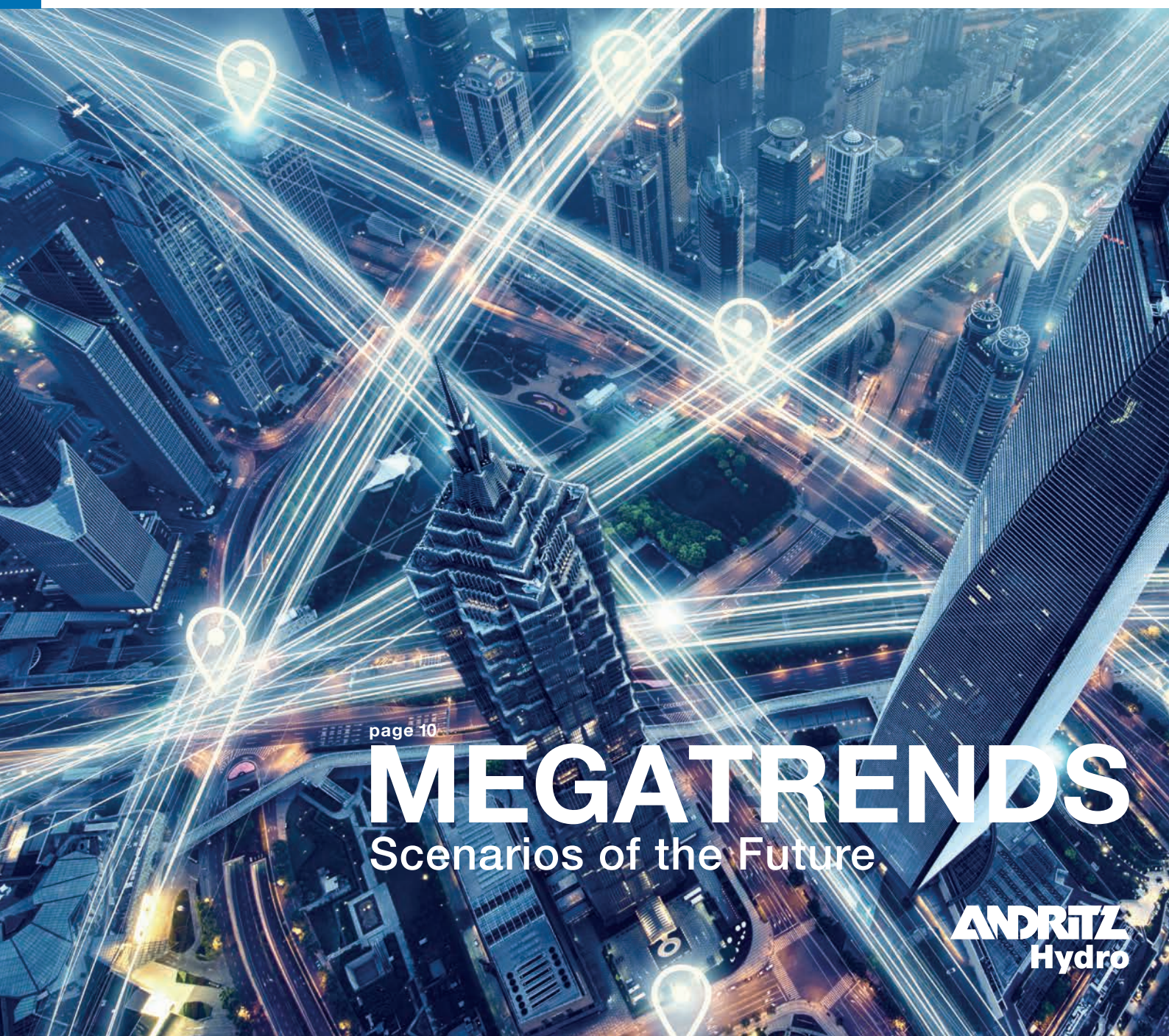
MAGAZINE OF ANDRITZ HYDRO | 02-2017 ENGLISH

SANTO ANTÔNIO
An Amazonian Example
of Sustainable Hydropower
(page 22)

HYDRONEWS

No.30



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MEGATRENDS

Scenarios of the Future

ANDRITZ Hydro

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Dear Business Friends,

Global demographic, technological and economic megatrends – such as urbanization, climate change, and the rising demand for electricity – will bring about major social and political changes over the coming decades to 2050. At ANDRITZ HYDRO we consider this "Scenario 2050" a motivating vision – finding tomorrow's solutions today.

So far, the enormous potential of hydropower has not been fully exploited. In fact, it can still make a significant contribution to the redesign of global energy supply on the road to sustainability.

At the moment the general conditions in the hydropower market are very challenging indeed. With investment levelling off, the market appears to be rather stagnating. However, in Europe and North America especially, further investments in the aging pool of facilities and in the expansion of pumped storage hydropower are needed urgently to ensure future network stability. In South America, Asia, and Africa, projects to harness vast hydro resources are under development.

This latest edition of Hydro News provides an overview of the various recent activities of ANDRITZ HYDRO worldwide. A special highlight is the completion of the hydropower plant Santo Antônio in the Amazon region of Brazil, which has the world's most powerful bulb turbines installed to date. The successful commissioning of this project, which went ahead on schedule, yet again underscores ANDRITZ HYDRO's high level of technical competence when it comes to low-head hydraulic power plants. Other examples include the new contracts for electro-mechanical equipment and hydraulic steelwork engineering for the Gouvães pumped storage power plant in Portugal, as well as for Nam Theun I in Lao PDR, Yusufeli in Turkey, and the John Day refurbishment project in the USA.

Each of these projects can be linked to at least one of the key megatrends mentioned above. In view of this, we are looking ahead to the coming developments in the hydropower market with optimism.

With kind regards and our sincere thanks for your continued trust

W. Semper

H. Heber

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Content

iPad App

Android App

Online magazine

Latest News

Fiji
Wailoa

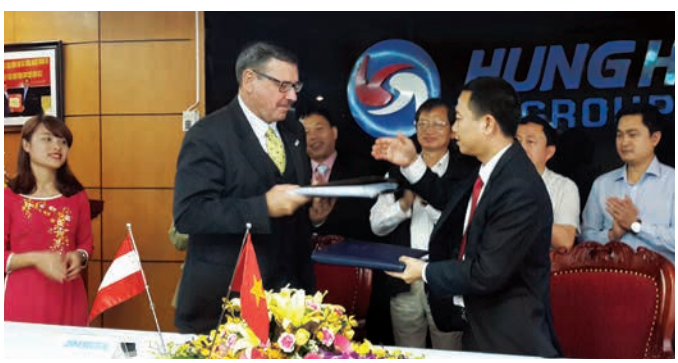
ANDRITZ HYDRO has received a further order for the replacement of three spherical valves at the Wailoa hydropower plant in Fiji, supplying up to 80 MW to the 150 MW grid on the main Fijian island of Viti Levu. The order was placed by the Fijian Electricity Authority.

A previously ordered main inlet valve also manufactured by ANDRITZ HYDRO was already installed with a station outage of only four days in 2016.

Vietnam
Nam Na 1

ANDRITZ HYDRO has received an order from Hung Hai Group of companies for the supply, supervision, and commissioning of the electro-mechanical equipment for the Nam Na 1 hydropower plant in Vietnam.

The hydropower plant is located on the Nam Na River, in the Lai Chau Province. With an installed capacity of 30 MW it will supply an annual average of 134 GWh of renewable energy to the national grid. The hydropower plant is scheduled to be put into commercial operation in 2018.



Costa Rica
Rio Macho

In December 2016, with the Final Acceptance Certificate (FAC) for unit five, Instituto Costarricense de Electricidad (ICE) completed the good collaboration with ANDRITZ HYDRO during the Rio Macho project in Costa Rica.

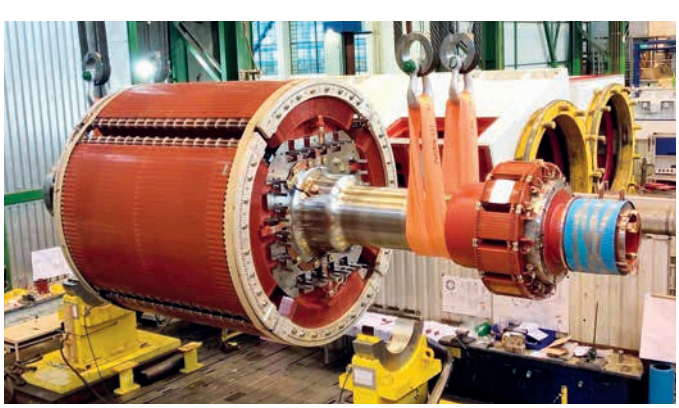
After this last step, all five units of the Rio Macho hydropower plant are rehabilitated and successfully put into commercial operation.

Germany
Langenprozelten

Since August 2016, the world's most powerful single-phase hydropower motor generator is in operation at the pumped storage power plant Langenprozelten in Germany. Dismantling and reassembling of the second machine will start in the second quarter of 2017 and should be completed until end of 2017.

With an output of 2 × 94 MVA, Langenprozelten is Deutsche Bahn's primary peak-load power plant, providing sufficient electrical energy to sustain 50 InterCity trains travelling at 200 km/h.

An article with detailed information about the refurbishment of the first machine was published in Hydro News 29.



Angola
Laúca

After two years of work, the rotor of unit #1 at the Laúca hydropower plant in Angola has been successfully installed.

This large project on the Kwanza River consists of two machine halls, for which ANDRITZ HYDRO is supplying electromechanical equipment for six 340 MW Francis turbines including generators, transformers, control and protection systems as well as auxiliary equipment.

DR Congo
Mwadingusha

ANDRITZ HYDRO has been awarded in a consortium a contract for the refurbishment of the existing Mwadingusha hydropower plant in the Katanga Province, DR Congo. The hydropower plant is equipped with six Francis units with a capacity of 11.8 MW each.

The scope of supply for ANDRITZ HYDRO comprises replacement of four turbine units, generators, governors, inlet valves, exciters, voltage regulations, and draft tube stop logs including dismantling, erection, and commissioning.

Uganda
Nkusi

In November 2016, ANDRITZ HYDRO received a contract for the complete electro-mechanical equipment for the new 9.6 MW Nkusi hydropower plant in Uganda.

The customer requested a complete “from water-to-wire” package to ensure a high quality delivery with minimal interphases and simplified logistics. The scope of supply for ANDRITZ HYDRO consists of engineering, two identical horizontal Francis turbines, generators, and all equipment and installation up to the 33 kV switchgear. Transportation up to Nkusi site, supervision of installation, and commissioning complete the contractual scope of supply. The HPP Nkusi project should be completed mid-2018.

Rwanda
Rusumo Falls

In November 2016, ANDRITZ HYDRO signed a contract for design, supply, installation, and commissioning of electromechanical equipment for the Rusumo Falls Hydroelectric Project with Rusumo Power Company Ltd. The new power station will be located at the border between Rwanda and Tanzania. The project is a joint development of three east African nations Burundi, Rwanda and Tanzania.

