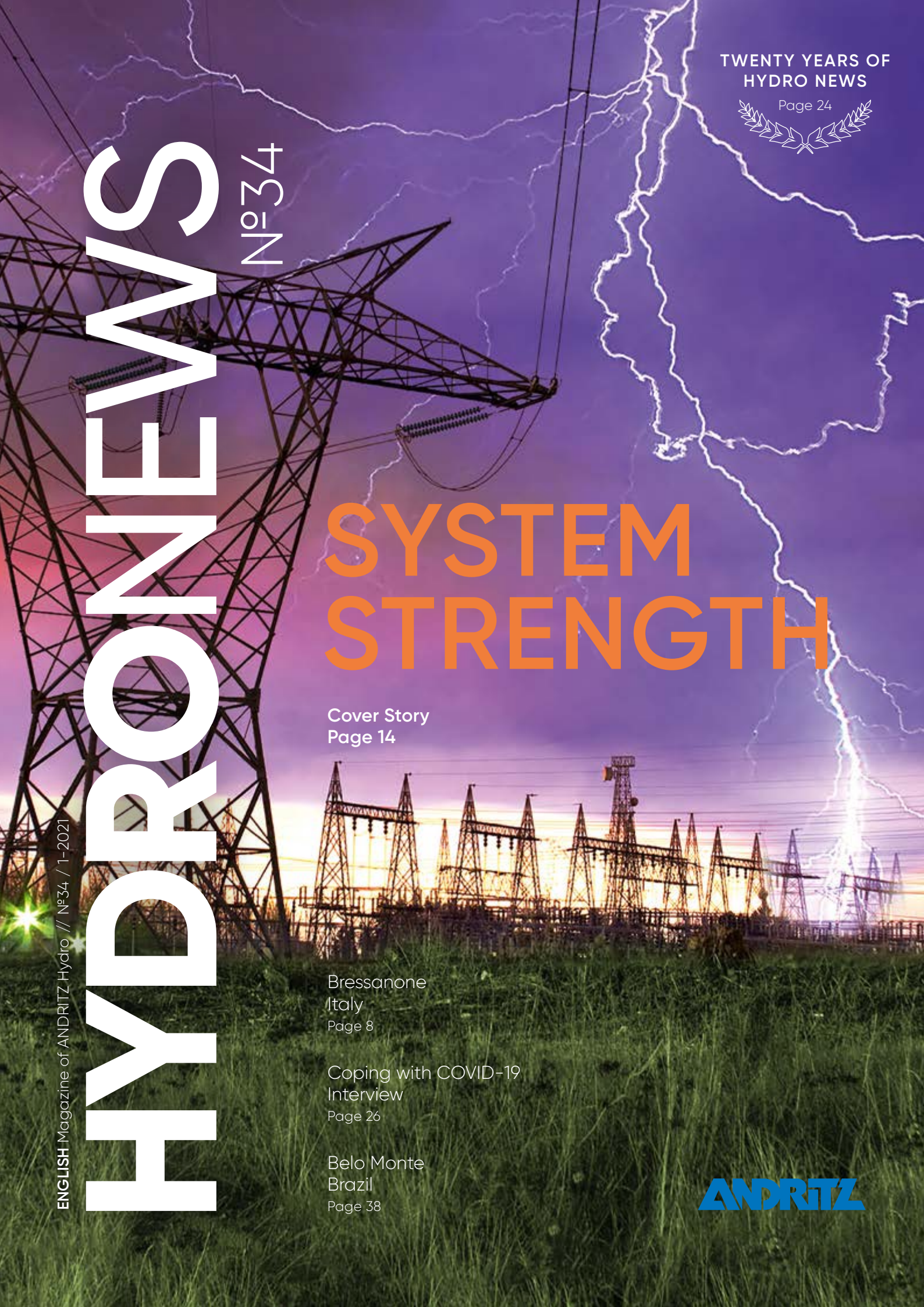


# HYDRO NEWS

№34

**ENGLISH** Magazine of ANDRITZ Hydro // №34 / 1-2021

**TWENTY YEARS OF HYDRO NEWS**

Page 24

# SYSTEM STRENGTH

**Cover Story**
**Page 14**



ANDRITZ

# LATEST NEWS

## Carillon, Canada

Oct. 2020

ANDRITZ was selected by Hydro-Quebec for the re-equipment of potentially all fourteen 54-MW turbine generator units at the Carillon generating station located on the Ottawa River in Canada. The order for supply and installation of the first set of six turbine-generator units was awarded on September 30, 2020. The contract encompasses complete re-equipping of six units with new generators, speed governors and turbines. ANDRITZ is responsible for design, manufacture, transportation, assembly, testing and commissioning of all equipment. Completion of this project with top-tier ANDRITZ equipment will have a significant impact on keeping Quebec's energy supply stable and secure for decades to come.

## Sambangalou, Senegal

Dec. 2020

ANDRITZ has received an order as part of a consortium with VINCI Construction for the supply of electro-mechanical equipment for the new Sambangalou hydropower dam in the Senegalese region of Kédougou, bordering Guinea. The ANDRITZ scope of supply comprises the complete "from water-to-wire" solution, including three Francis turbines with a total output of 128 MW, generators, and all other equipment required. The hydropower plant will enable the production of renewable energy for the benefit of the surrounding rural localities, the development of irrigation of agricultural land, as well as the supply of drinking water for the neighboring districts. This new contract – a further collaboration between ANDRITZ and VINCI – demonstrates ANDRITZ' strong market position for supply of hydropower equipment for sustainable hydroelectric infrastructure projects.

## Pinnapuram, India

Sep. 2020

ANDRITZ has received a contract from Greenko Energy Private Limited, an independent Indian power producer, for the supply of electro-mechanical equipment for the 1,200-MW Pinnapuram pumped storage plant in the Indian state of Andhra Pradesh. Pinnapuram will be the largest pumped storage power plant in India and will be part of the first integrated renewable energy storage project combining electrical energy production based on photovoltaic solar, wind, and pumped storage. The contract includes design, manufacture, supply, transportation, erection, testing, and commissioning of four 240-MW units, two 120-MW reversible pump units, main inlet valves, and associated auxiliaries. This order not only confirms ANDRITZ' strong position in the Indian hydro market, but also demonstrates the value of pumped storage technology, which plays an important role in providing grid stability to cope with volatile solar and wind power supplies.

## Barkley, USA

Nov. 2020

ANDRITZ has received a contract from the U.S. Army Corps of Engineers' Nashville District for the rehabilitation of the turbines and generators at Barkley hydroelectric power plant (186 MW), located on the Cumberland River in Western Kentucky near the town of Grand Rivers. Once fully commissioned, the power generation is estimated to be approximately 150 GWh per year. The scope of supply includes the design, manufacture, supply, transportation, erection, testing and commissioning of four Kaplan turbine generator units with a capacity of 46.5 MW each, along with associated auxiliaries and ancillary equipment. The contract will be executed by ANDRITZ' USA subsidiary in Charlotte, North Carolina, and will further consolidate ANDRITZ' position as a leading player in the United States' hydropower market.

# Challenges are also opportunities

**Dear Business Friends,**

Wolfgang Semper

Harald Heber

Gerhard Kriegler

For nearly two decades our Hydro News customer magazine has brought you the latest updates on projects, key trends and interesting market topics. We are very proud to be celebrating the 20th anniversary of Hydro News in 2021 and we hope you will continue to enjoy many more decades of enriching and informative business news.

The global COVID-19 pandemic has had a strong impact on every individual and therefore also on all our business activities around the world. Despite these challenging times, ANDRITZ is proud to have maintained a strong connection with our esteemed customers and partners and with all our projects. Through our local teams in the countries, a new meeting culture of online video conferences, new digital tools for supporting commissioning remotely or with specialist remote on-site assessment, we are keeping projects running. Together with customers, local authorities and our travel specialists, we were able to organize special travel permits to bring our staff back on-site after local lockdowns and to finish projects and commissioning activities as promised and agreed.

Several large projects are actively under construction or have been awarded to ANDRITZ in 2020, such as the exciting developments of Carillon in Canada, Sobradinho in Brazil, Pinnapuram and Kiru in India, Bressanone in Italy and Barkley in the USA, Belo Monte in Brazil, Nedre Otta in Norway, Gulpur in Pakistan, and Kpong in Ghana are some highlights of projects that have been successfully completed.

A power sector dominated by renewable resources is fundamental for the global energy transition. However, this change is challenging transmission system operators to ensure a stable, reliable and secure network. Synchronous Condensers from ANDRITZ provide these stabilization capabilities and much more, as presented in this issue's cover story.

For more than 180 years, ANDRITZ has been developing cutting-edge solutions for hydroelectric power generation. One of the pillars of our long-term success is a strong focus on research and development, where laboratories and test rigs sit at the heart of our R&D program. Supplementing our existing portfolio of R&D facilities by the end of 2021, ANDRITZ will inaugurate an exceptionally high-head test rig. With a head height of 260 meters, this outstanding piece of equipment will set a new benchmark for the global hydropower market.

Challenges are also opportunities, so despite the difficult times and the challenging market situation, ANDRITZ is confidently looking forward to the future. We place trust in our technical abilities, the depth of our experience, and our dedicated staff. We hope that the global hydropower industry will continue to place their trust in us, too.

**With kind regards and sincere thanks for your reliance,**

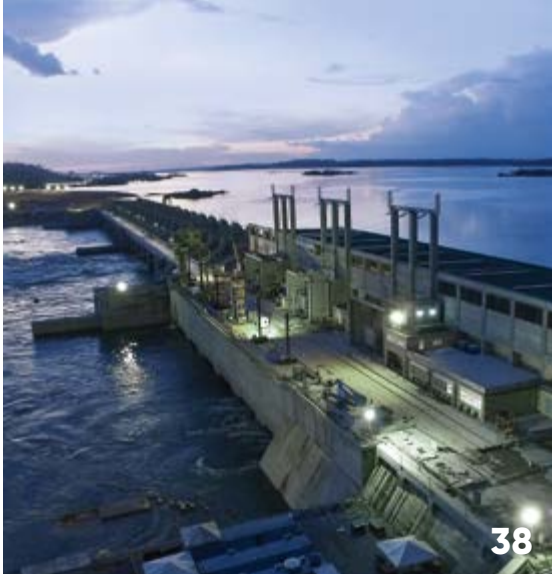
**Wolfgang Semper** **Harald Heber** **Gerhard Kriegler**

**Since January 1, 2020,** Gerhard Kriegler is a member of the board of ANDRITZ HYDRO GmbH, and is managing director of our German subsidiary in Ravensburg. Active for 20 years in the hydropower industry, Gerhard Kriegler is an accomplished management personality with international experience.

His personal motto "Walk the talk and act if problems occur" stands for focus and determination.











## SYSTEM STRENGTH



The renaissance of rotating machines – Synchronous condensers are the optimum solution to maintain the stability of the grid.

## COPING WITH COVID-19



All the measures we are taking to ensure the safety of our customers and employees at international construction sites.

## CELEBRATING 20 YEARS OF HYDRO NEWS!



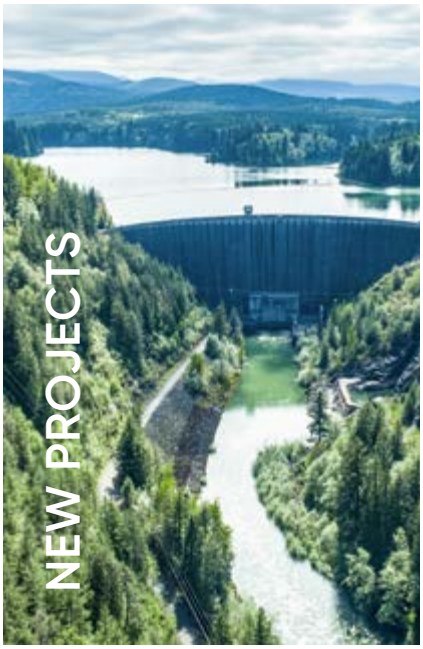
We are very proud to be celebrating the 20th anniversary of Hydro News in 2021

## TECHNOLOGY

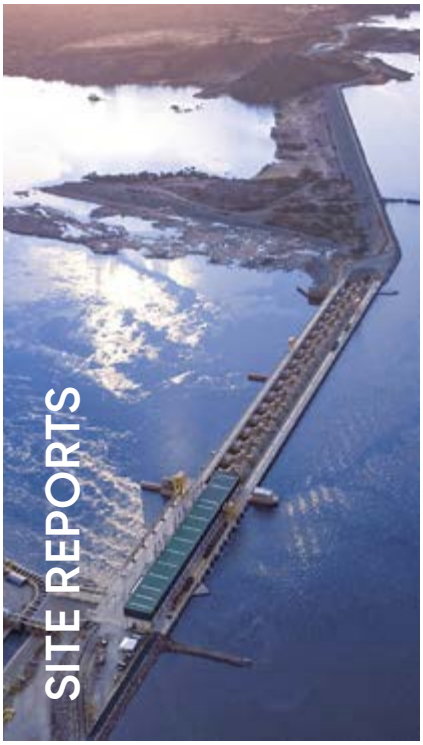


Testing for the best – As one of the world's major turbine manufacturers, ANDRITZ considers it vital to maintain a leadership role in research and development.

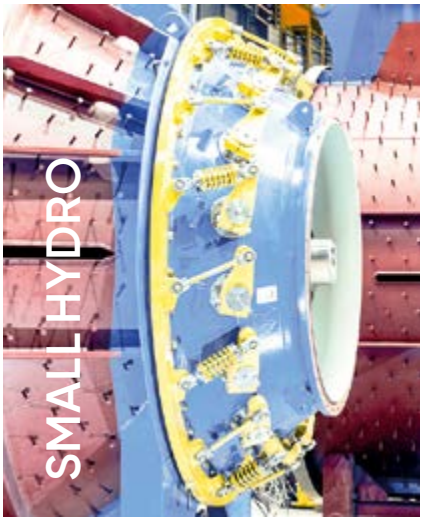
# OUR PROJECTS IN THIS ISSUE







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# BOOSTIN
# COTTAGE I

ANDRITZ Hydro received a contract for the supply and installation of the entire electro-mechanical equipment for Kiru hydropower plant.

**India –** The Kiru hydroelectric power project is a run-of-river scheme on the river Chenab near the village Patharnakki in the Kishtwar District of Jammu & Kashmir UT, about 42 km from the city of Kishtwar.

The hydropower project will include the construction of a concrete gravity dam with a height of 135 m and an underground powerhouse located on the left bank of the river that will comprise four vertical Francis turbines with a capacity of 156 MW each. The project will provide much needed power for the grid in northern India. The design of the project is in compliance with the requirements of the Indus Water Treaty 1960.

After a long period of evaluation, the environmental clearance was issued by the Ministry of Environment Forests and Climate Change (MoEF&CC) in 2016. The foundation stone for the Kiru hydropower plant was laid by Hon'ble Prime Minister Shri Narendra Modi in 2019. Shortly afterwards, Cabinet Committee on Economic Affairs also approved the investment sanction for construction of the 624-MW Kiru project by Chenab Valley Power Projects Private Limited (CVPPPL), a joint venture company amongst NHPC, Jammu & Kashmir State Power Development Corporation (JKSPDC) and PTC.

ANDRITZ Hydro received an order from Indian utility company Chenab Valley

The run-of-river scheme on the river Chenab will provide much needed power for the grid in northern India.

**TECHNICAL DETAILS**

**Kiru:**

Total output: 624 MW
Scope output: 4 × 156 MW
Head: 118 m
Voltage: 13.8 kV
Speed: 166.57 rpm
Runner diameter: 4,100 mm

# G LOCAL NDUSTRIES

Power Projects (P) LTD. to supply the complete electro-mechanical equipment. The order comprises the supply, design, manufacturing, erection, testing and commissioning of all four units, including turbines and generators, auxiliary electrical and mechanical equipment, as well as 400 kV GIS and 400 kV outdoor pothead yard equipment. This project will be executed by ANDRITZ Hydro's Indian subsidiary with its state-of-the-art manufacturing facilities in Mandideep (near Bhopal) and Prithla (near Faridabad).

Kiru will address energy deficiencies in the northern part of India while reducing dependence on fossil-fuelled energy sources. Electricity from Kiru will also enable industrial development while simultaneously improving the education, medical, and road transportation network in the region. Local small-scale and cottage industries will also benefit, creating revenue streams and hence providing more jobs for more people.

By securing this prestigious contract, ANDRITZ Hydro has yet again confirmed its position as a leading player in the hydropower market in India. We are happy to support the UT of Jammu and Kashmir to develop hydropower as a means to reach ambitious 2030 goals to significantly increase the use of renewable energy resources.

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Electricity from Kiru will enable the industrial development in the region.

## TO KNOW:

**India's hydropower scenario**

India's currently installed, 46 GW generation base is growing incrementally. Its goal to achieve 175 GW of renewables by 2021 will now include hydropower too.

By adding much-needed reactive power to the national grid, hydropower such as pumped storage will also play a major role mitigating grid stability risks associated with large volumes of variable output renewables.

Large projects are planned in the northern region of the country, notably Ratle (850 MW) and Kwar (540 MW). Additionally, India's north-eastern region is endowed with a rich hydro potential. Arunachal Pradesh, which shares its northern border with China, has a hydro potential of 50,328 MW. To begin harnessing this, state-owned utility NHPC Ltd. has already begun tendering activities for the 2,880 MW Dibang hydropower project.

