



HYDRO

# YOUR GLOBAL PARTNER FOR HYDRO SOLUTIONS

"FROM WATER-TO-WIRE"

**ANDRITZ**

ENGINEERED SUCCESS



With global megatrends shaping our present, answers to the questions of the future are needed today. Upon examination of changes in demographics, economics, and energy policy, it quickly becomes clear that we are heading toward a challenging future.





## URBANIZATION

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. However, they consume 75% of global resources. By 2025, there will likely be 40 cities with more than 10 million inhabitants. Megacities such as New York, São Paulo, Cairo, and Beijing will have to make billions of dollars of infrastructure investment within the next 10 years. Urban technologies are racing ahead. An example is the emergence of „smart cities“, where inhabitants can interact intelligently and efficiently with their urban environment. But despite increasing energy efficiency, the energy demands of such megacities will be enormously high.

## CLIMATE CHANGE AND RESOURCE SCARCITY

Population increase, urbanization, and increasing energy demands will ensure that conventional energy sources will reach their limits in the near future. With respect to current consumption data, it appears that in just a few decades it will no longer make economic sense to produce fossil fuels. Regardless of this, existing reserves are still being used extensively causing without appropriate filter systems an additional increase in emissions, and thus resulting in global warming. The climate target determined at the climate summit in Paris at the end of 2015 to limit global warming to less than 2°C will only be accomplishable with extreme efforts. Integrated solutions that optimally combine renewable energies are already in demand today and will be even more so in the future.

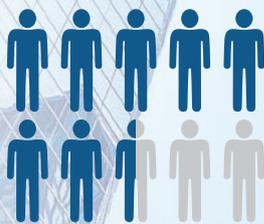
## DEMOGRAPHIC DEVELOPMENTS

Overall, the world's population increases by approximately 150 people every minute. And yet the regional differences in demographic development could not be more drastic. Especially in the industrialized nations, the majority of the population will be over 65 years old in the future. On the other hand, the population of Africa will probably have doubled by 2050, while the population of Europe will shrink. By this time, individual countries in Africa could have more inhabitants than the USA has today.

Demographic, technological, and economic megatrends – such as urbanization and increasing demand for electricity – will bring social and political upheavals in the next few decades. In this context, people are discussing a “Scenario 2050”.

According to current predictions, the global population will have increased to approximately 10 billion people in 2050. At the same time, energy demands will have doubled compared with today. This situation represents a challenge for politics, the economy, and research. It’s a challenge that requires consideration today.

POPULATION



**7.7 billion**  
AS OF TODAY

**10 billion**  
AS OF 2050

# Hydropower - a sustainable and renewable form of power generation



## **MANY BENEFITS – GREAT POTENTIAL**

Approximately 70% of the earth is covered with water, which means that there are 14.3 billion cubic meters of a renewable, clean energy source. Electricity from hydropower is cost-effective and not subject to price volatility –unlike fossil fuels. It offers socio-economic benefits since the construction of hydropower plants also creates local jobs, supports the regional economy, water supply and flood protection are guaranteed, and it can also be used for irrigation and shipping navigation.

In a time when harnessing fossil resources is becoming less economical and energy demands continue to climb, we must find a compromise between the needs of the present and the responsibility to future generations.

## **TECHNOLOGY WITH VISION**

Hydropower is the most proven and best-developed form of renewable electricity generation. An increasing awareness of global climate change and sustainable electricity generation, social responsibility on the part of politics, as well as an increasingly critical attitude toward CO<sub>2</sub> emissions from fossil fuels, will cause demand for hydropower to increase in the coming years.

## **PROVEN IN MANY APPLICATIONS**

Currently, approximately 16% of the world's electrical energy comes from hydropower. In the future, the assumption is that the enormous, increasing demand for electricity will be fulfilled by those energy concepts that best combine the various resources available. Hydropower is trendsetting here, for it does not end with power generation. Instead, it offers a wide spectrum of applications, including energy storage for grid stability and peak load coverage.

**BHUMIBOL**

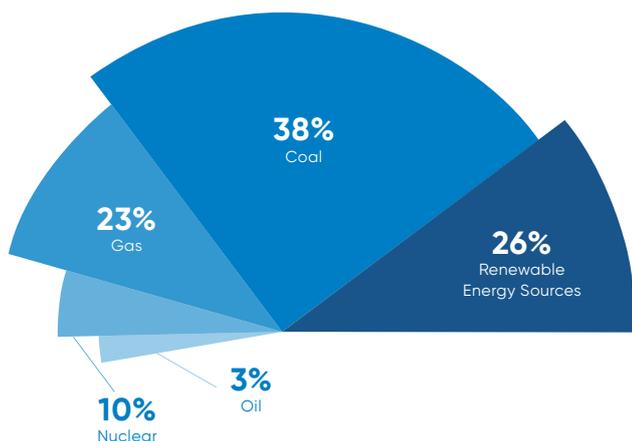
Thailand

# Possibilities and opportunities of the global hydropower market

## ONLY UP TO 27% OF POTENTIAL EXPLOITED

Approximately 26% of the world's demand for electricity is currently satisfied through renewable resources. At 62%, hydropower represents the largest share by far, followed by wind energy with approximately 19%. The shares of biomass, solar energy, and geothermal energy are in the single-digit range.