ANDRITZ HYDRO’s scope of supply comprises the delivery of three 27,5 MW vertical Kaplan turbines and its auxiliaries, generators, EPS, powerhouse cranes, draft tube gates and stop logs as well as the control and protection system of the whole power plant. Completion of the project is planned for the end of 2019.

Tedzani III

by Walter Schwarz
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Shire River

Machine hall before rehabilitation

Malawi – The Electricity Supply Corporation of Malawi Ltd (ESCOM) and ANDRITZ HYDRO signed a contract for rehabilitation, modernization and upgrading of the Tedzani III hydropower station in March 2016.

HPP Tedzani III is located in southern Malawi, about 100 km northwest of the city of Blantrye – Malawi's center of finance and commerce and the second largest city in the country. The majority of the country's hydropower stations are located on the Shire River; such as HPPs Nkula A and Nukla B, HPPs Tedzani I, II and III, and HPP Kapichira. Impressively, more than 90% of Malawi's power generation comes from hydropower.

ESCOM will execute the Tedzani III project together with ANDRITZ HYDRO as the original equipment manufacturer (OEM). The existing units were first commissioned in 1995–1996. ANDRITZ HYDRO will be responsible for design, manufacturing, supply, installation, and commissioning of a completely new control and SCADA system, new excitation, protection and synchronization systems, as well as specifically defined repair and replacement works on turbines and generators.

All installation works will be done by local ESCOM staff under supervision of ANDRITZ HYDRO. Specialist training in Malawi as well as in Austria also forms part of the contract. A project team from ANDRITZ HYDRO Austria is committed to complete the project within less than 20 months, so the Tedzani III hydropower plant will be put back into operation by the end of 2017.

Following the projects HPP Nukla A, HPP Tedzani I and II and HPP Wovwe, the order for HPP Tedzani III is the fourth contract for ANDRITZ HYDRO in Malawi. Recently, a further contract for a Generation Control and Monitoring System (GCMS), which is interfacing with all ESCOM hydropower plants has been awarded to ANDRITZ HYDRO. As such it underlines the technological know-how and confirms the high professionalism of ANDRITZ HYDRO employees.

TECHNICAL DATA	
Output	2 × 25.6 MW
Head	44.80 m
Speed	187.50 rpm
Runner diameter	2,950 mm

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Song Lo 6

by Xu Wenye
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Nearby HPP Song Lo 6 site

Vietnam – In 2016, ANDRITZ HYDRO received a contract for the delivery of electro-mechanical equipment for the Song Lo 6 hydropower plant from Xuan Thien Ha Giang Company Limited – a civil works company enlarging its field of activities into hydropower and developing several projects in Vietnam. Following the order for HPP Hang Dong A in 2012, this is the second project awarded to ANDRITZ HYDRO by this customer.

HPP Song Lo 6 is located on the Lo River in the two Vietnamese provinces of Ha Giang and Tuyen Quang. The hydropower plant is designed with an installed capacity of 60 MW. Once completed and synchronized with the national grid, the facility is expected to produce about 242 GWh of electrical energy per year.

For the newly built run-of-river plant ANDRITZ HYDRO will deliver three 20 MW turbines with oil-free hubs and accessory equipment. Further parts of the contract are the installation supervision and support during commissioning. ANDRITZ HYDRO has to meet a narrow time schedule for design and delivery; 19 months for unit #1, 20 months for unit #2 and 21 months for unit #3 were agreed upon.

On the occasion of the groundbreaking ceremony of HPP Song Lo 6, which took place in September 2015, the investor made a charitable donation to the Son Ca Kindergarten in the Vi Xuyen District, Ha Giang Province and the Vinh Hao and Yen Thuan communes.

After start of commercial operation in 2018, HPP Song Lo 6 will significantly contribute to the security of national energy supplies, ensure water resources for agricultural production and boost socio-economic development in the southern provinces.

TECHNICAL DATA		
Output	3 × 20	MW
Voltage	10.5	kV
Head	10.5	m
Speed	107.14	rpm
Runner diameter	5,500	mm
Av. annual production	242	GWh

John Day Lock and Dam

by Jack Heaton
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View of the dam

USA – In June 2016, the US Army Corps of Engineers, Portland District, awarded a contract to ANDRITZ HYDRO for the upgrade of the Kaplan turbine hubs of the John Day Lock and Dam hydropower station, in the northwest of the United States of America.

With a total installed capacity of 2,160 MW, HPP John Day Lock and Dam is the fifth largest hydropower facility in the United States. It is fed by Lake Umatilla, a reservoir running 123 km up to the foot of HPP McNary Dam.

Primary construction works of the run-of-river power plant began in 1958 and were completed in 1971, at the time making it the newest dam on the lower Columbia River with the highest lift (34 m) among all locks in the United States. The powerhouse is equipped with a total of 16 units, each with an output of 135 MW. All turbines and generators were originally provided by ANDRITZ HYDRO's predecessor companies.

After a half century of operation, some of the turbines have passed or are nearing the end of their design lives, especially the hub internals. This contract includes work on four units and a fifth unit as an option. ANDRITZ HYDRO will disassemble the entire turbine-generator unit, repair the Kaplan runner on-site, replace as-needed wearing components, install new runner hub internals, refurbish as-required mechanical components off-site, reassemble the unit, and perform testing and commissioning after the installation. Following the repair, all the runners under the contract will function as double-regulated Kaplan runners.

Prior to this award, ANDRITZ HYDRO successfully completed the Hills Creek turbine replacement and unit rehabilitation project for the same customer. Should the fifth unit option be exercised, the entire project is expected to be completed by 2021.

TECHNICAL DATA	
Output	16 × 135 MW
Voltage	13.8 kV
Head	30 m
Speed	90 rpm
Runner Diameter	7,925 mm
Av. annual production	8,418 GWh

Wettingen

by Christoph Bütikofer
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Switzerland – A contract for the refurbishment and revision of the electromechanical equipment at the Wettingen hydropower plant in the Swiss canton of Aargau was awarded to ANDRITZ HYDRO in June 2016.

Built in the years 1930–1933, HPP Wettingen utilizes the waters of the river Limmat between the upstream power plant of Dietikon and the downstream facility of Baden-Aue.

Under the terms of the contract awarded by Elektrizitätswerk Zürich (ewz), the public energy utility of the City of Zurich, ANDRITZ HYDRO's scope of supply includes the revision and refurbishment of essential components of the three units. In addition, ANDRITZ HYDRO will conduct hydraulic model tests for the design of the new turbine blades, which are expected to raise the annual output of the facility by 4%.

Working in close collaboration with ewz to identify relevant operating conditions as accurately as possible, the turbines were examined for their optimization potential and specific solutions developed. ewz decided in favour of a solution that reduces operating costs while maximizing the availability of the units and ensuring their safe operation. Based on an initial analysis of the turbine shafts' remaining useful life, it was decided to replace them as well and to optimize the shaft coupling and gasket construction at the same time. Essentially, the rehabilitation of the generators comprises control, dry-ice cleaning, and revision of the stators and rotors as well as the revision of the poles at the workshop in Kriens, the installation of new oil mist extractors, and the revision, modification and replacement of various pumps, bearings and instruments. Due to the narrow dimensions of the installation, the new exciter had to be specially manufactured and optimized for use with the generator.

Birdview of the powerhouse and dam area

Having a single-source supplier for the entire electro-mechanical equipment has a lot of advantages. The ability to leverage synergies in terms of order processing, installation, revision, and commissioning means less coordination effort and lower costs for the customer.

The handover of the model test results is scheduled for December 2016. On-site refurbishment work will start with the first unit in September 2017 and is scheduled to be completed by April 2018. The other units will be refurbished successively at one year intervals, which means the last unit is scheduled to be handed over to the customer for commercial operation in April 2020.

This project not only reinforces a long-standing business partnership with ewz, but also strengthens ANDRITZ HYDRO's position as a single-source supplier for service and refurbishment projects in Switzerland.


Powerhouse

TECHNICAL DATA	
Output	3 × 8.5 MW / 3 × 10 MVA
Voltage	6.4 kV
Head	21.5–23 m
Speed	214.3 rpm
Runner diameter	2,835 mm
Av. annual production	135 GWh

by Alexander Schwab
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and Peter Stettner
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We are living in a changing world, a rapidly changing world. Even though these changes are marked over years or even decades, they are long-term and fundamental. They are shaping the future of all nations, countries, social structures, and of every individual. And they are happening today.

MEGATRENDS SCENARIOS OF THE FUTURE

The biggest changes are encompassed in so-called megatrends. The most important of these megatrends are urbanization, shifts in economic power, demographic change, climate change, resource stress, and technology development. It is in this context that people are discussing a “Scenario 2050”.

Forecasts that the global population will be about 10 billion people in 2050 mean that energy demands will have at least doubled by then when compared with today. This situation poses a challenge for politics, economics, and research. It’s a challenge that requires serious consideration today.

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

Urbanization

In 2050, half of the world’s population will live in major urban centers and there will likely be at least 40 cities with more than 10 million inhabitants. Megacities such as New York, São Paulo, Cairo, and Beijing will have to make billions of dollars of infrastructure investment within the next 10 years. Urban technologies to keep growing cities viable are racing ahead. An example is the emergence of “smart cities” in which inhabitants can interact intelligently and efficiently with their urban environment. But despite increasing energy efficiency, the energy demands of such megacities will be enormously high.

Currently cities cover just 0.5% of the earth’s surface. However, they consume some 75% of global resources.

Climate change and resource scarcity

Population increases, urbanization, and increasing energy demand will ensure that conventional energy sources will reach their limits in the near future. With respect to current consumption data, it appears that in just a few decades it will no longer make economic sense to harness fossil fuels. Regardless of this, existing fossil reserves will still be used extensively causing additional increases in greenhouse gas emissions, resulting in global warming. The goal reached at the climate summit in Paris at the end of 2015 to limit global warming to less than 2°C will only be achieved with extreme efforts. Integrated solutions that optimally combine renewable energies are already in demand today and will be even more so in the future.