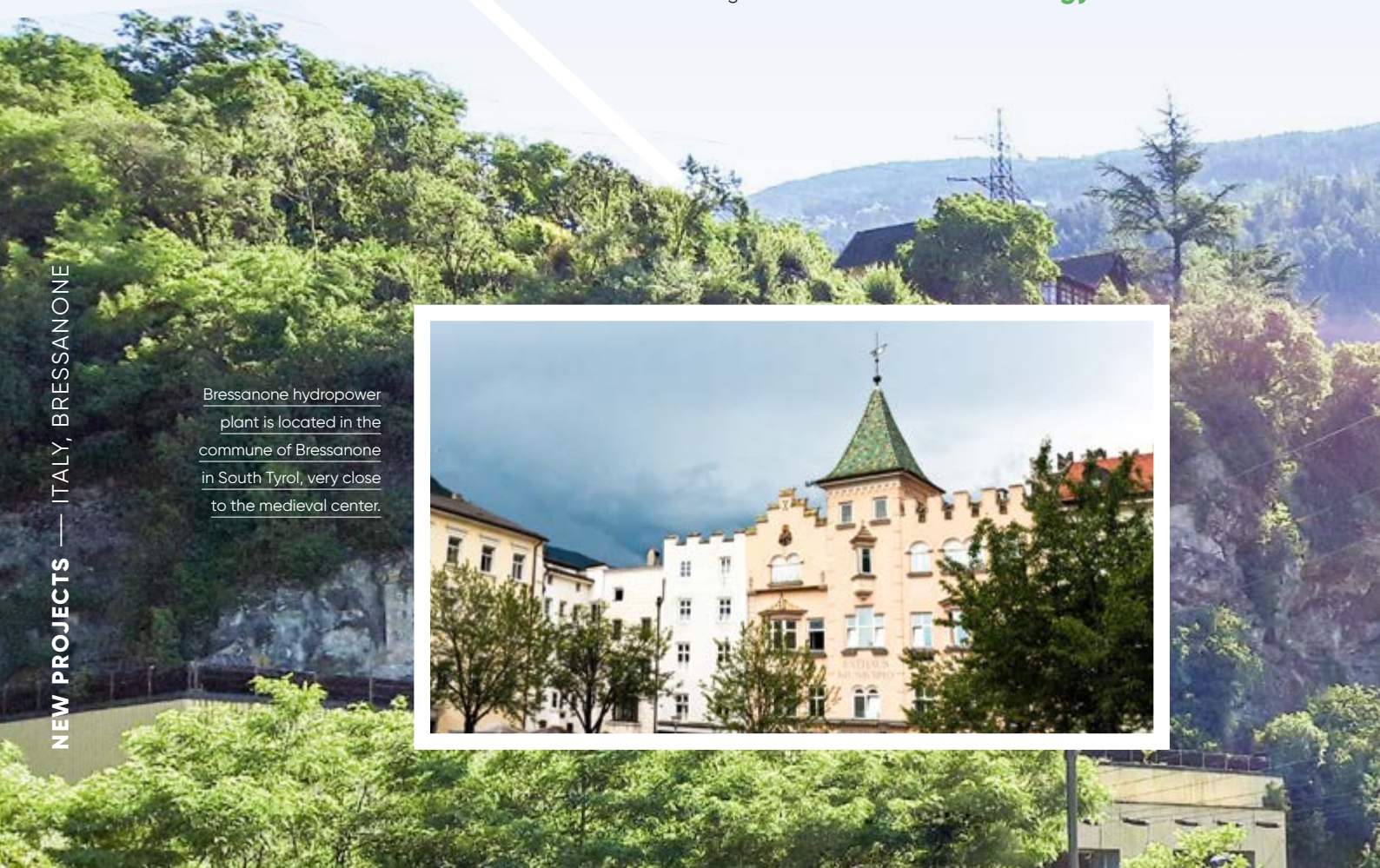
The government has also recently introduced some new concepts to the energy sector, such as Round-the-Clock (RTC) renewables, but this is viable only when storage is available. In such a scenario, pumped storage plants will be the most applicable long-term solution.

# HYDROPOW MEDIEVA

**Italy –** Alperia Greenpower and ANDRITZ Hydro have signed a contract for the rehabilitation of the Bressanone hydropower plant, one of the largest in Northern Italy.

Located in the commune of Bressanone (Brixen in German), very close to the medieval center of this beautiful city in the Alto Adige (South Tyrol) region, the power plant belongs to the Isarco and Rienza river complex. It is the second largest power plant in Alto Adige with a current installed output of 123 MW. Annual production of electricity is 520 GWh, which is used by some 170,000 households, equivalent to 9% of the total hydroelectric production of Alto Adige.

**"Bressanone is the oldest town in Tyrol dating back to the 9th century. It is the third largest city in South Tyrol and an important economic center. For 80 years, Bressanone hydropower station has been producing clean and sustainable energy for the people in the town and the whole area, combining medieval history with modern technology."**





Bressanone hydropower plant is located in the commune of Bressanone in South Tyrol, very close to the medieval center.

# VER FROM A
# AL HEART

Active since 2016 and born from the merger of AEW and SEL, Alperia is a new entity in the Italian energy market. An energy producer, grid operator and provider of services for the population of Alto Adige, Alperia owns 39 hydropower stations and six power plants for district heating systems, ranking it the third largest energy producer from hydroelectric sources in Italy. The company employs about 1,000 people.

Dating back to the 1930s, approval for Bressanone was awarded in 1938 and was built by the Italian railways. Around 6,000 workers took part in the construction campaign and the plant was operational only two years later in 1940.

The power plant takes water from two artificial impoundments. The reservoir Fortezza built on the river Isarco has a 61 m-high dam while the reservoir Rio Pusteria on the river Rienza has a 25 m-high dam. From the intakes, two galleries connect 6 km upstream of the surge tank and are then conveyed to the power plant by one common penstock. After passing through the turbines a discharge channel runs to the Rienza River.

Five generating units with vertical Francis turbines and synchronous generators are housed in the cavern powerhouse measuring 105 m × 15 m and with a height of 18 m from the generator floor. Three generator units have an output of 44 MVA and are complemented by two smaller units with 22 MVA each.

→

Housed in an underground powerhouse, five generating units with vertical Francis turbines and synchronous generators are now being refurbished to meet modern requirements.

With a current installed output of 123 MW and an annual production of about 520 GWh, Bressanone is the second largest power plant in Alto Adige, supplying some 170,000 households with clean energy.

The scope of work for ANDRITZ Hydro includes design, manufacturing, transport and installation of most of the equipment present in the power plant. Four out of five units will be refurbished with new turbine parts and new generators. Spherical valves, pressure relief valves, governors and a closed loop cooling system will all be newly supplied. The scope will also comprise most of the LV, MV equipment and a new ACP system.

One of the key elements of the contract award was the logistics and installation time schedule. Dismantling of the existing equipment and the installation of the new equipment will have to be performed in parallel. Given the limited space available inside the powerhouse cavern and the availability of only one crane, the logistics have been carefully planned to reduce any interference between activities on the units and keep the plant outage to an absolute minimum.

This large variety of different systems will have to be supplied and installed in a relatively short time frame. Site activities started in December 2020 with plans to be completed in September 2022. ANDRITZ Hydro will deploy its internal resources and know-how from five different locations to perform design and manufacturing activities, showing both flexibility and outstanding capabilities as a provider of integrated systems and complex solutions.

Bressanone is one of the largest projects to be awarded to ANDRITZ Hydro in Italy in decades and follows the successful completion of several contracts

## TECHNICAL DETAILS

**Bressanone:**

Total output: 150 MW

Scope Output: 3 × 38 MW / 1 × 18 MW

Head: 143 m / 155 m

Speed: 375 rpm / 500 rpm

Runner diameter: 2,220 mm / 1,530 mm

Av. annual production: 520 GWh

recently performed with Alperia, including San Pancrazio, Lappago, Molini di Tures and many other smaller projects. This makes Alperia one of the most relevant customers for ANDRITZ Hydro, not only in Italy but across the whole Europe.

This order represents an important success for ANDRITZ Hydro in the Italian hydropower market and follows many years of fruitful cooperation with customers in Italy.

**AUTHOR**

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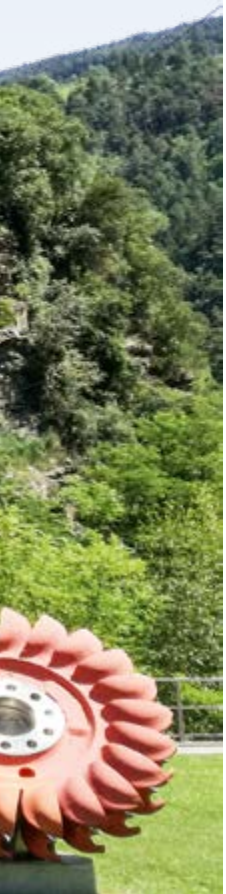
Bressanone is one of the largest projects to be awarded to ANDRITZ Hydro in Italy in decades and it follows the successful completion of several contracts recently performed with Alperia.





# STABLE AND RELIABLE FOR YEARS

**Brazil –** ANDRITZ Hydro has signed a contract with Companhia Hidrelétrica do São Francisco (CHESF) to execute the complete modernization and digitalization of the Sobradinho hydropower plant.

In commercial operation since 1979, the power plant has a total installed capacity of 1,050 MW provided by six vertical Kaplan turbines with a diameter of 9.5 m and an output of 175 MW each. Located on the São Francisco River in Bahia state some 50 km from Petrolina in the northeast of Brazil, the Sobradinho reservoir is one of the largest surface waters in the world. The reservoir regulates water flows in the São Francisco River Basin, providing water to maintain the downstream hydropower plants.

Founded in 1948, CHESF is a subsidiary of Eletrobrás and is one of the largest power generation and transmission utilities in Brazil. CHESF owns 12 hydroelectric power plants, two photovoltaic plants and two wind farms for a total 10,670 MW of installed capacity concentrated in northeastern Brazil.

Following the renewal of its concession until 2052, CHESF's main goal with this modernization project is a complete technological upgrade of Sobradinho. By implementing state-of-the-art technologies, CHESF aims to ensure safe and reliable operation, thus guaranteeing reliable energy supply to its customers.

ANDRITZ Hydro's contractual scope comprises the supply of new electromechanical equipment such as the automation and control systems for the powerhouse, spillway and water intake, conditioning monitoring system, HIPASE technology for synchronization, excitation, turbine governor and protection. In addition, instrumentation, complete medium and low voltage cubicles, complete direct current system, surge/grounding cubicles, repair services for station-services and step-up transformers, cooling system, air compressors, and ventilation system are also included. The contract is rounded out with a complete overhaul of all six Kaplan turbines, as well as the intake gates.

## TO KNOW:

**The São Francisco River "Old Frank"**

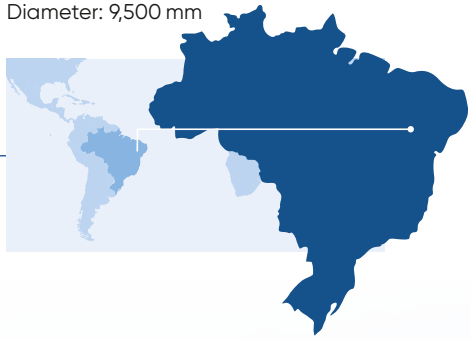
The São Francisco River – also known as Velho Chico (Old Frank) – is a Brazilian river named after Saint Francis of Assisi following its first discovery by Europeans on his feast day (October 4) in 1501. With a length of 2,914 km (1,811 miles), it is the longest river entirely within Brazil. It is also the fourth longest river in South America after the Amazon, the Paraná and the Madeira. The river collects water from 168 tributaries and is of strategic importance, crossing regions of significant climate, environmental and social diversity.

The São Francisco River Basin encompasses the states of Minas Gerais, Bahia, Goias, Pernambuco, and Sergipe and Alagoas. It carries about 64 billion m³ of water annually to the semi-arid region of northeastern Brazil. This corresponds to some 69% of the surface water in the northeastern region of Brazil and represents an annual accumulated potential of about 51 billion m³. The total hydroelectric potential available within this basin is approximately 26,320 MW.

### TECHNICAL DETAILS

**Sobradinho:**

Total output: 1,050 MW
Scope output: 6 × 175 MW
Head: 31.8 m
Voltage: 13.8 kV
Speed: 75 rpm
Diameter: 9,500 mm



The Sobradinho reservoir is one of the largest surface waters of the world, regulating the water flows in the São Francisco River Basin.

The scope of supply also includes engineering (basic and detailed design), overall project management, supply of equipment and installation materials, field installation services, training and other activities. Completion of this modernization contract is scheduled for 2025.

ANDRITZ Hydro is one of the few global suppliers that has reference projects and the necessary expertise to execute modernization projects of such magnitude. The award of this contract is a very important milestone for ANDRITZ Hydro that has once again confirmed its position as a leading company to supply electromechanical equipment and solutions for the hydropower industry.

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# ENERGY TO COME

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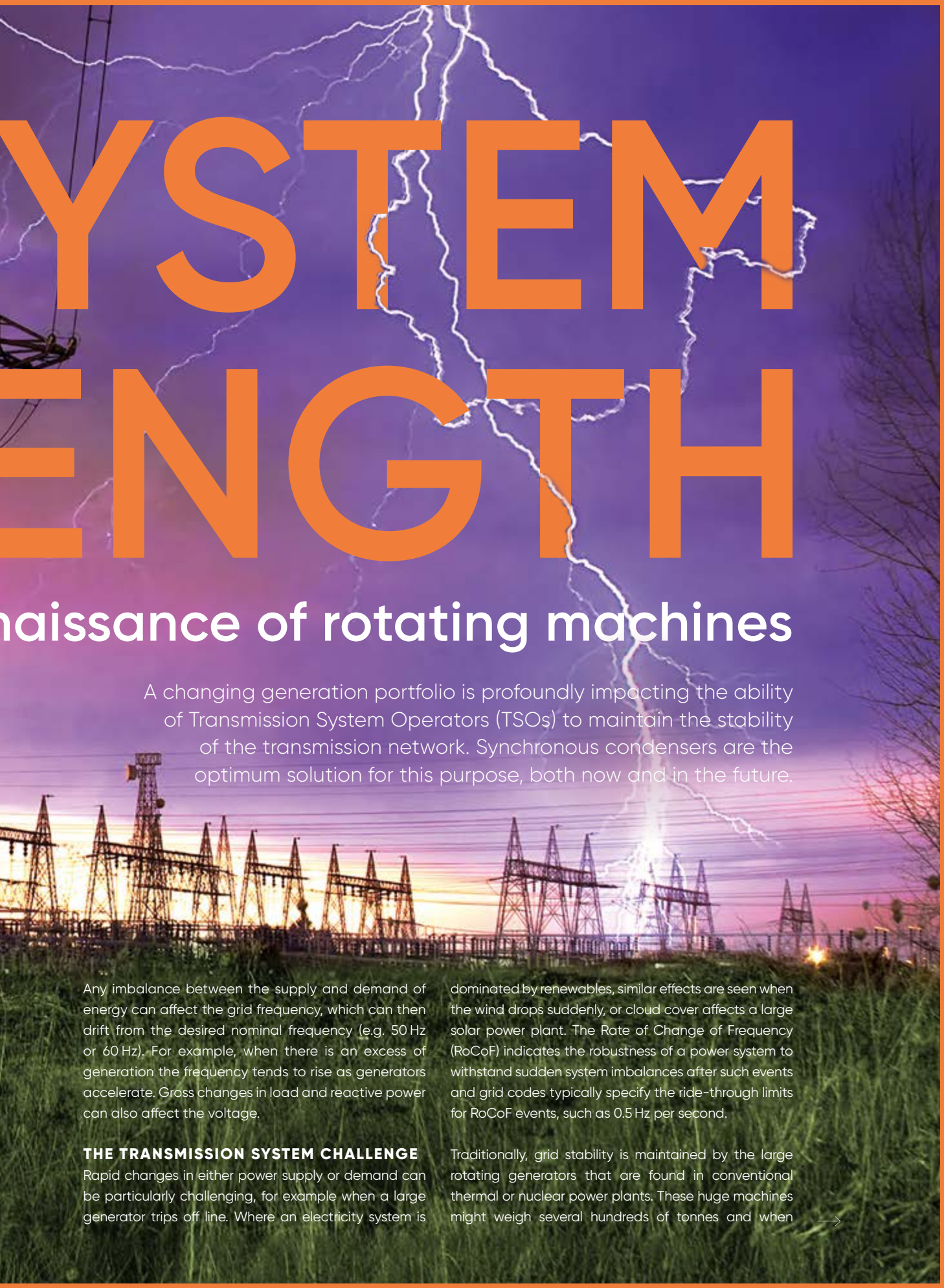
# STR
## The ren

### The smart solution for modern grids

Though the clean energy transition offers economic and environmental benefits, it also presents a number of challenges. One of the key mechanisms to reduce climate-changing carbon emissions is through the deployment of renewable electricity generation such as wind and solar. However, the variability of such energy sources can significantly affect the power transmission and distribution grid as well as the quality of the electricity supplied.

For the TSOs tasked with maintaining the stability of the grid, the massive introduction of clean energy to an existing and limited transmission infrastructure is a difficult issue to resolve.

PV and wind parks must therefore be integrated into the grid while considering the conditions and limitations of today's power system. In fact, the requirements for adaptation, expansion and interconnection of the transmission system to better balance the supply and demand of power are going to take years or even decades to realize. The synchronous condenser is the perfect tool to cope with these challenges.



# YSTEM ENGTH

## naissance of rotating machines

A changing generation portfolio is profoundly impacting the ability of Transmission System Operators (TSOs) to maintain the stability of the transmission network. Synchronous condensers are the optimum solution for this purpose, both now and in the future.

Any imbalance between the supply and demand of energy can affect the grid frequency, which can then drift from the desired nominal frequency (e.g. 50 Hz or 60 Hz). For example, when there is an excess of generation the frequency tends to rise as generators accelerate. Gross changes in load and reactive power can also affect the voltage.

### THE TRANSMISSION SYSTEM CHALLENGE

Rapid changes in either power supply or demand can be particularly challenging, for example when a large generator trips off line. Where an electricity system is dominated by renewables, similar effects are seen when the wind drops suddenly, or cloud cover affects a large solar power plant. The Rate of Change of Frequency (RoCoF) indicates the robustness of a power system to withstand sudden system imbalances after such events and grid codes typically specify the ride-through limits for RoCoF events, such as 0.5 Hz per second.

Traditionally, grid stability is maintained by the large rotating generators that are found in conventional thermal or nuclear power plants. These huge machines might weigh several hundreds of tonnes and when →

rotating at, perhaps 3,600 rpm, possess considerable physical inertia. This inertia is invaluable when absorbing potential shocks to the transmission system and any variability between supply and demand. It is very hard to rapidly accelerate or decelerate such large machines, which provides an inherent stability and therefore sufficient time for other reserves to be put in place.

However, the energy transition has seen large volumes of conventional thermal generation decommissioned to be replaced by non-synchronous renewable sources or HVDC connections. These are connected via power electronics and do not provide significant system inertia. In addition, renewable energy typically benefits from dispatch priority when it is available. Correspondingly, conventional rotating generation units are requested to reduce their output and consequently further reducing system inertia.

