MAGAZINE OF ANDRITZ HYDRO | 06-2016 ENGLISH

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ANDRITZ Hydro

Dear Business Friends,

For those involved in the hydropower business 2015 was a challenging year. Hesitant investments in the OECD region, especially in Europe and North America, were balanced by exciting projects in developing countries and emerging markets. Despite this shift in focus, ANDRITZ HYDRO has prevailed in these changing market conditions, with large contracts won in Brazil, Pakistan, China, India, and Vietnam. This shift was also reflected in our rehabilitation and service businesses, which, along with developments in the small hydropower market, mostly occurred outside the OECD region. With numerous global offices, ANDRITZ HYDRO has been able to strengthen its position to address these market shifts and provide outstanding support to local customers. A particular need for the development of hydropower solutions at middle- and lower-river sections arose, and ANDRITZ HYDRO's low-pressure and Bulb turbines are particularly suited to meet these demands. Continuous technological development – largely due to the exceptional expertise and commitment of our motivated employees – lays the foundation for ANDRITZ HYDRO to continue providing customers with tailored solutions from the smallest to the largest plant. As a result, even if market conditions remain challenging in 2016, ANDRITZ HYDRO is optimistic about this year's developments.

Today, ANDRITZ HYDRO is well positioned in the market and will strive for continued excellence. In light of the increasing need for renewable energy and the growing demand for the service and modernization of existing hydropower plants, ANDRITZ HYDRO is confident about the future.

Sincere thanks for your continued trust,

H. Heber

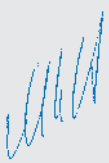
W. Semper

I would also like to take this opportunity to inform you that I have retired this year at the end of May after 38 years of service, when my colleagues in executive management, Wolfgang Semper and Harald Heber, are taking over my responsibilities.

I am very happy and thankful that I've been able to help shape the successful development of this company. ANDRITZ HYDRO's position as one of the global leaders in the hydropower market for electro-mechanical equipment and services would have been impossible without the trust of our customers and partners.

I wish to thank my colleagues and employees for their commitment and many years of great work.

And to my business partners, I would like to thank you for your outstanding cooperation and ask that you continue to place your trust in ANDRITZ HYDRO, its management and employees.



M. Komböck

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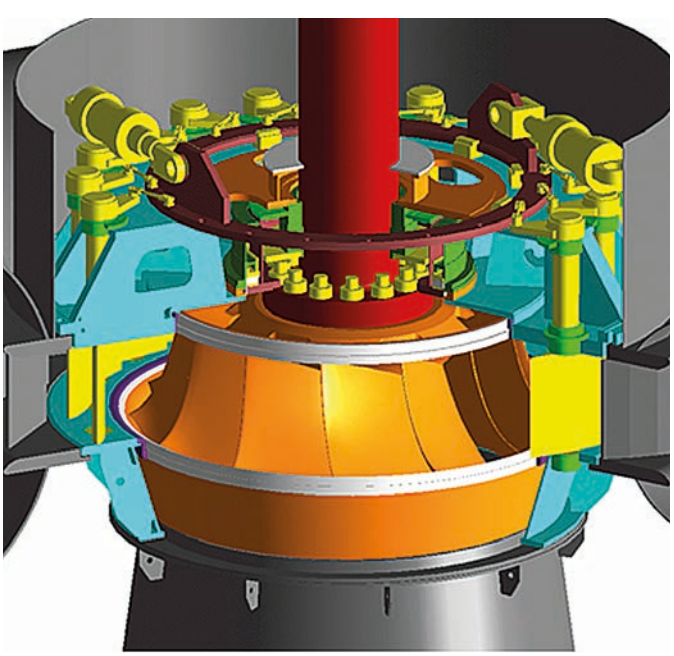
Latest News

Iceland, Búrfell

ANDRITZ HYDRO has received an order from Landsvirkjun to supply the electro-mechanical equipment and control systems for the Búrfell Extension hydropower station in Iceland. The existing HPP Búrfell is equipped with six units, providing electrical energy into the national grid since 1969. It has a total installed capacity of 270 MW and an annual electrical energy production of 2,300 GWh. A single 100 MW turbine unit in a separate underground power station will be installed at HPP Búrfell Extension increasing its generation capacity by up to 300 GWh per year. HPP Búrfell Extension is expected to go online in the first half of 2018.



Norway, Eidsfoss

ANDRITZ HYDRO has successfully finalized the commissioning of HPP Eidsfoss, located in the south-eastern part of Norway and using water from the Skien water system. Statkraft Energi AS awarded ANDRITZ HYDRO the rehabilitation of the control systems for HPP Eidsfoss (15 MW) and HPP Vrangfoss (35 MW). The scope of supply comprises the replacement of the local control systems, modifications of the turbine and generator control systems as well as the intake gates. To keep a constant water level under all operation conditions, a level controller with additional emergency functionality will be implemented into the control systems. Commissioning of HPP Vrangfoss is scheduled for the end of 2017.

Canada, La Grande-3

For the La Grande-3 hydropower plant on the La Grande River in northern Quebec, Canada, ANDRITZ HYDRO was awarded a contract for the modernization of Hydro Quebec's third biggest power plant. The scope of supply comprises design and supply of 12 excitation systems. Closing of the project and commissioning is scheduled for mid-2020.