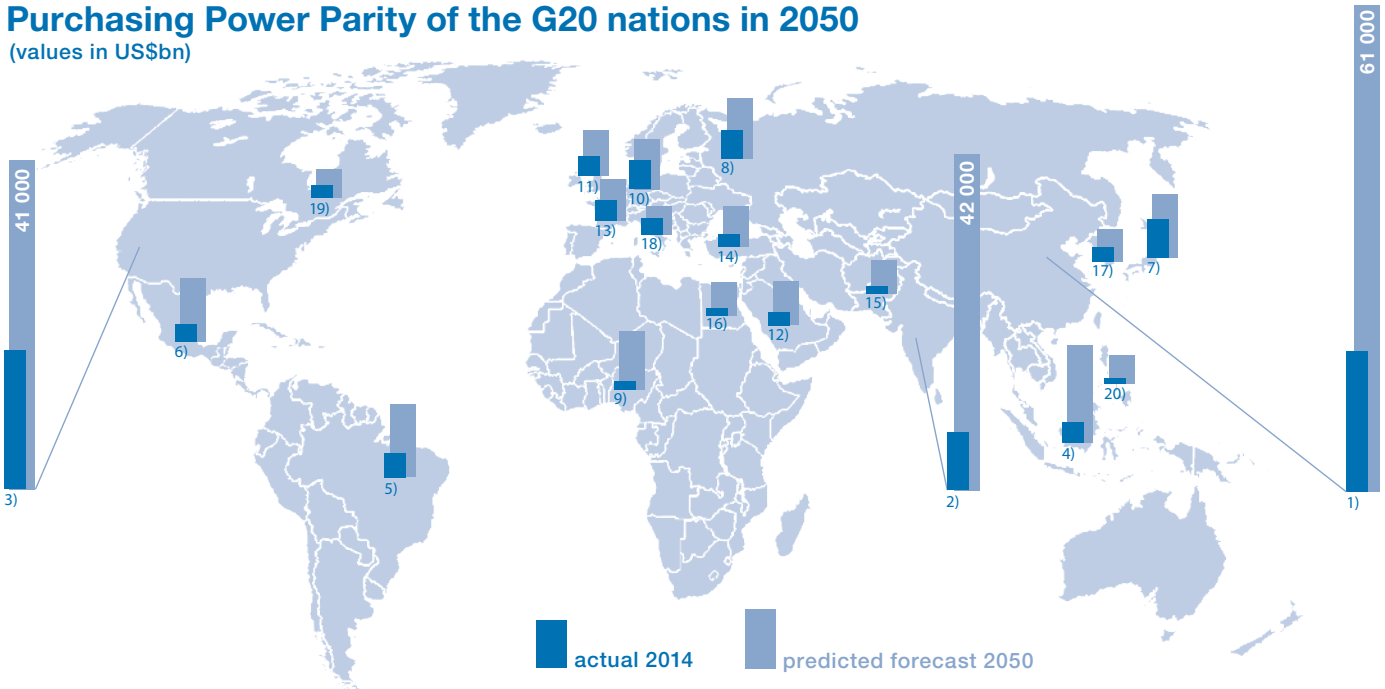
Demographic and social developments

Regional differences in demographic development could not be more dramatic. In the future, the majority of the world's population will be over 65 years old, especially in the industrialized nations. On the other hand, the population of Africa will probably have doubled by 2050, while the population of Europe will shrink. By this time, individual countries in Africa could have more inhabitants than the USA has today.

Overall, the world’s population increases by about 150 people every minute.

Purchasing Power Parity of the G20 nations in 2050

(values in US$bn)



*G20 nations according to GDP at PPP (Purchasing Power Parity) ranking: 1) China, 2) India, 3) USA, 4) Indonesia, 5) Brazil, 6) Mexico, 7) Japan, 8) Russia, 9) Nigeria, 10) Germany, 11) United Kingdom, 12) Saudi Arabia, 13) France, 14) Turkey, 15) Pakistan, 16) Egypt, 17) South Korea, 18) Italy, 19) Canada and 20) Philippines.

Based on the study "The World in 2050" by PWC, dated February 2015

Shift in global economic power

The way individual national economies are classified will become less relevant in the future. Increasing incomes and closing wage gaps will lead to a growing global middle class. Markets grow unpredictably, however. For example, China and Mexico have grown exceptionally over the last years, whereas countries in Europe have seen their economies stagnate. To reflect these changes we have to adjust our view of the global economy. Some markets will become more important due to the value chain and become core markets for global businesses. Developed countries will benefit from a more diverse business culture, skilled talent will be spread multinationally, education and health care will become more important indicators.

Today's frontier markets will become future emerging markets. Today's emerging markets will become future core markets.

Technological breakthrough

Technology development is an underestimated force today, but will gain more and more importance as a major component in the re-shaping of the future economy. The time it takes from invention to breakthrough to mass application is getting shorter and shorter. For example, it took 76 years for the telephone to reach half the population, the smart phone took only about a decade.

Digitalization has had a profound impact not only on society, but also on the economy. Today the value created by technology, especially internet-based technology, is extraordinary. The importance of e-commerce, interconnectivity and digital brands is crucial for industry. Social media, mobile applications and cloud services to meet the customers' needs are already vital parts of future strategy to succeed in the digital age.

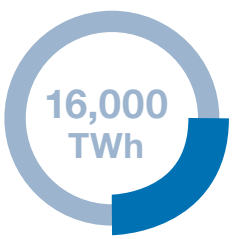
The role of hydropower in the future

In a time when producing fossil resources is becoming less economical and energy demands continue to climb, a compromise between the needs of the present and responsibility to future generations has to be found. Hydropower is the most proven and best-developed form of renewable electricity generation. Increasing awareness of global climate change

and sustainable electricity generation, social responsibility on the part of politics, as well as an increasingly critical attitude toward CO_2 emissions from fossil fuels, will cause demand for hydropower to increase in the coming years.

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

technically feasible hydropower potential



25% (4,000 TWh) exploited as per today

Hydropower is sustainable, renewable, and flexible, has many benefits and great potential. It is the answer to many of the questions posed for the future. Constant research and development will ensure that hydropower remains the most important renewable energy resource, as it is today.

The traditional approach to the operation of hydropower facilities has to be reconsidered though. New demands are fast response times, frequent load changes, and extended operational ranges. Anticipated future requirements include calls for frequency regulation by run-of-river power plants, mini pumped storage for balancing small wind farms, ocean energy applications combined with off-shore wind farms, small hydro to balance the impact of clouds passing over a solar plant, as well as upgrading all existing power plants to new standards and network codes, and linking them with the state-of-the-art automation systems of the digital world.

For ANDRITZ HYDRO, the changing future is a big motivation to find tomorrow's solutions today. The immense potential of hydropower has by no means been fully exploited – it can still make a significant contribution to the redesigned and sustainable future energy supply system.

"From water-to-wire" 2050

Çoruh River, near Deriner Dam

Yusufeli

by Özkan Yilmaz
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Turkey – ANDRITZ HYDRO received a second order within 12 months for the Yusufeli hydropower project in Turkey in September 2016. The actual order for three generating units and related equipment follows the recent contract for supplying the intake structure, as well as the penstock and gates (see Hydro News 29).

The impoundment facility is located on the Çoruh River in northeastern Turkey, upstream of HPP Borçka, HPP Muratli, and HPP Deriner. As with these plants, HPP Yusufeli is also owned by General Directorate of State Hydraulic Works (DSI), a company which has already been working with ANDRITZ HYDRO on these projects, as well as HPP Ermenek and HPP Ilısu, which is currently under construction.

The new Yusufeli hydropower plant will have a total installed capacity of 558 MW with a rated head of 191 m and a rated discharge of 107 m^3/s. The dam is of double-curvature type and with a height of 270 m from its foundation it will be Turkey's highest and the third highest dam of this kind worldwide.

ANDRITZ HYDRO's contractual scope of supply comprises design, supply, installation, and commissioning of three generating units, each with a rated output of 186 MW, main power transformers, 380 kV switchyard equipment (AIS and GIS), and all relevant control, measuring, and protection equipment.

With the focus on providing premium quality under challenging circumstances, handing over of the units is planned within 33 months after commencement of the works. ANDRITZ HYDRO takes advantage of its international structure, so several ANDRITZ HYDRO companies in close co-operation are contributing with supplies to the plant. ANDRITZ HYDRO Turkey will provide major equipment for the electrical power system and installation services. ANDRITZ HYDRO Austria will supply the turbine runners and governors. The generator and automation system will be provided from ANDRITZ HYDRO India, whereas the turbine auxiliary systems as well as main inlet valves will be supplied by ANDRITZ HYDRO China.

The start of commercial operation is scheduled for the third quarter of 2019. This contract strengthens again ANDRITZ HYDRO's leading position in the Turkish hydropower market.

TECHNICAL DATA		
Output	3 × 186	MW
	3 × 203	MVA
Head	191	m
Speed	214	rpm
Runner diameter	3,500	mm
Av. annual production	1,888	GWh

Huinco & Matucana

by Peter Gnos
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Powerhouse of HPP Matucana

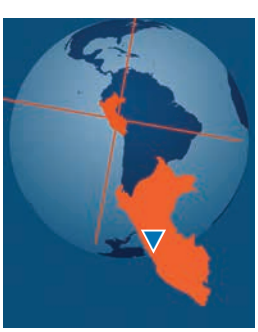
Peru – In June 2016, ENEL Generación Perú S.A.A. and ANDRITZ HYDRO signed a contract for rehabilitation works at the two Peruvian hydropower plants Huinco and Matucana. With a capacity of 1,283.8 MW (739.4 MW thereof produced by hydropower) Edegel S.A.A. is the largest private electric generation company in Peru.

Huinco and Matucana hydropower plants are located in the province of Huarochirí, about 70 km east of Lima. After continuously operation of more than 40 years, the rehabilitation of two generators at HPP Huinco and one generator at HPP Matucana is necessary.

The Huinco storage power plant is the result of an electric expansion plan intended to adequately meet the future electricity demand in the 1920s, using the waters of the Rímac and Santa Eulalia Rivers. After damming up the lakes on the Santa Eulalia River, diverting the waters of the Rímac River to the Santa Eulalia River, and building the Callahuanca, Moyopampa, and Huampaní hydropower plants, a trans-Andean tunnel was built in the early 1960s to provide sufficient water for HPP Huinco. HPP Huinco has an installed capacity of almost 265 MW. The first of the four horizontal Pelton turbines was commissioned in 1964. Currently, it has the highest head used to produce hydroelectric energy in Peru (1,293 m). HPP Huinco was built in a cavern, due to the river course of the Santa Eulalia, which runs near HPP Huinco through a narrow gorge and enforced the construction of an underground powerhouse.

HPP Matucana is located in the highlands of Lima and is fed by the Rímac River and the Yuracmayo dam. The run-of-river power plant began its power generation in 1972. It has an installed capacity of 137 MW and counts two double horizontal Pelton turbines. The intake is connected to the plant via a 20 km long tunnel. The reservoir tank at Matucana is made up of two 500 m long underground chambers, with a capacity of 30,000 m³ each. Thanks to these chambers, the plant's nominal capacity could last up to three hours, even during dry periods.

Both projects will be carried out by ANDRITZ HYDRO Peru and Austria. The scope of delivery comprises new complete stator windings for two units at HPP Huinco a new stator for HPP Matucana, as well as installation, supervision, electrical tests and commissioning. At present, the engineering process is finished and approved by the client and the manufacturing of components in the ANDRITZ HYDRO workshop in Araraquara, Brazil, has already started. All works on-site will be carried out between 2017 and 2019.



Machine hall of HPP Huinco

TECHNICAL DATA		
Huinco		
Output	265	MW
Voltage	12.5	kV
Head	1,245	m
Speed	514	rpm
Stator diameter	3,300	mm
Matucana		
Output	137	MW
Voltage	12.5	kV
Speed	450	rpm
Stator diameter	3,400	mm

Nam Theun I

by Oliver Gielesberger
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Region close to HPP Nam Theun I

Lao PDR – In August 2016, ANDRITZ HYDRO received an order from Phonesack Group (PSG) to supply electro-mechanical equipment for the Nam Theun 1 hydropower project in Lao PDR.