As a result of these changes, TSOs need to both monitor system inertia and take appropriate action to ensure enough inertia can be deployed when required. Today, TSOs worldwide are seeking out new methods to add inertia to the grid.

## THE SYNCHRONOUS CONDENSER SOLUTION

One technology that offers considerable benefits to the grid is the synchronous condenser, a synchronous rotating machine operating as a motor with no mechanical load. As a massive rotating machine, the synchronous condenser is able to provide grid inertia with excellent availability. As synchronous machines are electro-magnetically coupled to the power system, they are a source of system strength.

Indeed, synchronous condensers have been used within the transmission network since the beginning of the last century where they have provided various grid services, like voltage regulation and reactive power services.

After a steady decline in the use of synchronous condensers due to the introduction of solid-state compensation devices – such as the Static VAR Compensator (SVC) that provides reactive power when needed – today, the demand of synchronous condensers is now experiencing a strong resurgence.

Synchronous condensers not only provide inertia and variable reactive power to support the transmission system voltage during events, but they are also able to deliver a range of additional ancillary services for grid operators that increase the robustness of the system.

For TSOs synchronous condensers are able to provide stabilization capabilities that are being lost from the grid due to the the transformation of the generation mix.

For more than 120 years, ANDRITZ has supplied numerous synchronous and non-synchronous machines, mainly for generation purposes. About 5,000 units are in service all over the world relying on decades of extensive experience in plant and system integration in the renewable energy business.

## NOT JUST INERTIA FOR GRID STABILITY

Synchronous condensers are rotating compensators that provide a number of critical services to grid operators. To stabilize the grid during imbalances, synchronous condensers can deliver sufficiently large amounts of system inertia to attenuate or avoid any high Rate of Change of Frequency events. They also support TSOs by injecting dynamic reactive currents into the grid during and after faults, therefore they are able to prevent voltage collapse and have been used to provide this function for many decades.

Short-circuit power also plays a vital role in the proper functioning of the protection system of the transmission grid. It is typically mandatory that enough short-circuit power is available at the connection point for power generators. This is particularly important for non-synchronous power generators such as wind or solar, which contribute only up to their rated capacity (110%) to the available short circuit power.

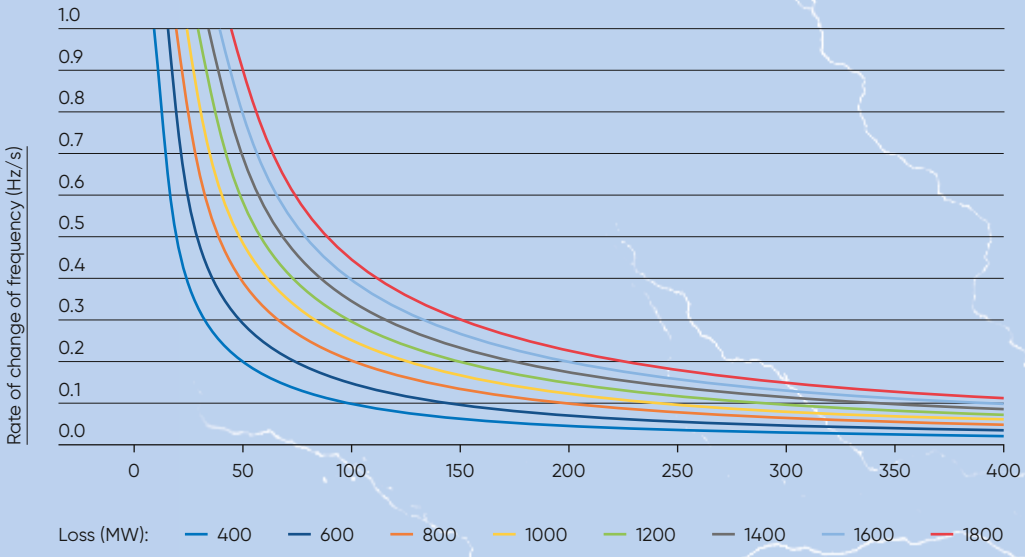
ANDRITZ Synchronous Condensers, for example, can provide up to five times more (500%) short-circuit power than their rated capacity and can also provide a time-limited overload capability, sustaining 200% for 30 seconds for instance, when responding to reactive power demands.

Short circuit power capacity is so important that some PV project developers have even proposed adding synchronous condensers in order to secure a TSO connection approval for their PV parks.

**"ANDRITZ' top-tier synchronous condenser technology improves the performance of power generation facilities and grid stability and increases revenue for our customers."**

Last but not least, it is important to note that synchronous condensers can also absorb harmonics caused by inverter-based generation such as solar.

Considering all the benefits that a synchronous condenser can provide with an extensive range of ancillary services to the grid in addition to inertia, synchronous condensers represent an attractive investment with elevated levels of return.

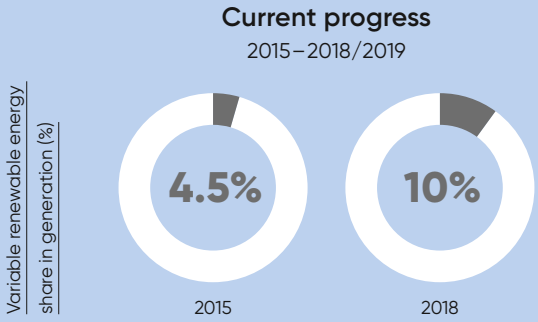



Relationship between system inertia and Rate of Change of Frequency (RoCoF) in a changing world with increased penetration of non-synchronous renewable energy power generation (wind and solar PV)

Source: www.nationalgrideso.com

# RENEWABLE POWER GENERATION –

**"Demanding new regulatory requirements and a cleaner, more diversified energy mix are giving rise to new issues for electricity grid operators tasked with maintaining a stable energy supply. The synchronous condenser is a reliable, proven, and cost-effective solution."**




## NEW BUILD VS EXISTING ASSETS

The global trend to retire fossil-fuelled generation plants is a significant factor in the loss of system inertia, but such facilities may be repurposed to act as synchronous condensers. The conversion process is beneficial as it allows asset owners to retain residual asset value while securing the grid benefits of a large rotating machine. In addition, such facilities are located at appropriate locations with good grid connections. HVDC substations also require precisely those qualities that can be supplied by synchronous condensers and are often co-located with existing generation assets.

ANDRITZ offers conversion services to ensure these benefits are retained, increasing the return on investment. We can also supplement existing facilities with the addition of rotating flywheels or by increasing the rotating mass of the machine.

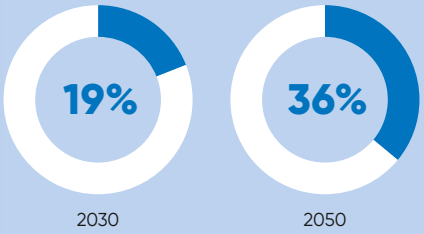
With well over a century of experience designing, manufacturing, supplying, installing, integrating, operating and maintaining a vast range of rotating electrical machines, ANDRITZ has a comprehensive reference list. Indeed, more than 5,000 synchronous generating units are in service today. For all kinds of synchronous condenser solutions, from greenfield projects to modernization and uprating, ANDRITZ always delivers top-tier solutions.

In Brazil, for example, ANDRITZ is currently supplying three synchronous condenser systems for grid services, three new long-distance transmission lines. One system is being installed at the existing 525-kV Marmeleiro 3 substation with another two systems at the new Livramento 230 kV substation. The scope of supply also comprises the step-up transformer, circuit breaker, automation, control and protection systems, as well as monitoring systems for the synchronous condenser and qualities such as vibration, air gap and partial discharge.

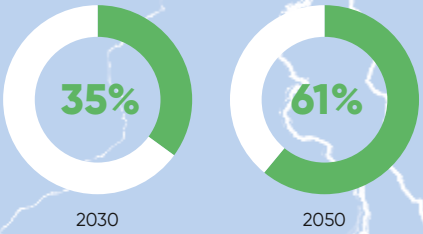
Marmeleiro and Livramento 3, Brazil; supply of three synchronous condenser systems for grid services.

# - A GLIMPSE OF THE DEVELOPMENT

**Where we are heading**
Planned energy scenario / 2030 and 2050




**Where we need to be**
Transforming energy scenario / 2030 and 2050




Source: IRENA, Global Renewables, Outlook 2020

## THE SYNCHRONOUS CONDENSER RENAISSANCE

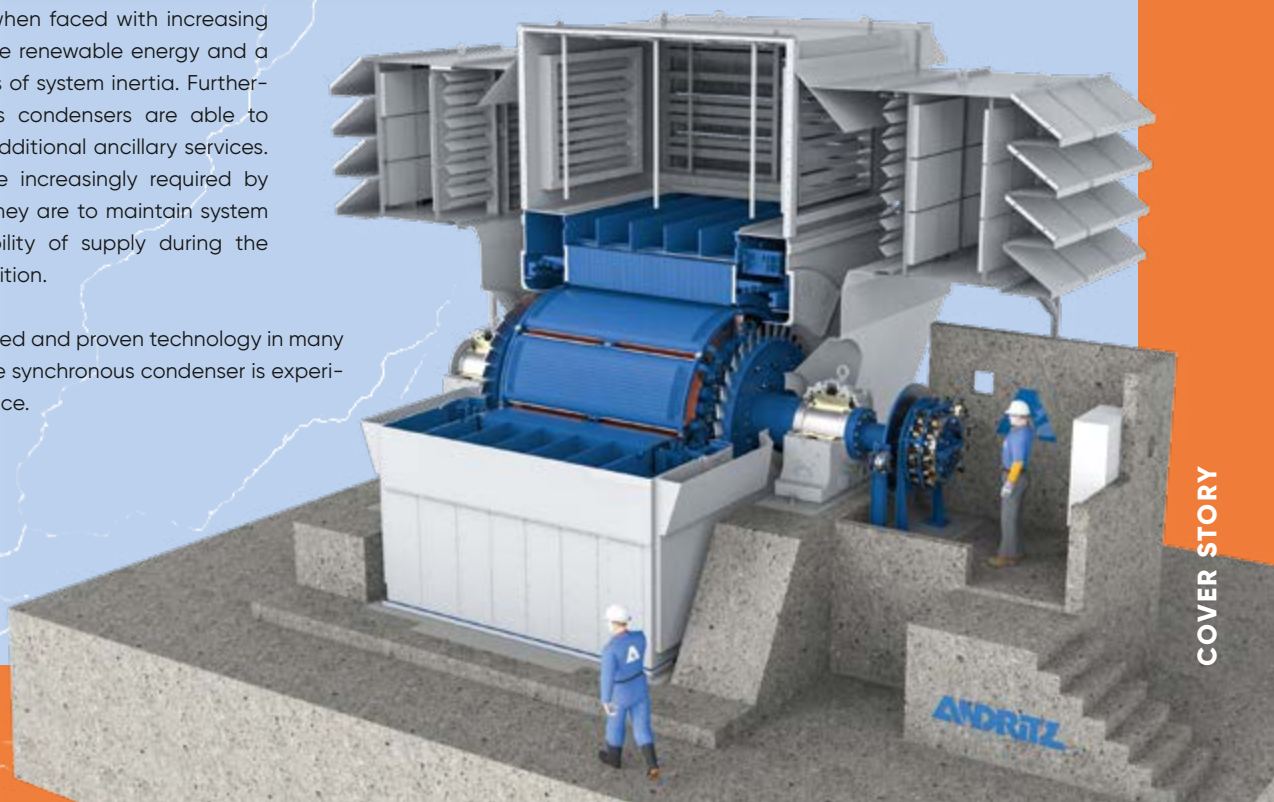
ANDRITZ' advanced designs offer a range of technical features such as reduced friction flywheels based on vacuum technology, direct air-cooling systems, sophisticated hydrogen/water cooling systems, and Totally Enclosed Water to Air Cooling (TEWAC), as well as salient pole and cylindrical rotor solutions with static and rotating high efficiency excitation systems. The ANDRITZ portfolio covers a range of standardized and tailor-made synchronous condenser solutions. In addition, advanced monitoring systems and sophisticated analysis of power flow, transients, grounding, insulation coordination, protection coordination, and dynamic performance allow the selection or design of the optimum synchronous condenser solution to meet the requirements of any specific project.

Synchronous condensers are a cost-effective and reliable solution and are able to address issues affecting grid stability when faced with increasing volumes of variable renewable energy and a corresponding loss of system inertia. Furthermore, synchronous condensers are able to supply a host of additional ancillary services. These services are increasingly required by grid operators if they are to maintain system security and stability of supply during the clean energy transition.

As a well-established and proven technology in many global markets, the synchronous condenser is experiencing a renaissance.

## BENEFITS

- Reliable proven technology
- Cost-effective
- Increased revenue
- Providing inertia – improving stability
- Short circuit power – essential for system protection
- Dynamic voltage support – overload capability
- Implemented in already existing infrastructure
- Reactive power
- Ancillary services

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# FROM SOUTH TO NORTH

**NEW PROJECTS** — CHINA, SHANXI XIAOLANGDI YELLOW RIVER DIVERSION PROJECT

**China –** China is facing the difficult situation of having to provide for 20% of the world's population with only just over 7% of global water resources. This situation is aggravated by the fact that 80% of its water sources are in the southern part of the country, but 64% of the agricultural land is in the northern part, where more than 50% of the population lives.

To solve this problem, China started a huge water supply project in 2002. From 2050, every year the South-North Water Transfer Project, based on three main routes – eastern, central, and western – will transport 44.8 billion m³ of water.

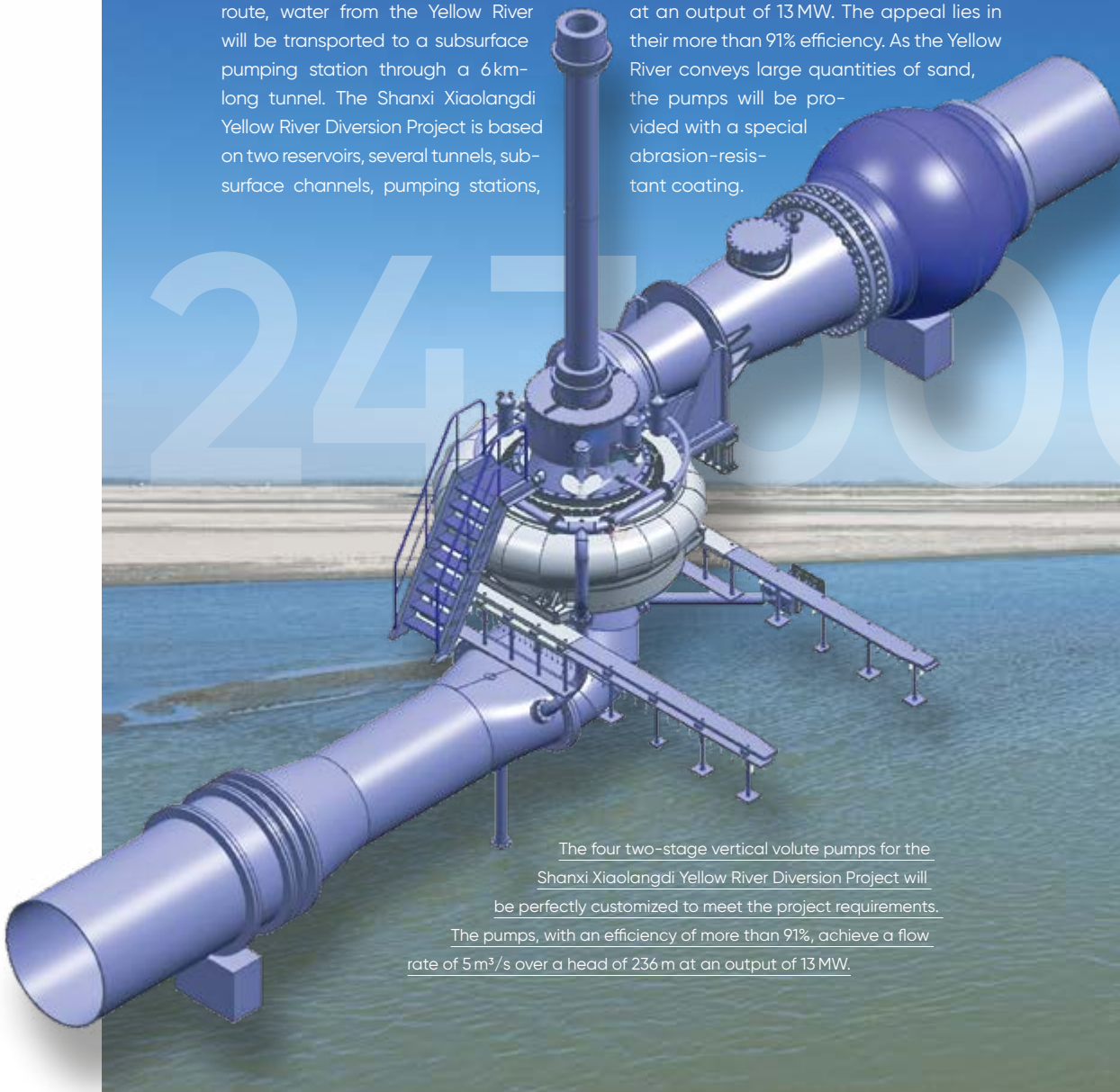
In addition to the Yangtze, the Yellow River plays a significant role in feeding these planned canals. Named from the yellow mud and sediments that it picks up in the Shaanxi Loess plateau, this river supplies water to 155 million people and irrigates 18 million ha of the agricultural land in China.

As part of a sub-project of the central route, water from the Yellow River will be transported to a subsurface pumping station through a 6 km-long tunnel. The Shanxi Xiaolangdi Yellow River Diversion Project is based on two reservoirs, several tunnels, subsurface channels, pumping stations, pipelines, and aqueducts and is designed to divert 247 million m³ of water annually. Irrigation will account for 116 million m³, industrial and urban water demand for another 116 million m³, and 15 million m³ will be used for ecological purposes. The pumping station is equipped with four machines that pump the water over a distance of 60 km to an artificial lake in Shanxi Province.

