

# Large Hydro



# ANDRITZ HYDRO

## Worldwide leader in the hydropower business

The ANDRITZ GROUP is a global market leader for customized plants, process technologies, and services for the hydropower, pulp and paper, metals, and other specialized industries, such as solid/liquid separation, feed, and biofuel.

The listed technology group ANDRITZ, headquartered in Graz, Austria, has around 24,000 employees and over 250 production sites, service, and sales companies throughout the world.

In a world trying to join forces to reduce emissions of greenhouse gases and pollution, we at ANDRITZ HYDRO support our customers in their environmental efforts by providing technologies that maximize generation of energy from hydropower.

Hydropower is the most important renewable energy resource. According to the International Energy Agency, only one third of the hydropower potential has been developed and thus, a large amount of new hydropower projects are expected in the future.

ANDRITZ HYDRO is a global supplier of electromechanical systems and services ('From water to wire') for hydropower plants. The company is a leader in the world market for hydraulic power generation. Our range of products and services cover the supply of equipment and services for new hydropower plants as well as for the refurbishment and overhaul of existing facilities. ANDRITZ HYDRO is the global leader in the market of small hydropower stations.

One of our goals is to provide innovative technology for the best return on investment and benefit to our customers.

ANDRITZ HYDRO is constantly improving the energy efficiency of its equipment and technologies through continued research and development.

Our commitment to serve our customers locally all around the world and our proven experience and state-of-the-art technologies are reasons why you can rely on obtaining the best energy application from us.



### Highlights

- More than 170 years of turbine experience, representing over 30,000 units with more than 420,000 MW installed
- More than 120 years of experience in engineering and manufacturing of hydro generators and auxiliaries
- Leading in Service and Rehabilitation
- World leader in small hydropower plants



# Large Hydro

## Competent partner for your large hydro projects

Building a new hydropower plant is a high asset-value investment. With ANDRITZ HYDRO your investment is safe and benefits from our long-term experience and innovative drive.

We focus our expertise on the ability to provide our customers with complete solutions, from project planning to design, engineering, model testing, project management, purchasing, manufacturing, site services, and training for the complete range of equipment and services.

Whether your hydropower project is a “green field” development, an extension or a modification of existing facilities, ANDRITZ HYDRO has the know-how to ensure your objectives and particular requirements are achieved on time and within budget.

The “green” power produced by our technology is the key to a clean and renewable source of energy for generations to come, in perfect harmony with solar, wind, and other regenerative solutions, for the good of the environment as a whole.

Storing energy at off-peak periods and grid regulating tasks become more and more important.

As one of the main suppliers for water-to-wire pumped storage technology, we have followed up those trends and have the solutions for pumped storage plants up to highest heads and for fixed or variable speed technology.

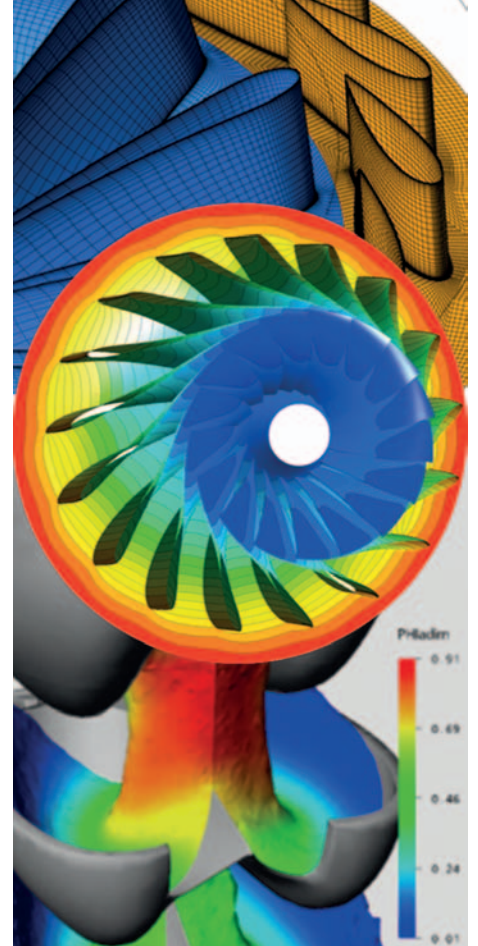
ANDRITZ HYDRO's tailor-made solutions are perfectly suited to your specific energy production cycles and market needs.

