



# NEW LIFE FOR HYDRO ASSETS

**ANDRITZ**

ENGINEERED SUCCESS





# Modernization and renovation of hydropower plants

HPP YBBS-PERSEBEUG

Austria





# Service "From water-to-wire"

Tailor-made solutions **Electro-mechanical**

Value **Operation and Maintenance**

Renewable

Modernization

# Rehabilitation

Spare parts 24 / 7

**Digitalization** Global Training **Overhaul Repair**

Life cycle analysis

# Upgrading

Flexibility

Competence

Modernization **Three-Phase-Approach**

Diagnosis

Innovation Hydro-mechanical

Improved performance



# Global growth for hydropower rehabilitation and upgrades

The world's hydropower fleet is aging. About 40% of all hydropower plants worldwide were originally commissioned more than 40 years ago. As a result, the demand for modernization and upgrades of these assets is rapidly growing.

Currently, hydropower generates about 16% of the world's total electricity production. Nonetheless, most mid-term scenarios predict that increasing awareness of global warming will lead to continuously growing demand for hydropower – currently the most proven and developed form of renewable electricity generation. To date, only about 30% of the potential global hydropower resources have been developed. However, with modernization and upgrading of the existing capacity, the global installed fleet of hydropower plants will be able to provide far greater additional capacity to meet rising energy demands with clean, sustainable renewable electricity.

## HYDROPOWER PLANTS ARE AGING

The demand for rehabilitation, modernization, and upgrade of installed hydropower equipment has seen dramatic growth over recent years. Europe and North America are especially active in this respect but other regions are seeing demand for rehabilitation and upgrade growth too. Furthermore, though much of the globally installed hydropower fleet is already decades old, even recently commissioned hydropower plants are going to need modernization and rehabilitation eventually.

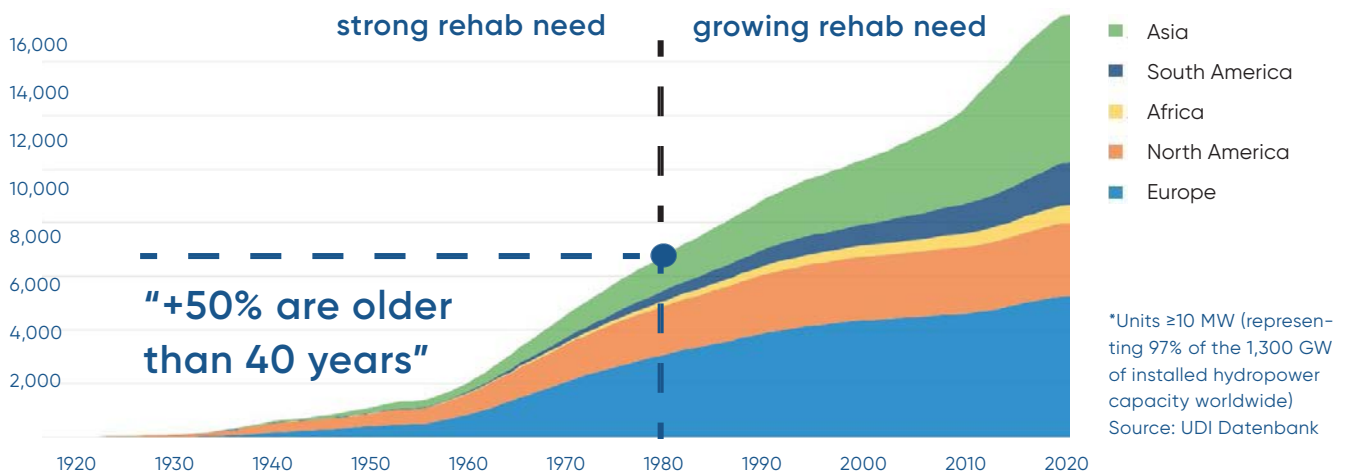
## EVERY COMPONENT HAS ITS SPECIFIC LIFETIME

Each of the various elements and components within a hydropower plant has a different and specific lifetime. For instance, while components like the stationary parts of a turbine or the mechanical elements of a generator see the slowest changes, equipment like the computers and IT that forms part of the control system are typically based on consumer products. This market continues to experience rapid technology development, leaving equipment of only a few years old vulnerable to becoming out of date.