## THE INFRASTRUCTURE EXPERTS

ANDRITZ was awarded the contract to deliver the pumps for the subsurface station having already assisted in other parts of the South-North Water Transfer Project. For instance, the Hui Nan Zhuang station features eight ANDRITZ horizontal, double-suction split-case pumps to supply drinking water to the capital Beijing, 60 km away.

The four two-stage vertical volute pumps for the Shanxi Xiaolangdi Yellow River Diversion Project will be customized to meet the project requirements. Each achieves a flow rate of 5 m³/s over a head of 236 m at an output of 13 MW. The appeal lies in their more than 91% efficiency. As the Yellow River conveys large quantities of sand, the pumps will be provided with a special abrasion-resistant coating.



The four two-stage vertical volute pumps for the Shanxi Xiaolangdi Yellow River Diversion Project will be perfectly customized to meet the project requirements. The pumps, with an efficiency of more than 91%, achieve a flow rate of 5 m³/s over a head of 236 m at an output of 13 MW.

The hydraulic design of the volute casing depends on the specific output characteristics. Optimum flow in the volute is achieved due to its individual shaping, which also guarantees a high level of efficiency. By varying the trailing edge, high-precision adjustments can be made to the desired duty points. The volute casing is designed as a welded structure consisting of several segments that may be embedded in concrete. However, the Shanxi Xiaolangdi Yellow River Diversion Project uses a solution without concrete because higher delivery heads are necessary. Due to the strength requirements, this application cannot be handled with a concrete volute.

The guide vanes are individually connected to the operating ring by means of articulated levers. This ring is actuated via hydraulic cylinders and rotates the guide vanes into the desired position. A guide vane mechanism is an emergency closing element in case of difficulties with the electric power supply, but it can also be closed to minimize the power required if synchronous motors are used during start-up. By closing the guide vane mechanism, it is possible to start up the pump when the pressure pipe is full. This guarantees a short start-up time with minimum power input.

Delivery, installation, and start-up of the ANDRITZ pumps is scheduled to take place in 2022. This will be another successful step towards a sustainable water supply for the north of the country.

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## TECHNICAL DETAILS

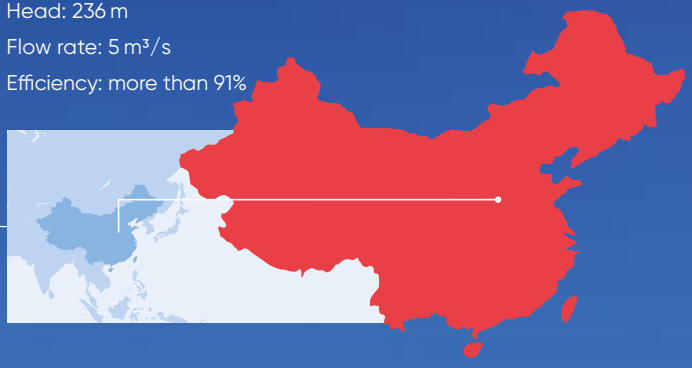
**Shanxi Xiaolangdi Yellow River Diversion Project:**

Scope: four two-stage vertical volute pumps

Head: 236 m

Flow rate: 5 m³/s

Efficiency: more than 91%



# ELECTRICITY FOR 16,000 HOMES

**USA –** In mid-2020, ANDRITZ Hydro received a Design-Build contract from Tacoma Power to rebuild unit #11 at the Alder Dam.

Tacoma Power is a public utility providing electrical power to the City of Tacoma and the surrounding areas and it supplies about 179,000 customers. Tacoma Power owns seven hydropower generation facilities in Washington State.

Alder Dam is located on the Nisqually River in Pierce County, about 32 miles (55 km) south of Tacoma in Washington. ANDRITZ Hydro is the OEM for both the turbines and generators in this powerhouse. Turbine components include a vertical shaft Francis turbine with a single turbine guide bearing that were both supplied by Pelton Water Wheel Co. The generator components include a vertical shaft with a combined guide and thrust bearing mounted above the rotor and a guide bearing mounted below the rotor as well as a closed ventilation system with surface air coolers. The generators for units #11 and #12 were manufactured by General Electric (GE) and were put into operation in 1947 and 1945, respectively. Both Pelton Water Wheel Co. and GE Electric (hydro business) are now part of ANDRITZ Hydro.

The project consists of the design, manufacture, procurement, and construction for the replacement, repair, or refurbishment of components relating to one vertical hydroelectric generator that has reached the end of its useful life. The scope of work also includes the rehabilitation of the major turbine components, and the complete unit disassembly and reassembly. This contract will be executed by ANDRITZ Hydro's local team in Charlotte, North Carolina with support from ANDRITZ Hydro locations in Weiz, Austria, and Morelia in Mexico.

Completion of the project is scheduled for the end of 2022.

The Alder Dam Design-Build contract is the most significant contract to be awarded by this utility since the major unit rehabilitation project at its Mossyrock Dam, which was completed by ANDRITZ Hydro approximately 10 years ago.

When completed in 1945, Alder Dam was one of the tallest dams in the nation with a height of 330 ft' (100 m) and a length of 1,600 ft' (488 m). The two 25 MW units in the powerhouse produce about 228 GWh of electricity each year.

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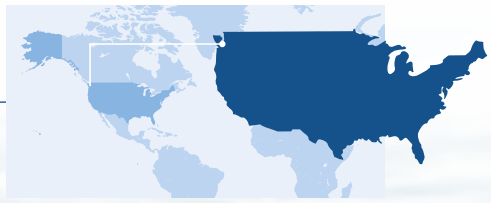
## TECHNICAL DETAILS

**Alder:**

Total output: 50 MW
Scope output: 1 × 25 MW
Head: 68.58 m
Speed: 225 rpm
Runner diameter: 2,463 mm



NEW PROJECTS — USA, ALDER

# MAXIMIZING REVENUES



Poatina is located in an artificial underground cavern, hence the name Poatina, Palawa for "cavern" or "cave".

**Australia –** ANDRITZ Hydro has signed a contract with Hydro Tasmania for the refurbishment of the Poatina Power Station in South Esk, Tasmania, Australia.

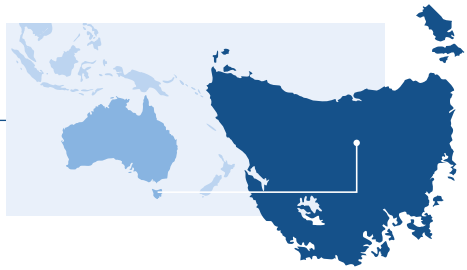
Originally commissioned in 1964, the Poatina station is part of the Great Lake Power Scheme and houses six vertical sets of between 51.6 and 60 MW. Annual energy production is estimated at about 1,255 GWh, which is fed to TasNetworks' transmission grid via underground circuit breakers.

Poatina is the second largest hydropower station in Tasmania and features a huge underground excavation, as wide as a city street, as long as a city block and as high as a seven-story building.

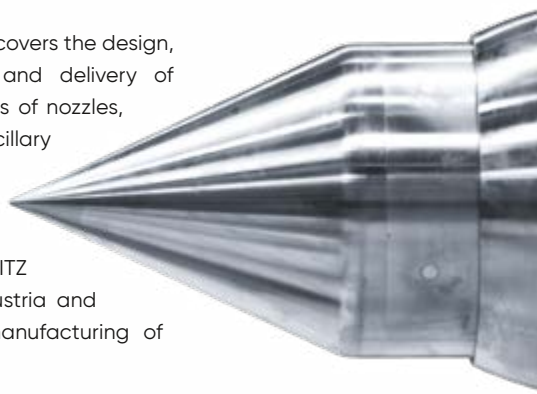
## TECHNICAL DETAILS

**Poatina:**

Total output: 338 MW
Scope output: 4 × 64 MW
Head: 735 m
Speed: 600 rpm
Runner diameter: 1,883 mm
Av. annual production: 1,255 GWh



The contract for ANDRITZ Hydro covers the design, manufacture, factory testing, and delivery of four new turbine runners, six sets of nozzles, five governor systems, and ancillary equipment to replace aging equipment. It includes further engineering, model test and transient studies from ANDRITZ Hydro European locations in Austria and Switzerland, as well as the manufacturing of components in Europe.



Technical highlights are the interoperability between the new runners for units #2 and #3 and the existing runners of units #1, #4 and #5. The nozzle profile design is also challenging. A solution featuring a much more compact torpedo has been proposed using a nozzle design without a spring. The absence of the spring helps to reduce the required space, which also leads to better efficiency.

The new equipment will reduce the asset risk over future decades and will maximize the interchangeability of parts between units #1–#5. Model test and transient studies will be performed to increase the turbine output to 64 MW, increase the runner efficiency and improve the operational flexibility from the Poatina machines, maximizing the revenue opportunities in the market.

The contract for Poatina is another important step in strengthening ANDRITZ' presence in the Australian hydropower market.

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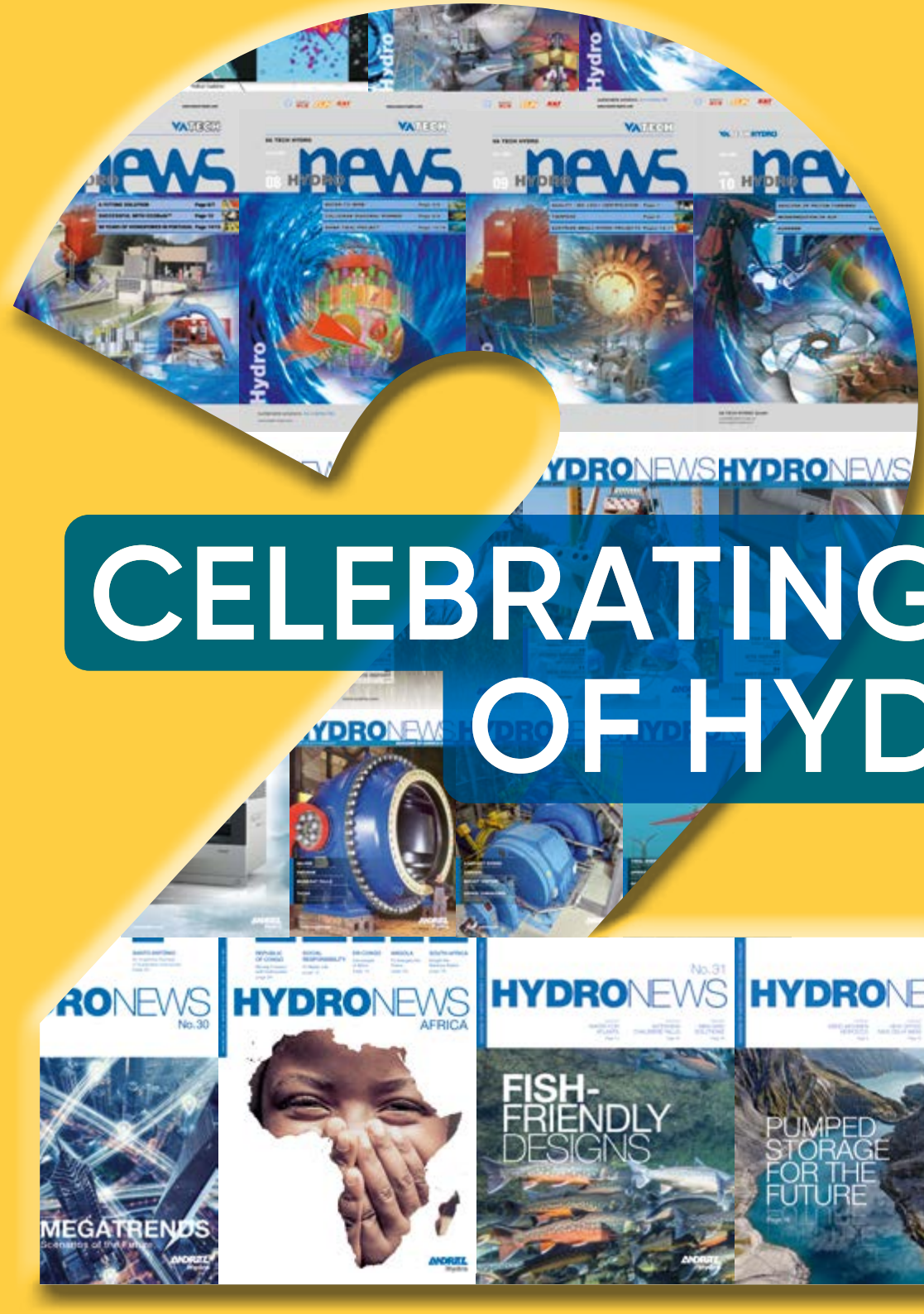


# CELEBRATING T
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interesting market topics. We are very proud to be celebrating
will continue to enjoy many more decades

HAPPY ANNIVERSARY


# TWENTY YEARS
# RO NEWS!

as brought you the latest updates on projects, key trends and
g the 20th anniversary of Hydro News in 2021 and we hope you
of enriching and informative business news.

HAPPY ANNIVERSARY

**Interview** *with*
**David Zrost**
*Head of Group Corporate Security*

# *Coping with the COVID-19 pandemic*


## Keeping colleagues and customers safe

In the midst of the global pandemic, David Zrost, Head of ANDRITZ Group Corporate Security, spoke with Hydro News about measures being taken to ensure the safety of ANDRITZ customers and employees at international construction sites.

**"We have never had a situation like this. It is a first for everyone – governments, companies, and individuals."**

While the number of infected people and death toll unfortunately continues to rise, reducing the social and economic disruption for regions, countries and communities is vital. The priority now is to ensure safety of people, while ensuring the reliable operation of assets and on-going manufacturing and installation works at the many active construction sites located around the world. Supporting the safe continuation of critical on-site activities ensures that the associated economic fallout from the pandemic is also minimized.

Mr. Zrost, you are responsible for measures to protect employees on business trips and assignments abroad. Extreme events such as terrorist attacks, natural disasters and epidemics are a part of your day-to-day work. What was different this time?

**During routine situation monitoring, in January 2020 we noted the first COVID-19 cases in China. The country very quickly implemented medical countermeasures and closed its borders. A feeling of uncertainty set in. What made this situation different was the global scope, the speed of developments and the simultaneous action many countries took. National borders and air space were closed, people were put into quarantine and whole nations in lockdown. As a result, there was hardly any time to start emergency protocols, not to mention work through them step by step. Solutions had to be found under difficult and even unique conditions, such as lockdown. All this was accompanied by a constant global flood of information, with pictures of medics in hazmat suits, patients in intensive care, and diagrams that tried to explain what was happening. The emphasis lies on the word "tried". We have never had a situation like this in living memory. It was a first for everyone – governments, companies, and individuals.**

What were your biggest challenges and main tasks during the crisis?

**With the speed of development and the flood of information, the biggest challenge for Corporate Security is effectively keeping track of the global situation at all times. This means constantly addressing questions like where are our colleagues, what is the status of client projects, how is the COVID-19 situation developing in each active location, and what is the status of any local countermeasures like quarantines or travel restrictions? In collaboration with the Hydro IT department, we quickly developed a dashboard that aggregates data from different verified sources. This gives us a daily situation update and based on this platform we can analyze the situation and take appropriate action to keep our colleagues and customers safe.**

**Our top priority is safety, even while continuing to execute projects where possible. Working with Group Site Installation and Group Quality we put together a catalogue of measures ranging from specific hygiene and social distancing measures, up-to more sophisticated digital solutions like using remote quality and safety checks. At the same time, we defined the parameters that established when we would start evacuating our**

→

## ABOUT:

**David Zrost:** Master in Natural Sciences, Master in International Relations (majoring in International Security), 15+ years of experience in risk management. Working at ANDRITZ since 2013.

**Group Security:** Supports employees and global business operations in navigating the travel and project security risk landscape when doing business worldwide. The overall objective is to ensure that projects successfully go ahead with as little disruption as possible and our people return home safe and sound.

people. Luckily, this has only been necessary in a very few cases so far. In most countries, projects were able to continue with these additional measures in place. In countries where there were travel restrictions but no immediate threats and non-availability of commercial flights, special entry permissions were organized, for example in Belarus, Germany, Ghana, New Zealand and Turkey. At the height of restrictions, commercial flights to most countries were not available. Thus, we organized privately chartered aircrafts for some of our technicians to reach our customers' respective project sites (see also Kpong, Ghana, on next page).

All these processes require an enormous amount of time and effort in terms of logistics and bureaucracy, for example sifting through entry regulations, inquiring about exemptions, contacting embassies, security and aviation service providers, and obtaining approvals for special flights. This process is made even more difficult by the fact that, even now, the relevant authorities are often overstretched and sometimes overwhelmed.

This intensive work is well worth the effort though, as it demonstrates to our customers and colleagues that we will not let them down, despite the many hurdles. I would also like to say a special word of thanks to my team. They provide our travelers, project managers and customers with the support needed. Continuing to work untiringly to overcome hurdle after hurdle, they make all this possible. Finally, I would like to extend my appreciation to our travelers who often have to undergo specific procedures like testing or quarantine. Their commitment is also vital to success.

Does our existing security structure hold up in this environment?

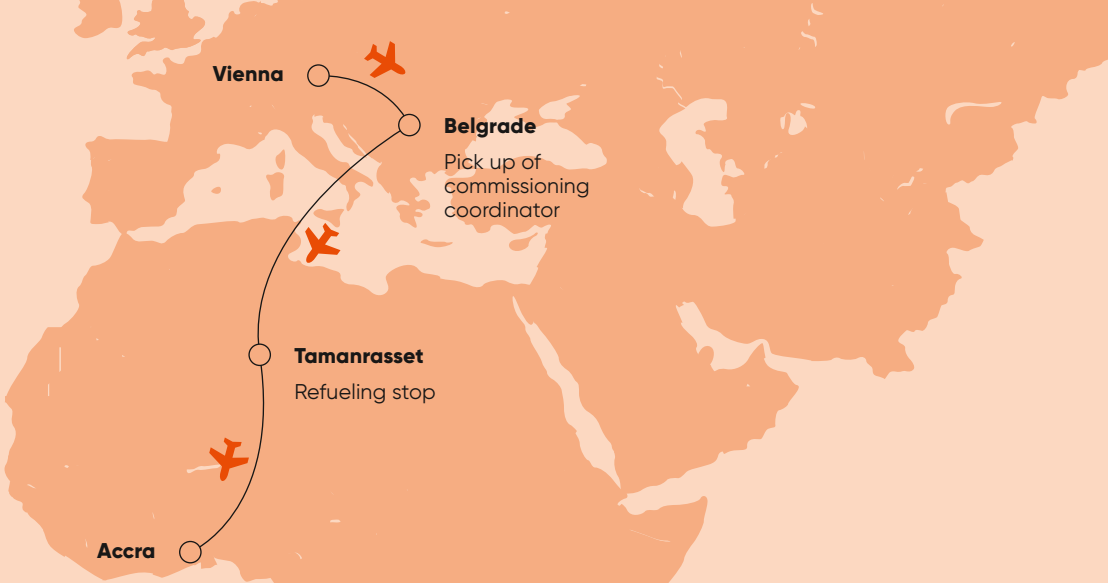
Yes. Overall, the structure of Corporate Security continues to prove its effectiveness. Thanks to our large network of medical, security, and aviation service providers, we are always able to act positively. Our collaboration with our travel assistance provider also continues to withstand this testing environment. The company quickly set up an online pandemic website in several languages. It provided information on current developments, travel restrictions, medical analyses and training material, and also freed up capacity to brief our people before departure and in the event of evacuation of Covid-19 patients. Along with our internal procedures this helps project managers and travelers understand what is happening in their countries of interest. It has also helped to create trust, an essential quality that means our people are still willing to travel.