### Highlights

- Market leader in Bulb technology
- Technical leader in Pelton turbines
- Variable-speed high-end generators
- On-site manufacturing
- Supplier of complete hydropower equipment



# Products and services



## Turbines

- Pelton  
up to 423 MW
- Francis  
up to 800 MW
- Kaplan  
up to 200 MW
- Bulb  
more than 70% market share
- Pit  
up to 15 MW
- S-type  
up to 25 MW
- Pump/ Pump turbine  
up to 350 MW
- Straflo™  
up to 12 MW
- HYDROMATRIX®  
up to 30 MW

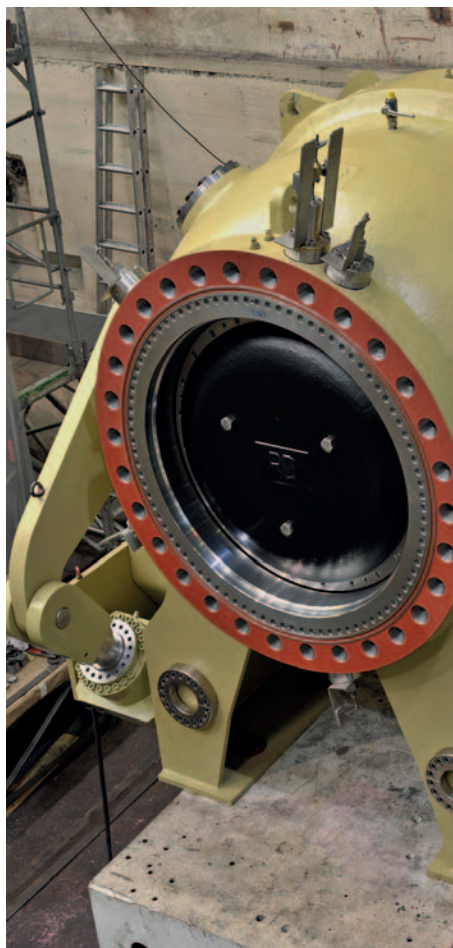
## Generators

- Bulb  
up to 85 MVA
- Vertical hydro generators  
up to 840 MVA
- Horizontal hydro generators  
up to 200 MVA
- Motor generators  
up to 340 MVA
- Asynchronous generators
- Straflo™ generators  
up to 14 MVA
- HYDROMATRIX® generators
- Synchronous condensers

## Research and development

- Hydraulic laboratories in Austria, Brazil, Canada, Finland, and in Switzerland
- Hydraulic, mechanical, and electrical design optimization
- Transient hydraulic and electrical system simulation
- Secondary equipment
- Measurement technology on-site and in the laboratories
- Fingerprint measurements and root cause analysis
- Coating technology
- High-end simulation methods and software packages
- Powerful computing centers
- Bearing test rig
- High-voltage test center





**Automation**

- Automation and control, mechanical protection
- Electrical protection
- Excitation system, static brushless
- SCADA system
- DIA TECH online monitoring and diagnosis system
- Power plant management (including third party-modules)

**Electrical equipment**

- Customized solutions and services for all electrical systems of the power plant
- Complete product range — from low-voltage up to high-voltage switchyards, including auxiliary equipment

**Valves**

- Spherical valves
- Butterfly valves
- Relief valves
- Ring sleeve valves
- Gate valves

**Penstocks and gates**

- All kinds of gates (roller, flap, radial or sliding gates, mitre gates, sector gates) including electrical and hydraulic equipment
- Trashracks
- Stoplogs and lifting beams
- Penstocks and manifolds
- Draft tubes

**Services**

- Design and engineering
- Purchasing
- Manufacturing
- Assembling
- Supply
- Project management
- Site management
- Installation
- Commissioning
- Performance testing
- Training
- Refurbishment
- Project development
- Feasibility studies
- Financing

# Research and Development

## Innovation management

ANDRITZ HYDRO looks back on more than 170 years of experience in design and development of hydropower technology. Due to the changing market conditions, customer requirements and progress in technology we are still faced with many challenges for research and development. Research and development at ANDRITZ HYDRO covers turbine, pump, generator, as well as automation and electrical power system technologies.