## ENVIRONMENTAL AWARENESS

The increasing awareness of global climate change and emissions of greenhouse gases is building demand for sustainable electricity generation. Policymakers are turning to renewables to address these social concerns, prompting increased demand for hydropower over the coming years. At the same time, existing hydropower plants need to adapt to new grid requirements in response to increased renewable energy penetration. Increasing environmental constraints for both new and existing hydropower plants call for new solutions, such as fish-friendly turbine technology and oil-free applications for turbine runner hubs.

## Commissioning year of hydropower units\*



# "Start a new life for your hydro assets today with leading ANDRITZ technology"

Every existing hydropower plant has its own specific operational history and defined future operational strategy. Today, solution-oriented service and rehabilitation concepts are needed to improve overall efficiency, reduce operational expenditures, extend life-times, and make hydropower plants fit for the future.

## **INCREASING ANNUAL POWER PRODUCTION**

The efficiency of turbines and generators has significantly increased over the last few decades. As a result, refurbishments to upgrade a plant's performance are possible and highly cost-effective. Depending on the circumstances, an upgrade of a 40-year-old turbine runner can offer up to 5% more efficiency and an even bigger increase in terms of annual energy production. The overall efficiency of a hydropower plant can be optimized using digital controllers, for example.

## **LIFETIME EXTENSION**

As hydro equipment ages, wear and tear affects the plant efficiency. Aging is accelerated by certain plant operational regimes such as start-stop cycles, abrasion due to large volumes of suspended solids like silt, and corrosion. All have an impact on the service life. Components related to consumer market products and/or automation and control systems typically need to be replaced first. High voltage electrical components such as cables, substations, and transformers, have a longer lifetime. Meanwhile, mechanical aging is a very slow process but nonetheless does affect the stationary parts of a turbine and generator, as well as structural elements like penstocks.

## **MODERN MARKET REQUIREMENTS**

Today, many hydropower plants are being challenged by more frequent start-stop cycles, operating at very low part loads and as spinning reserve, or as fast response capacity, for example to stabilize the transmission grid. Typically such installed equipment is aging much faster than originally envisaged because it was not designed for the demands of the modern grid.



# Global market leader built on technology, local presence and history

With more than 175 years' experience in turbine technology and 120 years' experience in electrical engineering, we take care of your hydropower plant.

## **ANDRITZ AND HYDRO**

The ANDRITZ GROUP is a leading global supplier of plants, equipment, and services for hydropower stations, the pulp and paper industry, the metalworking and steel industries, and solid/liquid separation in the municipal and industrial sectors. With more than 280 production locations and service and sales companies around the world, ANDRITZ is always close to its customers.

ANDRITZ Hydro is part of the ANDRITZ GROUP and a world-leading supplier of electro-mechanical equipment and services for hydropower plants - "from water-to-wire". Growth, mergers, and cooperation agreements have formed a modern state-of-the-art technology company with about 7,000 employees worldwide. Over the years, ANDRITZ has rehabilitated and modernized more than 10,000 hydropower units worldwide - covering machines from 1 MW capacity right up to 800 MW and across the full range of all possible heads and flows.