**"Our top priority is the safety of our customers and colleagues while continuing project execution work."**

Are there some lessons you have learned from the crisis? What is going to change?

Project and travel preparations will be different as long as there is no remedy for COVID-19. Preparation will be more detailed and take more time. In order to provide assistance here, we have defined specific COVID-19 site and travel guidelines. Nowadays, project managers are taking even more time to work through the process carefully. A sensitive evaluation of the situation and good cooperation with the customer is essential for the success of our on-site work.

On a positive note, our organization and those of our customers will probably become more resilient. ANDRITZ, for example, is moving forward in this process by means of a structured lessons-learned process. This could even present us with new opportunities to improve the process for the well-being of our staff and the benefit of our customers.




The chosen flight route of the commissioning team of HPP Kpong with stops in Serbia and Algeria until they reached their final destination.

HIGHLIGHT

# *Commissioning works despite all difficulties – Kpong, Ghana*

The finalization of the Kpong hydropower plant refurbishment project in Ghana was suddenly halted in mid-March 2020 due to the COVID-19 pandemic. Unit #4 was the last part of the retrofit project to be commissioned but travel and flight restrictions prevented the ANDRITZ commissioning team from travelling to Ghana.

Nonetheless, the pressing need for electrical energy led all involved parties to seek out a solution. As a result, a special charter flight was organized to fly in the team and finalize commissioning of the last unit. Following a huge effort by the customer, the local authorities, the responsible ANDRITZ team, and Goldeck-Flug airline, on August 3, two supervisors and five commissioning engineers departed from Vienna. After picking up the commissioning coordinator in Beograd, Serbia, and after a fuel stop in Tamanrasset, Algeria, the chartered plane safely arrived at Accra. After a 10-day quarantine in a government-determined hotel, followed by a four-day stay in the isolated ANDRITZ camp, the outstanding works could be started. Commissioning, including performance tests, were successfully completed on September 19, 2020. Now, all four units of the Kpong hydropower plant are fully operational.

The use of the chartered flight brought the project back on schedule. The customer, Volta River Authority, is very pleased that the unit is operational, and the project team is happy that the project could be finalized in a realistic time frame.

For more details about Kpong and the ceremonial inauguration, see our article on page 36.

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To put the last unit into operation for the customer, the ANDRITZ team undertook all possible measures and even organized a special flight and submitted to a 14-day-quarantine.

# PROJECT

**HWACHEON, SOUTH KOREA**

## For more efficiency

A project for the rehabilitation of South Korea's Hwacheon Hydro Power Plant unit #4 is ongoing. While the engineering phase was completed in April 2020, the last phase of manufacturing was concluded by mid-September. The Factory Acceptance Test date for the Francis turbine runner was also mid-September. The last component has been transported to the customer, Korea Hydro & Nuclear Power Co. (KHNP), which is executing the installation itself with supervision from ANDRITZ Hydro experts.

At the end of November 2020, the stacking and winding works of the generator were started on-site. Due to transport limitations and high costs, these works were shifted to the site in order to optimize transport.

In September 2018, KHNP awarded ANDRITZ Hydro the rehabilitation work for unit #4 of Hwacheon, including supply of a new turbine runner, a new generator, electrical power systems, automation systems, instrumentation and a fire-fighting system.

Commissioning works are scheduled to start in April 2021, and Notice of Acceptance is planned for the end of July 2021.

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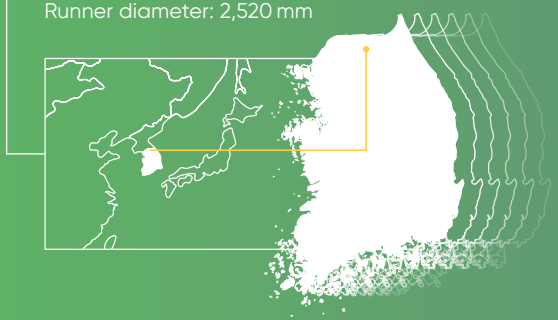
**TECHNICAL DETAILS**

Total output: 108 MW
Scope output: 1 × 27 MW
Head: 67 m
Voltage: 11 kV
Speed: 200 rpm
Runner diameter: 2,520 mm



# UPDATES

**RUSUMO FALLS, RWANDA**

## Cross-border project started

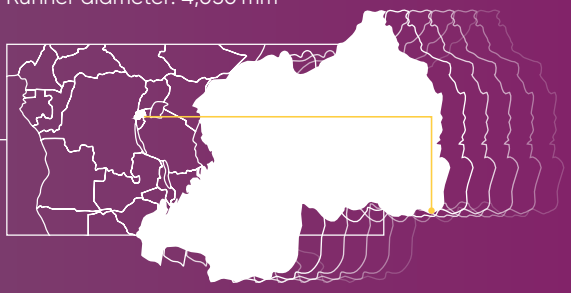
Located on the Kagera River on the border between Rwanda and Tanzania, the Regional Rusumo Falls Hydroelectric Project (RRFHP) is a hydropower project under joint development by Burundi, Rwanda and Tanzania.

The scope of work for ANDRITZ Hydro includes design, manufacturing, transportation, installation and commissioning of three new Kaplan turbines, generators, draft tube gates, electrical and mechanical auxiliaries.

As of July 2020, engineering, procurement and manufacturing was almost completed, and transportation was underway. The site is fully mobilized, and installation started in July 2020. However, due to the COVID-19 lockdown, all work had to be adjusted and additional health and safety measures had to be introduced. Commissioning of all units is now scheduled for 2022.

**TECHNICAL DETAILS**

Total output: 82.5 MW
Scope: 3 × 27.5 MW / 3 × 30 MVA
Voltage: 11.0 kV
Head: 25 m
Speed: 187.5 rpm
Runner diameter: 4,050 mm



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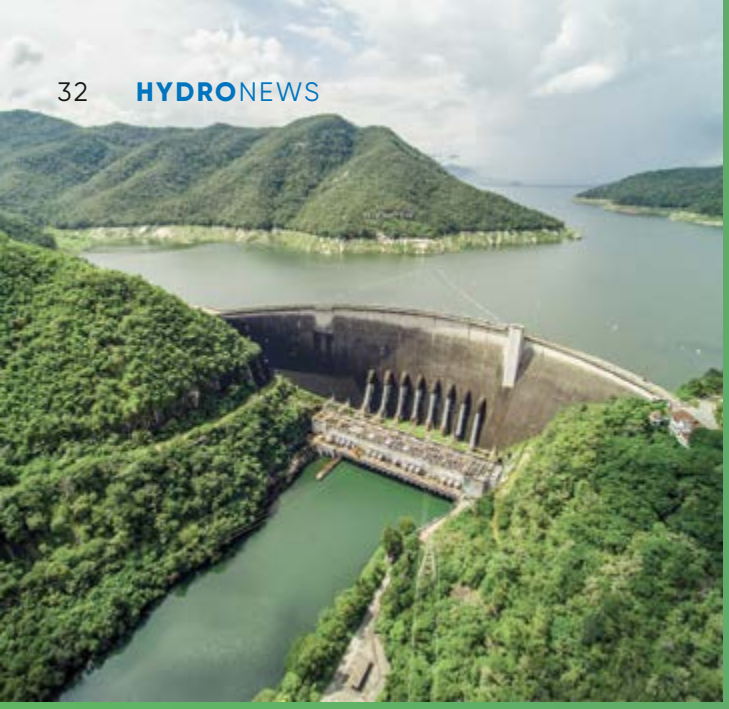
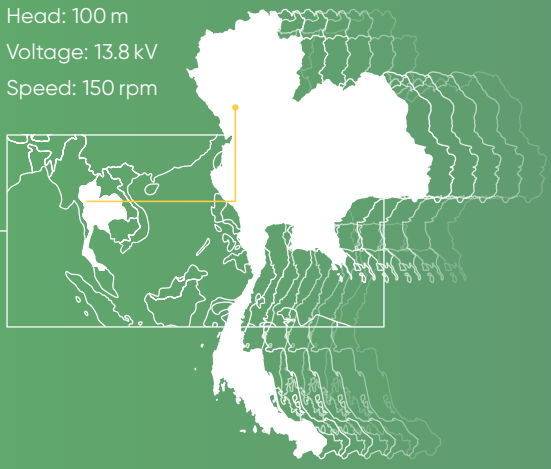
A joint development of three east African nations – Burundi, Rwanda and Tanzania – the implementation of Rusumo Falls will be driven by an investment program of the Nile Basin Initiative, the "Nile Equatorial Lakes Subsidiary Action Program (NELSAP)".




Bhumibol is a multipurpose dam for power generation, irrigation, flood control, salinity control, and fishery.

**TECHNICAL DETAILS**

Total output: 779.2 MW
Scope output: 1 × 121.75 MVA
Head: 100 m
Voltage: 13.8 kV
Speed: 150 rpm



**BHUMIBOL, THAILAND**

# Works successful completed

In May 2020, ANDRITZ Hydro lowered the rotor of generator unit #7 into the generator pit at the Bhumibol hydropower plant in Thailand. ANDRITZ Hydro received the order from the Electricity Generating Authority of Thailand (EGAT) for the generator replacement of unit #7 at Bhumibol back in May 2018.

The hydroelectric plant is located on the Mae Ping River about 480 km North of Bangkok and was originally commissioned in 1964. It is named after His Majesty King Bhumibol Adulyadej. A total installed capacity of 779.2 MW comes from its seven conventional hydropower generating units (units #1 - #6 with 82.2 MW each and unit #7 with a 115 MW output and unit #8, a reversible pump-turbine unit with 171 MW generating capacity). With a height of 154 m, Bhumibol is a multipurpose dam for power generation, irrigation, flood control, salinity control, and fishery.

The scope of supply for ANDRITZ Hydro comprises design, detailed engineering, manufacturing, delivery, installation, and commissioning of the generator and the associated equipment, an excitation system and a $CO_2$ fire protection system. The generator for unit #7 is a three-phase synchronous generator with vertical shaft and air-to-water heat exchanger. With an output of 121.75 MVA, the generator is designed for optimized performance and efficiency. The order is being executed by ANDRITZ Hydro locations in Austria and India together with local subcontractors for the installation works.

Though the coronavirus pandemic slowed down the progress of works, ANDRITZ Hydro has consistently worked to deliver the unit with minimum delay. Installation activities on unit #7 were completed end of July 2020. Following successful commissioning and the unit running to the full satisfaction of the customer, final acceptance (completion of warranty period) is expected beginning of December 2022.

ANDRITZ Hydro has been active in the Thai market for more than 50 years and executed a rehabilitation program on units #1 to #6 at HPP Bhumibol 20 years ago. Through the years we have worked on other projects with the customer in both Thailand and Lao PDR.

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**ALDEADAVILA, SPAIN**

# Technological breakthrough

In 2013, ANDRITZ Hydro signed a contract for the supply of new runners to the Aldeadavila hydropower plant. A key asset in Spanish utility Iberdrola's portfolio, Aldeadavila's 6 × 140 MW Francis turbines are used to provide regulating power to the national grid. Although the first runner went into operation in 2016 a few weeks after commissioning, higher levels of vibration and noise were perceived at deep part load when compared with the old runners.

Subsequently, ANDRITZ Hydro formed an international task force to develop a concept for improving deep part load operation. An elaborate design for runner central aeration now provides the airflow needed to stabilize the water flow pattern during part load operation, without the need for compressors. This significantly reduces noise and vibration.

Although the outcome of a project is not always exactly as expected, ANDRITZ Hydro's approach and proprietary tools for advanced flow simulation, state-of-the-art model testing and fast prototyping capabilities proved their worth as the modification was tested to the customer's full satisfaction at the power plant on two units. The rehabilitation of the third unit is ongoing.

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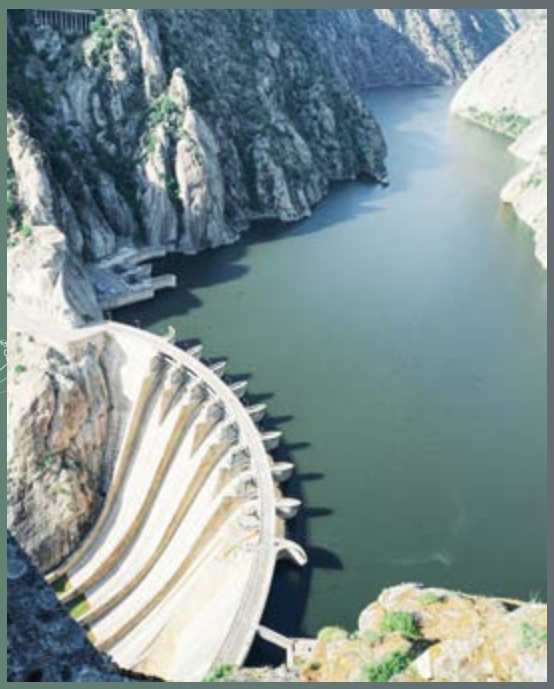
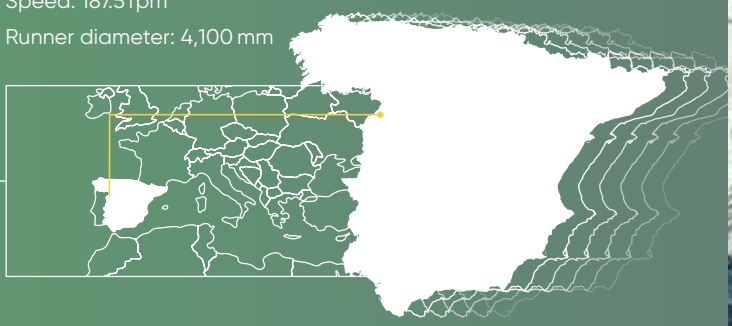
A key asset in Spanish utility Iberdrola's portfolio, Aldeadavila's 6 × 140 MW Francis turbines are used to provide regulating power to the national grid.



**TECHNICAL DETAILS**

Total output: 1,200 MW
Scope output: 6 × 140 MW
Net head: 140 m
Speed: 187.5 rpm
Runner diameter: 4,100 mm



The total capacity of Lower Kalekoey amounts to 500 MW. The hydropower plant will produce about 1,200 GWh of electrical energy per year, thus providing important support to the Turkish grid.

**LOWER KALEKOEY, TURKEY**

# Work on home straight

In May 2020, the first unit of Lower Kalekoey, Turkey, was successful synchronized. The unit is in operation and the reliability run was successfully completed in June 2020. The second unit was successful synchronized end of October 2020. Erection of the last unit was completed beginning of November and the unit was successfully synchronized end of November 2020.

As a member of an international consortium, ANDRITZ Hydro received a contract from the privately-owned Kalehan Genç Enerji Üretim A.S., part of the Kalehan Energy Group, to supply the electro-mechanical equipment for the Lower Kalekoey hydropower plant on the Murat River.

The scope of supply includes design, manufacturing, installation and commissioning of three 186 MVA generators and all associated equipment. Each of the three main generators for the plant weighs more than 535 tonnes. Moreover, the contractual scope of work covers excitation and monitoring systems for the three main units, as well as for an environmental unit which will generate power from ecological water flows.

The total capacity of Lower Kalekoey amounts to 500 MW and the hydropower plant will produce about 1,200 GWh of electrical energy per year, thus providing important support to the Turkish grid.

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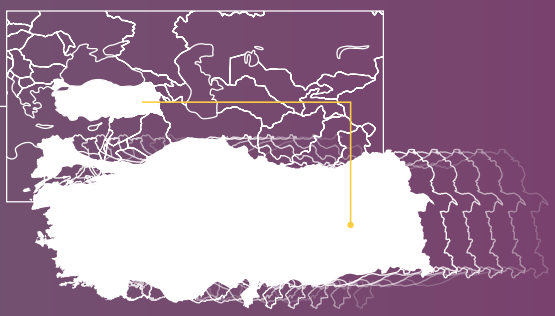
**TECHNICAL DETAILS**

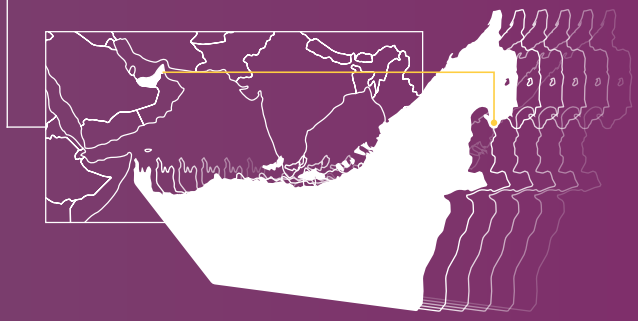
Total output: 500 MW
Scope: 3 × 186 MVA
Head: 88 m
Voltage: 14.4 kV
Speed: 166.7 rpm
Stator Diameter: 10,800 mm
Av. annual production: 1,200 GWh



Picture taken in Jan 2020 before COVID.

**TECHNICAL DETAILS**

Total output: 250 MW
Scope: 2 × 125 MW
Voltage: 15.5 kV
Head: 150 m
Speed: 285 – 315 rpm
Runner diameter: 3,800 mm



**HATTA, DUBAI**

# Hydraulic model "EDF-Accepted"

With the successful conclusion of a model test, an important milestone in the execution of a pump turbine project was reached. Now fabrication of a prototype machine can start based on the hydraulic model.