Lao PDR is a landlocked and mountainous country with borders to Myanmar, China, Vietnam, Cambodia, and Thailand. The Mekong River acts as a major part of the Laotian border and also represents a large part of the country's enormous hydropower potential. By developing these resources the Laotian government intends to transform the country into "the Battery of Southeast Asia".

HPP Nam Theun I aims to contribute to the Lao PDR's development by creating revenues from the export of electricity, as well as covering future increases in domestic demand.

The Nam Theun I hydropower storage scheme is located on the Nam Kading River, about 33 km upstream of its confluence with the Mekong River. It is the last plant in the Nam Theun-Nam Kading Hydropower Cascade. The inflow reaching the Nam Theun I reservoir is affected by the existing upstream hydropower plants including HPP Theun Hinboun, HPP Theun Hinboun Expansion, and HPP Nam Theun II. ANDRITZ HYDRO completes its supply of electro-mechanical equipment in this cascade by supplying the last plant on the river.

The hydropower plant houses three units with a total output of about 662 MW. The scope of supply for ANDRITZ HYDRO comprises design, manufacturing and supply of the complete electro-mechanical equipment, including three vertical Francis turbines, model test, generators, governors, and automation system. The scope also includes the main transformer, medium- and low-voltage switchgears, power and control cables, fire protection system, 500 kV GIS, the main inlet valve, mechanical auxiliaries, installation supervision, and commissioning. Commercial operation is scheduled for the end of 2020.

Following HPP Huay Ho, HPP Nam Theun II, HPP Theun Hinboun and HPP Nam Lik, this is a further private hydropower plant in Vietnam to be equipped with the state-of-the-art equipment of ANDRITZ HYDRO.

TECHNICAL DATA

Output	2 × 265 MW / 1 × 132.5	MW
Head	140	m
Speed	2 × 187.5 rpm / 1 × 250	rpm
Runner diameter	2 × 4,450	mm
	1 × 3,250	mm

Gouvães

by Franco Michele Bennati
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Portugal – ANDRITZ HYDRO has been contracted by the Spanish energy utility Iberdrola Generación S.A.U. to supply the electro-mechanical equipment and the penstock for the new pumped storage power plant Gouvães in Portugal.

With four 220 MW pump turbines PSPP Gouvães will be the heart of the Alto Támega hydropower scheme, consisting of three hydropower plants. The scheme will be built on the Támega River in northern Portugal, close to the seaport of Porto. Together with HPP Alto Támega and HPP Daivoes, the Gouvães pumped storage power plant will produce in total 1,468 GWh of electrical energy. PSPP Gouvães will cover the need for peak-load energy and provide fast-responding regulating power. Together with the baseload generation from the other two power stations of smaller size, this scheme will ideally complement volatile electricity generation from wind power, which has been growing significantly in recent years. Additionally, the project will have a very positive impact on the employment situation in the region.

The scope of supply for ANDRITZ HYDRO comprises design, manufacturing, delivery, and installation supervision for the reversible pump turbines, motor generators, and electrical power systems. Also part of the contract are design, manufacturing, supply, and complete installation of a penstock including three bifurcators with a total weight of about 12,000 tons, an average diameter of about 5,400 mm and a length of 2.5 km.

With a net head of about 660 m, to provide a safe basis for the design of the technically outstanding high head pump turbines extensive research and model testing activities have been performed in ANDRITZ HYDRO's test laboratory. Thus, the high requirements of Iberdrola Generación regarding feasibility and reliability will be met in an optimum way.

This is the third large contract between Iberdrola Generación and ANDRITZ HYDRO on the Iberian Peninsula, after having received the contracts for equipment deliveries for the San Pedro II hydropower plant in 2011 and for modernization of the Aldeadávila hydropower plant in 2014.

TECHNICAL DATA	
Output	880 MW
Head	660 m
Speed	600 rpm
Runner diameter	3,500 mm

Penstock area

Búrfell mountain

Búrfell Extension

by Michael Stadler
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Iceland – Icelandic utility Landsvirkjun has awarded a contract to ANDRITZ HYDRO for the supply of electro-mechanical equipment and control systems for the Búrfell Extension hydropower station in Iceland.

Located about 130 km east of Reykjavík, the existing Búrfell hydropower plant has been operating continuously since 1969. It is equipped with six Francis units with a total output of 270 MW, providing 2,300 GWh of electrical energy annually to the national grid. Until the inauguration of HPP Kárahnjúkar in 2007, it was the largest hydropower plant in the country.

The new HPP Búrfell Extension project is located about 2 km from HPP Búrfell at the foot of the Sámsstaðaklif depression. A 100 MW Francis turbine will be installed in a separate underground powerhouse. This new unit will increase the total capacity of the combined Búrfell hydropower stations by 300 GWh per year.

ANDRITZ HYDRO's scope of supply comprises the delivery and installation of the turbine and its auxiliaries, the generator, the electrical power system, MV and LV systems, a fire extinguishing system, the powerhouse cranes, the auxiliary systems, as well as the control and protection system of the whole power plant.

In June 2016, the first important milestone – the model acceptance test – was performed together with the customer in the ANDRITZ HYDRO hydraulic laboratory in Canada. Existing components from various developed projects were used to build a Búrfell Extension model. During the witness tests the combination of those components could be successfully verified. The use of existing hydraulic components made it possible to start the inquiry process of components with a long delivery lead time directly after the project commencement.

With an overall project duration of 26 months from commencement, the delivery and completion dates of this project are tight. Hence, the project management requires high performance engineering to place purchasing orders in due time, as well as a clear focus on the interface management, and close monitoring of sub-suppliers.

The Búrfell Extension hydropower station is expected to start operation in 2018.

TECHNICAL DATA

Búrfell		
Output	6 × 45	MW
Voltage	13.8	kV
Head	115	m
Speed	300	rpm
Runner diameter	2,460	mm
Av. Annual production	2,300	GWh
Búrfell Extension		
Output	1 × 100	MW
Voltage	13.80	kV
Head	119	m
Speed	230.70	rpm
Runner diameter	3,190	mm
Av. Annual production	300	GWh

View of the dam

Manic-5

by Francoys Gauthier
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Canada – In June 2016, ANDRITZ HYDRO received a contract from Hydro-Québec for the rehabilitation of turbine spherical inlet valves at the Manic-5 hydropower plant in the administrative region of Côte-Nord in Québec.

HPP Manic-5 is situated on the Manicouagan River at the Daniel-Johnson Dam. With a height of 214 m, a length of 1,314 m, and 2.200,000 m^3 of concrete, Daniel-Johnson Dam is the highest multiple-arch-and-buttress dam in the world.

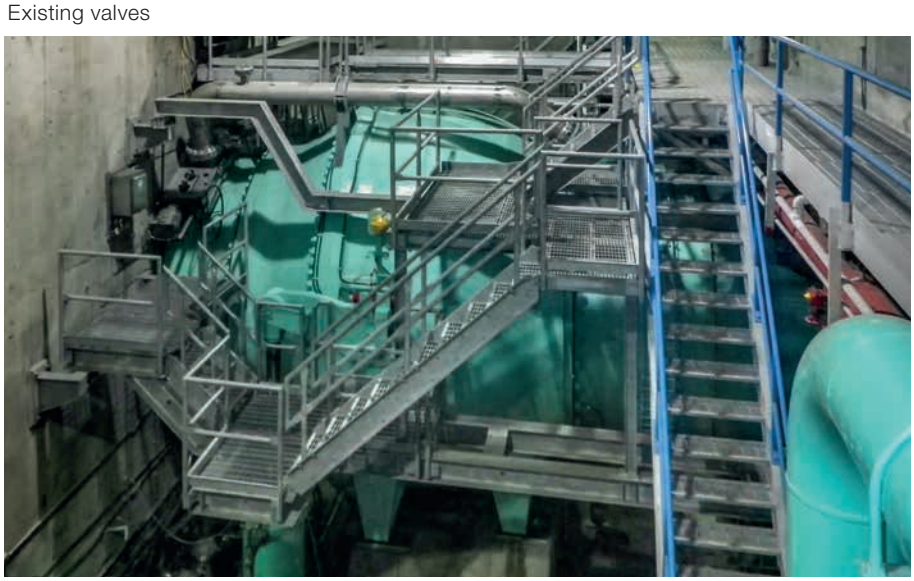
ANDRITZ HYDRO is very familiar with the project, since the company was the Original Equipment Manufacturer (OEM) of the valves back in the 1970s. The current contractual scope comprises engineering, supply, dismantling, refurbishment, and reassembly of the valves of six out of eight units at a rhythm of two per year. The scope of work also includes new electrical and hydraulic control panels, instrumentation, piping and platforms, as well as refurbishment of servomotors and levers. An anti-auto-oscillation hydraulic control system will also be provided preventing oscillation phenomena. In order to eliminate the old greasing system, self-lubricating bearings will be supplied to replace the old bronze bushings. The project, including all engineering activities, is being managed by ANDRITZ HYDRO Canada.

Works on the first two units at site will start in March 2017. A very challenging aspect of the project is that the valves cannot be removed from site or brought to a workshop for refurbishment works. The site set-up does not allow it as there is not enough access space outside the valve gallery and the overhead crane does not have the necessary lifting capacity. For the same reason, the valves cannot be completely dismantled. Much of the refurbishment work, including inspections, grinding, welding, machining, and painting, has to be done on-site directly in the valve gallery.

Following commissioning of the last two units completion of the contract is scheduled for October 2019.

TECHNICAL DATA		
Output	1,528	MW
Head	142	m
Valve nominal pressure	15.2	bars
Valve nominal diameter	3,658	mm

Existing valves



Pembelik

by Burak Celikel
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Turkey – In the summer of 2016, the Pembelik hydropower plant on the Euphrates River in Turkey was finalized and started commercial operation. The order for the project was awarded to ANDRITZ HYDRO in 2011 by Darenhes Enerji Üretim A.Ş. – together with a contract for HPP Tatar, which started commercial operation in 2014 (see Hydro News 25).

The Pembelik hydropower plant is located on the Peri Stream River, a major branch of the Euphrates which runs between the provinces of Tunceli, Bingöl and Elazığ and within the borders of the Karakoçan district in Turkey. HPP Tatar is situated downstream of HPP Pembelik. Both projects were won following an international bidding process, with ANDRITZ HYDRO succeeding through both its technological know-how and the best offer, as well its extensive expericence in the Turkish market.

The agreed time schedule was challenging from the beginning, but HPP Pembelik was completed and handed over to the customer for commercial operation two months earlier than the contractual handover date.

View of the hydropower station area

Machine hall

ANDRITZ HYDRO's contractual scope comprised design, engineering, manufacturing, transport, and installation of turbines, generators, and electrical equipment as well as supply of an automation and protection system. In addition a 161 kV switchyard, two feeder stations, and equipment training on-site were also part of the deal.

Executed by ANDRITZ HYDRO locations in Austria and Turkey, the design and supply of turbine and generator core equipment, the protection, automation and excitation system were provided by ANDRITZ HYDRO Austria. The delivery of the 161 kV switchyard and the special components of the turbine – like the head cover, bottom ring, and stay ring – and of the generator – like the rotor spider, lower and upper brackets – as well as installion service were provided by ANDRITZ HYDRO Turkey.