## **THE ORIGINAL EQUIPMENT MANUFACTURER**

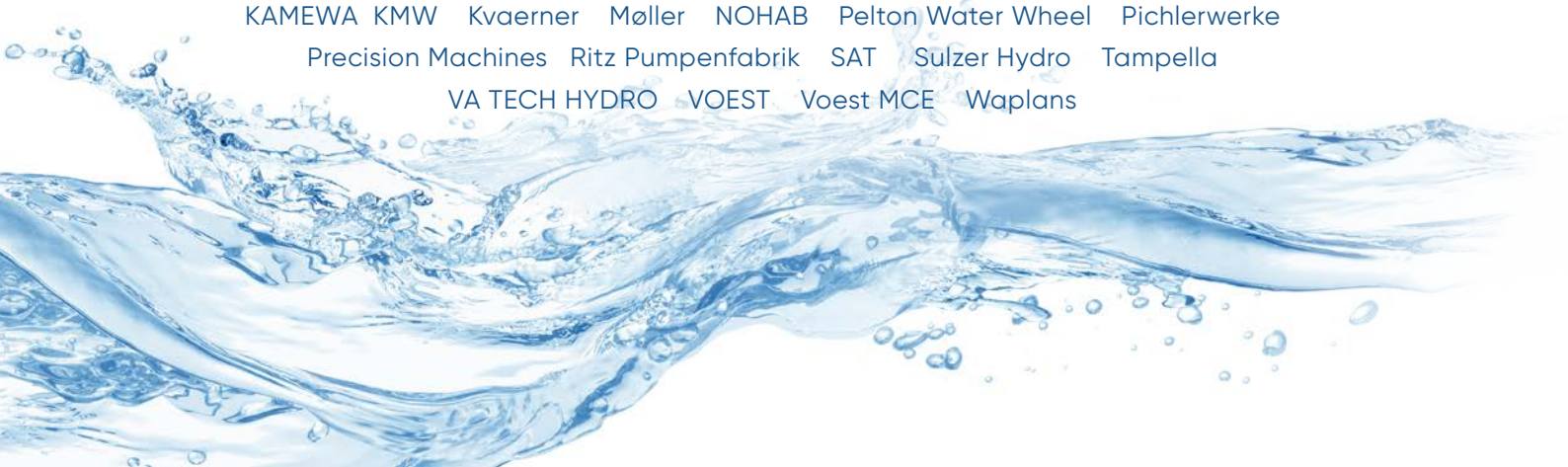
Building accurate knowledge of the market, long-term experience, and excellent service competence are skills that need specialists and time. The cornerstone for these core competencies was laid by the hydro turbine and generator pioneers in Europe and North America in the 19<sup>th</sup> century. We are proud to say that for almost half of all the hydropower equipment installed today, ANDRITZ owns the Original Equipment Manufacturer (OEM) rights.

## **YOUR LOCAL PARTNER**

With more than 50 service locations around the globe, we are able to take care of our customers and partners in their language and in their time zone. ANDRITZ's commitment to services is built on proximity and reactivity. The exchange of experience between our multitude of locations and knowledge centers guarantees rapid and smooth transfer of skills and information. It means that wherever our customers are located they have access to the vast ANDRITZ experience base that allows them to find the best solution quickly and easily.

## **OUR PIONEERS (ALPHABETICAL ORDER):**

AFI ANDRITZ Andritz VA TECH HYDRO Ateliers des Charmilles  
Ateliers de Constructions Mécaniques de Vevey (ACMV) Baldwin-Lima-Hamilton  
Bell Bouvier Boving C.E.G.B. Dominion Engineering ELIN English Electric  
Escher Wyss Finnshyttan GE Hydro GE Hydro Inepar General Electric  
Hammerfest Strom Hemi Controls Heneral Electric Hydro Vevey I.P.Morris  
KAMEWA KMW Kvaerner Møller NOHAB Pelton Water Wheel Pichlerwerke  
Precision Machines Ritz Pumpenfabrik SAT Sulzer Hydro Tampella  
VA TECH HYDRO VOEST Voest MCE Waplans







## "Our rehabilitation and service experts let your proven hydropower asset shine with new brilliance."

### **PASSION FOR REHABILITATION**

Over the long-term, the reliability, availability, and hydraulic performance of an operational hydroelectric power plant is diminished through wear. Consequently, earnings typically decrease over time whilst operation and maintenance costs are simultaneously increasing.

Compared with greenfield projects, additional challenges involved in modernization projects include:

- Plant assessment and development of the most economically beneficial concept based on smart solutions
- Management of the many interfaces with existing/remaining components and systems

- Risk management which naturally arises with the use of aging equipment
- Minimizing outage time and/or loss of customer revenue.