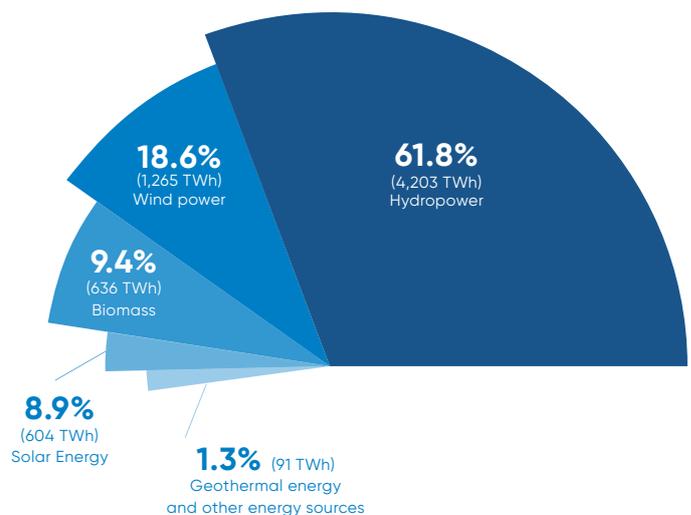
Although the technically feasible potential of hydropower is an unbelievable 16,000 TWh per year, today not even 27% of this potential has been exploited. Annual generation from hydropower is currently 4,300 TWh.



## STRONG GROWTH AROUND THE WORLD

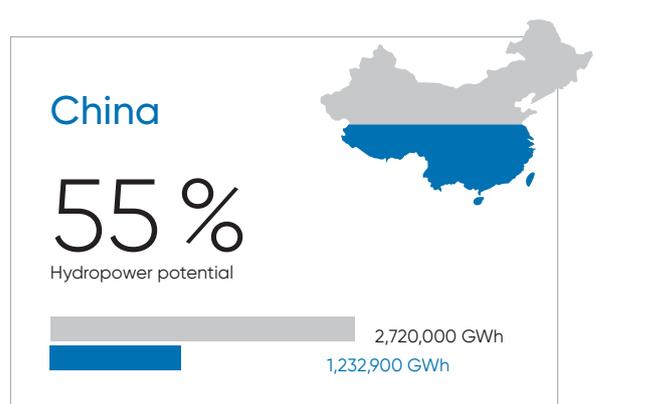
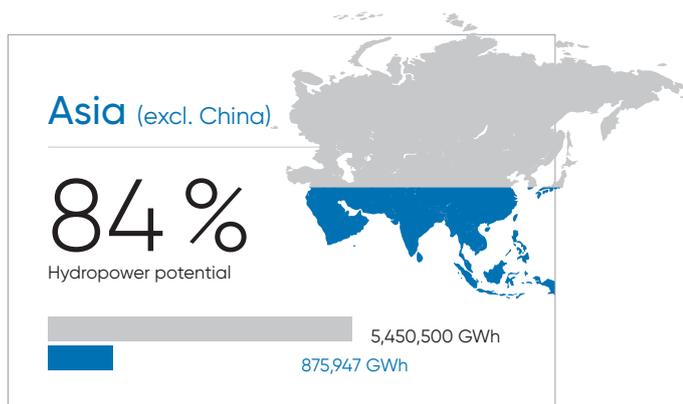
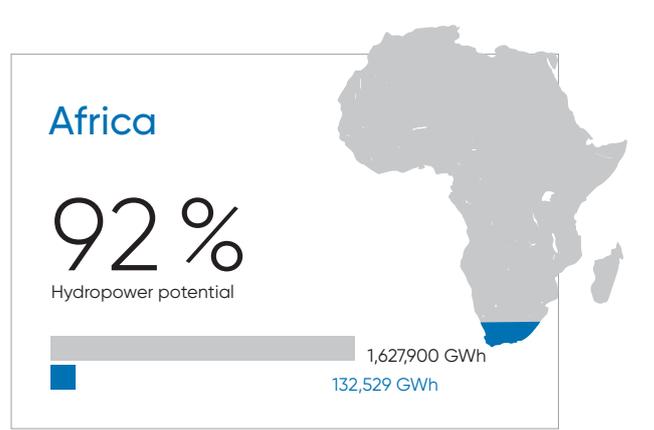
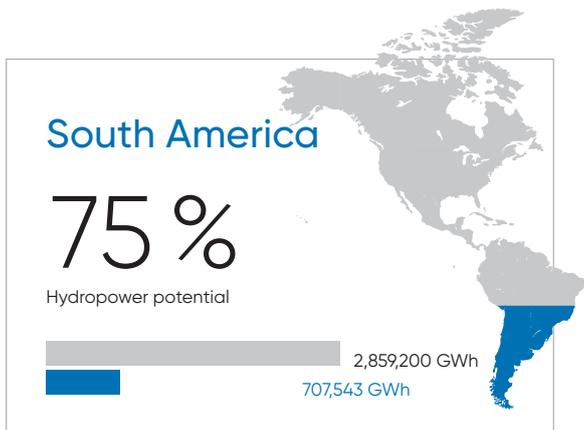
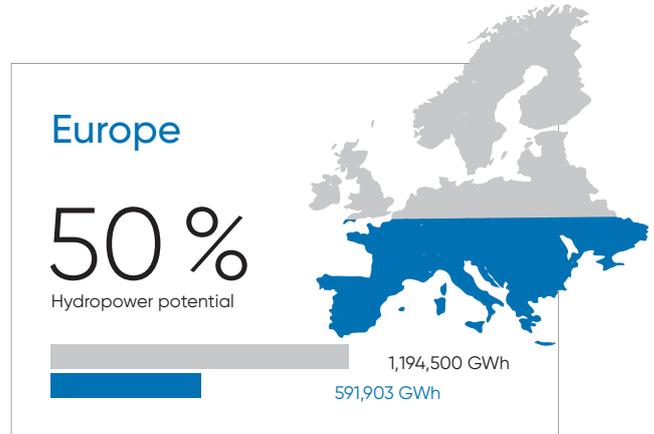
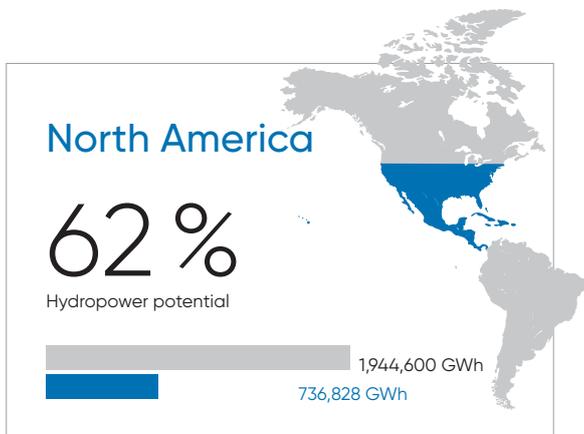
People around the world are working to exploit this potential by building new hydropower plants, as well as modernizing and improving existing ones. In particular in regions where energy demands will increase dramatically in the next few years – such as in Asia, South America, and Africa – in addition to new large plants, a multitude of small hydropower projects will be implemented.