Key Figures 2015

Order Intake
1.718,7 MEUR

Order Backlog (as of end of period)
3.640,9 MEUR

Sales
1.834,8 MEUR

Employees without apprentices
(as of end of period)
8.230

Vietnam, Hoa Binh

Vietnam Electricity (EVN) awarded a contract for the upgrade of the secondary equipment of the Hoa Binh hydropower plant to a consortium of ANDRITZ HYDRO and The National Research Institute of Mechanical Engineering (NARIME). The hydropower station is equipped with eight units (240 MW each) and has a total installed capacity of 1,920 MW, generating about 8,160 GWh of electrical energy annually. The scope of supply for ANDRITZ HYDRO comprises the modernization of eight unit control and monitoring systems, eight digital governors, eight unit protection systems, seven main excitation systems, four auxiliary excitation systems, the common control system, and the supply of a new SCADA system including mimic board. The modernization project will be realized in four steps of two units each in parallel with an overall end date in July 2018.

Peru

Renewable Energy for an Emerging Country

By Sergio Contreras
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The expanding Peruvian economy is one of the more active ones in the South American region. A combination of economic modernization, natural resource abundance and continued improvements in economic governance and political stability make Peru one of the most promising energy markets in Latin America.

ANDRITZ HYDRO in Peru

ANDRITZ HYDRO has a long history in Peru, with the first equipment deliveries for HPP Caxias I and II taking place back in 1913. Since then ANDRITZ HYDRO has installed and rehabilitated more than 110 units in the country, with a total output of about 3,400 MW. Some 15 years ago ANDRITZ HYDRO decided to establish a permanent office in the Peruvian capital Lima.

Machu Picchu

HPP Santa Teresa: In 2011, Luz del Sur, one of the leading power utilities in Peru, awarded ANDRITZ HYDRO a contract for the supply and installation of electro-mechanical equipment for the Santa Teresa run-of-river hydropower plant, 15 km downstream from the famous archeological site of Machu Picchu. ANDRITZ HYDRO supplied two 59 MW Francis turbines, main inlet valves, generators, electrical accessory, and automation equipment as well as the powerhouse crane. The hydropower plant was successfully put into operation by the end of 2015.

HPP Huanza: HPP Huanza uses the waters of the rivers Pallca and Conay and supplies electrical power to the Buenaventura mines. The project was developed by the Peruvian miners' subsidiary Empresa de Generación Huanza. Shortly after installation in 2013, the runners showed strong cavitation and had to be replaced. ANDRITZ HYDRO won a contract for the supply of three new MICROGUSS* Pelton runners. Commissioning of the first unit has taken place in September 2015. In March 2016, the other two runners were successfully delivered. ▶

Installation works at HPP El Carmen

HPP Cerro del Águila: For the major new hydropower plant Cerro del Águila, about 470 km east of Lima, ANDRITZ HYDRO received a contract from Consorcio Río Mantaro in 2011 for manufacturing, delivery, and installation of the electro-mechanical equipment, including three large 171 MW Francis units. In 2012, ANDRITZ HYDRO also won a contract for a "from water-to-wire" package for the additional small hydropower plant next to the main dam. All units will be completed in 2016.

HPP El Carmen and HPP 8 De Agosto: Generadora Andina, with Consorcio 8 de Agosto as the EPC contractor, developed these two small hydropower projects. For HPP El Carmen ANDRITZ HYDRO will supply two vertical, six-jet Pelton turbines with an output of 4.4 MW each, main inlet valves, and the hydraulic pressure units. The scope of supply for HPP 8 de Agosto comprises two 10.6 MW horizontal Francis turbines, main inlet valves, and the hydraulic pressure units. Commissioning of both projects will take place in the first half of 2016.

HPP Rucuy: Developed by Empresa Administradora Chungar SAC, HPP Rucuy uses the waters of the River Chancay about 160 km north of the capital Lima. The contractual scope for ANDRITZ HYDRO includes two horizontal, two-jets Pelton turbines with an output of 10 MW each, main inlet valves, and the hydraulic pressure units. Commissioning is expected in the first half of 2016.

HPP Gallito Ciego: The Gallito Ciego hydropower plant, owned by Statkraft Peru, is located in the Jequetepeque Valley north of Lima. ANDRITZ HYDRO won a contract for the complete mechanical rehabilitation of one turbine, including a new runner, covers, a new shaft, wicket gates, links, levers, coupling bolts, installation supervision, and commissioning, which is scheduled for October 2016.

HPP Huinco and HPP Matucana: The hydropower plants Huinco and Matucana are owned by EDEGEL, a company of the Enel Group, and are situated on the rivers Santa Eulalia and Rimac, respectively. After more than 40 years of continuous operation the rehabilitation of two generators at HPP Huinco and of one generator at HPP Matucana was necessary. The scope of the contract for ANDRITZ HYDRO comprises a new coil and rotor shaft for HPP Huinco and a new stator for HPP Matucana, as well as installation, supervision, electrical tests, and commissioning. The works on site will be carried out between 2017 and 2019.