ANDRITZ's service solutions contribute to the "from water-to-wire" approach, which results in the provision of a wide range of products, systems, and services. Our scope ranges from complex modernization contracts to small spare parts deliveries. All of our solutions optimally meet the specific customer requirements, preserve the environment and support operations management.





# Service and rehabilitation solutions to bring your hydro assets up to date

ANDRITZ specializes in rehabilitation, upgrading, and uprating of existing hydropower equipment. In addition, we offer solutions and services to optimize operation and maintenance of hydropower plants.

Innovative modernization measures and state-of-the-art technologies increase profitability and extend plant lifetimes – all whilst taking into account basic economic, ecological, and legal conditions.

**HPP RANNOCH**

United Kingdom









# Our product, system, and service portfolio

ANDRITZ's global service and rehabilitation teams develop the necessary solutions to achieve maximum customer benefit and return on investment, based upon energy market developments, customer goals and plant conditions.

## **HYDRO-MECHANICAL SCOPE**

Our hydro-mechanical scope comprises turbines, including bearings and shafts, gates, penstocks, valves, spiral and wicket gates. Valves and turbines are exposed to high loads during operation, but the years of operation are less critical than the effective number of load changes. Nowadays, hydraulic machinery is subject to an increased number of start/stop cycles due to changes in grid demands. However, their layout and design was typically calculated for far fewer cycles. Therefore, maintenance and rehabilitation are becoming even more essential to guarantee both the operational safety and the availability of the entire hydropower plant.

## **ELECTRO-MECHANICAL SCOPE**

ANDRITZ's scope includes all electrical equipment starting from the generator and excitation systems to the high voltage grid connection. Depending on specific demands, the generator is configured for either horizontal or vertical arrangement and for low or high speeds. The Electrical Power Systems (EPS) solutions cover all voltage levels, including transformers and substations. A dedicated part of the EPS is the automation/control system.

## **LIFETIME SERVICES**

In addition to the hydro- and electro-mechanical scope, our team provides general services such as expert support, training, spare parts inventory management, and service agreements as required to meet all technical, economic, and legal requirements. Special services can be offered for life cycle and risk analysis, as well as for operations and maintenance.

## **QUICK CUSTOMER SUPPORT WITH 24/7 SERVICE**

Requirements for support are created and triggered by our customers and their equipment. Our 24/7 support concept offers rapid solution-oriented services to solve any problems which occur as soon as possible in order to bring the units back online. Additionally, we provide diagnosis for repairs both on-site and remotely.

## **LIFE CYCLE AND RISK ANALYSIS**

Safety is a decisive factor for hydropower plants. Among the possible risks are mechanical or electric failure, flood, fire, and pollution. Therefore, engineering efforts are focused on three target areas with regard to safety: assess, prevent and reduce risk.







**“Operation and maintenance enhanced by digitalization will make your asset fit for the future.”**

#### **DIGITALIZATION AND AUTOMATION**

For the design of modernization projects, automation solutions based on optimized hardware architecture and systematic integration of the required functions are a significant factor. ANDRITZ's concepts enable fully automated operations, low investment costs, simple commissioning, and rapid system replacement.

#### **RESEARCH AND DEVELOPMENT**

ANDRITZ has various laboratories and established test rigs worldwide. These include coating test rigs in own wear lab, the hydraulic test rigs in own hydraulic laboratories, as well as a high voltage and a bearing test rig, among others. For refurbishment projects, the interdisciplinary approach of ANDRITZ's research and development department is especially important. We provide a thorough analysis of the existing equipment and various modernization scenarios, enabling an optimal solution to be developed. Hydraulic design and thermal distribution analysis requires a deep understanding of complex physical phenomena. To support that understanding, we have been using computational fluid dynamics (CFD) and finite element analysis (FEA) as well as reverse engineering tools for optimal design approaches for many years.

#### **OPERATION AND MAINTENANCE**

Based on the long-term experience and competences of our staff, ANDRITZ is able to provide operation and maintenance services in order to optimize power plant performance and to ensure asset reliability. Operational control can be achieved locally with an on-site team or remotely with our experienced operators located in our Regional Control Centre. They are able to manage plant performance and monitor trends and data in order to maximize availability and anticipate any potential issues. Our digital solution is based on a modular and flexible design, and provides decision guidance for target-oriented maintenance programs.