In July 2019, a consortium formed by ANDRITZ Hydro and the civil works partners STRABAG and ÖZKAR was awarded a contract to build the Hatta pumped storage power plant in Dubai.

In order to ensure the demanding high efficiency levels and several other characteristics of the hydraulic machine, such as cavitation, fabrication of the prototype pump turbine was preceded by a small-scale model test.

After less than a year of development at the beginning of July 2020, the hydraulic model was presented to the customer DEWA and their prestigious consultant engineer EDF. Over two weeks of intensive assessment, all the operational requirements of the pump turbine were tested on the hydraulic model based on the applicable IEC Standards and contract requirements. The tested model completely fulfills all the requirements and even exceeds the guaranteed weighted efficiency both in pump and turbine mode. Both the customer and EDF are very satisfied with the hydraulic performance of the pump turbine.

This challenging project is the first of its kind on the Arabian Peninsula and consists of a shaft-type powerhouse that will host two pump turbines and motor-generator units of 125 MW each. Once completed, the station will be capable of producing a total net energy of 1,500 MWh over a six-hour generation cycle and will hold about 4 million m³ of storage capacity.

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Over two weeks of intensive assessment the tested model completely fulfills all the requirements and even exceeds the guaranteed weighted efficiency both in pump and turbine mode. Model test and all relevant activities were made under corona measures enforced at that time.

1,000 GWh

# MEETING SUSTAINABLE ENERGY NEEDS

**Ghana –** Strategically important, the Kpong hydropower station in Ghana had been undergoing an extensive refurbishment when final commissioning was suddenly halted due to the COVID-19 pandemic. Despite this setback, with considerable effort and exceptional dedication, ANDRITZ Hydro still managed to put Kpong back into full commercial operation.

Located about 25 km downstream of Akosombo Generating Station, Kpong is a run-of-river hydropower station originally commissioned in 1982. After 30 years of reliable operation, the power generation components were experiencing higher failure rates and subsequent forced outages. A retrofit project was initiated to update the plant equipment to modern standards and to ensure reliable operation for many decades to come.

In 2013, ANDRITZ Hydro received a contract from Volta River Authority, a 100% state-owned public entity in Ghana, for the modernization of the entire hydropower station. The contract covered design, manufacturing, supply, installation and testing, as well as commissioning for the mechanical and electrical equipment. This included intake roller gates, turbines and governors, generators, excitation, protection, and control systems, as well as powerhouse station service facilities.

After the successful commissioning of units #2, #1, and #3 in 2016, 2017, and 2019, respectively, the installation of unit #4 was completed on schedule at the beginning of 2020. However, finalization of the commissioning of this unit was halted in mid-March 2020 due to the COVID-19 pandemic. Unit #4 was the last part of the retrofit project to be commissioned but travel restrictions prevented the ANDRITZ Hydro commissioning team from travelling to Ghana.

Nonetheless, the pressing need for electrical energy led all involved parties to seek out a solution. As a result, a special charter flight was organized to fly in the team and finalize the commissioning process. After a 10-day quarantine in a government-determined hotel, followed by a four-day stay in the isolated ANDRITZ Hydro camp, the outstanding works were started. (For more details on the challenges facing our customers and colleagues during the global pandemic please see the interview on page 26.)

Commissioning, including performance tests, was successfully completed on September 19, and on October 26, 2020, all refurbished units of Kpong hydropower plant were officially inaugurated in the presence of the president of the Republic of Ghana, H.E. Nana Addo Dankwa Akufo-Addo. Traditional representatives, a high-ranking governmental delegation

SITE REPORT — GHANA, KPONG

Ceremonial inauguration of HPP Kpong took place on October 26, 2020 in the presence of the president of the Republic of Ghana, traditional representatives, and a high-ranking delegation.

and international guests also attended the inauguration. Now, all four units of the Kpong hydropower plant are again fully operational to the utmost satisfaction of the customer.

Whilst contributing 160 MW of power to the national grid and neighboring countries, the dam provides additional services such as irrigation for farmland within the Fodjoku, Amedeka and Akuse districts, as well as flood control and fishing opportunities for local citizens.

Saving about 400,000 tonnes of carbon emissions per year, Kpong also plays an essential role in the mitigation of climate change. The safe and reliable annual production of about 1,000 GWh of electrical energy is thus a cornerstone of Ghana's climate policy and its sustainable future.

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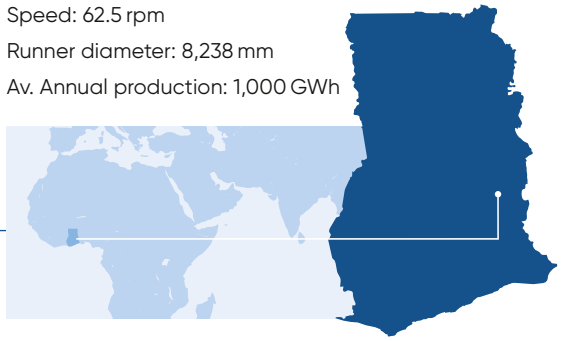
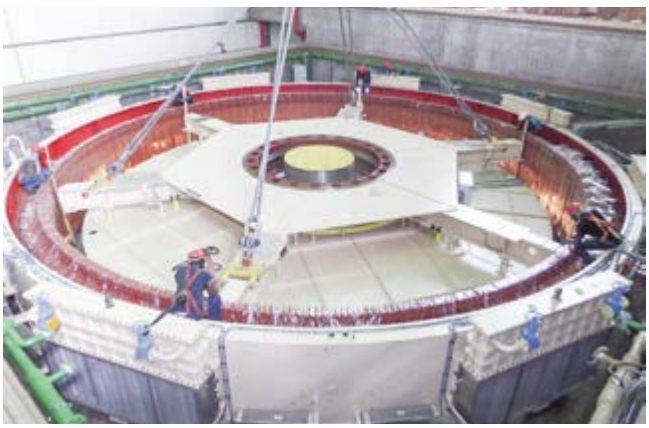
## TECHNICAL DETAILS

**Kpong:**

Total output: 160 MW
Scope: 4 × 40 MW
Voltage: 13.8 kV
Head: 11.75 m
Speed: 62.5 rpm
Runner diameter: 8,238 mm
Av. Annual production: 1,000 GWh





# GREEN ENER FOR 60 MILL PEOPLE

A mammoth project successfully completed – With the commissioning of its 18th and last turbine, the Belo Monte hydropower plant on the Xingu River in the Pará state of Brazil was officially inaugurated on November 27, 2019.

Belo Monte, the largest 100% Brazilian hydropower plant, has a capacity of 11,233 MW and is ranked as the third largest hydropower plant in the world. The complex has 18 vertical Francis units located in the main powerhouse at Belo Monte and a further six Bulb units located in the complementary powerhouse at Pimental.

This major undertaking achieved a number of impressive milestones, including the installation of about 100,000 tonnes of electro-mechanical equipment engaging over 30,000 employees at peak times. The three million m³ of concrete and the more than 160,000 tonnes of steel used to make this giant of the electricity sector a reality are equivalent to the construction of 37 Maracanã stadiums and 22 Eiffel Towers.

Belo Monte provides enough clean and renewable energy for about 60 million people or about 10% of total national demand.

## A GIANT PROJECT

Belo Monte has been in development for decades, but it wasn't until 2011 that ANDRITZ Hydro received an order for electro-mechanical equipment from the project developer, the consortium Norte Energia. The ANDRITZ Hydro scope of supply included five vertical Francis turbines and generators as well as 18 excitation systems. With an output of more than 620 MW each and a diameter of 8,500 mm the Francis runners, designed, manufactured and installed by ANDRITZ Hydro, are among the largest and heaviest in the world.

The transportation of the runners from São Paulo state to Belo Monte was a complex logistical operation made by road, sea and barge including navigating through 600 km of the Amazonas and Xingu rivers. A special truck – 100 m in length and almost 9 m wide – was used for the road transport section.

This giant project also saw the construction of a dam on the Xingu River, located 40 km above the city of

# RGY LION

**"DEVELOPMENT OF BELO MONTE ENSURES THAT THE BRAZILIAN ELECTRICITY GRID WILL CONTINUE TO BE ONE OF THE CLEANEST IN THE WORLD FOR MANY DECADES TO COME."**

Altamira at the Pimental site, forming the Xingu Reservoir. A complementary powerhouse was built at the Pimental site, which has a net head of 11.4 m and a total turbine flow of 2,268 m³/sec. Pimental has a total installed capacity of 233 MW.

In 2011, ANDRITZ Hydro received a contract for electromechanical equipment at the Pimental hydropower plant, again from Norte Energia.

At Pimental the ANDRITZ Hydro scope of supply included six 38.8 MW Bulb turbine units, six 40.9 MVA generator units, as well as governors, excitation systems, supervision and control systems, electrical protection system, and complete mechanical and electrical auxiliaries for the plant.

Additional elements of the scope included the spillway and substation, emergency gates and stop log, two cranes and lifting equipment for the powerhouse and spillway, 18 segment gates, as well as a complete 230 kV / 69 kV substation.

The main spillway for the Belo Monte complex is one of the largest in the world and is also at the Pimental site dam. At 445.5 m across it features twenty 20 m × 22.3 m gates with a total maximum flow of 62,000 m³/sec. The erection involved some 8,500 tonnes of equipment and was completed in 352 working days.

Designed, manufactured, supplied and installed by ANDRITZ Hydro, the Kaplan Bulb turbines have a runner diameter of 6,450 mm each. The final unit, #6, went into operation in the first week of January 2017, marking the start of full commercial operations. In March 2017, the turbine performance test was carried out, surpassing the contractual objectives.

## SUSTAINABLE HYDROPOWER DEVELOPMENT

Alongside the impressive engineering, more than 117 socio-environmental projects were carried out during the Belo Monte and Pimental HPP development process. Around R$6.3 billion (US$1.2 billion) was invested in the community as a result. This includes 78 educational works and 31 basic health units in addition to three new hospitals. Furthermore, equipment and vehicles are made available to the public health agencies that work with the indigenous population of the region.

Development of the Belo Monte project followed more than 35 years of studies and community dialogue. →

The complimentary powerhouse of Pimental has the world's largest spillway, supplied by ANDRITZ Hydro.

**"WITH A CAPACITY OF 11,233 MW, BELO MONTE IS RANKED AS THE THIRD LARGEST HYDROPOWER PLANT IN THE WORLD AND PROVIDES ENOUGH CLEAN AND RENEWABLE ENERGY FOR ABOUT 60 MILLION PEOPLE."**

This process resulted in an undertaking to have the least possible social and environmental impact while achieving Brazil's sustainable energy production objectives. The reduction of the flooded area by more than 60% when compared to the original proposal – thus avoiding the flooding of areas occupied by indigenous communities – is one of the outcomes of this process and guaranteed the integrity of the 12 territories – 1 area and 11 indigenous lands – occupied by the indigenous populations of the Middle Xingu. Not even a single square centimeter of the more than 5 million hectares occupied by nine ethnic groups was flooded by the plant's reservoirs.

The municipalities around the hydropower plant received investments of around R$6.3 billion (US$1.2 billion) including the expansion of a water supply system, the construction of a sewage system, and construction of five new neighborhoods built by the company. About 3,800 families who once lived on stilts today live in safe houses of 63 m², each of which is located on a 300 m² plot of land. With support from the developer consortium Norte Energia, the city also has a park of approximately 940 hectares along the river front.

Norte Energia also finances the Malaria Control Action Program that, in partnership with the state and municipalities, reduced the cases of the disease by 96% in Altamira, Anapu, Brasil Novo, and Vitória do Xingu.

At Pimental, a fish transposition system featuring a 1.2 km-long channel that allows the continuity of fish migration along the Xingu River was developed as part of the Belo Monte Ichthyofauna Conservation Program. The program also includes projects for monitoring ichthyofauna, taxonomic research, encouraging sustainable fishing, ornamental fish aquaculture, and monitoring of the transposition mechanism as well as the rescue of ichthyofauna.

Norte Energia also set up a seed bank from trees of native species in the surroundings of the plant. The material today underpins the production of scientific knowledge of national and international institutions.

With an output of about 620 MW and a diameter of 8,500 mm, the Francis runners for Belo Monte rank among the largest and heaviest of the world (Picture taken 2015).

The main powerhouse Belo Monte houses 18 vertical Francis units with a total capacity of 11,000 MW, making it the world's third largest hydropower plant.

The effort to conserve permanent preservation area also includes 26,000 hectares of permanent preservation area around the reservoirs and the derivation channel that connects the hydropower plant's reservoirs – of which around 5,000 hectares will receive measures to recompose the vegetation cover, from the production and planting of millions of tree saplings.

## BUILDING BELO MONTE

Such extensive environmental and social initiatives demonstrate the commitment of Norte Energia to generating sustainable energy for Brazil while supporting and improving the living conditions of the communities surrounding the project.

ANDRITZ Hydro is proud to have actively participated in this massive undertaking by acting in the development of electro-mechanical projects and the manufacture, supply and installation of the equipment of this extraordinary, once-in-a-lifetime project. The total ANDRITZ Hydro contribution to Belo Monte and the related Pimental project is 3,340 MW of installed capacity.

Since 1975 when the first studies were carried out, through to the final commissioning in November 2019, this project has proven to be complex and extensive. Nonetheless, it represents another milestone for economic development in the region, preserving the Amazon rainforest as well as indigenous communities. With the support of ANDRITZ Hydro, the development of Belo Monte ensures that the Brazilian electricity grid will continue to be one of the cleanest in the world for many decades to come.

## TECHNICAL DETAILS

Total output: 11,233.1 MW

ANDRITZ Hydro scope output: 3,340 MW

Head: 87 m

**Belo Monte Powerhouse:**

Output: 5 × 620.40 MW Francis units

Voltage: 18 kV

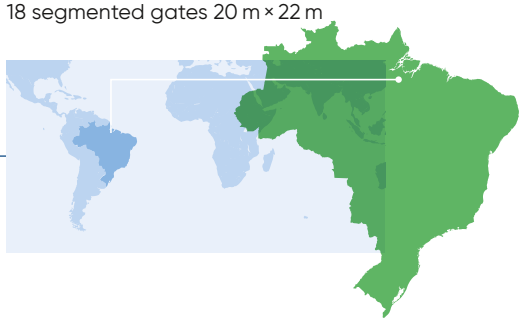
Runner diameter: 8,500 mm

**Pimental Powerhouse:**

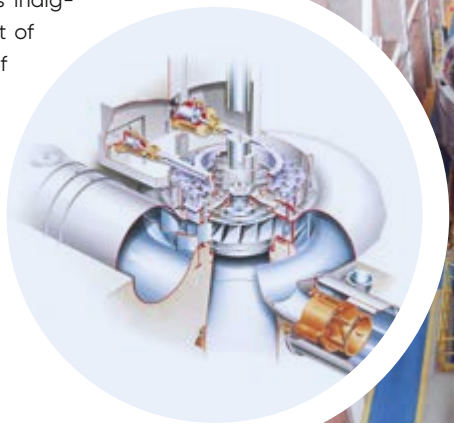
Output: 6 × 39.80 MW Bulb

Voltage: 13.8 kV

18 segmented gates 20 m × 22 m



The generators for Belo Monte have a generation power of 679 MVA and impressive internal diameter of the stator of 18.5 m.



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# ACHIEVING CLIMATE GOALS

Nedre Otta hydropower station 270 km north of Oslo is producing clean energy for the municipalities of Sel and Vågå.

**Norway –** Following a successful commissioning phase, the Nedre Otta hydropower plant in Norway was handed over to the customer in June 2020. Nedre Otta is located in the municipalities of Sel and Vågå, in the community of Oppland some 270 km north of Oslo. This new power plant is equipped with two 43 MW Kaplan turbines and operates as a run-of-river plant with no intake reservoir.

Back in 2016, ANDRITZ Hydro was awarded with a contract to supply the complete electro-mechanical and hydro-mechanical equipment for this project, as well as excitation systems. The extensive contract also comprised design, manufacturing, and delivery of mechanical equipment in the powerhouse including turbines, main inlet valves (MIV), inlet pipes, hydraulic pressure units (HPU), electronic turbine governor, and generators including excitation systems. The contract further included the mechanical equipment to be installed in the waterways, including trash racks, intake gates, draft tube gates, as well as cooling and bilge systems. Installation, supervision, and commissioning rounded out the contract scope.

The power plant's owners are AS Eidefoss with 50% and Hafslund E-CO with 50% (E-CO Energi 27% and Eidsiva Vannkraft AS 23%). Through participation in the development of Nedre Otta, E-CO Energi has confirmed the company's long-term strategy of developing new hydropower capacity and its position as an important and long-term player in Norway. This is also a project that contributes to achieving the country's 2020 climate goals, relevant to all hydropower projects in Norway today.

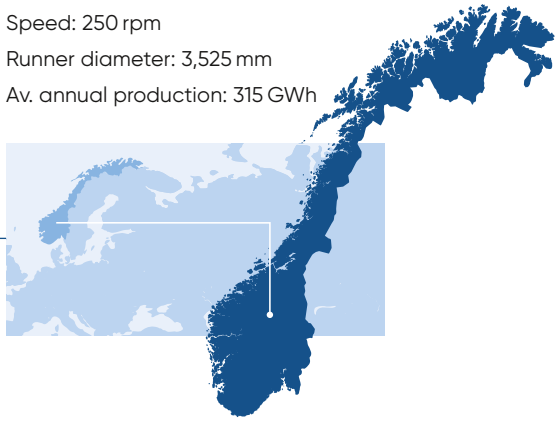
**"With an estimated production of approximately 315 GWh annually, of which 270 GWh is new production, Nedre Otta supplies enough power for over 15,000 households."**

Nedre Otta uses the natural fall of the Otta River at the existing dam at Eidefossen. A new powerhouse is located after a 4 km stretch of 95 m² tunnel downstream of the dam. A tailrace tunnel with the same cross section runs for another 4 km until the outlet to the river. With an estimated production of approximately 315 GWh annually, of which 270 GWh is new production, Nedre Otta is currently Norway's largest recently constructed hydropower project and will produce enough power for over 15,000 households.

