



LARGE HYDROPOWER SOLUTIONS

ANDRITZ

ENGINEERED SUCCESS

Large Hydro - more than a big idea

BHUMIPOL DAM

HPP BHUMIPOL

Thailand



Fish-friendly
Renewable

Large rehabilitation Tailor-made solutions

Run-of-the-river Sustainable Mega units
Bulb turbines

Large Hydropower

Tidal power Efficiency "From water-to-wire"

Generators Turbines Francis turbines
Hybrid solutions

Pumped storage Variable speed units

On-site manufacturing

Pelton turbines

Large hydropower assets are the key for the energy transition process

Around the world, there is still a huge potential for hydropower generation. Large-scale greenfield hydropower assets, as well as large rehabilitation projects can facilitate the exploitation of this important potential for clean energy generation.

Large-scale hydropower projects are playing an important role in the economies of many countries. On the one hand, they are feeding a huge amount of electrical energy into the grid. On the other, their infrastructure also supports water supply, irrigation, navigation, and flood control, creating local businesses, employment, and improving livelihoods. Large hydropower projects trigger investment in transportation, education and health services, as well as tourism and recreation, boosting economic growth and creating opportunities for trade.

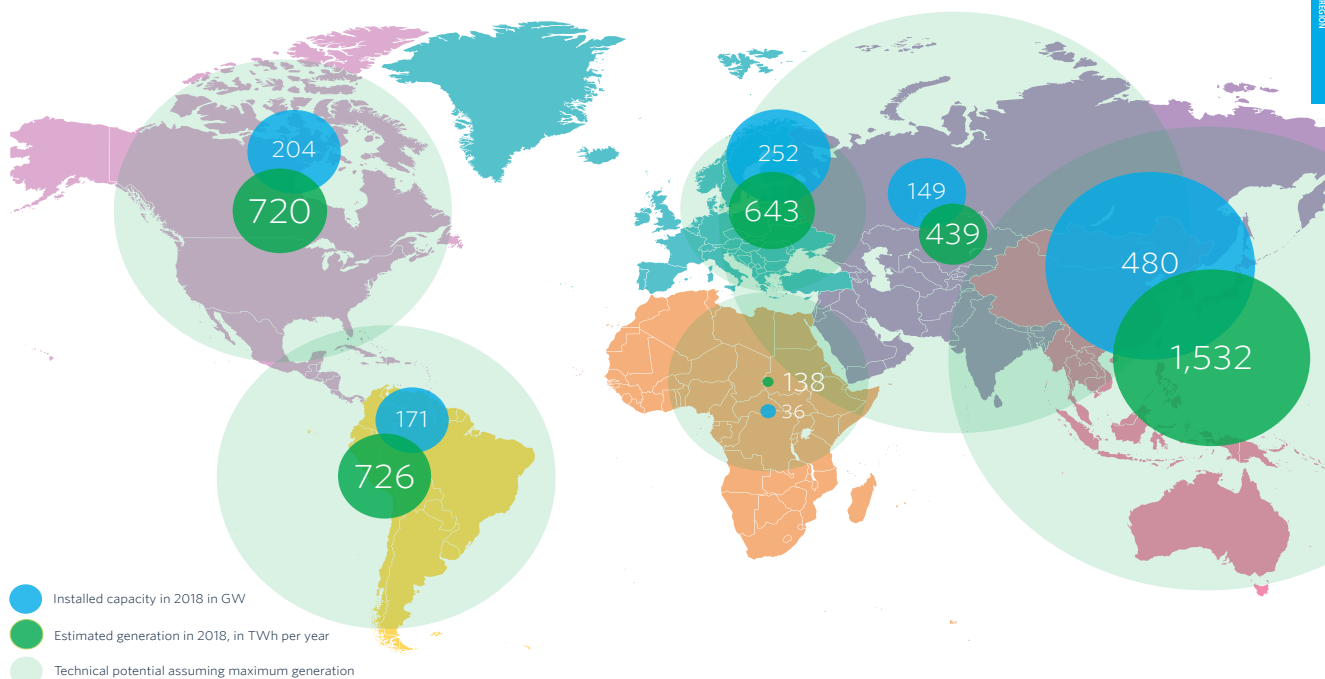
By the end of 2018, more than 1,292 GW of installed hydropower capacity was in operation worldwide.