Today's major challenges for HPP's are flexibility of operation and robustness of the electromechanical equipment over a long lifetime. Thus, the research activities of ANDRITZ HYDRO are targeting integrated optimization of hydraulic, mechanical, and electrical performance. This is achieved by

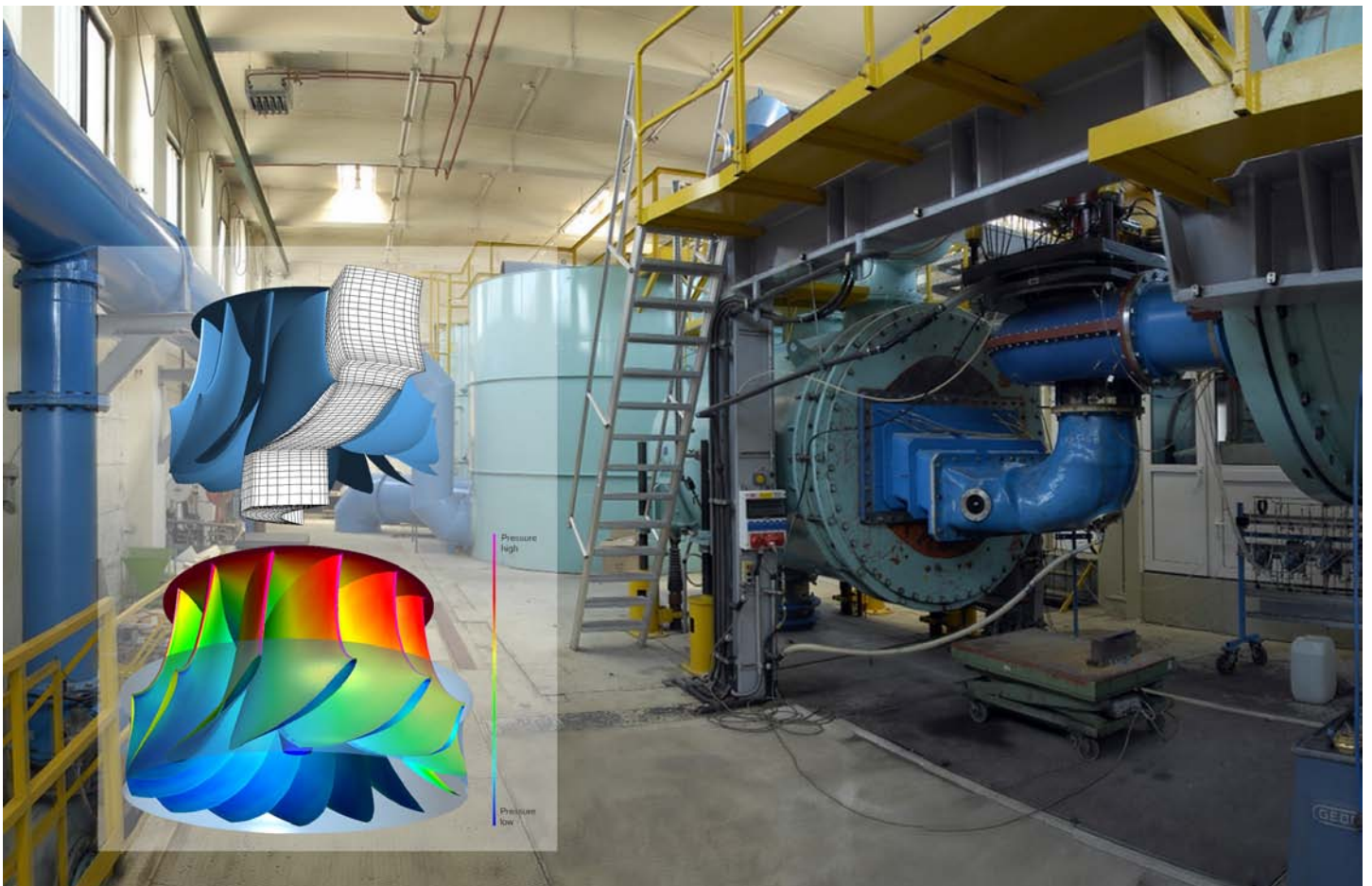
developing and applying numerical simulation methods and by measurements both on the test rigs as well as on-site. ANDRITZ HYDRO operates various laboratories and test rigs, like the coating test rigs in its wear lab, the hydraulic test rigs in its hydraulic laboratories, as well as a high voltage test rig and bearing test rig.