### TECHNICAL DETAILS

**Nedre Otta:**

Scope output: 2 × 43 MW / 2 × 50 MVA
Head: 50 m
Voltage: 11 kV
Speed: 250 rpm
Runner diameter: 3,525 mm
Av. annual production: 315 GWh




Although Norway is one of the world's leading petroleum exporters, domestic electricity production relies almost entirely on hydropower, with an annual production of about 141 TWh.

With the two host municipalities, Vågå and Sel, development agreements have been entered into where each of the municipalities will receive NOK 5 million to be used for mitigation measures. In addition, each of the municipalities will have a perpetual right to 3% of the power production from the Nedre Otta hydropower plant.

The whole project, both in terms of technological solutions and implementation methodology, was characterized by conventional and proven solutions, with a single exception. This was the first major project where the customer decided to carry out the entire project, from start to takeover, completely without old-fashioned paper drawings. By requiring BIM (Building Information Modeling) and a three-dimensional model, the client managed to streamline implementation and improve communication between the various professional groups, with few errors and conflicts.

Despite the strain of the situation due to COVID-19 and all related security and health measures, the project was completed in early summer 2020 with hand-over to the customer in June, one month earlier than by contractual schedule.

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Despite the strain of the situation due to COVID-19 and all related security and health measures, the project was completed in early summer 2020, one month earlier than scheduled.

**Pakistan –** Gulpur hydropower plant has successfully experienced an extensive commissioning program and began commercial operations by the contractually agreed date.

Construction of Gulpur, a run-of-river plant located in the Northwest of Pakistan on the Poonch River approximately 167 km from the capital Islamabad, began in 2014 and commercial operation began in February 2020.

# OVERCOMING

The project is located within Azad Jammu & Kashmir, which is close to the Indian Jammu & Kashmir Line of Control. Challenging regional and political conditions, associated logistical challenges, and demanding project characteristics all factored against the likelihood of timely completion. However, continuous effort by ANDRITZ Hydro and close cooperation with the project stakeholders permitted the implementation of project acceleration and schedule optimization measures. This enabled delivery of power to the grid to begin within the time frame established in the contract.

The initial plant capacity test was carried out during commissioning and exceeded the contractual requirement in favor of the customer. An absolute efficiency test in accordance with IEC 60041 is planned.

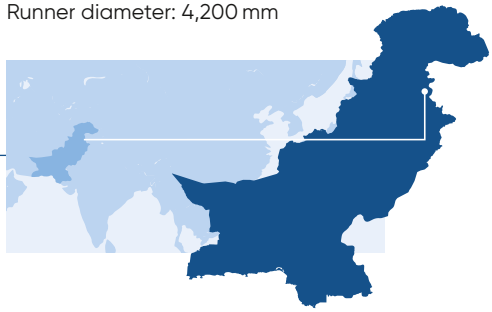
ANDRITZ Hydro signed the contract with the Korean Joint Venture Daelim/Lotte for the supply of electro-mechanical and hydro-mechanical equipment for the 102 MW project in December 2015. The owner, Mira Power Ltd. – a special purpose company of the Korea South East Power Co. Ltd – entered the turnkey EPC contract with Daelim/Lotte. Involved ANDRITZ Hydro locations included Germany, which lead the project, as well as Austria and China together with the support of the local ANDRITZ Hydro team in Pakistan.

The contract scope for ANDRITZ Hydro comprised the entire electro-mechanical and hydro-mechanical equipment for the power plant, including two vertical Kaplan turbine-generator sets with a power output of 51 MW / 64.7 MVA each. Also included was the homologous model test, six spillway radial gates, two intake roller gates, two draft tube gates, two bottom outlet bonneted gates for ecological flow, stop logs for all gates, trash rack cleaning machine, and the penstocks for the generating units.

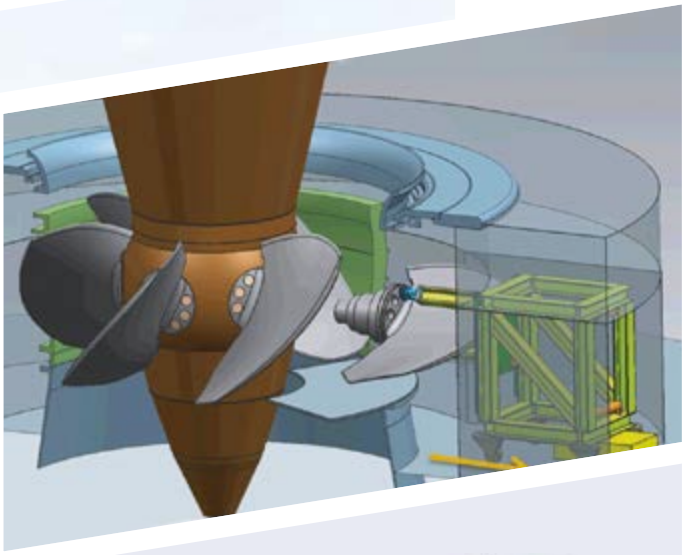
## TECHNICAL DETAILS

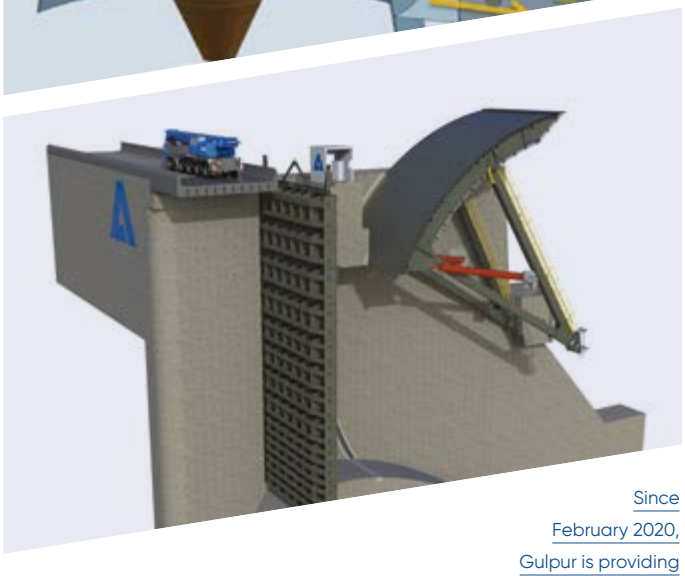
**Gulpur:**

Total Output: 102 MW / 129 MVA
Scope output: 2 × 51 MW / 64.7 MVA
Voltage: 11 kV
Head: 59.90 m
Speed: 214 rpm
Runner diameter: 4,200 mm



# CHALLENGES





Since February 2020, Gulpur is providing clean and sustainable energy to the national grid with top-tier customized equipment from ANDRITZ Hydro.

Complete plant control and SCADA, excitation and protection systems, electrical power systems including transformers and gas insulated switchgear (GIS), unit auxiliaries, cranes, ventilation and HVAC, fire detection and fighting, CCTV, telecommunication, as well as O&M equipment, were also part of the scope of supply. Installation and commissioning of the equipment including an additional test program as per the power purchase agreement, as well as training for the nominated O&M team rounded out the contract.

Due to the high silt load of the Poonch River, the runner blades (z = 7), guide vanes and facing plates were coated with a hard tungsten carbide coating (SXH*) to minimize erosion. A special feature of this design is that dismantling of the runner blades and guide vanes will be possible without dismantling of the entire turbine/generator unit.

The commercial operation of Gulpur adds an important reference in Pakistan where ANDRITZ Hydro now has more than 50 units and more than 3,800 MW of capacity installed and/or rehabilitated. This makes ANDRTIZ Hydro a market leader in the country. Recent projects like Golen Gol, New Bong Escape and Allai Khwar and Duber Khwar are proof of the expertise and trustworthiness of the company.

The experience and solutions from ANDRITZ Hydro, as well as proven competences for project management within turnkey EPC contracts, are amply confirmed with the completion of this particular project after a project execution time of just 50 months. Now Gulpur is helping to improve the stability of the Pakistani national grid with the use of green energy from hydropower.

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# SMALL HYDRO HIGHLIG

## DALSFOS

**New** | Kragerø | Norway
Output: 1 × 7.3 MW
Scope: "From water-to-wire" package
**Highlight:** Replacing old Francis turbine from 1906

More on Page 49

## SCHILS

Update | Flums Valley | Switzerland
**Ongoing Installation**
Output: 1 × 11.87 / 1 × 2.13 MW
Scope: Renewal and energy optimization of the aging systems
**Highlight:** Fully based on BIM (Building Information Modeling), energy production increase by 20%

More on Page 51

## KUHANKOSKI

**New** | Keski Suomi | Finland
Output: 2 × 2.6 MW
Scope: Electro-mechanical equipment with Bulb turbines and generators
**Highlight:** Optimized technical concept for high efficiency and flexibility

## NYAMWAMBA

**New** | Kasese District | Uganda
Output: 2 × 4.0 MW
Scope: Complete "From water-to-wire" package
**Highlight:** Supply additional 34,000 households with clean energy generation

## JIJI AND MULEMBWE

**New** | Bururi Province | Burundi
Output: 3 × 11.8 MW (Jiji) / 3 × 6.1 MW (Mulembwe)
Scope: Electro-mechanical equipment with Pelton turbines
**Highlight:** Power stations will double energy production in Burundi

More on Page 48

## CHEMOSIT

**New** | Kericho County | Kenya
Output: 1 × 2.6 MW
Scope: Complete electro-mechanical package
**Highlight:** Follow-up project to earlier orders in Kenya (North Mathioya, Lower Nyamindi and South Mara)

# HTS

"The global small hydropower market has continued to recover over recent months. Africa, East and South East Asia remain the most active regions. However, the new corona virus pandemic puts a question mark over the short-term market perspective. This does not change the fundamental importance of small hydropower though, which is vital for increasing rural electrification with sustainable energy from renewable resources."

## KAWARSI II

Update | Himachal Pradesh | India
**Successfully completed**
Output: 2 × 7.5 MW
Scope: "From water-to-wire" package
**Highlight:** First five-jet vertical Pelton project executed by Compact Hydro India

→ More on Page 52

## KARGALY

**New** | Southwest of Almaty | Kazakhstan
Output: 1 × 2.97 MW
Scope: Complete electro-mechanical package
**Highlight:** Further success for Compact Hydro in an important and emerging hydropower market

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## SHI ZHUN

**New** | Near Taipei | Taiwan
Output: 1 × 4.64 MW
Scope: Compact Francis turbine
**Highlight:** Hydropower station added to an existing dam

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## CHI CHI NANAN 1, 3, 4, 9, 10, 11

**New** | Central Taiwan | Taiwan
Output: 2 × 1.61 MW / 2 × 0.8 MW / 2 × 0.97 MW / 2 × 0.84 MW / 2 × 0.86 MW / 2 × 0.88 MW
Scope: Bevel gear Bulb turbines
**Highlight:** Hydropower stations added to an existing irrigation canal

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## KARUWA SETI

**New** | Seti Khola River | Nepal
Output: 3 × 10.6 MW
Scope: Electro-mechanical equipment incl. Francis turbine
**Highlight:** Follow up project after having commissioned Madhkyu Khola project

## DA NHIM UPPER 3

**New** | Lam Dong Province | Vietnam
Output: 2 × 4.67 MW
Scope: "From water-to-wire" package
**Highlight:** First Compact Axial turbine project in Vietnam

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## MATIRI

Update | Lake Matiri | New Zealand
**Ongoing Installation**
Output: 1 × 4.79 MW
Scope: Electro-mechanical equipment (turbine, generator and main inlet valve)
**Highlight:** Further success for Compact Hydro in New Zealand

# JIJI AND MULEMBWE, BURUNDI

**Doubling energy production**

According to the World Bank, less than 10% of the population in Burundi has access to electricity. Even compared with the average in sub-Saharan Africa (around 44%), this is a very low level. Nonetheless, Burundi does have a huge potential for the development of renewable energy. Hydropower resources have been evaluated at around 1,700 MW with some 156 potential sites available throughout the country.

In 2016, the state-owned water and electricity distribution group Regideso launched a joint tender process with the World Bank for the construction of the Jiji and Mulembwe hydropower projects. Located around 100 km southeast of the former capital Bujumbara, the two stations are only a few kilometers apart in Bururi Province.

Following the tender, ANDRITZ Hydro was successfully awarded the delivery of the complete electro-mechanical equipment for the installation. The scope of supply consists of 3 × 11.8 MW horizontal Pelton turbines (Jiji) and 3 × 6.1 MW horizontal Pelton turbines (Mulembwe). The contract also includes associated equipment, such as governor oil supply units, main inlet valves, synchronous generators, and cooling systems. The scope adds delivery of electric power system (switchyards and transformers) and automation and control equipment. The contract scope was completed by supervision of site installation and commissioning, performance tests, a reliability run and training.

After the planned completion of the projects by 2023, they will be synchronized to the 110 kV grid in Burundi's national transmission network and will almost double the national installed power capacity. The project will also contribute to the reliability and availability of electricity, thus directly improving living standards, economic activity, growth and development for the country.

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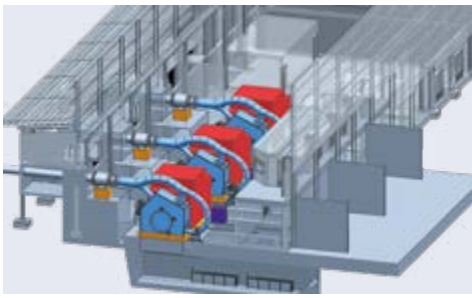

## TECHNICAL DETAILS

**Jiji:**

Total output: 3 × 11.8 MW
Head: 437 m
Speed: 500 rpm
Runner diameter: 1,670 mm

**Mulembwe:**

Total output: 3 × 6.1 MW
Head: 257 m
Speed: 428.6 rpm
Runner diameter: 1,480 mm

Example of a Pelton turbine

# DALSFOS, NORWAY

**From old to new**

ANDRITZ Hydro has received an order from Skagerak Kraft AS for a "from water-to-wire" package for the Dalsfos hydropower plant in Telemark County, Norway.

In 2017, the Norwegian Water Resources and Energy Directorate granted approval for a new power plant in Dalsfos. The new hydropower plant, located in Kragerø Municipality, will be built inside a mountain on the opposite side of the river to the current Dalsfos hydropower plant on the Tokevannet Lake at the top of the Kragerø watercourse. Over a century old, this plant is still in daily operation, and even one of the original turbines from 1906 is intact and working. However, the facility is worn down and has low efficiency by today's standards. Conservation authorities have proposed placing the power plant under a preservation order as the machine room is unique with its art nouveau style, the roof trusses are open and visible and there are many decorative elements in the form of stairs, railings and windows. Also, the generating unit's rotating parts are visible, unlike those found in more modern power plants.

ANDRITZ Hydro was chosen for the electro-mechanical delivery with Skanska conducting the civil works. Three old Francis turbines will be replaced with one top-notch Compact Axial Turbine (CAT). The scope of supply comprises a complete "from water-to-wire" electro-mechanical package including the turbine, generator, automation and electrical power systems, intake gates, and trash rack. Commissioning is scheduled for the end of 2021.

The river Kragerøvassdraget has a population of migratory eels, therefore, fish-friendly facilities will be built to enable continued migration for eels to safely get past the new power plant.

The modernization of Dalsfos hydropower plant is a further step towards a modern and sustainable energy supply for this Norwegian region, and ANDRITZ Hydro is proud to be part of this project.

**TECHNICAL DETAILS**

Total output: 7.3 MW
Scope: 1 × 7.3 MW
Head: 20.21 m
Voltage: 6.6 kV
Speed: 230.77 rpm
Runner diameter: 2,350 mm

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# DA NHIM UPPER 3, VIETNAM

**First CAT project in Vietnam**

ANDRITZ Hydro has signed a contract for the electrical and mechanical works of the Da Nhim Upper 3 hydropower project with Toan Thang Dat JSC (Vietnam). The scope of supply comprises design, engineering, manufacture, supply and supervision of installation, as well as commissioning of the complete electro-mechanical equipment.

With an output of 9.35 MW, the run-of-river power station on the Da Nhim River basin is in Lam Dong province in Vietnam's Central Highlands (Tay Nguyen) region.

Da Nhim Upper 3 project will be the first Compact Axial Turbine (CAT) project to be developed in Vietnam. In comparison with the originally planned Francis turbine, the CAT solution is more efficient and provides better part-load performance under the natural conditions found at the plant. This results in better annual energy generation and higher revenue for the customer.

This project is a repeat order following ANDRITZ Hydro's successful execution of the customer's first hydropower project (Da Cho Mo 2 HEPP, 5.5 MW), which has been in commercial operation since November 2019.

**TECHNICAL DETAILS**

Total output: 9.35 MW
Scope output: 2 × 4.67 MW
Head: 24.05 m
Voltage: 6.3 kV
Speed: 428.57 rpm
Runner diameter: 1,770 mm

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# CHICHI NANAN AND SHIZHUN, TAIWAN

**Pushing renewable energy**

Following orders for two hydropower plants in 2019, EPC-contractor Nan Dao Engineering has awarded a contract for a further 13 small turbines at seven different locations in Taiwan to ANDRITZ Hydro. As with the earlier projects, Chichi Nanan 2 and Hoshan, the hydropower stations will be added to an existing dam and irrigation canal and will thus help to boost renewable energy in Taiwan.

Six of the seven new power stations will be equipped with a total of 12 bevel gear Bulb turbines with runner diameters of 1,770 mm and 2,150 mm. One of the projects, the Shizhun power station, will be equipped with one vertical Compact Francis turbine with a runner diameter of 1,245 mm. The Bulb turbine sites are located mainly in central Taiwan while the Francis turbine is near the capital Taipei.

The delivery of the first main turbine components is scheduled for the third quarter of 2021.

Taiwan has become a very interesting market for hydro and especially small hydro over recent years as the government has set ambitious targets to increase the share of renewable energy.

The trust the customers place in ANDRITZ Hydro is proven with these follow-up contracts. ANDRITZ Hydro is proud to be a part of the positive development of renewable energy in Taiwan.

## SUSTAINABLE ENERGY OUT OF URBAN INFRASTRUCTURE

Existing irrigation canals and drinking water reservoirs in urban areas can be effectively used for the generation of electricity. Using small hydropower plants developed by ANDRITZ Hydro, this water may be harnessed to generate electrical energy. The units can be applied in any number of diverse locations. The only requirement is an economically viable combination of head and flow. By using this electrical energy local communities can be supplied with power and thousands of tonnes of $CO_2$ emissions can be saved over time.