Source: IHA Status Report 2019

With about 60% of the total, hydropower is the most important renewable source of electricity generation today. It thus makes a major contribution to the ambitious goals of the Paris Climate Agreement and wider sustainable development goals.

With more than 13 GW of newly installed capacity in 2018, Asia, specifically South East Asia, is the world's fastest growing hydropower region. It is followed by South America (4.9 GW), Europe (2.2 GW), Africa (1.0 GW), and North America (600 MW). Overall, more than 21 GW were put into operation worldwide during 2018, including nearly 2 GW of pumped storage. The countries with the highest individual increases in installed capacity were China and Brazil.

HYDROPOWER CAPACITY AND GENERATION BY REGION



REPORT BY STRATAGIE



“Hydropower is the world’s largest source of renewable electricity generation.”

Hydropower offers a range of benefits for both the environment and society. Especially for the local electricity market, large-scale hydropower plants are able to provide clean, sustainable, and flexible power generation as well as important energy storage capacity. At the same time, they reduce dependence on fossil fuels and support the trend to a zero-emission future.

SUSTAINABLE ENERGY FOR DECADES

The lifetime of a large hydroelectric plant is measured in decades, up to 100 years or more. Thus, the installed electro-mechanical equipment has to last a very long time. New technological developments and changing market conditions require more flexibility. These operational strategies define the best technical solutions for large-scale new as well as large rehabilitation projects.

EMISSION-FREE ENERGY

The Paris Climate Agreement’s long-term goal is to keep the increase in global average temperature to below 2 °C above pre-industrial levels, since this reduces the risks and effects of climate change significantly. More and more countries are adapting or developing their energy strategies according to this goal. Without the contribution of hydropower, the target of limiting climate change would likely be out of reach. Large hydropower therefore plays a key role in delivering a sustainable future.

PROVIDING GRID SERVICES AND INERTIA

The development, financing, and realization of a new large hydropower plant poses a number of complex challenges. With increasing intermittent energy provided by wind and solar, grid services like reactive power and inertia are needed. This provides new opportunities for large greenfield as well as large rehabilitation hydropower projects, the technical and economically best answer to meet all these new needs.



We are a global market leader based on outstanding technology and long history

With more than 175 years' experience in turbine technology and 120 years' experience in electrical engineering, we are a competent partner for your hydropower project.

ANDRITZ AND HYDRO

The ANDRITZ GROUP is a globally leading supplier of plant, 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. ANDRITZ is always close to its customers, with more than 280 production locations and service and sales companies around the world.

ANDRITZ Hydro is part of the ANDRITZ GROUP and a world leading supplier of electro-mechanical equipment and services "from water-to-wire" for hydropower plants. Growth, mergers, and cooperation agreements have formed a modern state-of-the-art technology company with about 7,000 employees worldwide.

THE ORIGINAL EQUIPMENT MANUFACTURER

By the turn of the 20th century hydropower technology was spreading around the globe, with the first large applications established in Europe. Over time, large hydropower developments were carried out all over the world, and in most ANDRITZ was involved. Today, we are proud to own Original Equipment Manufacturer (OEM) rights for almost half of the worldwide installed hydropower base.

Whether the hydropower project is a greenfield development, an extension or a modification of an existing facility, ANDRITZ has the expertise to ensure the customer's objectives and particular requirements are achieved on time and within budget.

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 Escher Wyss
Finnsyttan GE Hydro GE Hydro Inepar Hammerfest Strom Hemi Controls
General Electric Hydro Vevey I.P.Morris KAMEWA KMW Moller NOHAB
Pelton Water Wheel Pichlerwerke Precision Machines SAT Sulzer Hydro
Tampella VA TECH Hydro VOEST Voest MCE Waplans





LARGE HYDRO BUSINESS

Our highly skilled engineers at Large Hydro cover all aspects of the project – from low head to high head, from low speed to high speed, from intake to switchyard and from feasibility to operation – our tailor-made solutions are perfectly suited to specific energy production cycles and market needs.

ANDRITZ supplies large turbines up to 800 MW and 1,800 m heads, powerful generators up to 840 MVA, the complete product range for electrical systems, mechanical auxiliary systems, inlet valves up to 200 bar and 6 m of nominal diameter, automation including SCADA systems and power plant management and all kinds of gates, penstocks and manifolds.