#### **LONG-TERM OPTIMIZATION OF ASSETS**

Maintenance of the electro-mechanical equipment is key to the long operational lifespan of a hydropower asset. The profitability and long-term value of a hydropower plant is significantly impacted by the quality of the rendered services. To fulfill value requirements and return on investment, remote assistance, emergency troubleshooting and preventive, corrective and predictive maintenance are necessary. ANDRITZ services can range from continuous monitoring of relevant key performance indicators (KPIs) to adaptive operational optimization of multiple units and power plants.





# Our systematic “Three-Phase-Approach” for tailor-made solutions

Modernization of a hydropower plant is an extremely complex issue. Aging of the various plant components and systems depends on operational, environmental and ambient conditions. Based on well over a century of hydropower experience, ANDRITZ has developed a structured process for assessing and modernizing hydropower plants in the most economical way. This systematic approach ensures tailor-made solutions that guarantee the maximum benefit for asset owners and operators.



## **DIAGNOSIS**

Our approach is based on a profound understanding of our customers' machinery together with individual inspection and specific repair needs. All the required data, parameters and measurement results are registered, thoroughly assessed, and evaluated during this phase. This forms the basis for design evaluations.

## **ANALYSIS**

During this phase, our engineers focus on root cause analysis using modern in-house calculation tools for hydraulic and electro-mechanical design, as well as thermal distribution. The calculation results are validated with measurements and operational data coupled with the comprehensive design knowledge of ANDRITZ engineers. Knowing the root cause is the basis for the design of unique solutions matching the specific hydro turbine and generator and avoiding a repeat of the same issue.

## **THERAPY**

We develop suitable scenarios to address the root cause of machine failures. These scenarios are evaluated and finally the most appropriate, feasible and economic solution is selected by the customer. The selected solution may also include conducting temporary repairs to keep the equipment in operation until a planned outage is possible in order for the final repair to take place. This reduces downtime and the related costs to a minimum for optimized life cycle costs.





“Innovative modernization measures and state-of-the-art technologies increase profitability and extend the lifespan of your hydropower asset.”



### **Teesta Stage III, India**

1,200 MW (6 x 200 MW Pelton); A five-year operating and maintenance contract for the Teesta Stage III hydropower station, one of the largest hydropower plants in India. The new hydropower plant provides some 5,300 GWh of electrical energy to the Indian power grid every year.