All these projects confirm and consolidate the leading position of ANDRITZ HYDRO in the promising hydropower market of Peru. ■

TECHNICAL DATA

Santa Teresa	
Output	2 × 58.84 MW
Head	178.38 m
Speed	360 rpm
Runner diameter	1,985 mm
Huanza	
Output	3 × 46.3 MW
Head	654 m
Speed	600 rpm
Runner diameter	1,740 mm
Cerro del Águila	
Large Hydro unit:	
Output	3 × 171 MW
Head	277.7 m
Speed	300 rpm
Runner diameter	2,623 mm
Compact Hydro unit:	
Output	1 × 5.38 MW
Head	60 m
Speed	514.3 rpm
Runner diameter	1,121.8 mm
El Carmen	
Output	2 × 4.4 MW
Head	228 m
Speed	720 rpm
Runner diameter	820 mm
8 de Agosto	
Output	2 × 10.6 MW
Head	128 m
Speed	720 rpm
Runner diameter	1,006 mm
Rucuy	
Output	2 × 10 MW
Head	666 m
Speed	900 rpm
Runner diameter	1,130 mm
Gallito Ciego	
Output	2 × 17 MW
Head	83 m
Speed	400 rpm
Runner diameter	1,550 mm
Huinco	
Output	85 MVA
Voltage	12.5 kV
Speed	514 rpm
Runner diameter	3,000 mm
Matucana	
Output	80 MVA
Voltage	12.5 kV
Speed	450 rpm
Runner diameter	3,400 mm

Vietnam

Renewable Energy in Harmony with Nature

By Martin Koubek
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Ha Long Bay, UNESCO World Heritage site in northern Vietnam

Vietnam has a fast growing population of about 90 million people and an economy which is rapidly developing. The country is focusing on renewable energy, mainly hydropower, which currently contributes some 33% of the total power generation. With an annual hydro potential of 120,000 GWh, of which less than half has been developed as of today, Vietnam is one of the most vital and prospective hydropower markets.

ANDRITZ HYDRO in Vietnam

ANDRITZ HYDRO has run a representative office in the capital Hanoi for more than 15 years, but has been active in the country since the 1960s. More than 50 units with a combined total capacity of about 1,000 MW has been installed or rehabilitated by ANDRITZ HYDRO. In 2016, ANDRITZ HYDRO Company Limited was established (100% FDI of ANDRITZ HYDRO Austria GmbH) to better cover the local activities in Vietnam. ▶

HPP Thuong Kon Tum: In 2012, ANDRITZ HYDRO signed a contract for the electro-mechanical works for the Thuong Kon Tum hydropower plant, located at the border between Laos and Vietnam, near the city of Kon Tum.

ANDRITZ HYDRO is going to supply turnkey electrical and mechanical equipment, including two high-head Pelton turbines with speed governors, generators, and auxiliary systems.

After completion in 2017, this hydropower plant will have an installed capacity of 220 MW and will generate about 1,000 GWh of electrical energy per year.

HPP Nam Tha 3: ANDRITZ HYDRO has received an order from Phuc Khanh Energy Development and Construction Investment JSC for the 14 MW Nam Tha 3 hydropower plant, located on the Nam Tha River in Lao Cai province.

ANDRITZ HYDRO's scope of supply comprises the complete electro-mechanical equipment, including two four-jet Pelton turbines, generators, and mechanical auxiliaries. The project is scheduled to be put into commercial operation in mid-2016.

HPP Dak Mi 2: In 2014, following the HPP Chi Khe project, ANDRITZ HYDRO signed a second contract with Agrita-Quang Nam Energy JS Company (AGRITAM) for the complete electro-mechanical scope of supply for the Dak Mi 2 hydropower plant, located on the Dak Mi River, in the province of Quang Nam.

ANDRITZ HYDRO is supplying the complete electro-mechanical equipment, including two vertical 49 MW Francis turbines, governors, and generators. HPP Dak Mi 2 will supply 415 GWh of sustainable and clean electrical energy per year.

HPP Chau Thang: In February 2015, ANDRITZ HYDRO's Compact Hydro business division made a breakthrough in the field of low-head turbines in Vietnam and signed a contract with Prime Que Phong JSC for the supply of two vertical Kaplan units for the 14 MW Chau Thang hydropower plant. The project is located on the Quang River, some 330 km north of the capital of Hanoi and is scheduled to be put into commercial operation in 2016.

Contract signing for HPP Xim Vang 2

HPP Xim Vang 2: In July 2015, ANDRITZ HYDRO received an order from Xim Vang Hydroelectric Power JSC for the Xim Vang 2 hydropower plant, located on the Xim Vang River in the Son La Province. HPP Xim Vang 2 will have a total installed capacity of 18 MW. ANDRITZ HYDRO's scope of supply comprises electro-mechanical equipment, including two Pelton turbines, generators, and auxiliary systems. The hydropower plant is planned to be put into commercial operation in 2017.

HPP Hoi Xuan: ANDRITZ HYDRO won a contract for the supply of electro- and hydro-mechanical equipment for the new 102 MW Hoi Xuan hydropower plant, owned by VNECO Hoi Xuan Investment and Electricity Construction JSC. The scope of supply includes design, delivery, installation, and commissioning of three Bulb turbines and generators, as well as automation and the hydraulic equipment. Commissioning of the plant is scheduled for the beginning of 2018. Thereafter, more than 425 GWh of renewable energy will be supplied every year for Vietnamese households and local industry.