This expertise and many decades of experience result in our market leadership in Bulb-type technology, in technical leadership in Pelton turbines and unique expertise in the design and manufacture of high-end variable speed generators. These are only some of our product highlights. Besides this, we are also one of the worldwide top-tier suppliers for “from water-to-wire” pumped storage technology, providing products up to the highest heads.

RESEARCH AND DEVELOPMENT

To meet today’s market needs, but also to prepare for the challenges of the future energy transition, ANDRITZ’ Research and Development activities target the integrated optimization of hydraulic, mechanical and electrical performance, covering technologies such as turbines and pumps, penstocks and gates, generators, Electrical Power Systems (EPS), and automation. Today’s major challenges are centered on flexibility of operation and a long lifetime of the mechanical equipment.

ANDRITZ operates various laboratories and test rigs around the world, where numerical simulation methods are being developed and applied. Simulations are carried out for fluid dynamics, mechanics, heat transfer and electromagnetic processes, as well as the dynamic behavior of the hydraulic-electrical system as a whole with state-of-the-art software and high performance hardware. ANDRITZ has been using computational fluid dynamics (CFD) and finite element analysis (FEA) as well as reverse engineering tools for optimal design approaches for many years.

Research which takes place at universities is directly being utilized through research cooperation with our many partners all over the world.

For large refurbishment projects, we provide a thorough analysis of the existing machine and various modernization scenarios, enabling the development of an optimal solution in every case.



**Take the best -
from feasibility
to operation**

A large concrete dam with water flowing through its spillways. The dam is made of grey concrete blocks and has several spillways. Water is flowing out of the spillways, creating a large plume of white water. The dam is situated in a valley with green trees in the background.

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



Our product, system, and service portfolio

ANDRITZ' "from water-to-wire" concept covers the full span of hydro-electrical and electro-mechanical equipment. This includes penstock and gates, inlet valve, turbine, generator, automation, mechanical and electrical balance of plant, as well as all necessary product services.

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.

This is realized by a highly-skilled engineering team which is used to optimize every product in order to achieve the utmost revenue and availability. Continuous development is important for us, improvements regarding performance, operating range and reliability are the targets for which we strive on a daily basis. Future technologies like pumped storage, tidal energy or environmentally-friendly components are treated with utmost importance, since they represent the future green energy supply in the world.

PROJECT DEVELOPMENT

With the focus on enabling technically- and financially-optimized plant layouts and project set-ups, ANDRITZ is ready to get involved at all phases of a project. Starting at the prefeasibility phase where basic parameters are defined, followed by the feasibility phase, ANDRITZ supports 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.

HYDRO-MECHANICAL SCOPE

Our hydro-mechanical scope comprises turbines including bearings and shaft, gates, penstocks, valves as well as spiral and wicket gates. Valves and turbines are exposed to high loads during operation. Nowadays, hydraulic machinery is subject to an increased number of start/stop cycles due to changes in grid demand. For ANDRITZ, valves and turbines are therefore one of the core competences of our portfolio.

PENSTOCK AND GATES

In the market for hydraulic steel structures, ANDRITZ Hydro has positioned itself as a world leader, one that sets records. The product and service offerings for hydropower plants, water supply, treatment and irrigation facilities include manifolds, bifurcations, pipe bridges, and penstocks, as well as gates.

ELECTRO-MECHANICAL SCOPE

Our scope includes all electrical equipment starting from the generator and excitation to high voltage grid connections. Depending on specific demands, generators are provided for horizontal or vertical arrangements and for low as well high speed. The Electrical Power Systems (EPS) provide solutions for all voltage levels including transformers and substation. A further dedicated part of EPS is the automation/control system.





LARGE MODERNIZATION AND REHABILITATION

About 50% of the primary and secondary equipment installed worldwide is more than 40 years old. As a result of the long-term operation of hydroelectric power plants the reliability, availability, hydraulic performance and, consequently, the earnings are decreasing while the operation and maintenance costs are increasing. Our large hydro rehabilitation experts are the perfect answer to bring your hydro asset up-to-date, increase energy production, and ensure that modern operational regimens, market requirements and environmental stipulations are met.

