and sensitive analysis and diagnosis methods as well as by offering overhaul plans for automation systems and other parts, our experienced staff will be able to prevent a breakdown.

Solutions adapted to your needs
Furthermore, HyCon MD Monitoring, Analysis and Diagnosis systems offer intelligent instruments and solutions to identify repair and modernization needs early on. All essential parameters can be monitored fully automatically and/or with expert support – via either local or remote access. We offer packages and systems that are completely adapted to your needs.

Service starts with diagnosis
Many hydropower plants have been operating reliably for decades, but may not be running as efficiently as they could. Voith specializes in modernizing and overhauling components and machines in plants to make them state-of-the-art. Installing our seamlessly integrated automation solutions and our HyCon Optimization Modules generates an additional benefit which will further increase the return on investment. As a result, efficiency and reliability are often substantially improved. Moreover, plant operators can provide much more environment-friendly electricity as a result of extensive upgrades.

Making hydropower systems fit for the 21st century is therefore one of the best options for increasing the supply of clean energy. Repairing and modernizing a plant is often a complicated task. Replacing certain components can affect the operation of the entire plant. Voith Hydro is aware of the detailed interaction between various components and machines. This means we can help to minimize the risk of surprises that jeopardize the time schedule of the rehabilitation project.

HyCon Optimization Modules
increase efficiency, reduce demands
and optimize plant lifetime

Unit-Specific Optimization Modules

CCO	Cam Curve Optimization for HyCon turbine governor
Quantizer	Unit lifetime optimization in frequency control for double regulated turbines

Plant Optimization Modules

JC	Joint Control
PO	Plant Optimization
WMC	Water Management Control

Multiple Plant Optimization - Cascade

SCO	Storage Cascade Optimization

1 Voith Hydro specialists in modernizing and overhauling components.
2 Global experts – from preventive maintenance to troubleshooting.

Comprehensive Service Capabilities

From preventive maintenance to troubleshooting, Voith Hydro offers reliable service for all types of generators, hydraulic machinery, for automation technology and all other subsystems. Our HyService™ ranges from simple repairs to complex emergency servicing.

Scope of HyServiceTM
- Spare parts deliveries
- Spare parts installation service
- Repairs, servicing and maintenance
- Troubleshooting

Solution Service
- Inspection and health check
- Mobile emergency service

Added Value Service
- Service contract
- Service hotline
- Service and maintenance concept
- Updates and upgrades

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