Simulations are carried out for mechanics, fluid dynamics, heat transfer, and electromagnetic processes, as well as for the dynamic behavior of the hydraulic-electrical system as a whole with state-of-the-art software and high-performance hardware.

University research in the fields of coating and material technology, fluid dynamics, structural mechanics and electrical design

is being utilized directly through research cooperation with partners all over the world. Research and development in the automation business are integrating the most recent technologies of IT and the telecommunication industry, while the efforts in the field of electrical power systems are targeting the connection of plants to the power grid. ANDRITZ HYDRO's computer-aided engineering (CAE) together with the excellent measurement technology guarantees successful product development in the interest of our customers.

In order to meet future challenges, ANDRITZ HYDRO's research and development are directed at new products and new product properties, as well as manufacturing methods.



# Project development

## From feasibility to operation

With the focus to enable technically and financially optimized plant layouts and project setups ANDRITZ HYDRO is ready to be involved in all phases of projects.

Starting in the Pre-Feasibility phase, where basic parameters are defined, followed by the Feasibility phase, ANDRITZ HYDRO can support developers, investors, and consulting engineers with preliminary layouts of the main equipment and auxiliaries, resulting in estimates with regards to implementation time, performance, and costs.

Based on such inputs, the consulting engineer is in a position to further optimize the overall plant concept together with the

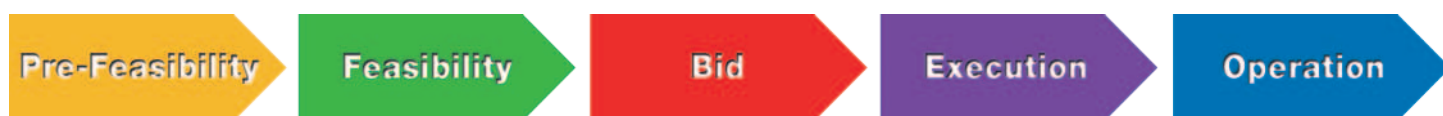
sourcing and financing scheme. The result of this process ensures project specifications combining the operating experience and the requirements usually available on the customer side with most recent product developments, adapted to the specific needs of the project and contributed by an experienced and reputable contractor.

Consequently, such cooperation provides an excellent basis for a technically and economically viable project, which is the goal of all parties involved.

During the Execution phase all prior considerations turned out proving the correctness of all assumptions made in the

earlier processes. The success of this important project phase is very much dependent on professional project management and interface coordination between all those involved in the project. ANDRITZ HYDRO is ready to support these management and coordination efforts with all due care and its globally evidenced competencies.

After-sales services, such as spare part management, regular maintenance activities, service rehabilitation, and modernization projects during the Operation phase complete ANDRITZ HYDRO's involvement throughout the entire life cycle of the plant.



Pre-Feasibility	Feasibility	Bid	Execution	Operation
<p><b>CUSTOMER:</b></p> <ul style="list-style-type: none"> <li>Project purpose and description</li> <li>Site assessment, regulatory framework</li> <li>Topography, hydrology, geology</li> <li>Environmental and social studies</li> <li>Economic and financial analysis</li> </ul> <p><b>ANDRITZ HYDRO:</b></p> <ul style="list-style-type: none"> <li>Initial verification of concept and budget</li> </ul>	<p><b>CUSTOMER:</b></p> <ul style="list-style-type: none"> <li>Additional site survey</li> <li>Discharge, head, energy information</li> <li>Overall implementation schedule</li> <li>ESIA, RAP, etc.</li> <li>Financial arrangements</li> </ul> <p><b>ANDRITZ HYDRO:</b></p> <ul style="list-style-type: none"> <li>Budgetary proposal, layout, performance, price, and time schedule performance</li> <li>Price</li> <li>Time schedule</li> </ul>	<p><b>CUSTOMER:</b></p> <ul style="list-style-type: none"> <li>Contract structure</li> <li>Preparation of tender documents</li> <li>Bid invitation, evaluation, negotiation and award</li> </ul> <p><b>ANDRITZ HYDRO:</b></p> <ul style="list-style-type: none"> <li>Firm bid incl. price and technical and commercial conditions</li> <li>Financing offer (if applicable)</li> </ul>	<p><b>CUSTOMER:</b></p> <ul style="list-style-type: none"> <li>Project and contract coordination</li> <li>Overall planning lead</li> </ul> <p><b>ANDRITZ HYDRO:</b></p> <ul style="list-style-type: none"> <li>Participation and support in management and coordination of interfaces and implementation schedule</li> <li>Capacity building</li> </ul>	<p><b>CUSTOMER:</b></p> <ul style="list-style-type: none"> <li>Regular operation and maintenance</li> </ul> <p><b>ANDRITZ HYDRO:</b></p> <ul style="list-style-type: none"> <li>Spare part supply</li> <li>Residual life analysis</li> <li>Diagnosis and preventive maintenance</li> <li>Training services</li> <li>Modernization and upgrading</li> </ul>