LARGE ENGINEERED PUMPS

ANDRITZ provides pumps that meet the demand for ever larger, higher-performance units, whether for low flow rates or wear-resistant applications. Depending on the application case, ANDRITZ develops, produces, tests, and supplies both standard pumps and custom-tailored large pumps. ANDRITZ engineered pumps operate worldwide in large infrastructure projects for irrigation, drainage, desalination, flood control and for drinking and industrial water supplies.

DIGITALIZATION AND AUTOMATION

For the design of modernization projects, automation solutions based on optimized hardware architecture

and step-by-step function integration are a significant factor. ANDRITZ Hydro's concepts enable fully-automated operation, low investment costs, simple commissioning, and rapid system replacement.

OPERATION AND MAINTENANCE

Our competent and experienced staff provides operation and maintenance services in order to optimize power plant performance and ensuring the reliability of the asset. Operational optimization decisions can be realized either directly on-site through our team or remotely by our experienced operators in our Global Control Centre. We take care of the plant performance and monitor trends and data to maximize the availability and anticipate any issues. Our digital solution is based on a modular and flexible design, and provides decision guidance for target-oriented maintenance.

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 meeting technical, economic, and legal requirements. Special services are offered for life-cycle and risk analysis, as well as for operations and maintenance.



"ANDRITZ is fully committed to continuous development in regard to environmental friendliness of hydropower units and structures."





Green Technology

Because of the fact that hydroelectric dams do not use fossil fuel, no carbon dioxide is produced by their power generation. Therefore, hydropower has the lowest life-cycle greenhouse gas emissions of any power generation technology.

ANDRITZ Hydro is strongly committed to the sustained protection of the environment in accordance with economic growth and social progress.

FISH-FRIENDLY DESIGN

Among the many different topics that must be addressed to optimize a hydropower project from an environmental point of view, fish migration is a highly significant issue for many water courses. Since the 1990s, ANDRITZ has followed a combined design strategy to ensure high rates of fish survival. Reduced gap runners, blunt leading edges, or the optimized alignment for stay and guide vanes are only some examples of measures which can be applied to accomplish fish survival.

Serious consideration of the many parameters affecting fish mortality rates and optimization of the tools and measures used to mitigate those impacts can have a dramatic and positive effect on the environmental performance of hydro-power plants.