Current predictions indicate that installed hydropower capacity will grow by 1.5 - 2% per year. There is also a big potential in Europe and North America, since half of the facilities here are older than 30 years and can make a more significant contribution toward power supply in the future through modernization.



1) Percentage distribution of worldwide power generation (Source: IEA World Energy Outlook 2019)

2) Percentage distribution of power generation from renewables (Source: IEA World Energy Outlook 2019)



## HYDROPOWER POTENTIAL PER REGION

- Power generation from hydropower
- Technically feasible hydropower potential

3) Global hydropower generation  
(Source: Hydropower & Dams World Atlas 2019)



# Power generation from hydropower in the future – a scenario 2050





## APPLICATION EXAMPLES

- ① Annual storage reservoir
- ② Short-term storage reservoir
- ③ Conventional river power plant
- ④ Small hydropower plant
- ⑤ Mini hydropower plant
- ⑥ Urban river power plant
- ⑦ Hydropower plant with low head
- ⑧ Tidal power plant
- ⑨ Pumped storage power plant (fresh water); energy storage for solar power plant
- ⑩ Pumped storage power plant (salt water); energy storage for wind park
- ⑪ Energy island; off-shore pumped storage power plant for wind/solar/tidal range
- ⑫ Tidal stream power array
- ⑬ Irrigation plant
- ⑭ Desalination plant
- ⑮ Flood control pump station



# From the historic pioneers of technology to a modern global market leader

International technology group ANDRITZ offers a broad portfolio of innovative plants, equipment, systems and services for the pulp and paper industry, the hydropower sector, the metals processing and forming industry, pumps, solid/liquid separation in the municipal and industrial sectors, as well as animal feed and biomass pelleting. The global product and service portfolio is rounded off with plants for power generation, recycling, the production of nonwovens and panelboard, as well as automation and digital solutions offered under the brand name of Metris. The publicly listed group today has around 27,800 employees and more than 280 locations in over 40 countries.

ANDRITZ Hydro is one of the globally leading suppliers of electro-mechanical equipment and services for hydropower plants. With over 175 years of experience and an installed fleet of more than 430 GW output, the business area provides complete solutions for hydropower plants of all sizes as well as services for plant diagnosis, refurbishment, modernization and upgrade of existing hydropower assets. Pumps for irrigation, water supply and flood control as well as turbo generators are also part of this business area's portfolio.

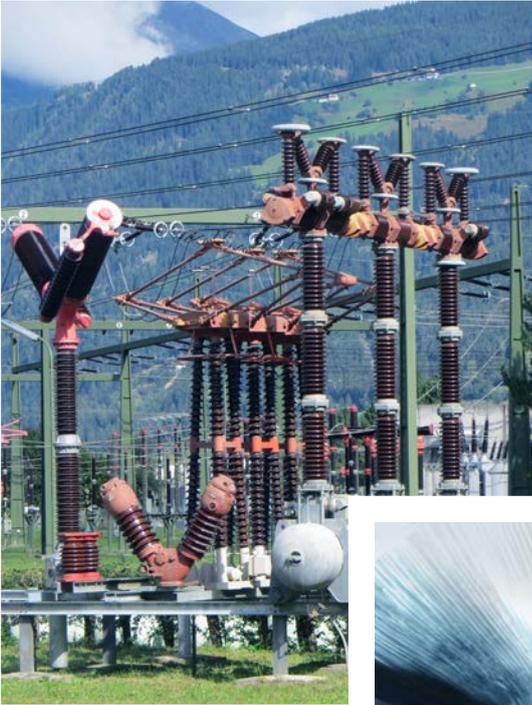
The cornerstone was laid by the turbine and generator pioneers in Europe and North America in the 19<sup>th</sup> century. Over time, growth, mergers, and co-operation agreements have created a state-of-the-art technology company with more than 7,200 employees.



As a leading global supplier with its roots  
in Europe, ANDRITZ has been meeting  
the needs of the market and those of our  
demanding customers for more  
than a century.

**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



# ANDRITZ` comprehensive hydro expertise - „from water-to-wire“

The hydro service and product portfolio supports the entire life-cycle of a hydropower plant, from design and engineering to manufacturing, installation, on through to commissioning and training. Whether the project at hand concerns hydraulic and electro-mechanical equipment for new hydropower plants or the modernization and automation of existing facilities, ANDRITZ provides custom-tailored solutions “from water-to-wire” – everything from a single source.

The committed employees in research and development are working constantly to improve and enhance technologies and products. They make an essential contribution to the market leadership of ANDRITZ. Production locations and test benches around the world guarantee the high quality of ANDRITZ' products and services.