HPP Pembelik has two units with a total capacity of 131.6 MW and will deliver 372 GWh of electrical energy per year to the national grid.

TECHNICAL DATA		
Output	2 × 65.8	MW
	2 × 74.2	MVA
Voltage	13.8	kV
Head	69.8	m
Speed	166.7	rpm
Runner diameter	3,620	mm
Av. Annual production	372	GWh

Transportation of the rotor

Reisseck II

by Walter Scheidl
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and Rupert Kirchengast
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Austria – Commercial operation of the new pumped storage power plant Reisseck II in Austria started in October 2016.

Owner VERBUND has awarded a contract to ANDRITZ HYDRO for the delivery of electro-mechanical equipment, the control system and protective infrastructure in 2013 (see Hydro News 24).

As part of the Malta-Reisseck Power Plant Group – the largest group of hydropower plants in Austria – PSPP Reisseck II consists of an underground powerhouse. It is owned by VERBUND and is situated in the province of Carinthia in the Austrian Alps. The newly built pumped storage power plant extends this group by using the existing reservoir Grosser Mühldorfer See.

In addition to design, installation and commissioning of automation systems (control, excitation, and protection), hydraulic protection, gates and valves, ANDRITZ HYDRO also installed two identical generator units in the cavern.

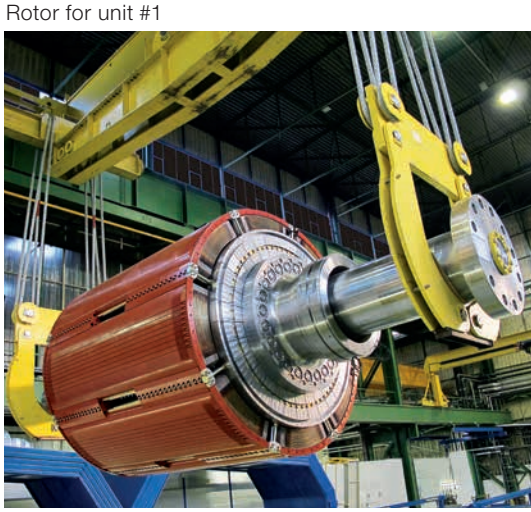
The ideal hydraulic unit is a 215 MW single-stage reversible pump turbine with vertical shaft, a nominal speed of 750 rpm and a dynamic runaway speed of 1,142 rpm. During the project planning process, potential European generator manufacturers were asked to examine the basic feasibility of an appropriate motor generator, which was confirmed, even though units with an output of 30 MVA per pole had not been realized in Europe at that time.

To achieve a robust unit with a long service life, many different load cases needed to be mastered and their definitions represented the basis for the design. VERBUND requested rotor overspeed testing of at least 1,200 rpm. Highly stressed areas tend to plastify during overspeed testing and compressive residual stresses remain, which reduces tensile stresses during operation. In contrast to many common designs of units without overspeed testing, this allowed the value for peak stress to be increased by 50 % (as calculated with linear material properties).

With this project ANDRITZ HYDRO once again strengthened its relationship with the customer and adds an important Austrian project to its references.

TECHNICAL DATA		
Output	2 × 215 MW / 2 × 240	MVA
Head	595	m
Speed	750	rpm
Rotor diameter	3,202	mm
Annual production	970	GWh

Rotor for unit #1



INTERVIEW

Santo Antônio

An Amazonian Example of Sustainable Hydropower

Brazil – Recently completed, the 3,568 MW Santo Antônio hydropower plant is one of the five largest hydroelectric stations in Brazil and supplies energy to some 44 million people from its 50 units.

Antônio de Pádua Bemfica Guimarães is technical director of Santo Antônio Energia (SAE), a company responsible for implementation of Santo Antônio, he talked to Hydro News about the project.

World's largest bulb turbine being installed at Santo Antônio

> An evaluation made by the International Hydropower Association (IHA), considered Santo Antônio the most sustainable project evaluated by them in the world.
>
> *– Antônio de Pádua Bemfica Guimarães*

What makes the bulb turbines at HPP Santo Antônio special?

HPP Santo Antônio uses the largest bulb turbines in the world. The previous record-holder uses machines rated at 68 MW, our turbines have 71.6 MW. In terms of size, at 7,500 mm diameter they are second only to the 8,410 mm units installed at HPP Murray Lock, in the USA.

The decision to use bulb turbines was driven by the flow characteristics of the Madeira River and the necessity to minimize the environmental impact of a large project, significantly reducing the area of the reservoir. Precisely because it is a run-of-river power plant, the bulb turbine proved the best solution to combine lowest impacts with highest use of the hydroelectric potential of the river.

What were your main considerations in selecting the key contractors for Santo Antônio?

Due to the project complexity, a lot of equipment involved, and the size of the turbine set for the Santo Antônio hydropower plant, the supply chain was concentrated in the most experienced and largest power generation equipment manufacturers. In addition, the Santo Antônio project implementation is under an EPC (Engineering Procurement and Construction) contract structure.

ANDRITZ HYDRO is part of the Santo Antônio Constructor Consortium (CCSA). Its scope of supply included 14 bulb turbines, 13 generators, 28 excitation systems, 26 generator switchgear systems, and three power transformers rated at 13.8 kV–500 kV.

The companies that make up the CCSA had, in addition to their expertise, an important role in the development of local companies and service providers. This partnership is leaving an important legacy because they prepared local companies to meet the demands of other projects.

Installation works

Bulb nose

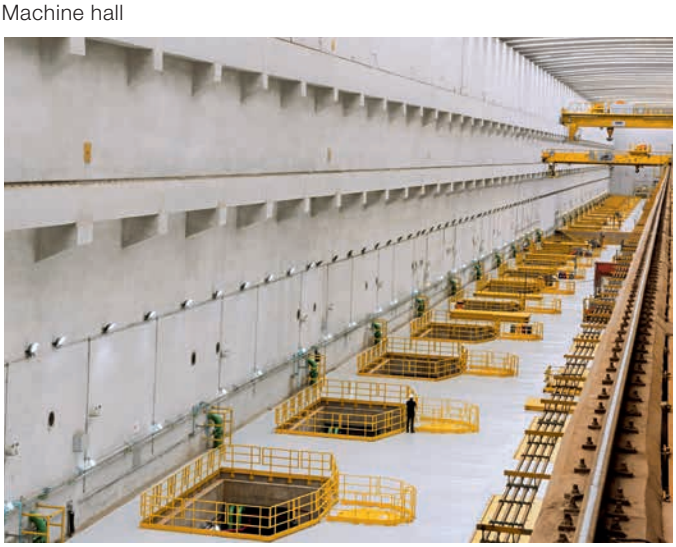
What unexpected challenges have arisen during the construction and installation of Santo Antônio?

Many adverse situations have arisen during the implementation phase of the Santo Antônio hydroelectric plant. Two of them deserve to be highlighted:

The high concentration of sediments carried by the Madeira River, which reaches 500 million tons/year; and, the large amount of floating elements during the flood season, which add up to about 30,000 logs, antlers and other objects a day.

Construction, erection, and commissioning activities took place simultaneously with operating activities so while generation units were being installed many problems were identified in the units that were in commercial operation. This required a continuous reassessment of the project and often further studies.

Machine hall



Given its location on the Amazon, how does Santo Antônio address environmental sustainability concerns?

The Amazon is a sensitive area, with strict environmental preservation standards. Therefore, it is essential to adopt practices that minimize to the maximum the effects that large infrastructure projects, such as hydroelectric dams, can cause in a region like the Amazon. One way to ensure this is to allocate financial resources and apply techniques and appropriate technologies to mitigate these effects, compensating for the impacts caused.

The Basic Environmental Project (PBA) is a document that describes the set of actions and measures to be implemented before, during and after the works of our hydroelectric installation. Despite the name, it does not cover only environmental initiatives. The recovery and strengthening of the history and culture of Porto Velho, as well as the enhancement and development of the local population, are vectors of sustainability that are also part of our company project. In total, 28 programs have been conducted and add great results.

Regarding social and environmental concerns in the country, the Santo Antônio hydropower plant is a good example for implementation of sustainable power generation models. Strictly respecting the rules established by the Brazilian environmental agencies, the project was designed to respect the natural characteristics of Amazonia, at the same time taking the maximum advantage of the Madeira's hydraulic potential.

An evaluation made by the IHA – International Hydropower Association, considered Santo Antônio the most sustainable project evaluated by them in the world, achieving the highest number of top marks in more than 20 topics related to environmental issues and stakeholders influenced by the project.

Powerhouse and dam area

How do you see future hydropower development in the Amazon region of Brazil unfolding?

The Amazon is the last frontier of the country's hydropower generation development, with about 70% of its potential yet to be explored. Given this, it is natural that there is a strategic interest in making the region an important hub of clean and renewable power generation, attracting large projects. Today, using the Santo Antônio hydropower plant as an example, you realize that you can explore all this power responsibly, incorporating the new project mechanisms that significantly reduce the environmental impact and ensure the use of the Amazon's potential. The implementation of Santo Antônio is an important benchmark for other projects planned for the region, especially in breaking the old paradigm. It is possible to generate energy from the Amazon with sustainability.

Joining knowledge and the sum of the technical experience of the team of Santo Antônio Energia, ANDRITZ HYDRO and other manufacturers, we are certainly making history in the implementation of large infrastructure projects, and helping to avoid imperfections in future projects.

Interview by David Appleyard
Freelance journalist focused on energy and technology (UK)

SANTO ANTÔNIO IN SHORT

Part of the Madeira River Complex
3,568 MW installed capacity
50 units in operation since November 2016
71.6 MW, world's largest bulb turbines
7,500 mm runner diameter, among the largest worldwide

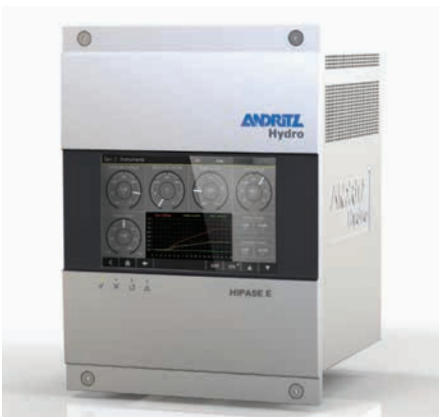
2.5 km dam length – The amount of steel and concrete used correspond to 40 Maracanã Stadiums and 18 Eiffel Towers.

ABOUT

Antônio de Pádua Bemfica Guimarães *is technical director of the Santo Antônio Energia (SAE) Company, responsible for implementation of the Santo Antônio hydropower project on the Madeira River in Porto Velho, the capital of the northwestern Brazilian state of Rondônia.*

A civil engineer, since graduating in 1980 he has held senior roles in Enerpeixe and Furnas Centrais Elétrica. Today, Antônio de Pádua is responsible for the EPC Contract Management and construction inspections on this giant project.