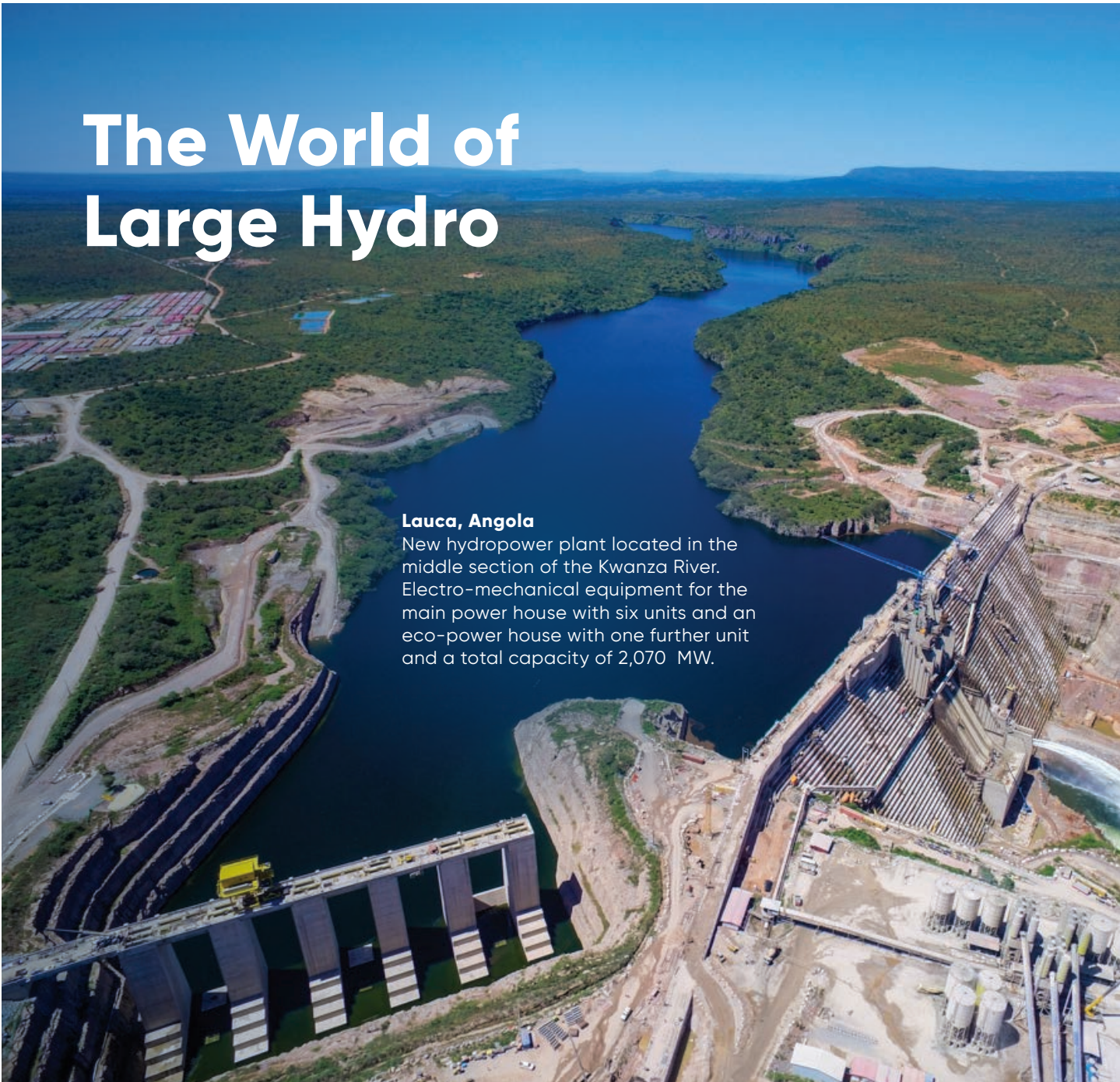
OIL-FREE RUNNER TECHNOLOGY

Another key issue for run-of-river power plants is the mineral oil found in Kaplan runner hubs. The simple philosophy "better the oil leaks out other than dirty water leaks into the hub" has allowed thousands of liters of mineral oil to leak into water courses, polluting the rivers. Since many rivers must meet standards for drinking water quality, the oil-free runner hub is required and is a defined market need at many new and rehabilitation projects. Within the last 20 years ANDRITZ has established more than 130 references for oil-free Kaplan runners up to largest diameters, outputs and heads, showing and proving that adequate solutions are available.

SEDIMENT MANAGEMENT

Each river in the world transports sediments, material that is broken down by the processes of weathering and erosion. Especially for run-of-river hydropower plants, sedimentation can change the hydraulic scheme, damage the hydro-mechanical structures and turbines, and lead to inefficiencies in power generation and costly repairs. ANDRITZ is permanently improving the technological solutions to avoid the negative impacts of sedimentation.

The World of Large Hydro



Lauca, Angola

New hydropower plant located in the middle section of the Kwanza River. Electro-mechanical equipment for the main power house with six units and an eco-power house with one further unit and a total capacity of 2,070 MW.



Churchill Falls, Canada
5,428 MW
Refurbishment of ten large units and runner replacement