## **LARGE HYDROPOWER**

As a comprehensive supplier, ANDRITZ provides turnkey hydro- and electro-mechanical equipment for large new installations and implements expansion projects; as well as modifies existing plants, hence they meet changing customer and market requirements.

## **SMALL HYDROPOWER**

ANDRITZ is the world's leading provider on the small hydropower plant market and provides a full spectrum of electro-mechanical equipment based on pre-defined modular components.

## **MODERNIZATION AND RENOVATION**

For maximum customer benefit, ANDRITZ develops solution-oriented service and rehabilitation concepts, ones that offer a short return on investment. Innovative modernization measures and state-of-the-art technologies increase profitability and extend system life span, taking into account basic economic, ecological, and legal conditions.

## **HYDRAULIC STEEL STRUCTURES**

In the market for hydraulic steel structures, ANDRITZ 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.

## **ELECTRICAL POWER SYSTEMS**

ANDRITZ' employees' many years' experience in the electrical power systems sector provides an optimal basis for implementing project-specific customer requirements for fully-functional hydropower plants.

## **AUTOMATION**

For the design of new installations and modernization projects, automation solutions based on optimized hardware architecture and step-by-step function integration are a significant factor. ANDRITZ' concepts enable fully automated operation, low investment costs, simple commissioning, and rapid system replacement.

## **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

## **TURBO GENERATORS**

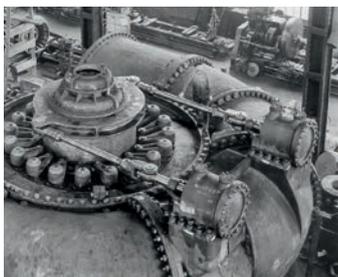
The heart of a gas-fired combined- and open-cycle power plant is a high-performance turbo generator. ANDRITZ is one of the leading suppliers of air-cooled turbo generators, which correspond to the highest technical specifications and requirements.



# The Hydro World of ANDRITZ

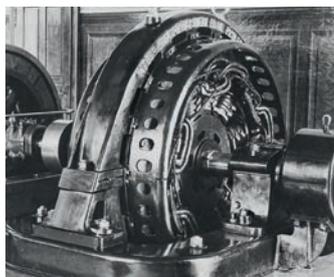
If the concern is heads of up to 2,000 meters, penstocks with a diameter of more than 13 meters, turbines up to more than 800 MW, generators with 850 MVA, or multi-year construction projects, then investors, project developers, and clients rely on a partner that distinguishes itself.

A partner, that characterizes itself not just through its technical expertise, but also its social competence, financial strength, and solid, long-term project management experience.



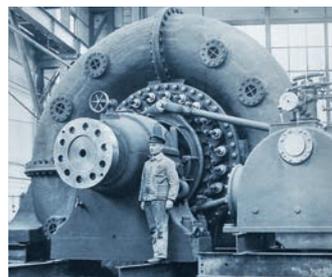
**Niagara Falls, USA**  
1903

Francis turbine for the world's first commercial hydropower plant



**Stubenbergklamm, Austria**  
1905

Generator for one of the first hydropower plants in Styria



**Niederwartha, Germany**  
1929

Electro-mechanical equipment for the world's first commercial pumped storage power plant



**Ruacana, Namibia**  
1974

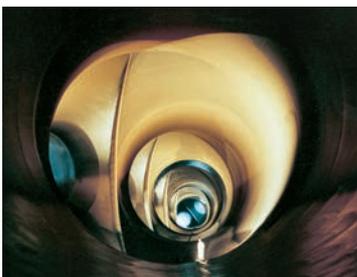
Turbines for Namibia's largest hydropower plant





**Hatta,  
Dubai (2019)**

A lighthouse project in the desert of the Arabian Peninsula. Using an existing reservoir in the mountains, the two 125 MW Francis pumped turbines will support the Emirates in achieving the target of increasing the clean energy share of the generation mix of 75% by 2050.



**Tarbela Dam, Pakistan**  
1993

World's largest bifurcator (diameter 13.2 m; height 16 m); Guinness Book of World Records