With its long-established presence in Vietnam, ANDRITZ HYDRO is prepared for the future and is looking forward to providing tailor-made solutions to its local customers. ■


Runner installation at HPP Chi Khe

TECHNICAL DATA

Thuong Kon Tum	
Output	2 × 110 MW
	2 × 129 MVA
Head	879 m
Speed	600 rpm
Runner diameter	2,060 mm
Nam Tha 3	
Output	2 × 7 MW
Head	274 m
Speed	428.6 rpm
Runner diameter	1,350 mm
Dak Mi 2	
Output	2 × 49 MW
Head	252.4 m
Speed	428.57 rpm
Runner diameter	1,530 mm
Chau Thang	
Output	2 × 7 MW
Head	21 m
Speed	272.7 rpm
Runner diameter	2,350 mm
Xim Vang 2	
Output	2 × 9 MW
Head	568 m
Speed	750 rpm
Hoi Xuan	
Output	3 × 34 MW
Head	21.5 m
Speed	166.66 rpm
Runner diameter	4,500 mm

Nkula A

Malawi

By Philipp Schmitt
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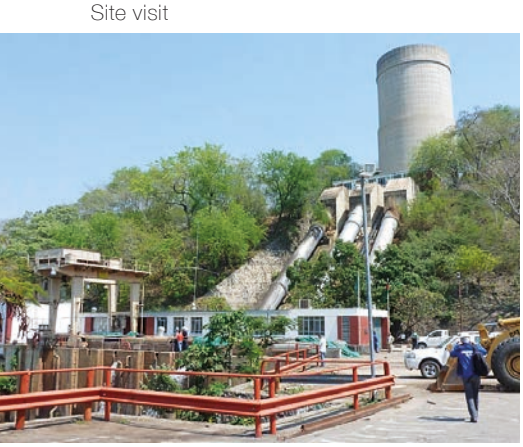
Contract signing

A contract to rehabilitate and upgrade the Nkula A hydropower station has been awarded to ANDRITZ HYDRO as leader to a consortium by the Millennium Challenge Account – Malawi (MCA-M).

Commissioned in 1966, HPP Nkula A was the first hydropower station in Malawi. Along with Nkula B, it is one of two hydropower stations in the first cascade of the Nkula Falls on the Shire River, about 50 km northwest of the city of Blantyre. Due to its age, the hydropower plant has experienced numerous forced outages over recent years, which made a major overhaul an absolute necessity for a stable power supply in the region.

Site visit



The scope of supply for consortium leader ANDRITZ HYDRO includes modernization of intake and draft tube gates, penstocks, installation of new turbine runners and non-rotating turbine components, complete new generators, mechanical and electrical auxiliary systems, as well as a new high-voltage hybrid switch gear, and SCADA system.

The project is funded by Millennium Challenge Corporation (MCC), a US foreign aid agency under the compact to reduce poverty through economic growth in Malawi. The main target areas to achieve this goal are improving the availability, reliability, and quality of the power supply and increasing the capacity and stability of the national electricity grid, which is operated by the Malawian government utility ESCOM. A further objective of the MCC compact is to create an enabling environment for future expansion of the power sector by strengthening sector institutions and enhancing regulation and governance of the sector.

The refurbished hydropower plant, with an increased total output of 35.1 MW, is expected to resume operation in mid-2018. ■

Penstocks before rehabilitation works

TECHNICAL DATA	
Output	3 × 11.7 MW
Voltage	11 kV
Head	55.2 m
Speed	375 rpm
Runner diameter	1,650 mm

Power house and Sholayar River

Sholayar

India

By Neelav De
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In July 2015, ANDRITZ HYDRO signed a contract for the renovation, modernization, and upgrade of the Sholayar hydropower plant, located on the Sholayar River in Tamil Nadu, India.

The project on behalf of Tamil Nadu State Generation & Distribution Corporation Ltd. (TANGEDCO) – an utility owned by the state government – currently comprises two power houses, Stage I (2 × 35 MW) and Stage II (1 × 25 MW).

The equipment for the Stage I powerhouse was originally commissioned in 1971 and has been operating for more than 350,000 hours. ANDRITZ HYDRO will supply the electro-mechanical equipment for both units, including design, CFD analysis, engineering, manufacturing, delivery, erection, testing, and commissioning. Within the scope of supply new turbines, generators, runners, automation panels, and certain balance of plant equipment are included. After uprating, the plant capacity will be changed from 70 MW (2 × 35 MW) to 84 MW (2 × 42 MW) representing an overall output increase by 20%.

In the past, ANDRITZ HYDRO has renovated, uprated, and modernized several projects for this customer, namely HPP Shivasamudram and HPP Periyar. This is ANDRITZ HYDRO's third service and rehabilitation project in the state of Tamil Nadu.

The guaranteed technical parameters required by the customer are challenging for the cooperating teams from ANDRITZ HYDRO India, Austria, Switzerland, Germany and China.

Overall completion period of the project is only 42 months. Delivery of the first unit, including reverse engineering, is scheduled within 18 months of contract signing. With the successful execution of this order, ANDRITZ HYDRO will further strengthen its position in the Indian hydropower market and retain its leading position in the state of Tamil Nadu. ■

TECHNICAL DATA

Stage I:	
Output	2 × 42 MW
	2 × 56 MVA
Voltage	11 kV
Head	379 m
Speed	750 rpm
Runner diameter	1,675 mm

Unit hall

Centroamérica and Carlos Fonseca

Nicaragua

By Luis Barillas
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Powerhouse and existing penstock of HPP Carlos Fonseca

Nicaragua's Government of Reconciliation and National Unity – through Empresa Nicaragüense de Electricidad (ENEL) – signed a contract with ANDRITZ HYDRO in October 2015 for the renovation of the hydroelectric stations Centroamérica and Carlos Fonseca.