Dam area HPP La Grande-3



HIPASE-E as installed at La Grande-3

La Grande 3 & 4

by David Tawfik
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Canada – 2015 Hydro-Québec has awarded two contracts to ANDRITZ HYDRO for modernization works at the James Bay Project in Canada. Initiated by Hydro-Québec and the Québec government in the 1970s, and located between James Bay and Labrador on the La Grande River in Northwestern Québec Canada, it is one of the largest hydroelectric systems in the world with a total capacity of more than 16,000 MW. Eight hydropower stations generate an average of 83 TWh a year, allowing pollution-free production of a significant portion of Québec's electricity. After more than 30 years' of operation the need to exchange parts of the secondary systems has arisen.

In December 2015, ANDRITZ HYDRO received a contract for design, manufacturing, supply and delivery of 12 static excitation systems with transformers for HPP La Grande-3. Each unit has an output of 200 MW. Of the delivered excitation systems each has the capacity to produce 2,199 A at 306 V and comprises a redundant thyristor bridge with forced cooling, the static excitation system will be the biggest ever delivered by ANDRITZ HYDRO. The exciter cubicle contains power circuits, the automatic voltage regulator and the complete sequencer, which is necessary to control the individual components. The system also comprises the newly developed HIPASE-E platform.

Hydro-Québec is stringent regarding quality in many segments, like drawings, selection of the material, test procedures and homologation process. Given the size of each unit, minimum ventilation is required to properly cool the exciter and some modifications had to be made. The first system has already been delivered, the remaining 11 excitation systems will be delivered over a period of five years up to 2020.

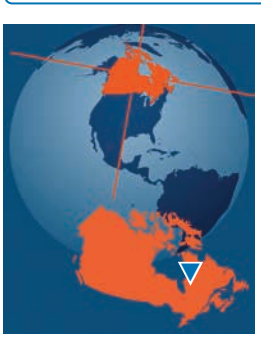
Previously, another contract for the modernization of the 2,772 MW La Grande-4 hydropower station was awarded to ANDRITZ HYDRO in November 2015. The scope of supply comprises design, supply, and delivery of nine digital HIPASE-T turbine governors, including the process of homologation for the hardware and software for the new product. This order is the first turbine governor project for the new HIPASE-T platform. The first unit was successfully commissioned end of 2016. Closing of the complete project and commissioning is scheduled for 2019.

Both contracts strengthen ANDRITZ HYDRO's position in the Canadian market.

TECHNICAL DATA

La Grande-3		
Output	12 × 200	MW
Voltage	13.8	kV
Frequency	60	Hz
Head	79.2	m
Speed	112.5	rpm
Av. annual production	12,484	GWh

La Grande-4		
Output	9 × 308	MW
Voltage	13.8	kV
Frequency	60	Hz
Head	116.7	m
Speed	128.6	rpm
Av. annual production	13,670	GWh



Generator Rehabilitation Program

by Peter Jaunecker
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Contract signing

Tasmania – Just over one year ago in October 2015, Hydro Tasmania and ANDRITZ HYDRO signed a frame agreement for a generator rehabilitation program – a contract lasting for seven years. ANDRITZ HYDRO agreed to supply seven stators, five stator windings and four pole sets for 12 generators in eight different hydropower plants with rated outputs of 11–66 MVA.

In 2015, Hydro Tasmania produced more than 8,000 GWh of electrical energy – mainly through its 30 hydropower stations. Founded more than 100 years ago, today Hydro Tasmania is Australia's largest renewable energy producer and the main energy supplier in Tasmania.

A key criteria for Hydro Tasmania to choose ANDRITZ HYDRO as supplier was the company's technological know-how as well as positive experiences from previous co-operations, such as the stator rehabilitation at the Cethana and Fisher hydropower plants (see Hydro News 25). The Alternator Upgrade Program forms part of Hydro Tasmania's overall upgrade program, and ANDRITZ HYDRO is pleased to support Hydro Tasmania with a rehabilitation program for Kaplan turbines, governors and control systems.

The contract started with the Separable Portion No.1 (SP1), an order for the design of 12 generator units. After finalization of the design works for the generator at HPP Repulse (see Hydro News 27), Hydro Tasmania issued SP2, an order for the supply of a new stator winding for the same generator in March 2016. ANDRITZ HYDRO is manufacturing the stators and poles of the generator units for HPPs Catagunya 1 and 2, which will be delivered out of India in 2018. Furthermore, a design and lifetime study of the remaining generator components will be carried out. It will form the basis for a decision on whether any other generator components need refurbishment and if the expected lifetime of 50 years can be achieved without any further major refurbishment works.

Co-ordination between two generator manufacturing sites, while preserving highest quality standards and optimizing on-site works with local partners, proves the vast experience of ANDRITZ HYDRO in project execution.

TECHNICAL DATA	
Output	12 × 11–66 MVA
Speed	136.4–600 rpm
Voltage	6.6–16 kV

Machine hall HPP Catagunya

Concrete Volute Pumps

by Elisa Wielinger
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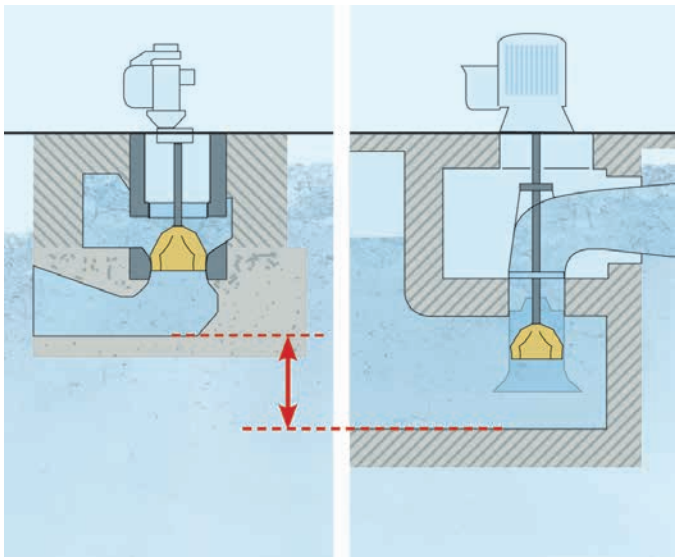
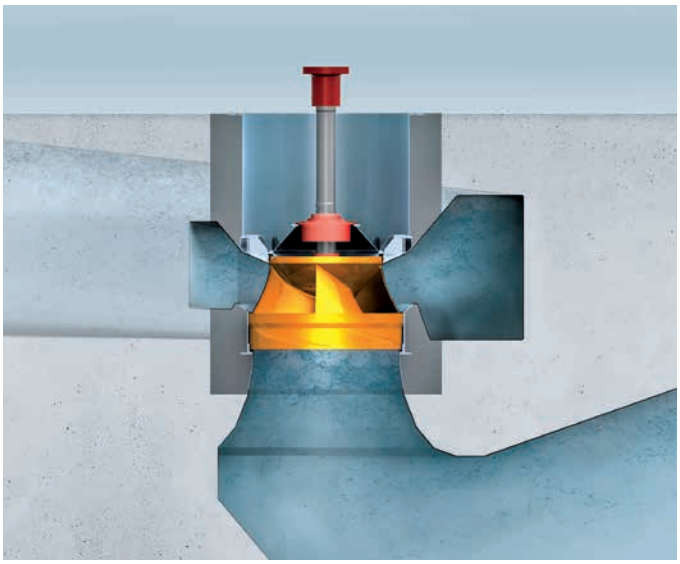
Concrete volute pumps are vertical volute pumps whose casing is made of concrete. Using concrete volutes is a well-known technology which has been applied for more than a century for Kaplan turbines. In the pumps sector it is currently not a commonly used technology, but has many advantages for large discharge and low head applications. The demand for exactly those features for flood control pumping stations is increasing, especially in Southeast Asia, where extreme weather conditions are causing a lot of infrastructure damage and loss of life.

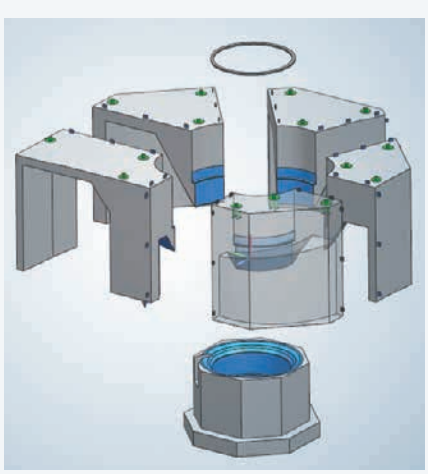




The concrete volute pump's advantages are immense for those applications in comparison to commonly used vertical line shaft pumps. The main feature of the concrete volute pump is the very compact, simple and rigid design which leads to lower investment costs. To ensure optimal hydraulic performance as well as simple geometries for the civil works, ANDRITZ HYDRO has conducted specialist development of the inlet bend and spiral with CFD calculations and model tests, leading to a very high efficiency.

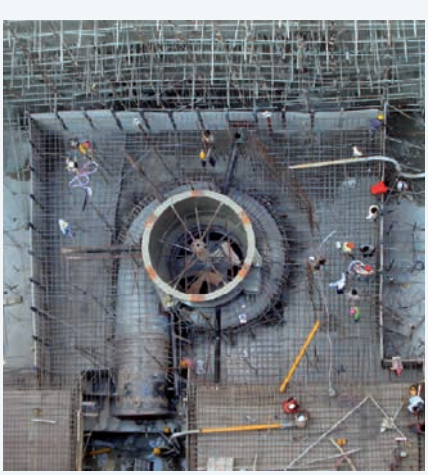
ANDRITZ HYDRO offers three different procedures for the civil construction of the concrete volute pump. The chosen construction procedure of the spiral depends on the number and size of the pumps as well as the medium to be pumped (fresh, brackish or salt water).

ANDRITZ HYDRO has dealt extensively with these topics to give customers the best possible solution for every purpose.



Prefabricated elements

In-situ casting



Steel liner

Prefabricated elements

The spiral is split into segments, which get poured in a concrete factory and are erected on-site. The final fixing is done by a poured layer of concrete on the outside of the elements.

In-situ casting

A wooden formwork is placed on-site, reinforcement bars are positioned and the surrounding concrete is poured. After setting of the concrete, the formwork is pulled out and can be reused several times.

Steel liner

The steel liner, stiffened to avoid any deformations during pouring of the concrete, is positioned. After concreting, the stiffening is removed and the steel liner remains in the volute. The spiral surface consists therefore of steel and not of concrete.

Issyk 1

by Hans Wolfhard
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Kazakhstan – Project company Hydro Power LLP has awarded ANDRITZ HYDRO an order for the small hydropower plant Issyk 1 in Kazakhstan.

The powerhouse of the new Issyk 1 hydropower plant will be located about 100 km east of the city of Almaty upstream of the existing site of HPP Issyk 2, which was successfully executed by ANDRITZ HYDRO in 2008.

ANDRITZ HYDRO's scope of supply includes the entire "from water-to-wire" package for the complete electromechanical equipment. This includes one horizontal Compact Francis turbine, the hydraulic power unit, one 5.7 MVA synchronous generator, 10 kV switchgear, and the entire electrical and control equipment.