**Goldisthal, Germany**  
1997

First asynchronous, variable-speed pumped storage units outside of Japan



**Three Gorges (Sanxia), China**  
1997

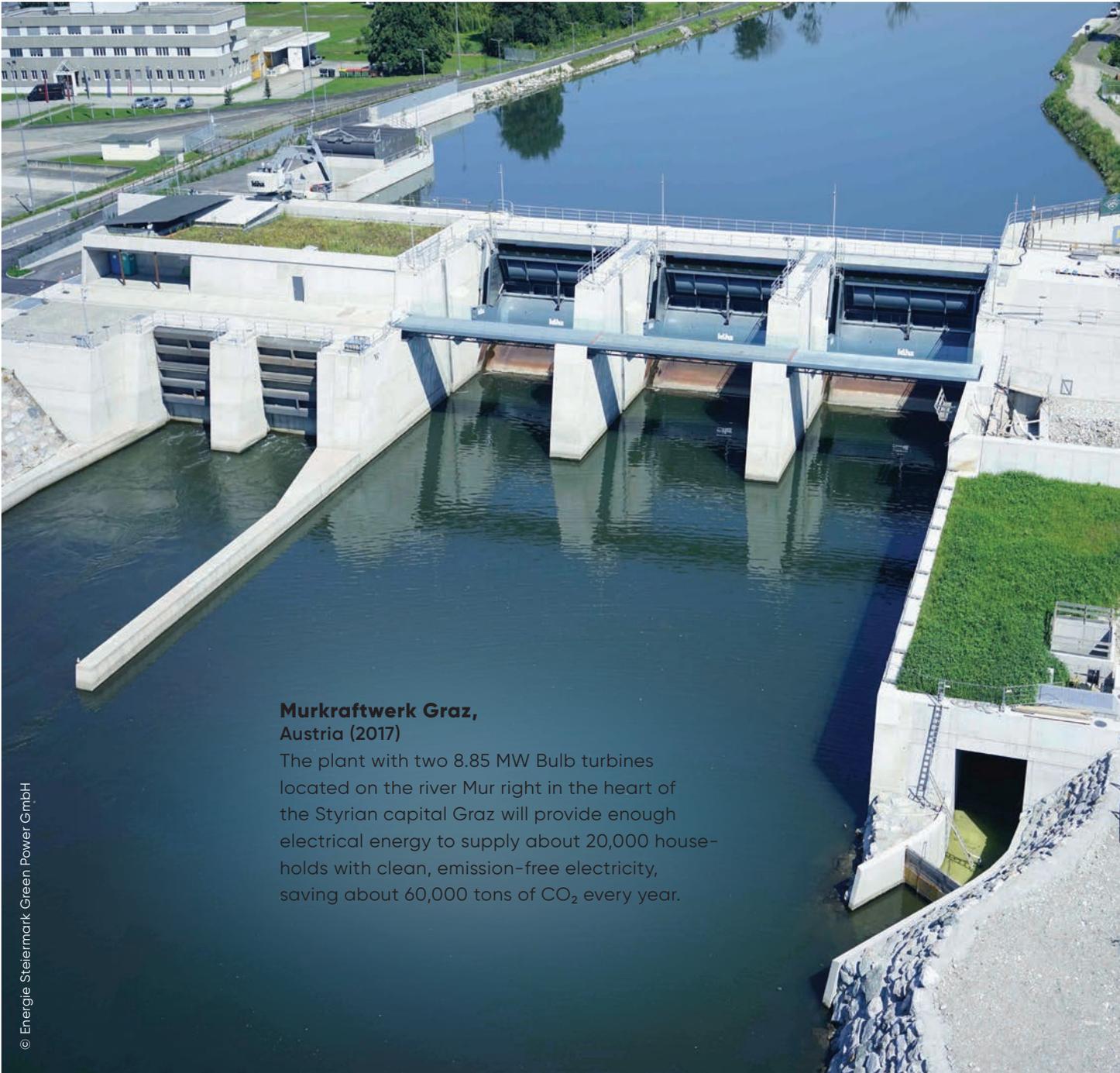
Turbines and generators for the world's largest hydropower plant



**Tsankov Kamak, Bulgaria**  
2004

Electro-mechanical equipment for Austria's first joint implementation project acc. to the Kyoto Protocol





**Murkraftwerk Graz,  
Austria (2017)**

The plant with two 8.85 MW Bulb turbines located on the river Mur right in the heart of the Styrian capital Graz will provide enough electrical energy to supply about 20,000 households with clean, emission-free electricity, saving about 60,000 tons of CO<sub>2</sub> every year.

© Energie Steiermark Green Power GmbH



**Simón Bolívar, (Guri II), Venezuela**  
2006  
World's largest Francis turbines (5x770 MW) for the largest hydropower plant in Venezuela



**Sihwa, Korea**  
2006  
10 Bulb turbines (26 MW each) for the world's largest tidal power plant



**Peking, China**  
2006  
Large pumps for water supply with a total flow rate of 60 m<sup>3</sup>/s across a distance of 60 km