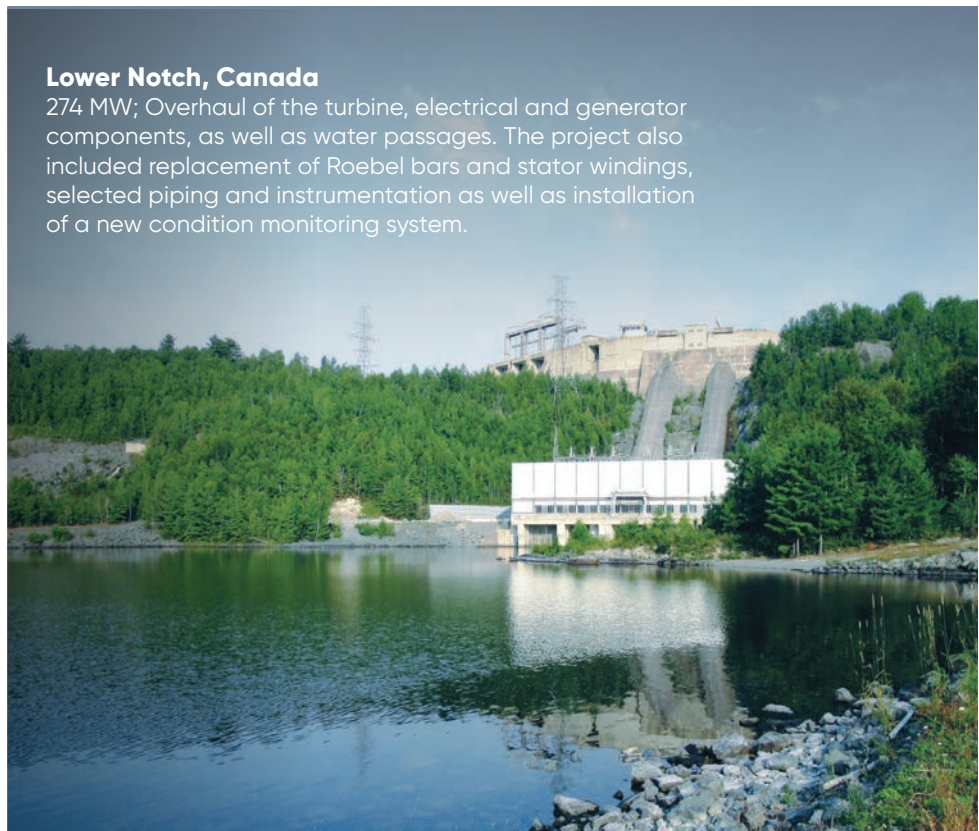






### **Mwandingusha, DR Congo**

78 MW; Replacement of six turbine units, generators, governors, inlet valves, exciters, voltage regulators, and draft tube stop logs. The project resulted in a power increase of about 10% for this copper mine project.



### **Lower Notch, Canada**

274 MW; Overhaul of the turbine, electrical and generator components, as well as water passages. The project also included replacement of Roebel bars and stator windings, selected piping and instrumentation as well as installation of a new condition monitoring system.





### Lochaber, Scotland

5 x 17.3 MW; Supply, installation and commissioning of five new turbine-generator units with complete replanting. Two of the units were combined into one. The plant remained in operation throughout the modernization program.



**Wettingen, Switzerland**  
3 x 8.5 MW; Refurbishment and revision of three turbines and generators



**Drakensberg, South Africa**  
250 MW; Emergency repair, return to operation in minimum time



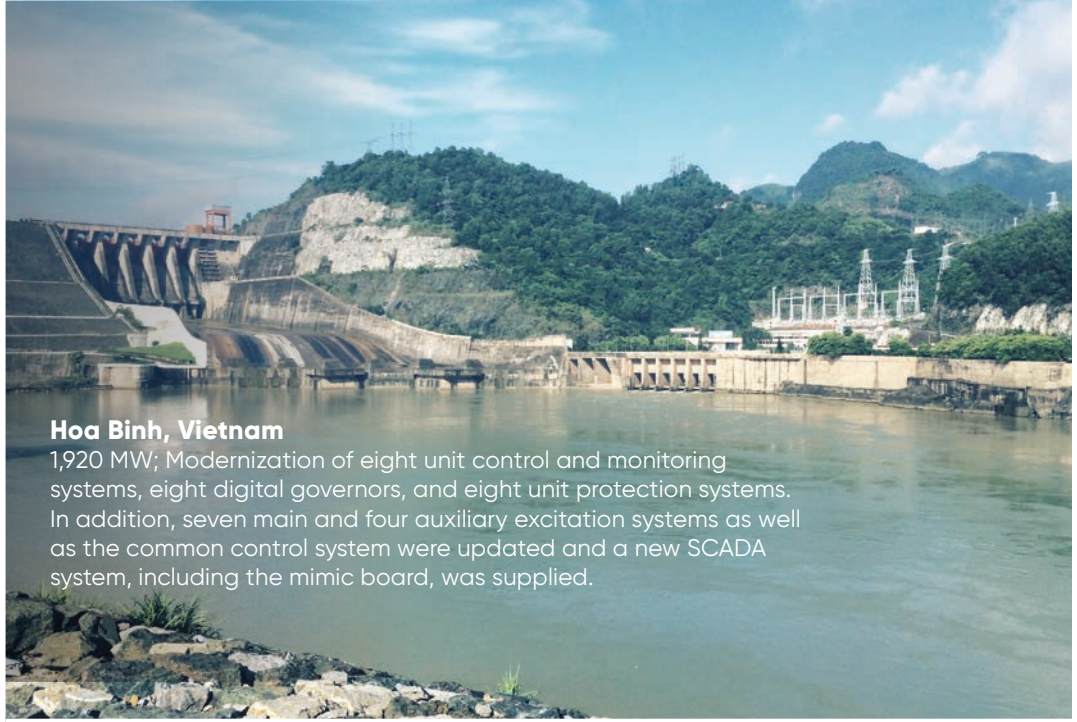
**Ambuklao, Philippines**  
105 MW; Complete rehabilitation and increase of turbine output by 40%