# Pumped storage plants

## Equipment for the battery of the grid

Increasing renewable energy sources will require flexibility and storage capacity to compensate variable electricity production. Reservoir and pumped storage hydropower can provide that flexibility and capacity – they are the only economical means of storage of large amounts of energy.

Besides the classical operation method of pumped storage plants (PSP's), storing energy at off-peak periods and using it at peak-periods, regulation tasks of PSP's are becoming more and more important.

PSP's are used nowadays to provide ancillary services and stabilizing elements in case of fault situations by contributing balancing power and inertia, respectively. These requirements yield to operational modes of pumped storage plants, which

are very flexible, with frequent changes of load cycles, a wide hydraulic operating range, and the necessity also to regulate power in the pumping mode.

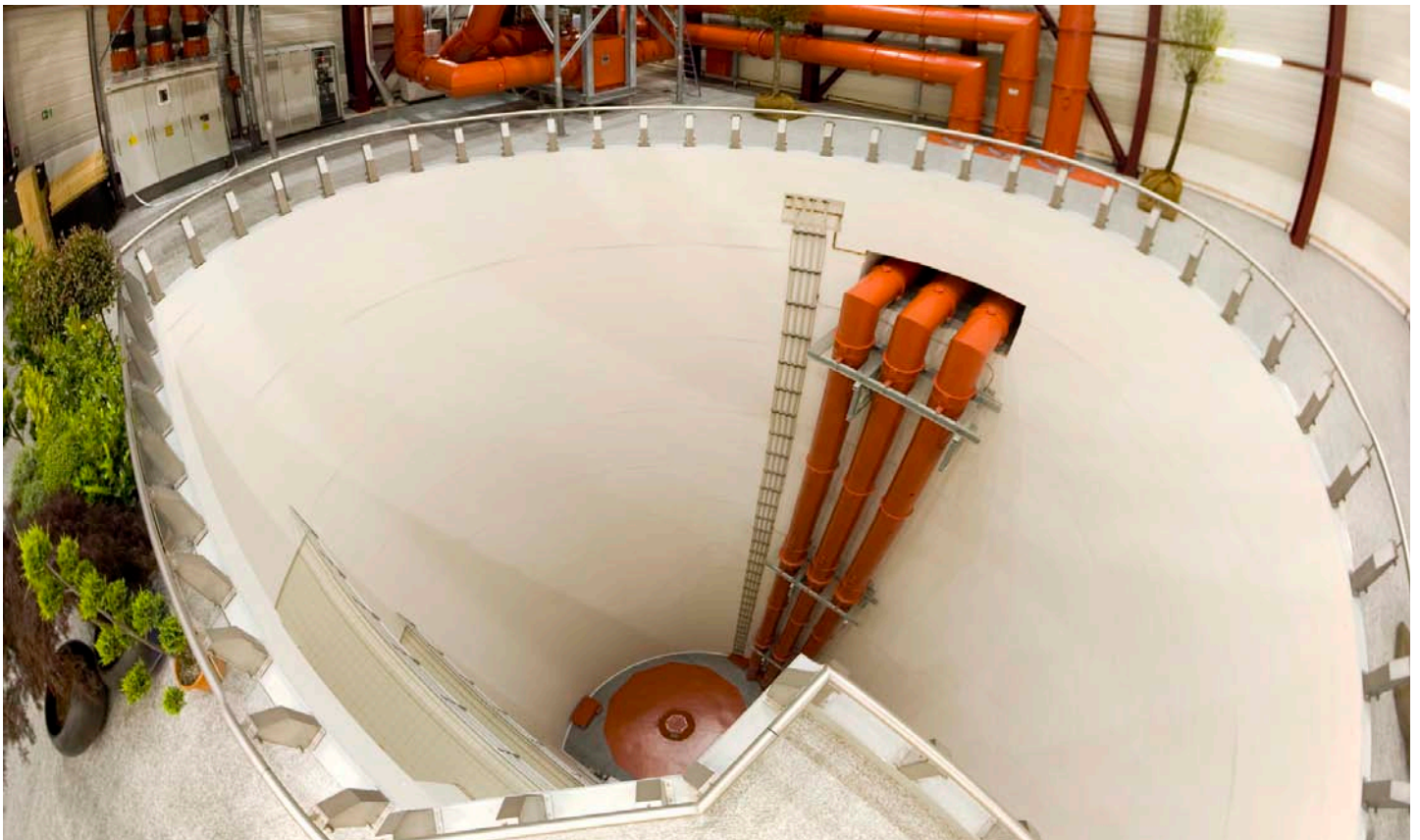
ANDRITZ HYDRO, as one of the main suppliers for water-to-wire pumped storage solutions, has followed up those trends extending and developing solutions for pumped storage plants up to highest heads, as well as further developing its variable-speed technology.