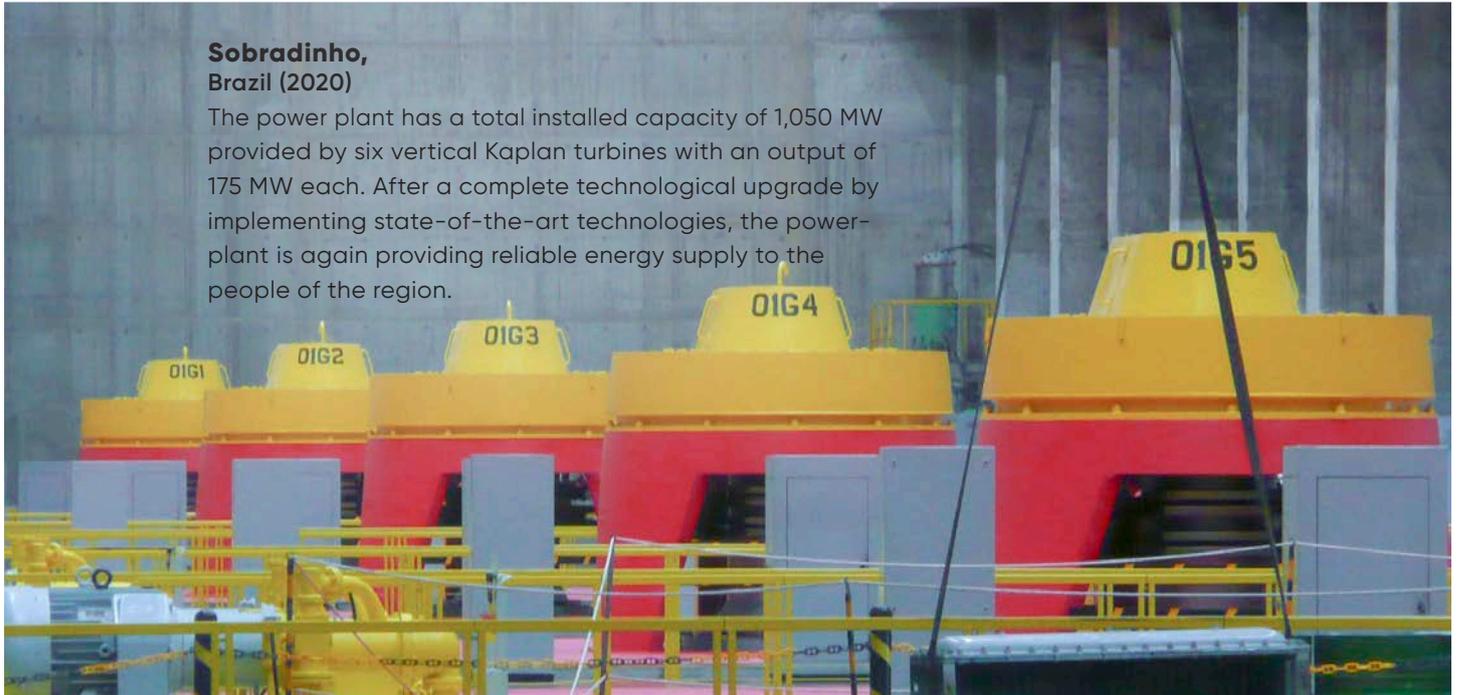


**Ilisu, Turkey**  
2008  
Electro-mechanical equipment for the largest hydropower plant in south-eastern Anatolia



**Hoa Binh,  
Vietnam (2015)**

With a total installed capacity of 1,920 MW, the power plant is the second largest hydropower project in Vietnam and key to the country's power system, playing a crucial role in the socio-economic development of the country.



**Sobradinho,  
Brazil (2020)**

The power plant has a total installed capacity of 1,050 MW provided by six vertical Kaplan turbines with an output of 175 MW each. After a complete technological upgrade by implementing state-of-the-art technologies, the power-plant is again providing reliable energy supply to the people of the region.



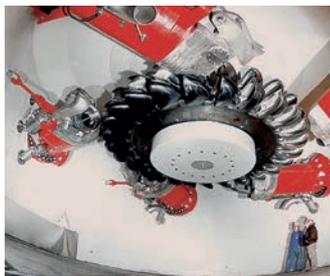
**Ashta, Albania  
2008**

90 modules for the world's largest HYDROMATRIX\* power plant (Ashta I with 24 MW, Ashta II with 45 MW)



**Santo Antônio, Brazil  
2008**

Bulb turbines (D 7,500 mm) for the world's largest low head hydropower plant



**Cleuson-Dixence, Switzerland  
2009**

Two world records for the most powerful Pelton turbines (3x 423 MW) and highest head (1,883 m)



**El Hierro (Gonora del Viento), Spain  
2010**

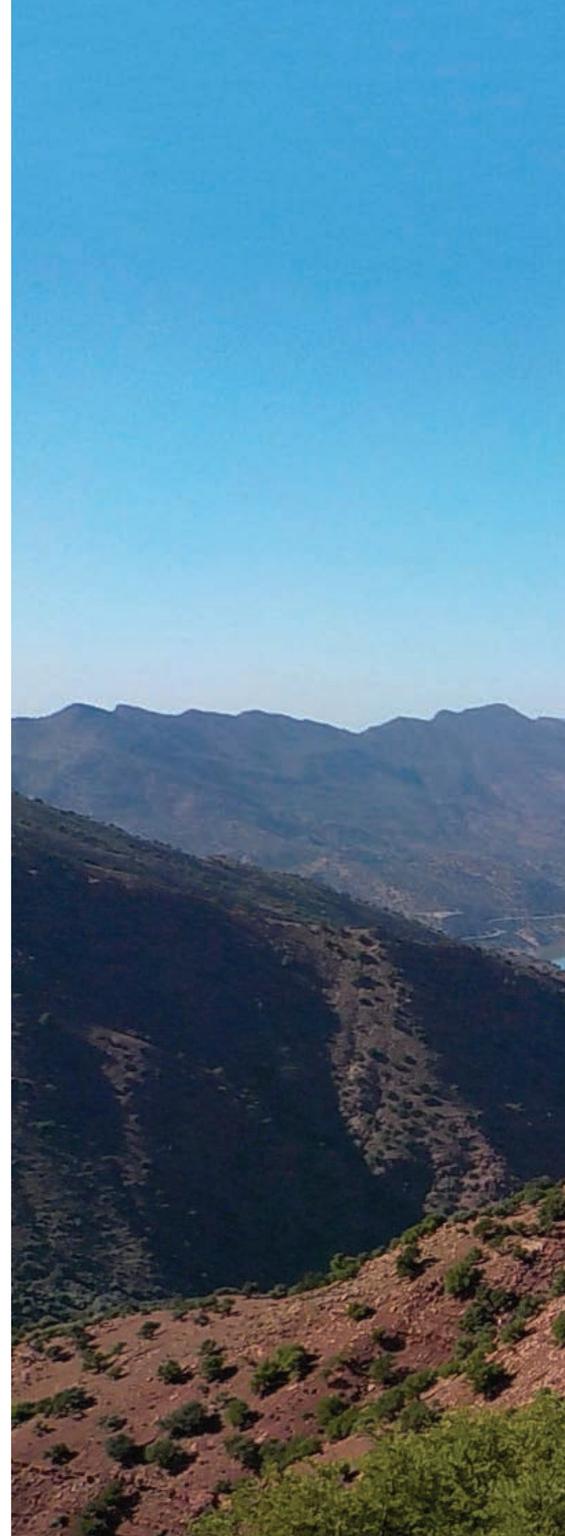
Turbine runners for a small pumped storage power plant combined with a 10 MW wind park





**NUREK,  
Tadjikistan (2018)**

With 3,420 MW and the second highest earth-filled dam in the world, the largest hydropower plant in Central Asia covers 70% of the national electricity demand. Rehabilitation and modernization of the entire electro-mechanical equipment will boost its power generation by about 700 MW.