Transportation to the site, supervision of installation, and commissioning complete the extent of the contract.

Start of commercial operations for HPP Issyk 1 is scheduled for summer 2017. The order for the Issyk 1 hydropower plant represents an important success for Compact Hydro in the Kazakh hydropower market.

TECHNICAL DATA	
Output	5.3 MW
Net Head	144.5 m
Speed	1,000 rpm
Runner diameter	715 mm

Serra da Mesa

by Gustavo Ribeiro
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Brazil – A contract for the modernization of the excitation system at the Serra da Mesa hydropower plant in Brazil was awarded to ANDRITZ HYDRO by CPFL Energia and Furnas.

This hydroelectric power plant has an installed capacity of 1,275 MW and is situated on the Tocantins River near Minaçu, in Goiás state. HPP Serra da Mesa creates, at 54.4 million m³, the largest reservoir by volume in Brazil. It is indispensable to the interconnected Brazilian energy system.

The contractual scope of supply comprises design, supply, delivery, and commissioning of three excitation systems, including the new HIPASE-E regulators with redundancy. Commissioning of the first unit took place at the end of 2016.

This order represents an important excitation reference for the new HIPASE platform developed by ANDRITZ HYDRO.

TECHNICAL DATA	
Output	3 × 425 MW
Voltage	15 kV
Head	117.2 m
Speed	120 rpm
Runner diameter	6,000 mm
Av. annual production	6,300 GWh

Ohau A

by Michael Ploschnitznigg
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New Zealand – A major project milestone has been achieved with the installation of the first new excitation system at the Ohau A hydropower plant in New Zealand.

In June 2015, ANDRITZ HYDRO received an order from Meridian Energy Ltd. for the design, manufacturing, delivery, and commissioning of four static THYNE 5* excitation systems for the Ohau A station.

ANDRITZ HYDRO met the stringent timeframe of the contract in terms of design, manufacturing, and workshop testing. The new excitation systems were shipped on schedule and arrived at the powerhouse in late February 2016. Subsequently, installation of the first new excitation system followed. It has been successfully completed and was handed over to the customer in June 2016.

ANDRITZ HYDRO is looking forward to the completion of the other three excitation systems. Commissioning of the last installation is scheduled for mid-2017.

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TECHNICAL DATA	
Output	4 × 66 MW
Voltage	13.2 kV
Head	57.6 m
Speed	166.7 rpm
Runner diameter	4,120 mm
Av. annual production	1,140 GWh

Blåfalli-Vik

by Ola Morstad
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Norway – All works at the Blåfalli-Vik hydropower plant in Norway were recently completed and the plant has started commercial operation. The contract for the large refurbishment and repair order was signed by SKL Produksjon AS and ANDRITZ HYDRO in December 2015.

In September 2015, the 270 MVA generator dropped out due to a stator earth fault. This was the result of a broken bolt on a pole winding support, which had loosened and damaged the core.

ANDRITZ HYDRO was contacted to support the dismantling of the unit for a closer inspection. A Core Induction Test (loop test) was performed, following which the customer ordered a new stator core from ANDRITZ HYDRO. The winding was re-used, therefore dismantling was performed carefully. Every single bar had to be inspected and tested before preparation for re-winding. A set of new spare bars was also manufactured.

Furthermore, the customer awarded a second order to ANDRITZ HYDRO for the refurbishment of the turbine, after an inspection revealed problems there as well.

TECHNICAL DATA	
Output	235 MW / 270 MVA
Head	365.5 m
Speed	333.33 rpm
Runner diameter	3,686 mm
Av. annual production	710 GWh

Solu

by Sanjay Panchal
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Nepal – ANDRITZ HYDRO has won a contract from Upper Solu Hydro Electric Company Pvt. Ltd. for the supply of electro-mechanical equipment for the Solu run-of-river power plant, located on the Solu Hola River in the Solukhumbu District of Nepal.

In order to end the energy crisis in the country, the Department of Electricity Development (DoED) has defined a program to develop projects under a BOOT (Build-Own-Operate-Transfer) scheme. Upper Solu Hydro Electric went through such a bidding process and won one of the eight tendered projects.

The scope of delivery for ANDRITZ HYDRO comprises two 11.75 MW vertical Francis turbines, generators, governors, main and auxiliary transformers, 145 kV GIS system, switchgear, as well as control and protection system. Under the terms of the contract, other supply includes inlet valve, cooling water system, auxiliary and associated secondary equipment.

Commissioning of the project is scheduled for mid-2018.

TECHNICAL DATA		
Output	23.5 MW/27.65	MVA
Head	218.66	m
Speed	750	rpm
Runner diameter	906	mm

Su Pan 1

by Sanjay Panchal
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Vietnam – Viet Long Industry Joint Stock Company has signed a contract with ANDRITZ HYDRO for the supply of electro-mechanical equipment for the Su Pan 1 hydropower plant, located on the Bo River in the Vietnamese province of Lào Cai.

HPP Su Pan 1 has an underground powerhouse, which ANDRITZ HYDRO will equip with two vertical 15 MW Francis turbines, generators, governors, and both main and auxiliary transformers. Additionally, the scope of supply includes a 110 kV switchyard system, 11 kV switchgear equipment, control and protection systems, inlet valve, and cooling water system,

as well as auxiliary and associated secondary equipment.

Commissioning of the project is scheduled for mid-2017.

TECHNICAL DATA		
Output	2 × 15	MW
Voltage	11	kV
Head	229.2	m
Speed	600	rpm
Runner Diameter	1,038	m

Hatillo

by Bismarck Arciga
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Dominican Republic – ANDRITZ HYDRO has received an order for the 10.7 MW Hatillo small hydropower plant, located on the Río Yuna in the Dominican Republic. In order to increase the output of the existing unit, the owner, Empresa de Generación Hidroeléctrica Dominicana (EGEHID), decided to add a new powerhouse together with a new generation unit.

ANDRITZ HYDRO's scope of supply comprises a new penstock with a bifurcation, new gates for the spillway, a crane for the new powerhouse, and the rehabilitation of an existing draft tube, as well as erection of existing components such as the turbine, generator and power transformer. ANDRITZ HYDRO will supply new hydraulic pressure units, control equipment, SCADA system, EPS equipment, as well as fiber optic and lightning systems for the new powerhouse. Erection, erection supervision, commissioning, and training are also part of the contractual scope. The project is scheduled to be completed in spring 2017.

TECHNICAL DATA		
Output	10.7	MW
Head	30.6	m
Speed	360	rpm

Hunter Creek

by Reza Shahsavari
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Canada – Hunter Creek Hydro LP signed a contract with ANDRITZ HYDRO for the delivery of equipment for the Hunter Creek hydropower plant, located close to the town of Hope in British Columbia in June 2016.

ANDRITZ HYDRO's contractual scope includes design, manufacturing, installation and commissioning of one turbine inlet butterfly valve with external by-pass system and one six-jet vertical Pelton turbine. In addition, one vertical synchronous generator with self-lubricating water-cooled sleeve bearings, one high pressure unit for actuating the turbine nozzles/deflector servomotor, turbine inlet and bypass valve, as well as a cooling system for the generator bearings, form part of the order.

A special feature of the project is the guaranteed hot re-synchronization operation mode using deflectors in the engaged (in front of jet) position for a relatively long period of time. This design, which enables re-synchronization within seconds, helps to bring the unit back on-line after a grid fault without flow reduction and gives the customer the opportunity to generate power again without running a mandatory multiple-hour ramping process.

The project is expected to start commercial operation in December 2017.

TECHNICAL DATA	
Output	1 × 11.2 MW
Voltage	13.8 kV
Head	323.2 m
Speed	720 rpm
Runner diameter	980 mm

Renace 4

by Leticia Arenas
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Guatemala – ANDRITZ HYDRO received an order from Cobra Infraestructuras Hidráulicas, S.A. for the supply, transport, erection, and commissioning of two 28 MW Pelton turbines for the Renace 4 hydropower plant In March 2016. The project, located on the lower Canlich River, is part of the Renace Hydroelectric Complex, which – together with Renace 1, 2 and 3 – will become the largest hydroelectric complex in Guatemala, with a total installed capacity of 300 MW.

The contractual scope for ANDRITZ HYDRO includes two six-nozzle, vertical shaft turbines, hydraulic power units, a cooling water system, penstock connection pipes, main inlet valves, and generators. The manufacturing and pre-assembly of the main turbine components will be done in ANDRITZ HYDRO's workshop in Spain. Start of commercial operations is scheduled for spring 2018.

After the successful execution of previous orders for the 120 MW HPP Renace 2 in 2012 and 66 MW Renace 3 in 2014, this new order further strengthens ANDRITZ HYDRO's strong position in the Guatemalan hydropower market.

TECHNICAL DATA	
Output	2 × 28 MW
Head	489.50 m
Speed	720 rpm
Runner diameter	1,250 mm

Intermediate & Khaw

by Rudy Yvrard
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Jordan – ANDRITZ HYDRO signed a contract with Fayat Energie Services International (FESI) for the supply of electro-mechanical equipment for two small hydropower plants in Jordan in June 2016.

FESI is involved in the construction of a 35 km-long water transmission pipeline, the so-called "Abu Alanda–Khaw Pipeline", providing drinkable water to the capital city of Amman. This pipeline will allow the transfer of about 30 Mm^3 of water per year. Along this pipeline two hydropower plants – HPP Intermediate and HPP Khaw – will be installed, each equipped with one unit of 1,320 kW and 897 kW, respectively.

ANDRITZ HYDRO will supply vertical Pelton turbines, generators, inlet valves and hydraulic power units. Commissioning is scheduled for mid-2017.

The experience of ANDRITZ HYDRO in the field of drinking water supply technology together with the management of a transient calculation due to the very long penstocks, have been key factors in the awarding of this contract.

TECHNICAL DATA

Intermediate		
Output	1,320	kW
Head	164	m
Speed	750	rpm
Runner diameter	670	mm
Khaw		
Output	897	kW
Head	168	m
Speed	750	rpm
Runner diameter	660	mm

Kavak

by Alp Töreli
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Turkey – In April 2016, ANDRITZ HYDRO received an order for two horizontal Francis turbines and electrical power systems for the Kavak hydropower plant, located in the city of Arhavi in the Artvin Province, Turkey.

The order was placed by Arhavi Elektrik, part of the MNG Group of Companies, for which ANDRITZ HYDRO has already successfully executed two hydropower projects – HPP Aralık and HPP Sukenarı.

ANDRITZ HYDRO won the contract after an international tendering process. With the scope of supply including design, manufacturing, testing, supply, transportation, installation, and commissioning, the turbines and related equipment will be supplied by ANDRITZ HYDRO France. Electrical power systems, turbine spiral case, and draft tube as well as installation of all electro-mechanical equipment will be delivered by ANDRITZ HYDRO Turkey.

The project is expected to see commercial operations within the second half of 2017.