Variable-speed pumped storage units have the important advantage of continuous power regulation also in pump mode, enabling frequency and power regulation capabilities for grid-disturbances. In addition, they stabilize the grid-frequency to provide a secure and stable energy distribution, due to their very fast reaction times.

ANDRITZ HYDRO's references in pumped storage date back to the early 1900s. Our technology is adapted to the specific characteristics to cover the complete head range up to more than 1,400 m.

Large PSP's with more than 1,000 MW total output like Dinorwig in the UK, Reiss-eck II and Limberg II in Austria, Vianden 11 in Luxembourg, Tianhuangping, Tong Bai, and Lang Ya Shan in China, as well as the variable-speed plant Goldisthal in Germany contain our pump turbines, motor generators, and plant technology and operate successfully.

The four-stage reversible pump turbines and motor generators for the PSP Tierfehd in Switzerland with more than 1,000 m head are strengthening ANDRITZ HYDRO's multi-stage high-head experience.





# Modernization and rehabilitation

## New life for existing hydropower plants

About 50% of the primary and secondary equipment installed in existing hydropower plants all over the world is more than 40 years old.

Thus, the market is being increasingly driven by modernization and upgrading of existing hydropower plants.

Technological leadership with long-term experience coupled with a global network ensuring proximity to our customers is the added value of our service and rehabilitation organization. The longer a hydropower