**Belo Monte Complex, Brazil  
2011**

Equipment for the second largest hydropower plant in Brazil and the largest spillway in the world



**Ybbs-Persenbeug, Austria  
2012**

Modernization of the oldest hydropower plant on the Danube in Austria



**Turbogenerator, USA  
2013**

Transport of a 90-ton turbo generator with one of the world's largest airplanes – an Antonov 124



**Xayaburi, Lao PDR  
2013**

Electro-mechanical equipment for the largest hydropower plant on the Mekong River in Lao PDR



**Abdelmoumen,  
Morocco (2017)**

The 350 MW pumped storage plant will cover peak-load energy demands and provide rapid response power to regulate the Moroccan grid. The new plant plays a vital role in harnessing sustainable and renewable energy resources to achieve the state's ambitious goals for the future.



**MeyGen UK  
2014**

Three 1.5 MW tidal stream units for the largest commercial tidal energy project worldwide



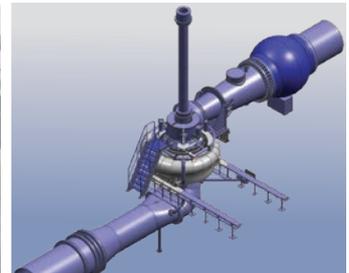
**Láuca, Angola  
2014**

Electro-mechanical equipment for two power houses, six 340 MW Francis units, and a eco-flow unit.



**Langenprozelten, Germany  
2015**

The world's most powerful hydropower single-phase motor-generators (2x 94 MVA)



**Shanxi Xiaolangdi Yellow River  
2019**

Four two-stage vertical volute pumps for one of the largest water transfer projects of the world



# The future of hydropower begins now

The electricity market is subject to constant change. The dynamic load of power grids is increasing due to the growing share of wind and solar energy, not to mention power trading. This requires new technical specifications. Existing hydropower plants must be adapted to these new requirements. At the same time, ecological restraints are increasing for new projects and existing hydropower plants.

ANDRITZ has always been focused on providing equipment that is optimally adapted to the special requirements and customers' 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 facilities will fulfill more demanding requirements in the future. Today, consideration of ecological issues is increasing. ANDRITZ invests extensively in the research and development of solutions for these requirements, such as in

the advancement of fish-friendly turbine technology or oil-free applications for Bulb turbine runners.

The possibilities for generating electrical energy from the ocean are many and varied, whether through waves, streams or tidal lift. ANDRITZ is aware of the role that ocean energy can play in the future and contributes to the development of trendsetting concepts. In addition, topics like energy storage, grid services, and solutions for low head sites also present interesting possibilities for the future.



## ENERGY STORAGE

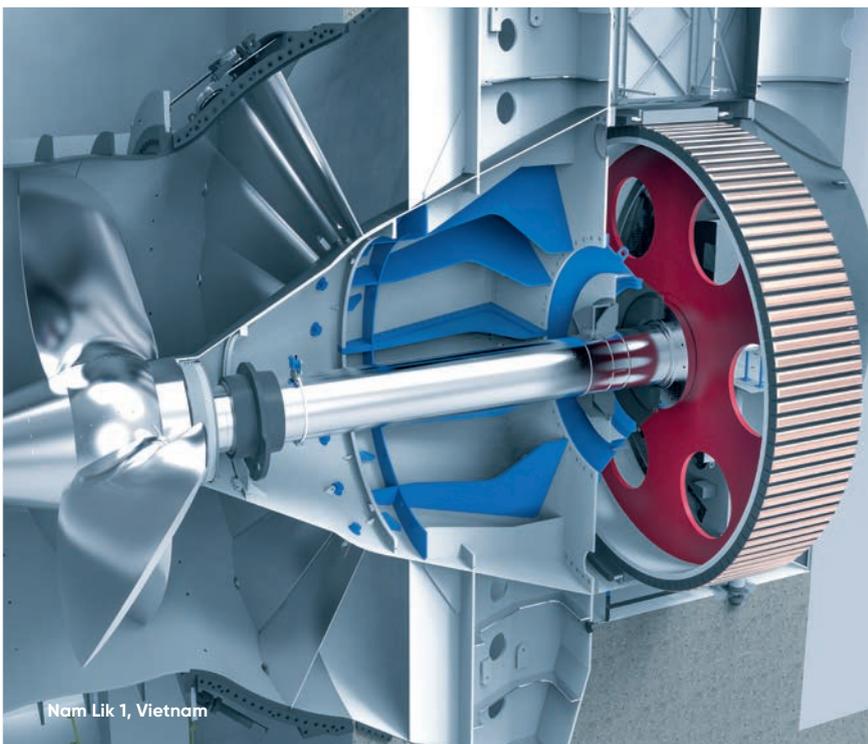
Pumped storage power plants are currently the most economical way of efficiently storing large amounts of energy. They also play a significant role as a stabilizer for power grids. For example, in case of sudden shortages such as those due to power failures, large amounts of power can be quickly provided. The first pumped storage power plants were built at the beginning of the 20<sup>th</sup> century. ANDRITZ was and is one of the pioneers of this technology, supplying groundbreaking technology solutions ever since.



## GRID SERVICES

Volatile energy production and economic growth are creating new challenges for the grid, e.g. fast response times, frequent load changes, frequency regulation and extended operational changes. A 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. HyBaTec – ANDRITZ’ hybrid solution dedicated to the hydropower industry, where a battery is combined with a turbine unit, offers new possibilities for low-head assets.