HPP Centroamérica is located near the city of Jinotega about 180 km from Managua City, while HPP Carlos Fonseca can be found in the valley of La Rauda in the west central part of the country in the department of Matagalpa about 150 km from the capital. Both hydroelectric plants have been in operation for more than 45 years – commissioned in 1964 and 1970, respectively – with an installed capacity of 50 MW each. The decision to refurbish the plants was made in order to improve mechanical efficiency and to extend the life of the generating equipment for the next 25 years.

The project is being financed by the Inter-American Development Bank (IDB), the Central American Bank for Economic Integration (CABEI) and ENEL.

ANDRITZ HYDRO will supply new equipment for the substation, including main transformers, medium voltage equipment (24.9 kV, 10.5 kV, and rehabilitation of bus bars), low voltage AC and DC distribution system, protection, excitation, control and automation system, communication system, cooling system, firefighting system, and instrumentation, as well as repair and rehabilitation works for spherical and butterfly valves, gates, and cranes. The contractual scope of the services comprises design, manufacturing, delivery, disassembly and assembly, commissioning, and turbine efficiency and cavitation studies. The project is being executed by teams from ANDRITZ HYDRO Italy and Mexico.

Commissioning for HPP Carlos Fonseca is scheduled for 2017, and subsequently for HPP Centroamérica for spring 2018.

This project is an important step in strengthening ANDRITZ HYDRO's position in the hydropower market of Nicaragua. ■

TECHNICAL DATA

Centroamérica:	
Output	2 × 25 MW
Voltage	10.5 kV
Carlos Fonseca:	
Output	2 × 25 MW
Voltage	10.5 kV

Old existing control system at HPP Carlos Fonseca

Unit hall of HPP Centroamérica

Norwegian landscape

Smibelg and Storåvatn

Norway

By Uwe Krawinkel
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SmiSto Kraft AS has awarded ANDRITZ HYDRO a contract for the delivery of the electro-mechanical equipment of the new Smibelg and Storåvatn hydroelectric power plants.

HPP Smibelg is on the southern side and HPP Storåvatn on the northern side of the Gjervalen Fjord in Nordland County, Norway. Located on the polar circle, installation and commissioning engineers will perhaps be exposed to the Aurora borealis. The project site is very remote, without any access roads, and boat access is the only option. In order to increase production at HPP Smibelg, a pump station will be built permitting water to be pumped from Vakkerjordvatn to the HPP Smibelg reservoir.

ANDRITZ HYDRO's scope of supply comprises the delivery of three five-nozzle Pelton turbines and three synchronous generators, main inlet valves, and all necessary auxiliary systems like hydraulic pressure units and cooling water systems, turbine governors, and excitation systems. The two larger turbines and generators at HPP Smibelg and HPP Storåvatn, will be manufactured at ANDRITZ HYDRO workshop in India while the smaller unit at HPP Storåvatn is part of the ANDRITZ HYDRO Compact Hydro program.

ANDRITZ HYDRO was also awarded the delivery and installation contract for the electrical equipment, such as control and electrical power systems including medium voltage switchgear and step-up transformers. In order to increase safety and availability of the installed equipment, the automation concept is based on two independent control systems in normally-open contact principle – in accordance with Norwegian regulations. Due to the remote nature and difficult access, reliability of the equipment is an indispensable requirement of the project. Both hydropower plants will be completely remote controlled from the customer's dispatch centre in Fauske.

Handing over of both hydropower plants to the customer is scheduled for the second and third quarters of 2019. ■

TECHNICAL DATA

Smibelg:	
Output	33 MW
Voltage	11 kV
Head	482.5 m
Speed	500 rpm
Runner diameter	1,810 mm
Storåvatn:	
Unit #1:	
Output	7.9 MW
Voltage	11 kV
Head	435.5 m
Speed	750 rpm
Runner diameter	1,160 mm
Unit #2:	
Output	27.1 MW
Voltage	11 kV
Head	599.1 m
Speed	750 rpm
Runner diameter	1,300 mm

Contract signing for HPP Xekaman Xanxay

Xekaman Xanxay

Laos

By Shan Qi
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In July 2015, ANDRITZ HYDRO signed a contract with Song Da Corporation of Vietnam for the supply of the complete electro-mechanical equipment and technical services for the Xekaman Xanxay hydropower plant in Laos.

HPP Xekaman Xanxay will be constructed on the Xekaman River, in Xanxay District, Attapeu Province, near HPP Xekaman 3 and HPP Xekaman 1, about 40 km from the border with Vietnam.

ANDRITZ HYDRO's scope of supply includes two Bulb turbines, horizontal generators, governors, mechanical auxiliaries, electric power systems and automation, protection and control systems. Song Da Corporation will take care of local transport and erection under the supervision of ANDRITZ HYDRO.

The project is an essential part of the 300 MW hydropower station Xekaman 1, acting as downstream regulator to avoid flooding and to stabilize the water level. HPP Xekaman Xanxay will have an installed capacity of 32 MW and an average annual output of about 131.2 GWh of electrical energy.

This is the third order for ANDRITZ HYDRO from Song Da Corporation, the largest Vietnamese civil construction company with a long history in hydropower plant construction in Vietnam and Laos. It follows the Laotian projects HPP Xekaman 3 (250 MW, completed in 2013) and HPP Xekaman 1 (290 MW, signed in 2013). All three projects are based on a bilateral governmental agreement between Laos and Vietnam for the joint development of hydropower plants. In all these projects Song Da is the main shareholder, EDL (Electricité du Laos) holds the minority interests.