Ilisu, Turkey
1,224 MW
Complete electro- and hydro-mechanical equipment

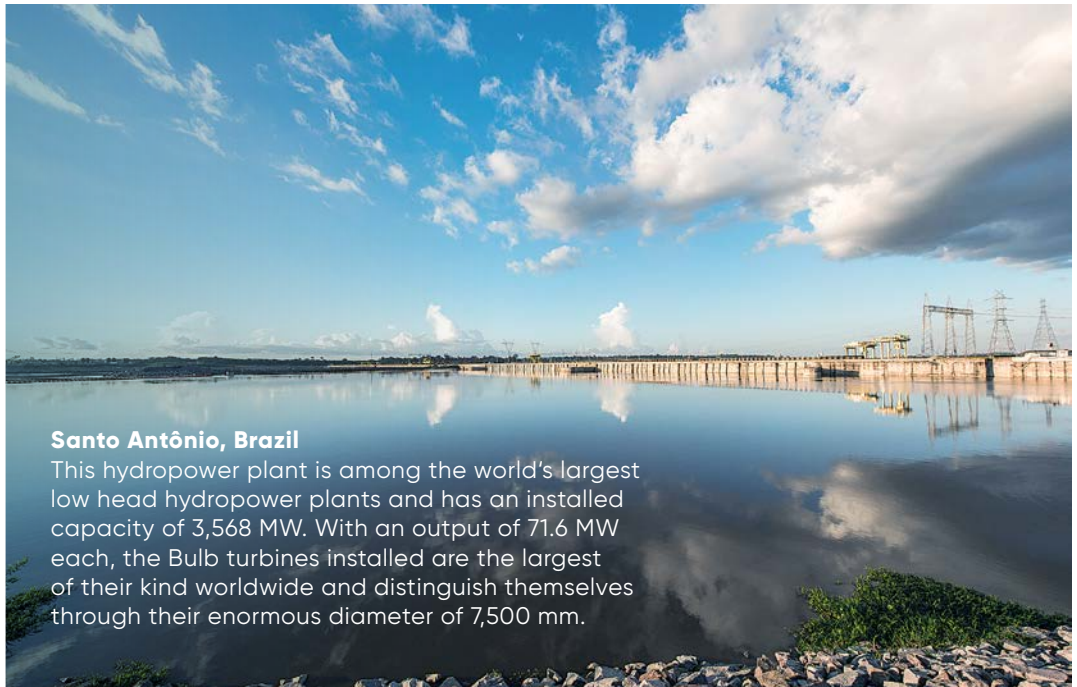


Kpong, Ghana
160 MW
Rehabilitation of the second largest hydroelectric dam in Ghana



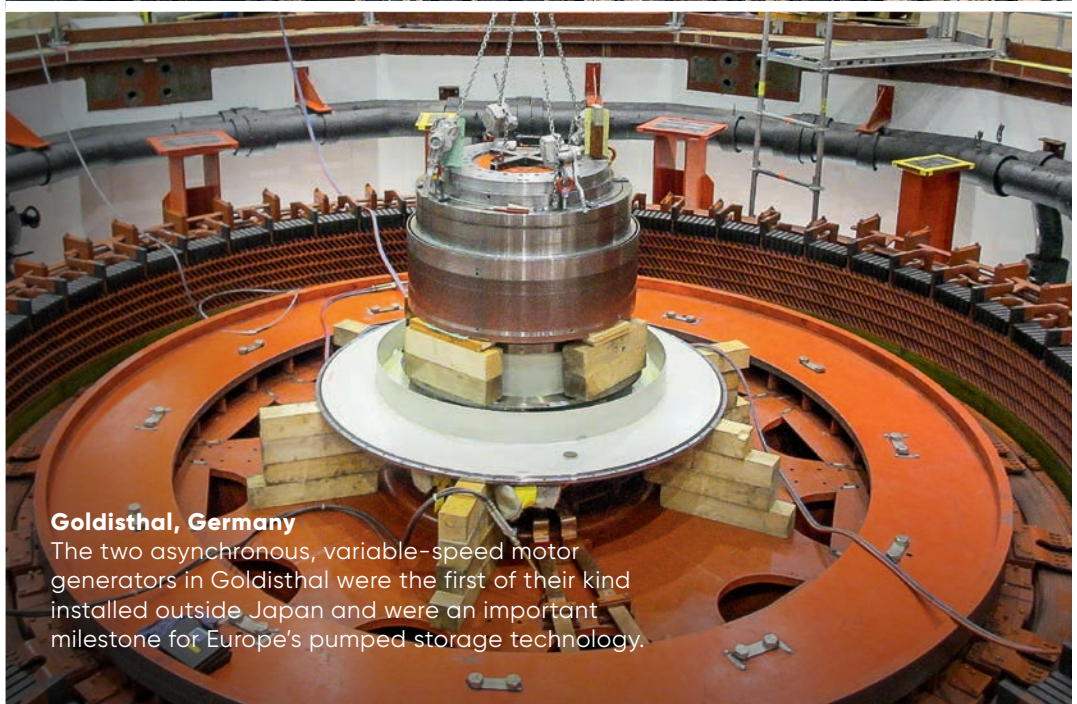
Xayaburi, Lao PDR
1,285 MW
Kaplan turbines for largest hydro-power plant on the Mekong River