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. Balancing the reactive power, a synchronous condenser by ANDRITZ with a high capacity for supplying synthetic inertia can supply needed reactive current and inertia – stabilizing the grid.



## ENERGY FROM LOW HEADS

New market requirements for hydropower development in middle and lower river sections have necessitated the revision of some basic design principles of hydropower technology. At the same time, more emphasis is being placed on ecologically and economically sustainable solutions. ANDRITZ’ low head and Bulb turbines are especially well-suited for fulfilling these requirements. They can be applied very flexibly, whether large or small, run-of-river or tidal power plant or HYDROMATRIX\*, fixed or variable-speed – with a Bulb turbine, everything is possible for heads from 0.5 up to 30 meters.



# ANDRITZ HYDRO Worldwide

More than  
**175 years'**  
experience in  
turbine design

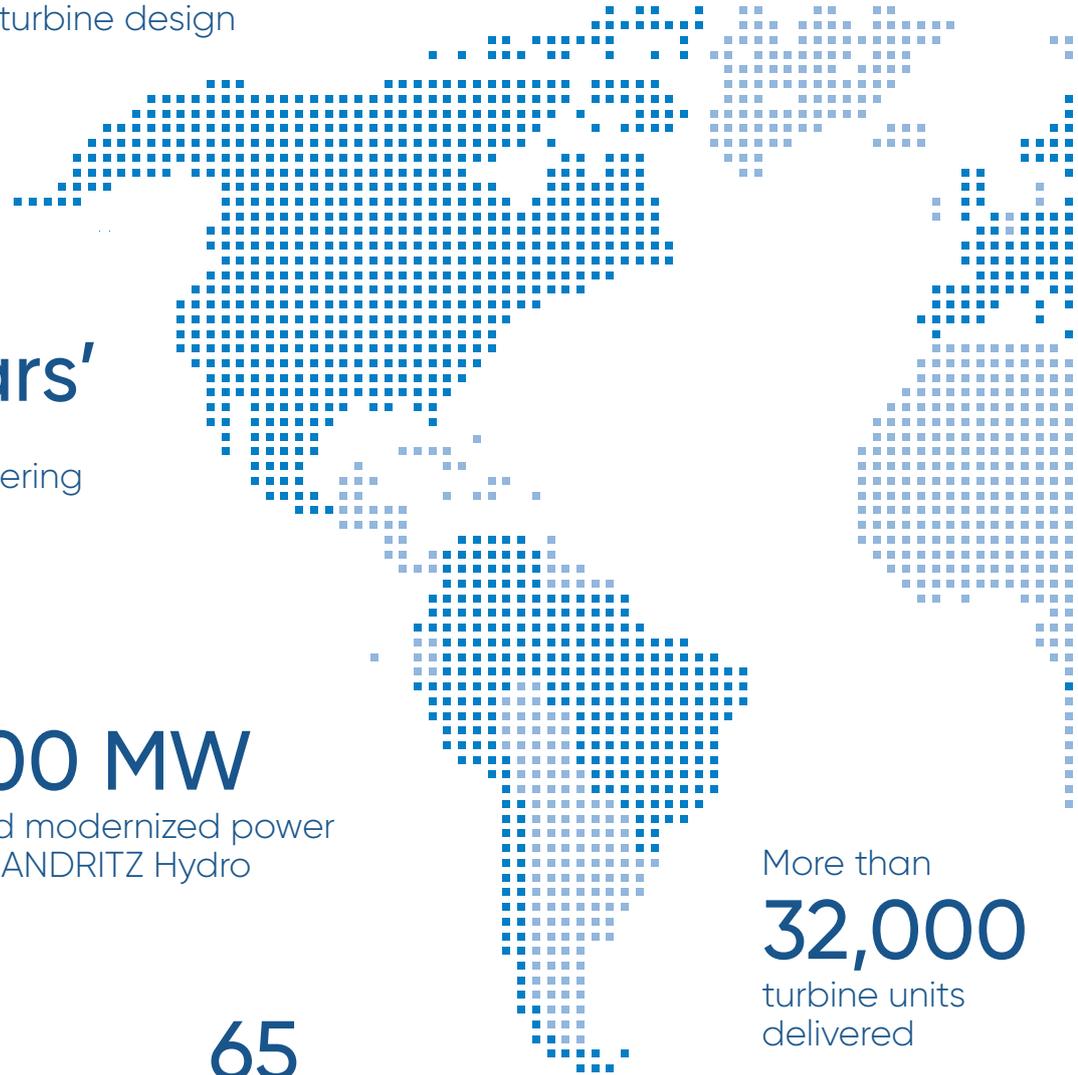
**12**  
test benches  
worldwide

More than  
**120 years'**  
experience in  
electrical engineering

More than  
**430,000 MW**  
of installed and modernized power  
capacity from ANDRITZ Hydro

**65**  
locations  
around the world

More than  
**32,000**  
turbine units  
delivered



- Countries with ANDRITZ Hydro locations
- Countries with ANDRITZ Hydro presence



More than

**100** Compact Hydro  
units per year

**4,278 TWh/year**

worldwide annual  
hydropower generation

More than

**7,200**

employees  
worldwide

**20**

manufacturing  
locations

Complete design  
range up to

**800 MW**

**15,800 TWh/year**

global hydropower potential

**FIND YOUR LOCAL CONTACT**





For ANDRITZ Hydro, the discussion of the „Scenario 2050“ is a motivating vision of the future – to find tomorrow’s solutions today. The immense potential of hydropower has by no means been fully exploited. It can make a significant contribution to the redesign of energy supply on the road to sustainability.





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