**Temascal, Mexico**  
4 x 38.5 MW; Rehabilitation of four units of the hydropower plant

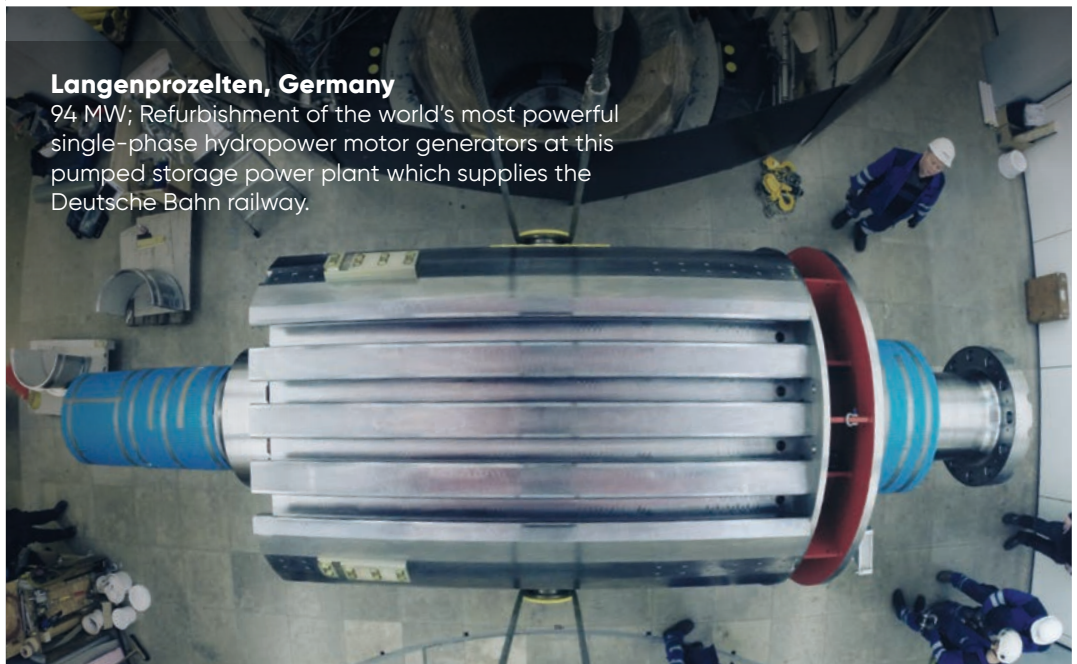






**Hoa Binh, Vietnam**

1,920 MW; Modernization of eight unit control and monitoring systems, eight digital governors, and eight unit protection systems. In addition, seven main and four auxiliary excitation systems as well as the common control system were updated and a new SCADA system, including the mimic board, was supplied.



**Langenprozelten, Germany**

94 MW; Refurbishment of the world's most powerful single-phase hydropower motor generators at this pumped storage power plant which supplies the Deutsche Bahn railway.



**HIPASE Platform**

Solution for excitation, protection, turbine controller, and synchronization



**Generator Rehab, Tasmania**

Rehabilitation program for 12 generators distributed across eight hydropower plants



**Cerro del Aguila, Peru**

Predictive maintenance and asset optimization with Metris DiOMera platform



**Ruacana, Namibia**

87 and 92 MW; Improving the hydraulic performance of the runners





# Global megatrends will influence the future of existing hydropower assets

Changing social, political and economic trends across the globe demand different perspectives. Technology has to adapt and develop to support new ideas and to meet new requirements.