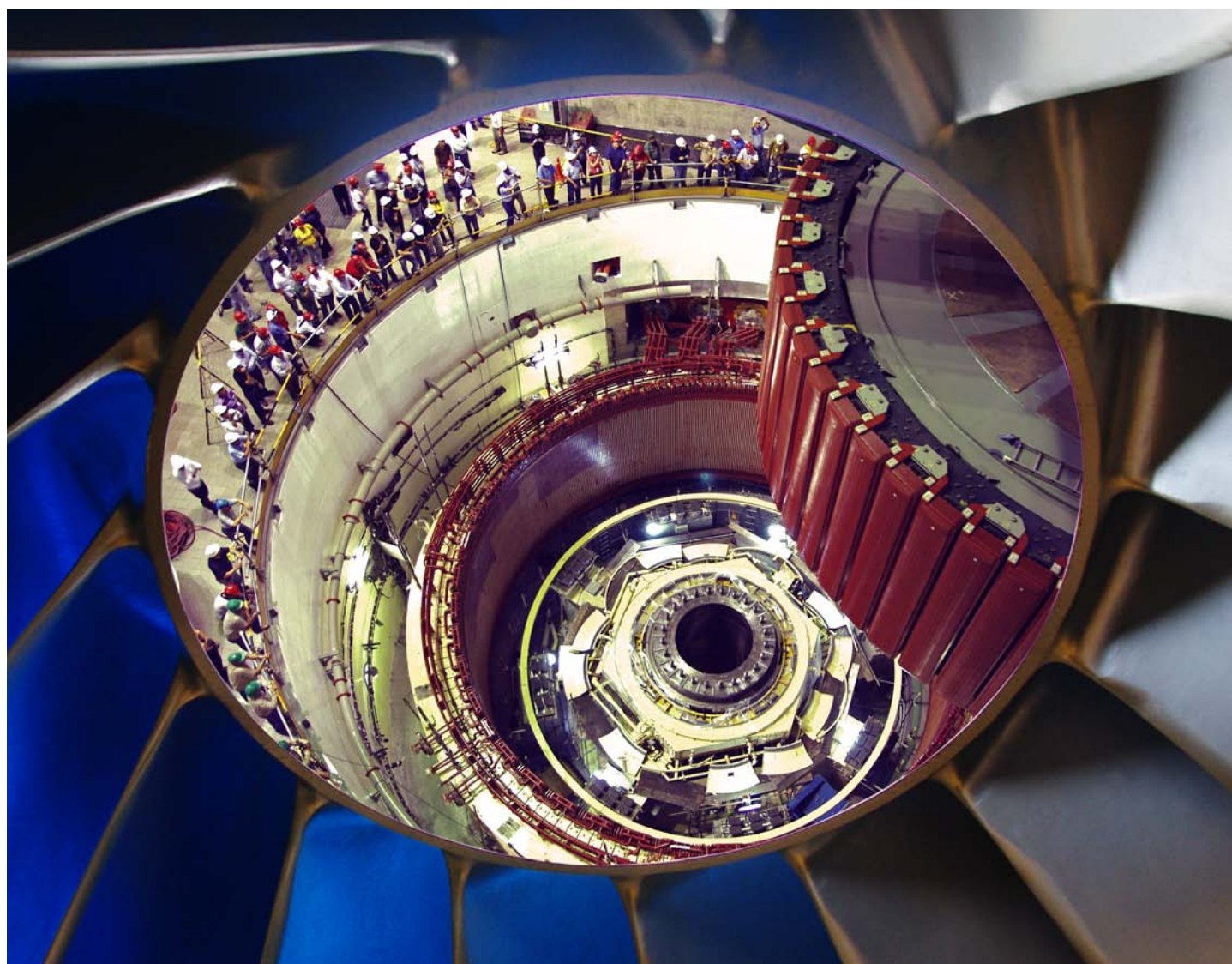
power plant is in operation, the more its reliability, availability, hydraulic performance, and consequently the earnings decrease and operation/maintenance costs increase.

ANDRITZ HYDRO's rehabilitation experts have the perfect solution and let your proven machinery shine like new.

Improved hydropower generation through optimal utilization of available water resources, increased revenues from power generation, reduced risks of standstill or unplanned maintenance, and the guar-

antee to be compliant with environmental regulations are only some of the benefits. Rehabilitation is a very complex issue, the aging of the various plant components and systems depend on environmental and ambient conditions. Based on many years of experience and work, ANDRITZ HYDRO has developed a structured and very economical process for assessing and modernizing hydropower plants.

This systematic approach ensures tailor-made solutions guaranteeing the maximum benefit for the owner.





# Large Hydro

## Selected references worldwide



### ANGOSTURA, Chile

6 radial gates 13.2 x 16.33 m, head 22 m  
 4 roller gates 4.75 x 7.5 m, head 37.18 m  
 1 roller gate 6.0 x 7.3 m, head 37.56 m  
 1 roller gate 6.4 x 8.0 m, head 66.224 m  
 2 roller gates 8.1 x 16.6 m, head 74.22 m



### BELES, Ethiopia

4 Francis generating units  
 Output: 105 MW/ 133 MVA  
 Head: 332 m/ Voltage: 15 kV  
 Speed: 375 rpm  
 Runner diameter: 1,900 mm



### BIEUDRON, Switzerland

3 Pelton turbines  
 Output: 423 MW (world record)  
 Head: 1,874 m (world record)  
 Speed: 428.6 rpm  
 Runner diameter: 3,993 mm



### IFFEZHEIM, Germany

1 Bulb generating unit  
 Output: 38 MW/ 38.85 MVA  
 Head: 13.2 m/ Voltage: 6.5 kV  
 Speed: 83.3 rpm  
 Runner diameter: 6,800 mm