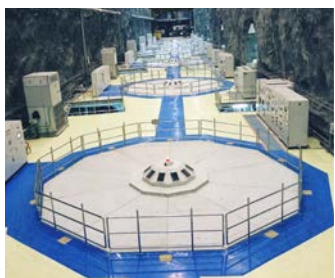
Santo Antônio, Brazil

This hydropower plant is among the world's largest low head hydropower plants and has an installed capacity of 3,568 MW. With an output of 71.6 MW each, the Bulb turbines installed are the largest of their kind worldwide and distinguish themselves through their enormous diameter of 7,500 mm.



Goldisthal, Germany

The two asynchronous, variable-speed motor generators in Goldisthal were the first of their kind installed outside Japan and were an important milestone for Europe's pumped storage technology.



Teesta III, India
1,200 MW

O&M contract for one of the largest hydro plants in India



Kops II, Austria
450 MW

Three Pelton turbines for this important pumped storage project



Yen Nghia, Vietnam

Ten vertical shaft pumps for the biggest flood discharge pumping station in Vietnam



Mey Gen, Scotland
4.5 MW

Three tidal stream turbines for the world's largest tidal stream project

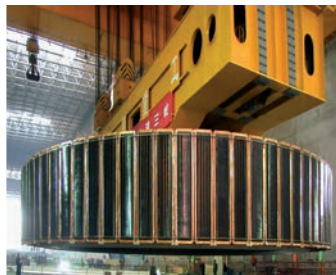


Sihwa, Korea

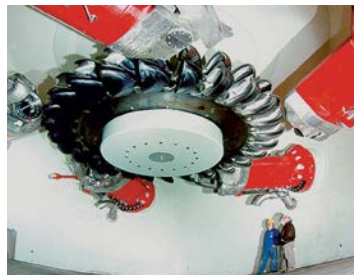
With a total output of 260 MW and an annual power generation of 543 GWh, Shiwa is the largest tidal power plant in the world. ANDRITZ designed ten Bulb turbine-generator units and their ancillaries, delivered core components for turbines and generators, the automation system, and supervised the site installation, as well as commissioning.



Ashta, Albania
24 MW + 45 MW
90 modules for the world's largest HYDROMATRIX* plant



Three Gorges, China
22,500 MW
Turbines and generators for the largest hydropower plant of the world



Cleuson Dixence, Switzerland
1,269 MW
Two world records for the most powerful Pelton turbines and highest head



Nurek, Tajikistan
3,015 MW
Rehabilitation and modernization of the largest hydropower plant in Central Asia





Mica Dam, Canada

More than 1,000 MW of additional capacity due to the supply and commissioning of two further units. Each of the two 520 MW Francis runners weighs more than 137 tons and increases the total power of the hydropower plant to more than 2,800 MW.



Gouvães, Portugal

Electro-mechanical equipment, penstocks, and bifurcators for the 880 MW pumped storage power plant, the heart of the Tâmega Complex, the largest hydropower complex in South Europe. Technically outstanding reversible high head pump turbines to compensate variable electricity generation from wind power.



Tsankov Kamak, Bulgaria
80 MW

Austria's first joint implementation project acc. to the Kyoto Protocol



Kárahnjúkar, Iceland
696 MW

Electro-mechanical equipment for six turbine generator units



Abdelmoumen, Morocco
350 MW

Two reversible pump turbines for rapid load change



Hatta, Dubai, UAE
250 MW

Equipment for a unique pumped storage plant in the desert



A bright future for large-scale hydropower

The future of the global electrical energy production will mainly be provided by renewable energy sources. Energy sources such as wind and solar are intermittent and need balancing to guarantee a safe and secure energy supply. Large new as well as existing hydropower assets are the best solution due to efficiency, flexibility and competitive costs.

Today and in the near future, the dynamic loading on power grids will increase due to the growing share of wind and solar energy, not to mention power trading. Therefore, worldwide investments in large new hydropower plants and the refurbishment of such assets are needed to realize large-scale renewable growth in the future. Any final solution must be adapted to these new requirements. At the same time, ecological restraints are increasing demand for new projects and existing hydropower plants.