There are numerous alternative applications for hydro equipment aside from the classical use for power generation. This includes provision for agriculture and irrigation as well as flood control, among others. Turbines may also be used in the cooling circuits of thermal power plants, pumps are used as turbines, and power recovery turbines are installed in 3,000 meter-deep mines to recover energy otherwise lost in the

re-cooling circuit. Turbines are found in desalination plants too. In combination with pumps they recover about half the energy used to process drinking water for populations of dry and remote areas that depend on these processes. This provides additional revenue streams and opportunities for profitability as well as independence for regional suppliers, adding to the stability of the local grid.



## **GROWING ENERGY DEMAND NEEDS STABLE GRID**

Global growth in the installed capacity of wind and solar generation and the move away from fossil-fueled energy production is creating new challenges and requirements for grid control capabilities. This can motivate hydropower plant owners to adapt their assets and provide grid frequency stabilization services, for example. Most existing low head hydropower plants are fitted with Bulb and Kaplan turbines designed to operate in level control mode. The new generation of turbines are also able to support primary control. Medium head assets will be also effected. Francis units that are capable of operating over a wide range and especially in part load offer new opportunities. Our new generation of Bulb and Kaplan turbines, as well as the 0-100% Francis\* design offers solutions for the future of your hydropower asset that are already available today.







### UNIQUE OPPORTUNITIES WITH DIGITALIZATION

In the near future, digitalization – also known as Industry 4.0 – will play a much more important role in the economy. The opportunities for additional value created with the help of technology, especially internet-based technology, is enormous. Automation, networking, cloud services, and Big Data will be decisive for the future hydropower industry.

Today, digitalization is already having a big impact on hydropower. For more than two decades digital

controllers, IP-based communication and computerized engineering have been state-of-the-art. The next generation digital breakthroughs are based on smart sensors, use of Big Data for predictive maintenance, and virtual/augmented reality.

Digital solutions from ANDRITZ can be optimally adapted to specific customer needs and are already important components for a future-oriented asset strategy.

### NEW DRIVERS FOR OPERATION AND MAINTENANCE

In 2050, half of the world's population will live in major urban centers. Currently, cities cover just 0.5% of the earth's surface but consume some 75% of global resources. In parallel, developments in demographics could not be more drastic. The population of Africa will probably have doubled by 2050 – mostly in urban areas – while the population of Europe will shrink. With these trends in urbanization and associated demographic changes, existing manpower strategies for the operation and maintenance of hydropower assets must be adapted and evolve.

Profound knowledge of the aging of hydropower plants, which are mostly located in remote areas, and over the full life cycle is essential for developing an effective operation and maintenance program. Even as recently as a few years ago, the operation and maintenance of a hydropower plant was one of the core competences of an asset owner and was executed by local staff. Today, the energy market is changing as it moves towards a strategy of outsourcing these competencies to full service providers. Simultaneously, the demand for completely unmanned operation and maintenance solutions is steadily growing. Preconditions for unmanned O&M concepts are digitalization, group dispatch centers for operation, and powerful digital solutions for predictive maintenance.



ANDRITZ Regional Control Center; Advanced data analysis and predictive indications for hydro asset optimization







ANDRITZ HYDRO GmbH  
contact-hydro.hsr@andritz.com

**ANDRITZ.COM/HYDRO**

**ANDRITZ**

All data, information, statements, photographs and graphic illustrations in this brochure are without any obligation and raise no liabilities to or form part of any sales contracts of ANDRITZ GROUP or any affiliates for equipment and/or systems referred to herein. All rights reserved. No part of this copyrighted work may be reproduced, modified or distributed in any form or by any means, or stored in any database or retrieval system without the prior written permission of ANDRITZ HYDRO GmbH or its affiliates. Any such unauthorized use for any purpose is a violation of the relevant copyright laws. © 2019 ANDRITZ HYDRO GmbH, Eibesbrunnnergasse 20, 1120 Vienna, Austria.



\*Trademark of the ANDRITZ GROUP. For information regarding ownership and countries of registration, please visit [www.andritz.com/trademarks](http://www.andritz.com/trademarks).

AH. SR.01.en.03.19