### KAUNERTAL, Austria

Embedded penstock and manifold  
 Design head: 1,007 m  
 Length: 2,290 m  
 Diameter: 6.3-2.5 m  
 Weight: 9,300 tons



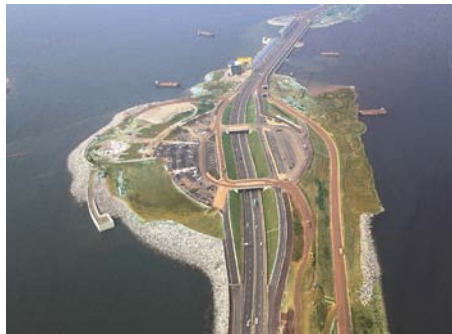
### MICA, Canada

2 Francis generating units  
 Output: 520 MW/ 570 MVA  
 Head: 170 m/ Voltage: 16 kV  
 Speed: 133 rpm  
 Runner diameter: 5,600 mm



### SAO SALVADOR, Brazil

4 Kaplan generating units  
 Output: 124.5 MW/ 135 MVA  
 Head: 22.8 m/ Voltage: 13.8 kV  
 Speed: 85.71 rpm  
 Runner diameter: 8,360 mm



### SIHWA, South Korea

10 Bulb generating units  
 Output: 26 MW/ 26.76 MVA  
 Head: 5.8 m/ Voltage: 10.2 kV  
 Speed: 64.3 rpm  
 Runner diameter: 7,500 mm



### SIMON BOLIVAR, Venezuela

5 Francis rehabilitation runners  
 Output: 770 MW  
 Head: 144 m  
 Speed: 112.5 rpm  
 Runner diameter: 6,974 mm





**BOYABAT, Turkey**

3 Francis generating units  
Output: 176 MW/ 204.8 MVA  
Head: 141.3 m/ Voltage: 14.4 kV  
Speed: 187.5 rpm  
Runner diameter: 3,850 mm



**CHIEVO, Italy**

5 HYDROMATRIX® generating units  
Output: 1.35 MW/ 1.5 MVA  
Head: 3.8 m/ Voltage: 450 V  
Speed: 250 rpm  
Runner diameter: 1,320 mm



**GOLDISTHAL, Germany**

2 sync., 2 async. motor generators  
Output: 380/ 357 MVA  
Voltage: 18 kV  
Speed: 333.3 / 300-346.6 rpm  
Stator diameter: 8,700/ 8,200 mm



**PIRRIS, Costa Rica**

2 Pelton generating units  
Output: 75.6 MW/ 96.14 MVA  
Head: 890.7 m/ Voltage: 13.8 kV  
Speed: 600 rpm  
Runner diameter: 1,980 mm



**RIO MADEIRA, Brazil**

44 Bulb generating units  
Output: 76.55 MW/ 83.33 MVA  
Head: 15.2 m/ Voltage: 13.8 kV  
Speed: 94.7 rpm  
Runner diameter: 7,500 mm



**ROCK ISLAND, USA**

4 Kaplan gen. units (rehab)  
Output: 28.3 MW/ 28.8 MVA  
Head: 11.6 m/ Voltage: 13.8 kV  
Speed: 100 rpm  
Runner diameter: 5,740 mm



**TIERFEHD, Switzerland**

1 four-stage rev. pump turbine/ motor gen.  
Output: 142 MW/ 175 MVA  
Head: 1,000 m/ Voltage: 13.8 kV  
Speed: 600 rpm  
Runner diameter: 2,260 mm



**VARAHI, India**

2 Pelton generating units  
Output: 31.2 MW/ 127.8 MVA  
Head: 465.66 m/ Voltage: 11 kV  
Speed: 300 rpm  
Runner diameter: 2,910 mm



**VIANDEN, Luxembourg**

1 Pump turbine motor-generating unit  
Output: 200.4 MW/ 230 MVA  
Head: 294.6 m/ Voltage: 15.75 kV  
Speed: 333.3 rpm  
Runner diameter: 2,595 mm

# ANDRITZ HYDRO

## Worldwide presence



- ANDRITZ HYDRO locations
- ANDRITZ locations



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