ANDRITZ has always been focused on providing equipment optimally adapted to special requirements and customer needs – durable, environmentally-friendly, and efficient solutions for hydraulic power generation. The experienced employees of ANDRITZ work constantly on adapting proven technologies to changing market conditions so that hydro assets fulfill ever more demanding requirements in the future. Topics like hybrid solutions, energy storage, and the extension of operational ranges for low-head sites all represent interesting possibilities for the future.

HYBRID SOLUTIONS – CREATING „BASE LOAD RENWABLES“

At a time, when power generation based on fossil resources has to be replaced by carbon-free, renewable electrical energy production, a compromise between the needs of the present and responsibility to future generations has to be found. One possible approach for a safe and sustainable future energy supply are large-scale hybrid solutions – “base load renewables”. They are defined by a combination of two or more power generation technologies involving of at least one renewable energy source, and a combined power and energy storage system. In addition to these solutions, integrated hybrid solutions for the core products and services of the hydropower industry are increasingly requested. For instance, a battery combined with a turbine unit offers new possibilities for low-head assets.

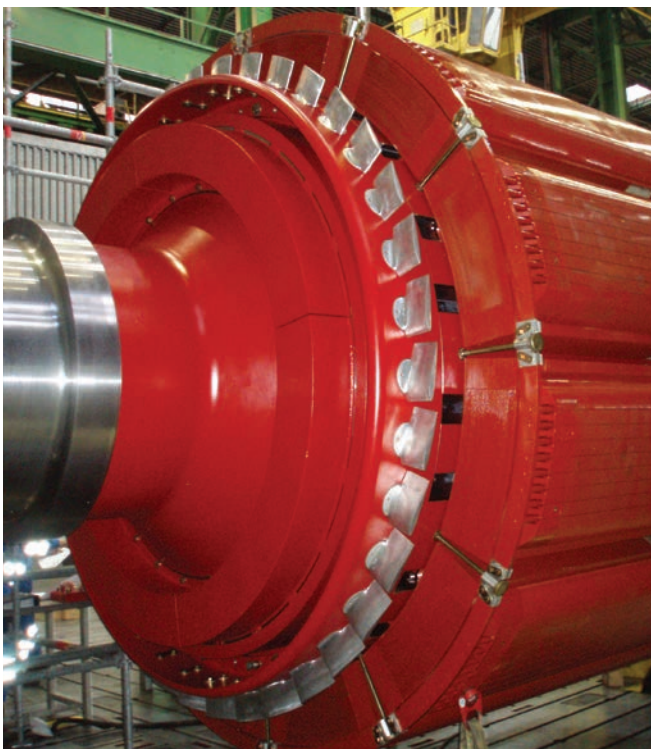


PUMPED STORAGE - THE BATTERY OF THE GRID

The remarkable increase in the use of intermittent renewable energy sources such as wind and solar, coupled with the displacement of conventional generators, has put increasing pressure on power grids and underlined the need for additional energy storage capacity.

With pumped storage technology, hydropower operators can quickly respond to fluctuations in electricity supply and demand. Utilities are offered a cost-effective way to combine variable energy resources into the grid. Pumped storage is the most important and economically viable solution for large-scale energy storage available today. It is an essential component for modern and future clean energy systems.

Pumped hydropower storage will continue to deliver grid services, either through existing or new projects, therefore the market framework and regulatory treatment of this technology will have to evolve accordingly.



SYNCHRONOUS CONDENSERS – ADDITIONAL REACTIVE POWER AND INERTIA

Often new adaptations of existing and well-proven technologies offer attractive solutions for future challenges.

For instance, intermittent grid-connected wind and solar power production provides mainly active power – but zero mechanical inertia.

Together with the increase of modern High-Voltage – Direct Current (HV-DC) interconnections between AC grids, modern grid operators are faced with a new challenge. In the case of a disturbance on the HVDC link, at the connection point the HV-AC system will show a high rate of frequency change. To balance the reactive power a synchronous condenser with a high capacity for supplying synthetic inertia is often installed near the connection point. A synchronous condenser has similar features to a large rotating synchronous generator and can supply needed reactive current and inertia – stabilizing the grid.



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