## TECHNICAL DETAILS

**Shizhun:**
Total output: 4.64 MW
Scope output: 1 × 4.64 MW
Head: 42.3 m
Speed: 450 rpm
Runner diameter: 1,245 mm

**Chichi Nanan 1:**
Total output: 3.2 MW
Scope output: 2 × 1.61 MW
Head: 7.9 m
Speed: 250 rpm
Runner diameter: 1,770 mm

**Chichi Nanan 3:**
Total output: 1.6 MW
Scope output: 2 × 0.8 MW
Head: 4 m
Speed: 171 rpm
Runner diameter: 2,150 mm

**Chichi Nanan 4:**
Total output: 1.94 MW
Scope output: 2 × 0.97 MW
Head: 4.7 m
Speed: 182 rpm
Runner diameter: 2,150 mm

**Chichi Nanan 9:**
Total output: 1.68 MW
Scope output: 2 × 0.84 MW
Head: 4.1 m
Speed: 171 rpm
Runner diameter: 2,150 mm

**Chichi Nanan 10:**
Total output: 1.72 MW
Scope output: 2 × 0.86 MW
Head: 4.2 m
Speed: 171 rpm
Runner diameter: 2,150 mm

**Chichi Nanan 11:**
Total output: 1.76 MW
Scope output: 2 × 0.88 MW
Head: 4.3 m
Speed: 171 rpm
Runner diameter: 2,150 mm

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# SCHILS, SWITZERLAND

**Renewal and energy optimization**

ANDRITZ Hydro was awarded a contract for the complete electro-mechanical equipment for the Schils hydropower plant in the Flums Valley in St. Gallen, Switzerland.

In 2014, SAK (St. Gallisch-Appenzellische Kraftwerke AG) acquired the historic hydroelectric power plants of the former spinning mill Spoerry & Co. AG. As part of the acquisition, EW Schils AG, part of SAK, committed to rehabilitate the existing facilities in accordance with existing laws and the implementation of several environmental measures. After thorough evaluation and discussions, a very interesting project was developed. The plant, which today consists of five control centers and eight machine groups, will be reduced to one control center with two machine groups (2 MW Aeuli and 12 MW Bruggwiti).

Besides the two Pelton turbines, the scope of supply for ANDRITZ Hydro comprises the delivery and installation of the complete control system, the heating and ventilation equipment, the electrical installation, and the powerhouse crane system.

The new center is SAK's first project fully based on BIM (Building Information Modeling). This means that the entire project will be engineered as a 3D-model down to the smallest details before project execution starts. The goal of BIM is to discover possible engineering conflicts at an early stage and to coordinate interfaces between the various companies involved as efficiently as possible. The progress of the construction works on site can also be followed via a live webcam from SAK.

Rehabilitation of the plant will increase the total annual energy production by about 20% from 39 GWh to 48 GWh. As a result, about 2,000 additional households will be supplied with renewable electricity.

Construction works were completed on time and installation of the powerhouse equipment is due to be finished by the end of 2020. Currently, wet commissioning tests are taking place and readiness for operation is scheduled for the end of the first quarter of 2021.

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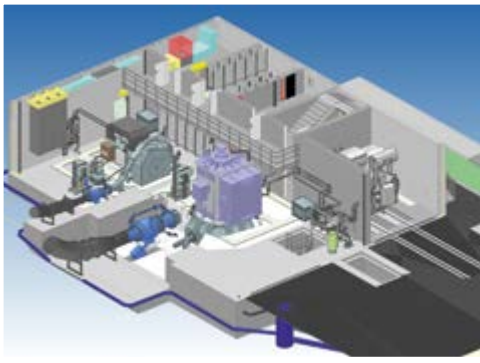
## TECHNICAL DETAILS

Total output: 14 MW
Voltage: 6.3 kV
**Bruggwiti:**
Scope: 1 × 11.87 MW
Head: 469 m
Speed: 750 rpm
Runner diameter: 1,195 mm
**Aeuli:**
Scope: 1 × 2.13 MW
Head: 342 m
Speed: 1000 rpm
Runner diameter: 755 mm



# KAWARSI II, INDIA

**Challenging terrain**

In February 2017, ANDRITZ Hydro signed a contract with Jagdambey Hydro Projects LLP for the complete electro-mechanical equipment on a "from water-to-wire" basis for the Kawarsi II hydropower project. Commissioning of the project in Himachal Pradesh in northern India has now been completed.

The contract included design, engineering, manufacturing, testing and installation of two turbines. In addition, electrical and mechanical balance of plant equipment, 66 kV switchyard, generator, transformer and auxiliary equipment also formed part of the scope of supply.

This is the first five-jet vertical Pelton project from Compact Hydro India. Located in very difficult terrain, the weather conditions can be hard with winter temperatures of about -5 °C. There are also frequent landslides during monsoon season, often blocking the roads. Given the challenging road conditions, a major difficulty during execution was transportation of oversized cargos to the site.

Our highly motivated team collaborated brilliantly with all involved parties, showcasing the excellent work of our engineers and allowing the project to be completed on time and as per the contract terms.

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### TECHNICAL DETAILS

Total Output: 15 MW
Scope output: 2 × 7.5 MW
Head: 304.31 m
Speed: 600 rpm
Runner diameter: 1,150 mm

# KARGALY, KAZAKHSTAN

**Investment into hydropower**

After earlier successes in Kazakhstan with projects such as Issyk 2 in 2008 and Issyk 1 in 2016, ANDRITZ Hydro has now been awarded another contract in Central Asia. ANDRITZ Hydro received a contract for the supply of electro-mechanical equipment for the 2.97 MW Kargaly hydropower plant, located some 2 hours' drive southwest of the former Kazakh capital Almaty. Although the project owner has previously made successful investments in wind power, Kargaly is the company's first waterpower project.

The scope of supply for ANDRITZ Hydro comprises the complete electro-mechanical package, including a horizontal Francis turbine, the hydraulic power unit, synchronous generator and the main inlet valve. Along with the turbine control, automation and visualization systems, the supervision of installation and the commissioning will complete the scope of contract. The installation and commissioning of the turbine is planned for mid-2021.

Central Asia is an important and emerging hydropower market. With an office in Almaty as a regional hub, ANDRITZ Hydro has a finger on the pulse of regional hydropower development.

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### TECHNICAL DETAILS

Total output: 2.97 MW
Scope output: 1 × 2.97 MW
Head: 92.6 m
Speed: 750 rpm
Runner diameter: 737 mm

Example of a horizontal Francis turbine

# HYDRO NEWS

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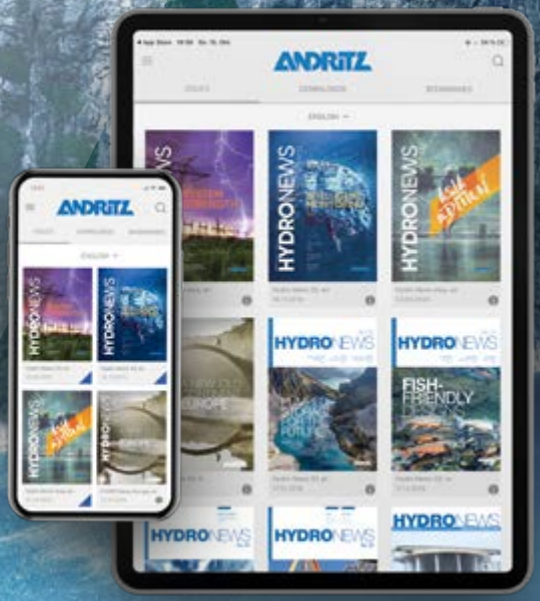


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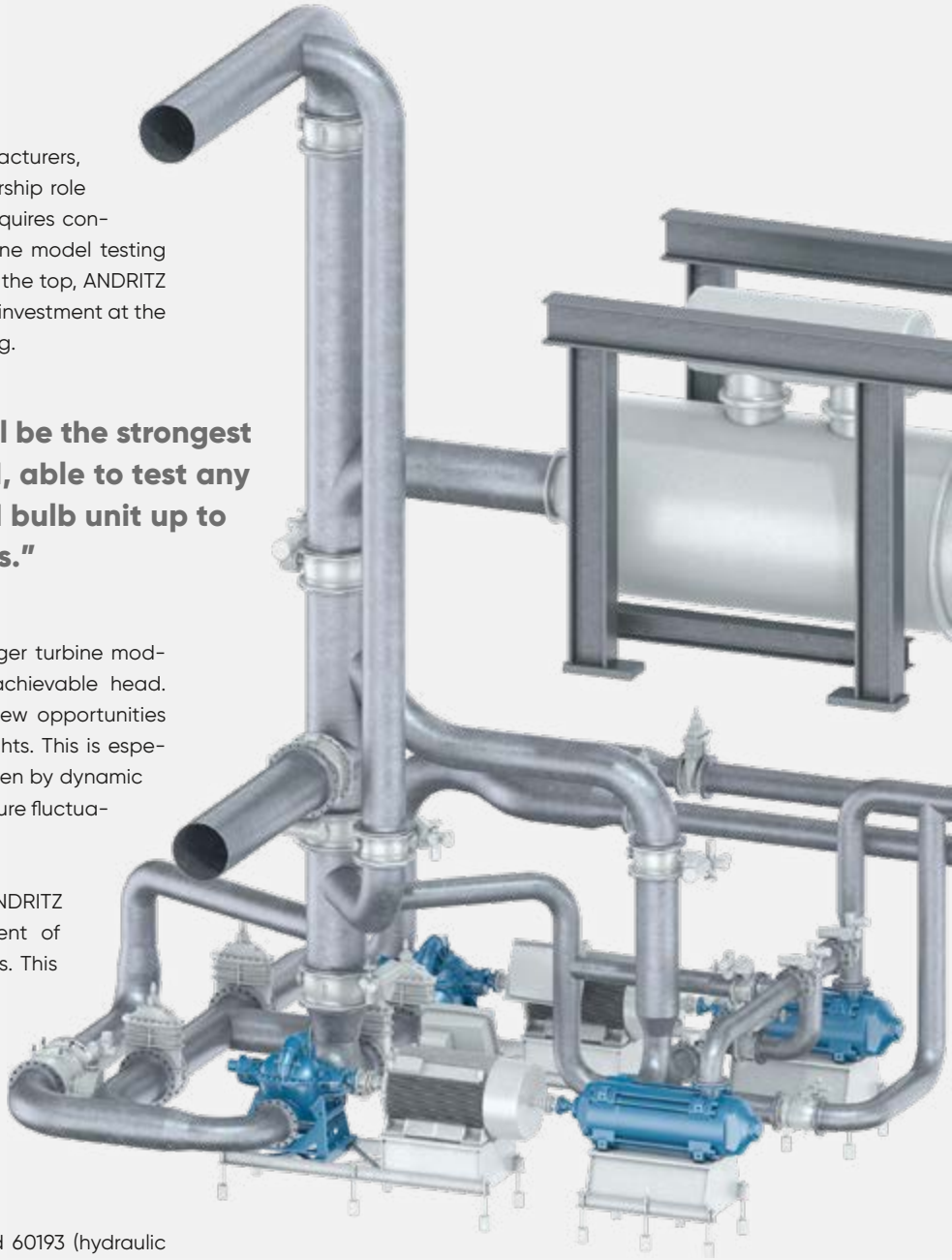
# TESTING FOR THE BEST – WITH THE WORLD'S STRON



**NEW HIGH-PERFORMANCE TURBINE MODEL TEST RIG HEADING FOR LINZ**

As one of the world's major turbine manufacturers, ANDRITZ considers it vital to maintain a leadership role in research and development. However, this requires continued investment to elevate the current turbine model testing technology to new levels. In order to remain at the top, ANDRITZ has now initiated an extensive program of R&D investment at the core of which is a new high-performance test rig.

**"The new ANDRITZ test rig will be the strongest universal test rig in the world, able to test any turbine type from a low head bulb unit up to high head multi-stage pumps."**

The new test rig will allow ANDRITZ to test larger turbine models and at more than twice the currently achievable head. Such a high-performance test rig will open new opportunities for research and enable further technical insights. This is especially important in key areas of technology driven by dynamic behaviour and multi-phase flows, such as pressure fluctuations, transient behaviours, and cavitation.

Due to the particularly high testing head, ANDRITZ will have new possibilities in the development of high-head Francis and pump turbine machines. This will enable ANDRITZ technology to rapidly advance, especially in key growth markets like pumped storage. An additional benefit will be that most Kaplan machines can be tested under prototype head conditions, providing new insights into the critical areas of cavitation and vortex formation.

Fully compliant with the relevant IEC standard 60193 (hydraulic turbines, storage pumps and pump turbines – Model acceptance tests), this new test rig will be the strongest universal test bed in the world. As such it will be able to test any turbine type from a low head bulb unit up to high head multi-stage pumps and will be more than twice as strong as the most powerful test rig currently available at ANDRITZ. It will enable not only research work, but also performance testing for customer acceptance tests. It will help to meet the very highest standards and the most extreme customer expectations of state-of-the-art testing technology.

The construction of the new test rig will be accompanied by an automation initiative resulting in an overall upgrade of ANDRITZ' turbine model testing facilities. This will allow increased flexibility and faster testing. The new test rig and the automation initiative will prove beneficial for both contractual work and pure R&D. All test rigs will benefit from the full integration of ANDRITZ' world-leading operation and maintenance system DiOMera, for example.

Due to be installed at the turbine test centre in Linz, Austria as the sixth testing line, the new test rig is expected to go into commercial operation by the end of 2021.

This substantial investment once again illustrates ANDRITZ' on-going commitment to leading research and development, particularly in areas related to key markets such as pumps and pump turbines.

# GEST R&D RIG

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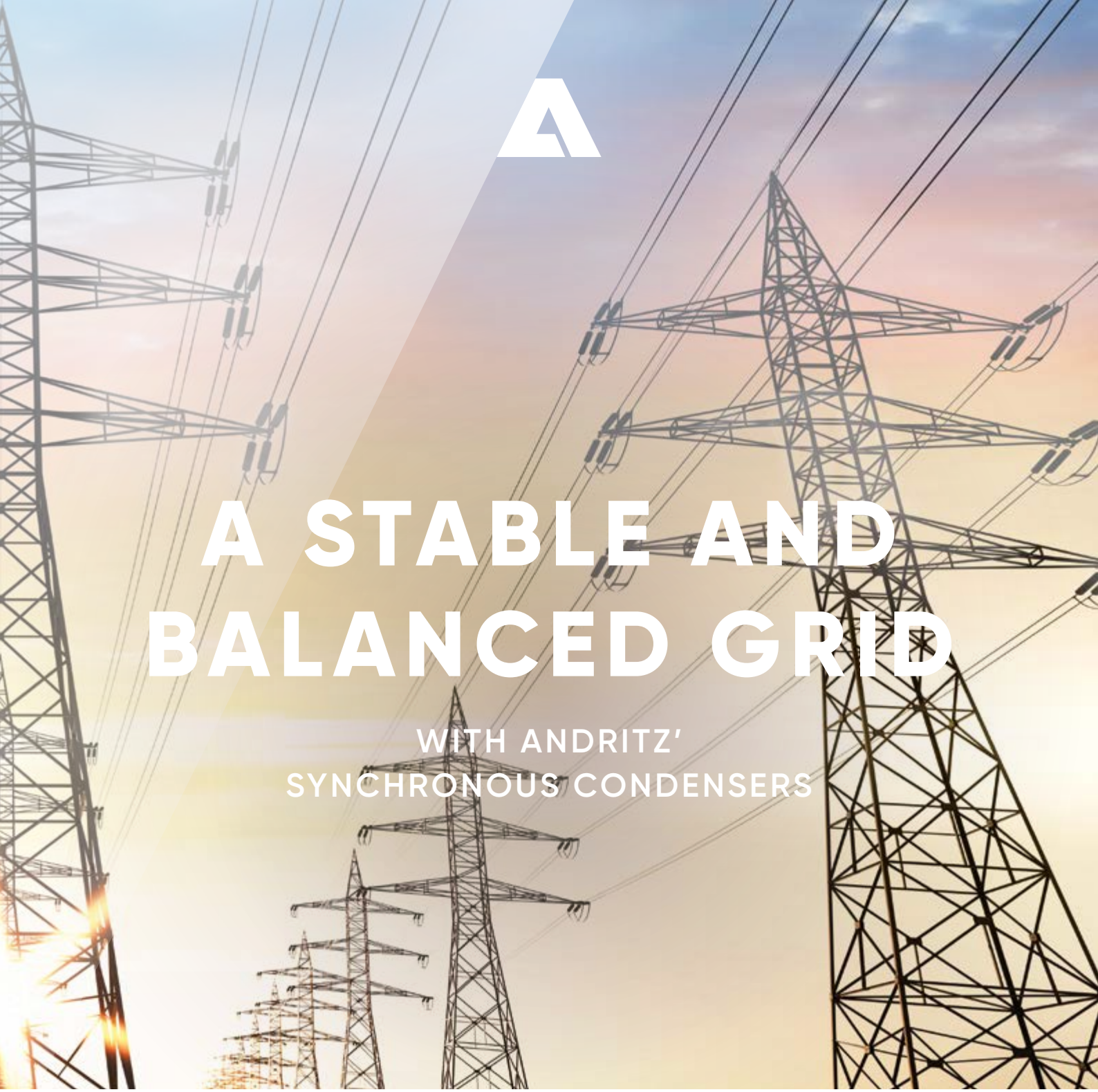
## BENEFITS:

- Strong commitment to the pump and pumped storage market
- Strong commitment to a leadership role in research and development
- Major upgrade and modernization of testing facilities

## PERFORMANCE DATA:

- Maximum testing head: 250 m
- Maximum discharge: 1.75 m³/s
- Maximum testing power: 1.25 MW
- Maximum torque: 6,000 Nm



# A STABLE AND BALANCED GRID

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From greenfield projects to modernization and uprating, ANDRITZ provides top-tier solutions for all kinds of Synchronous Condenser systems. ANDRITZ' engineering excellence is focused on the entire power train, from the Synchronous Condenser unit with its mechanical and electrical auxiliaries right up to the defined Point of Common Coupling (PCC) with the high voltage transmission system.

ANDRITZ' Synchronous Condensers – the smart solution.