Manufacturing of stator for HPP Xekaman 1

Commissioning is scheduled for the second half of 2017, only 26 months after the contract commencement. The project will be executed by an international team of ANDRITZ HYDRO in Austria and China.

This contract marks another important milestone for ANDRITZ HYDRO in Laos as well as with the esteemed client Song Da Corporation. ■

TECHNICAL DATA	
Output	2 × 16.19 MW
	2 × 17.6 MVA
Voltage	10.5 kV
Head	10.2 m
Speed	100 rpm
Runner diameter	5,500 mm
Av. annual generation	131.2 GWh

Foz do Areia

Brazil

By Ricardo Calandrini
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In October 2015, ANDRITZ HYDRO signed a contract with Companhia Paranaense de Energia (COPEL) for the modernization of their largest hydropower plant Foz do Areia on the Iguaçu River in the state of Paraná.

HPP Foz do Areia has a total installed capacity of 1,676 MW with a head of 135 m and is located about 15 km from the city of Faxinal do Ceu and 240 km from the state capital of Curitiba. The name of the plant was recently changed to Bento Munhoz da Rocha Netto plant as a tribute to the former governor, who led Paraná state from 1951 to 1955. Netto initiated many important works, such as the construction of the Civic Center in Curitiba and the creation of COPEL on October 26, 1954.

In order to build the dam, the river water was diverted into a single stage, using two tunnels located on the right bank, with a diameter of 12 m each and a joint flow capacity of 3,800 m^3/s. The plant was put into operation in 1975, the dam completed in 1979, becoming operational in the beginning of the 1980s. At that time, its generating units were the largest in Brazil. Its construction caused the shutdown of the Salto Grande do Iguaçu hydropower plant, the first on the Iguaçu River, with an installed capacity of 15.2 MW.

COPEL held a public bidding for the modernization of the four generating units at HPP Foz do Areia, which was won by ANDRITZ HYDRO Brasil. The contractual scope comprises the supply of four new turbine runners, including turbine governors, complete HPU and air compressors, four new excitation systems, shaft seals, auto lubricating distributor bushings, head cover drainage system, pipes, valves, and additional hydro-mechanical equipment. A turbine model test will be carried out at the ANDRITZ HYDRO lab in Linz, Austria. Besides the supply of new components and the refurbishment, transportation, installation, and commissioning are also part of the contractual scope.

After rehabilitation the cavitation conditions of the four Francis runners will be seriously improved.

The project is scheduled to be executed within 70 months. ■

TECHNICAL DATA	
Output	4 × 419 MW
Head (nominal)	135 m
Speed	128.6 rpm
Runner diameter	5,810 mm

Downstream view of power house, dam and spillway

Lower Monumental Dam

USA

By Yunfeng Gao
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The U.S. Army Corps of Engineers, Walla Walla District, awarded a contract to ANDRITZ HYDRO in July 2015, for generator rewind and turbine cavitation repairs at HPP Lower Monumental Dam. With 810 MW it is one of the four major hydropower plants on the lower Snake River in Washington State, USA.

HPP Lower Monumental Dam is a run-of-river plant with six Kaplan turbines installed. Construction began in 1961, with three units completed in 1969 and an additional three units finished in 1981. All six generators and three of the six turbines were originally provided by ANDRITZ HYDRO's predecessor companies.

Some of the generator and turbine units, after nearly a half century's operation, have performed past or are nearing the end of their design life. Major rehabilitations have been carried out or are planned. ANDRITZ HYDRO will continue to work very closely with the Walla Walla District on these rehabilitation activities awarded under this contract.

At the Lower Monumental Dam hydropower plant, the turbine unit #1 experienced a runner hub linkage failure, prompting the customer to weld blocks to the hub to hold the blades in a fixed position. The work will replace internal hub linkage components requiring disassembly of the main unit and turbine runner, with a provision to inspect and refurbish other turbine and generator components.

Repairs also include cavitation repair to unit #1 blades, hub and discharge ring as well as repair of cavitation damage to the unit #2 runner. Following the repair, both runners will work as completely functional double-regulated Kaplan runners.

ANDRITZ HYDRO will also supply new stator windings and a stator core for unit #1. Replacing the stator core will be dependent on the on-site inspection and condition assessment of the existing core.

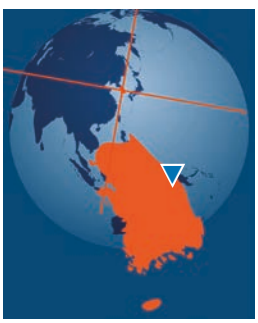
Just prior to this award, ANDRITZ HYDRO successfully completed a generator rewind project on 10 of 14 units at the McNary hydropower plant, located on the Columbia River near Umatilla, Oregon.