TECHNICAL DATA

Output	1 × 8.44 MW / 1 × 2.38	MW
Head	40.5	m
Speed	1 × 750 rpm / 1 × 375	rpm
Runner diameter	1 × 862	mm
	1 × 1,677	mm

Angel I and III

by Sergio Contreras
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Peru – Generadora de Energía del Peru (Gepsa) awarded ANDRITZ HYDRO two contracts for the supply of electro-mechanical equipment for the hydropower plants Angel I and Angel III in March 2016. Both orders followed the contract for HPP Angel II, which was also awarded to ANDRITZ HYDRO.

All three hydropower plants are part of a cascade system, located in the Carabaya Province in the south of Peru.

HPPs Angel I–III are identical and hence have the same scope of supply – combining two vertical, six-jets Pelton turbines (10 MW output each), two 11.22 MVA generators (6.6 kV each), spherical inlet valves, hydraulic pressure units, cooling water systems, control and SCADA system, speed governor, automatic voltage regulator, and auxiliary equipment.

The supervision of erection and the commissioning are scheduled for mid-2017. With the new contracts for HPPs Angel I and III all three hydropower plants are under execution by ANDRITZ HYDRO.

TECHNICAL DATA

Angel I–III identical equipment		
Output	2 × 10 MW / 2 × 11.22	MVA
Voltage	6.6	kV
Head:	277	m
Speed	600	rpm
Runner diameter	1,110	mm
Av. annual production	131	GWh

Storåselva

by Kristian Glemmestad
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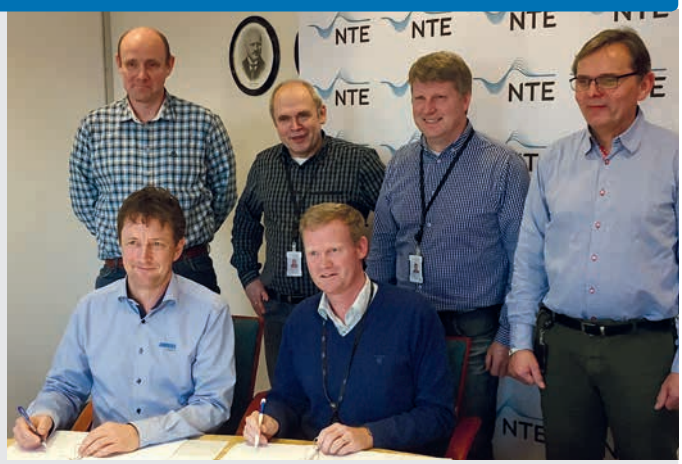
Norway – In December 2015, Nord-Trøndelag Elektrisitetsverk AS (NTE) awarded a contract to ANDRITZ HYDRO for the supply of electro-mechanical equipment for the Storåselva hydropower plant in central Norway.



Owned by North Trøndelag County Council, NTE is a utility focusing on production and distribution of electrical energy. In total the company operates 29 hydropower plants and two wind parks.

The new Storåselva underground power station will be built inside the Skromoen Mountain, with an intake about 1 km west of Mollansetra, 16 km from the city of Snåsa and near the Blåfjella-Skækerfjella Nasjonalpark.

ANDRITZ HYDRO will supply three horizontal 8.85 MW Francis turbines, associated generators, automation system and electrical power systems, inlet pipes, and cooling systems. Engineering, procurement, and manufacturing of the core components were finished in late 2016. Assembly of the generator is now ongoing. The Factory Acceptance Test is scheduled for January 2017.

After commissioning in 2018, HPP Storåselva will deliver about 75 GWh of electrical energy per year.

TECHNICAL DATA	
Output	3 × 8.85 MW
Head	122 m
Speed	600 rpm
Runner diameter	1,037 mm
Av. annual production	75 GWh

Carema

by Stefano Rizzi
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Italy – Only 11 months after contract signing, the Italian hydropower plant Carema was successfully commissioned in August 2016. ANDRITZ HYDRO received the contract for the supply of electro-mechanical equipment for the hydropower project by COGEIS S.p.A in 2015.

In 2010, ANDRITZ HYDRO began rehabilitating the Tavagnasco hydropower plant for the same customer. HPP Carema, located 60 km east of the city of Aosta in the region of Piemonte, is located close to this project. It utilizes the flow of the Dora Baltea River and the environmental flow from the intake of the Tavagnasco hydropower plant.

During the execution of this project ANDRITZ HYDRO equipped a greenfield powerhouse with one 1,185 kW ECOBULB* turbine, as well as a permanent magnet generator, mechanical auxiliaries, electrical power systems, and automation.

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TECHNICAL DATA	
Output	1 × 1,185 kW/ 1 × 1.25 MVA
Head	3.5 m
Speed	150 rpm
Runner diameter	2,240 mm

Hydro 2016

by Veronique Hill
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Montreux (Switzerland) – HYDRO 2016 took place in Montreux, Switzerland, at the beginning of October 2016. This conference and exhibition is one of the largest conventions for the global hydropower market and brought together numerous delegates and experts.

As well as with a new booth design, ANDRITZ HYDRO participated with six paper presentations and over the three-day event there were lots of opportunities for discussion and exchange of experience. ANDRITZ HYDRO was also pleased to invite more than 150 customers and business partners to a Gala Dinner at the Hotel Eden Palace in Montreux. Roland Cuénod, ANDRITZ HYDRO's managing director in Switzerland, held the keynote speech welcoming guests to the enjoyable dinner and a magic entertainment show.

ANDRITZ HYDRO's participation at HYDRO 2016 emphasizes its position as a leading global supplier of electromechanical systems and services for hydropower plants.

HIPASE Launch Day

by Jens Päutz
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India – In November 2016, 140 technology experts from India participated in the HIPASE Launch Day, which was held by ANDRITZ HYDRO in Faridabad.

During this event the HIPASE platform has been successfully launched for the first time on the Indian hydropower market.

HIPASE is the first common platform which covers excitation, protection, synchronization, and turbine governor for hydropower plants, unifying for the first time in one product the different device characteristics of electrical protection, voltage and turbine control as well as synchronization.

After product induction two years ago, the pilot project stage has been successfully completed. ANDRITZ HYDRO is proudly looking back on a number of worldwide installations.

Customer Day Colombia

by Diana Rodriguez
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Bogotá (Colombia) – For the second time ANDRITZ HYDRO has held an event for customers and business partners operating in the hydropower and construction sector of Colombia. On March 1st, 2016, the event offered the opportunity to optimize networking and also to share ANDRITZ HYDRO's know-how and state-of-the-art technology through presentations and training. This was also an opportunity to invite academics and students from universities in order to enhance cooperation and to inspire a new generation of engineers.

HydroVision 2016

by Vanessa Ames
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Minneapolis (USA) – The HydroVision 2016 conference and exhibition took place in Minneapolis, USA, from July 26th–29th, 2016. Once again, ANDRITZ HYDRO had an impressive booth display and served as Gold Sponsor, allowing the ANDRITZ HYDRO brand to be front and center.

During the event ANDRITZ HYDRO hosted many customers and consultants at ANDRITZ HYDRO NIGHT, held in the Millennium Hotel in its spectacular rooftop dome. Guests enjoyed beautiful views of downtown Minneapolis, while enjoying a wonderful selection of food and great musical entertainment. This customer appreciation event has become much anticipated for customers as well as colleagues.

HydroVision 2016 proved once again to be a valuable resource for strengthening the ANDRITZ HYDRO brand in the North American hydropower market, highlighting the company's technological know-how and comprehensive portfolio of products and services.

50 years IFAT

by Anita Rieg
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Munich (Germany) – The jubilee event of IFAT – the world's leading trade fair for water, sewage, waste and raw materials management – was held in Munich between May 30th and June 3rd, 2016. ANDRITZ has been exhibiting at this fair since it began in 1966 and has been honoured this year for its 50-year presence at IFAT. At the 2016 event roughly 138,000 visitors from more than 170 countries came to Munich in order to inform themselves about the latest developments in environmental technology from more than 3,000 exhibitors.

Under the slogan "Pure Efficiency", ANDRITZ HYDRO presented their powerful centrifugal pumps, submersible motors and hydrodynamic screws. The focus was on the newly-developed high-pressure pump (HP 43 series). Due to its efficiency of up to 90%, conceptually the pump is strictly ecologically aligned, which means enormous savings on energy costs for the operator.

After 50 years, once again IFAT 2016 was a great success for ANDRITZ HYDRO and the number and quality of contacts made during the exhibition was excellent.

Customer Day Vietnam

by Jens Päutz
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Hanoi (Vietnam) – For the fifth time, ANDRITZ HYDRO invited customers, partners, investors and governmental bodies to its Customer Day Vietnam, held in the capital Hanoi on October 6th, 2016. More than 150 participants accepted the invitation and joined ANDRITZ HYDRO at this great event, which opened with keynote speeches from H.E. Dr. Thomas Loidl, Ambassador of Austria to Vietnam, and Mr. Nguyen Van Thanh, General Director of Vinh Son – Song Hinh Hydro Power JSC.

The comprehensive range of products and services offered by ANDRITZ HYDRO was highlighted by presentations from ANDRITZ HYDRO group companies based in Vietnam, India and Europe – addressing turbines, generators, small hydro, rehabilitation, and automation, as well as pumps and financing. Alongside the interesting presentations and an informative Q&A session, the networking lunch offered excellent opportunities for an intensive information exchange between all participants.

ANDRITZ HYDRO is one of the leading players in the booming hydropower market across the entire Indochina peninsula and once again strengthened its regional presence with this latest successful event in the promising market of Vietnam.

Powertage 2016

by Alexandre Fournier
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Zurich (Switzerland) – Every two years the “powertage” – the meeting place of the Swiss power industry – takes place. In 2016, some 163 exhibitors welcomed more than 2,200 visitors from Switzerland and neighboring countries to the trade fair, which ran from May 31st to June 2nd.

Designed as an open and welcoming space, the ANDRITZ HYDRO booth attracted numerous interested participants at the fair. This exhibition provided an ideal setting for an intensive exchange of experiences and opinions.

The new developed turbine governor solution – part of the HIPASE platform – was presented and attracted particular attention.

With the challenges of the market in view, ANDRITZ HYDRO is already looking forward to the next “powertage” in 2018.

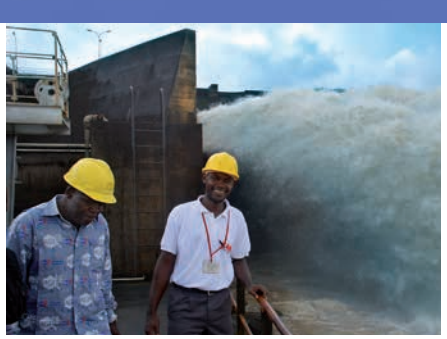
ANDRITZ Hydro

Hydropower for Africa

Renewable and sustainable energy for the future

ANDRITZ HYDRO is a global supplier of electromechanical equipment and services ("from water-to-wire") for hydropower plants. With over 175 years of experience and more than 31,600 turbines installed, we are a market leader for hydraulic power generation.

We have a passion for Africa: with a market presence for over 100 years, ANDRITZ HYDRO has supplied or refurbished around 50% of Africa's installed hydropower capacity – large hydro, service and rehabilitation and small hydro. **We focus on the best solution – "from water-to-wire".**



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