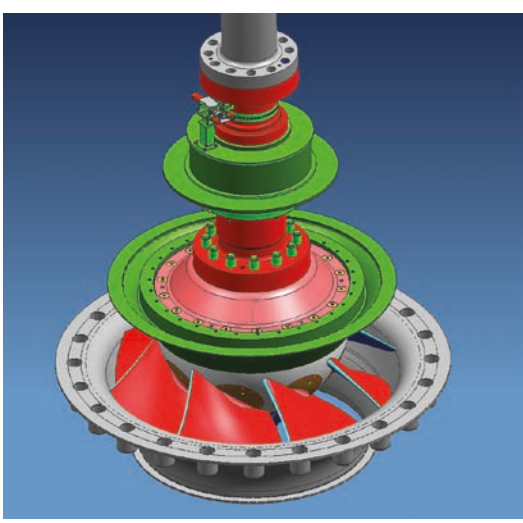
The entire project is expected to be completed by May 2017. ■

TECHNICAL DATA	
Output	810 MW
	900 MVA
Voltage	13.8 kV
Head	30 m
Speed	90 rpm
Runner diameter	7,925 mm

Lower Monumental Dam

Dam and spillway





Schematic drawing of unit

Andong

South Korea

By Bernhard Mühlbachler
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K-water, a South Korean utility and top level water service company, has awarded ANDRITZ HYDRO an order for the refurbishment of the Andong hydropower station on the Nakdong River in South Korea.

The scope of supply and services comprises model test, design, engineering, manufacturing, installation, and commissioning of two 46.3 MW generating units. Regarding the turbine, the main parts to be renewed are the turbine runners, the distributor, and the shaft assembly, including guide bearing and main shaft seal. A new generator and excitation system – including accessories and special tools – a new unit control system, a new protection system, a 12 kV bus duct and a switchgear, and neutral grounding equipment will also be supplied.

One of the more remarkable aspects of this order is that the turbine runners are of the so-called “Deriaz” type. This design, which can be compared with a diagonal flow turbine having movable blades, is very rarely applied for high head axial applications. Only a few companies beside ANDRITZ HYDRO have the required know-how to design this type of turbine and can provide adequate reference projects.

For many years ANDRITZ HYDRO and K-water, which supplies one quarter of South Korea’s renewable energy, have maintained a good business relationship, which started years ago with the successful execution of HPP Sihwa, the world’s largest tidal hydropower station. ANDRITZ HYDRO’s willingness to support K-water in addressing complex technical challenges, which finally turned into the first direct domestic contract, was also a key factor in winning this order.

This contract not only strengthens further the good cooperation with K-water, but also ANDRITZ HYDRO’s strong position in the South Korean hydropower market.

Commissioning of the new units is scheduled for mid-2019. ■

TECHNICAL DATA	
Output	2 × 46.3 MW
Voltage	12 kV
Head	57 m
Speed	189.5 rpm
Runner diameter	3,750 mm

Bulb Turbines
Technology Fit for the Future

By Andreas Rammler
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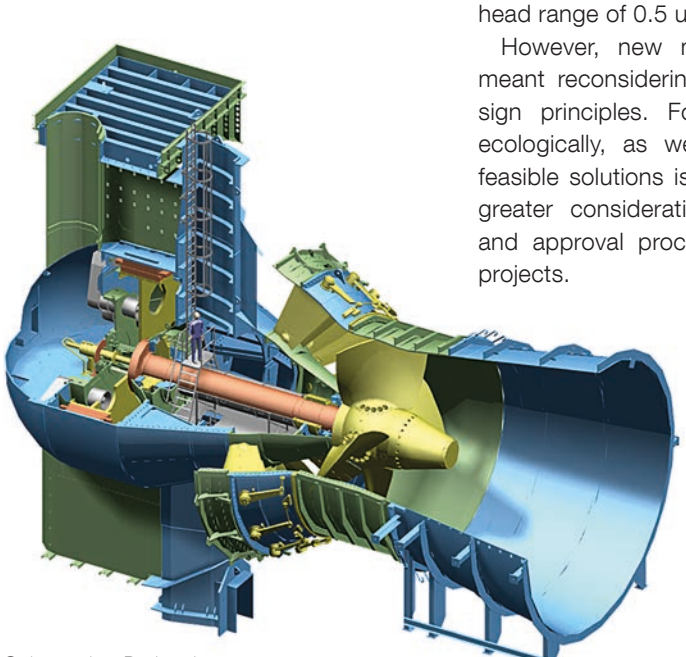
Bulb turbine runner during installation process at HPP Iffezheim, Germany

ANDRITZ HYDRO team during Bulb turbine installation

When Austrian professor Viktor Kaplan (1876–1934) filed his essential patents for the eponymous turbine in 1912 and 1913, he opened the way for a new technology able to use low hydrostatic heads for power generation in an economically feasible way – especially at run-of-river plants.



Schematic 3D-drawing
of Bulb turbine for HPP Iffezheim, Germany

In particular, the horizontal type of Kaplan machine – the Bulb turbine – shows extraordinary flexibility in its application. From small to large, from run-of-river to tidal, and from fixed to variable-speed – everything is possible within a head range of 0.5 up to 30 meters.

However, new market needs have meant reconsidering several basic design principles. For example, having ecologically, as well as economically, feasible solutions is becoming an ever-greater consideration in the planning and approval process for hydropower projects.

Furthermore, new requirements for grid control have motivated energy producers to switch Bulb and Kaplan turbines – which were formerly operated in level control – to primary control in order to provide grid frequency stabilization services.

In addition, the intention to utilize tidal forces as renewable and clean energy resource has triggered new concepts concerning hydraulic as well as mechanical design and the extended application of sophisticated, stainless materials.

The worldwide leader in Bulb turbine units – with a total installed capacity of approximately 6,500 MW and covering a market share of more than 70% – ANDRITZ HYDRO focused its research and development efforts on these new demands at an early stage. ▶

Installation of Bulb Turbine parts at HPP Sihwa, South Korea

Demanding environmental performance

Increasing demands for ecological performance have prompted changes in the use of problematic substances, such as lubricating oils, while the impact hydropower stations have on aquatic life has become a major issue for new and the refurbishment of existing hydraulic turbines.

The development of oil-free solutions for Bulb turbine runners was initiated many years ago and ANDRITZ HYDRO has recorded more than 130 references within the last 20 years for oil-free Kaplan runners up to largest diameters, outputs and heads in the Kaplan range – always offering the best solutions.

Instead of oil, the hub is filled with water together with a corrosion inhibitor similar to the citric acid found in lemons and which is non-toxic and not hazardous.

Blade bearings also represent a key element in realizing an oil-free runner hub. Extensive testing has been performed in order to determine the best solutions for bearing materials. The result is a comprehensive database comprising coefficients of friction, wear and allowable pressures. Based on that, the best material can be selected for each application.

ANDRITZ HYDRO also invests in the research and development of fish-friendly turbine technology. In order to reduce damage to the fish population – as well as avoiding damage to the turbines – many theoretical approaches and computation models have been developed over the years. By combining hydraulic knowledge with biological understanding, ANDRITZ HYDRO is able to minimize fish injury without major energy losses.

Changing control requirements

Switching turbine regulation from level control to primary control introduces a significant change in the frequency of regulation movements by the runner and the guide vane mechanisms. More regulation movements result in more load cycles for the affected parts.

Records from one unit operating in these two different modes show a significant increase in load-cycles for the differential pressure of the runner servomotor actuating the blade movements during primary control, when compared with discharge control operation.

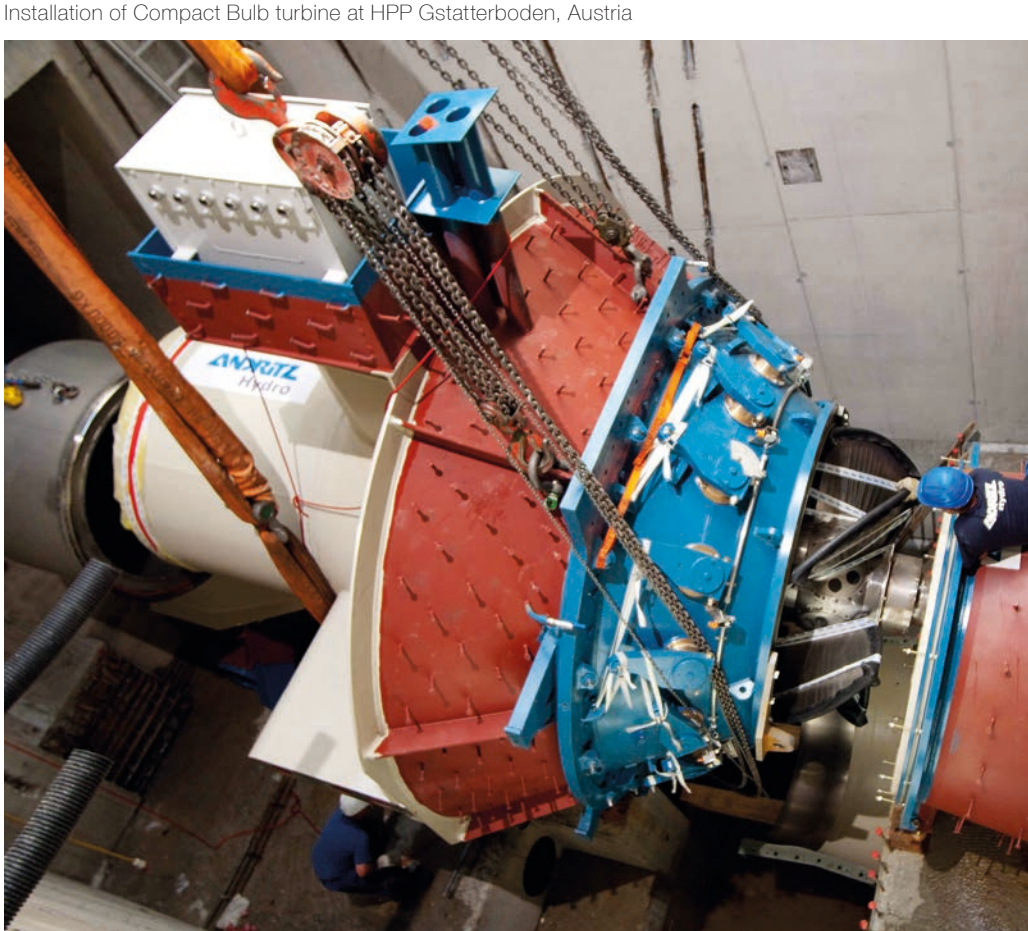
More load cycles inevitably make fatigue a greater consideration. Fatigue is influenced by the material, the geometry of the parts and the cyclic loading. In a Bulb turbine the blade is affected by centrifugal force, axial thrust and circumferential force as well as hydraulic torque from the pressure distribution on the blade.

Faced with changing operational demands ANDRITZ HYDRO has developed tools to accurately assess the impact of changing operational requirements on fatigue – as well as other considerations – and can therefore support energy producers in the diagnosis and assessment of the residual service life of turbine equipment.

Tidal applications

ANDRITZ HYDRO has also developed a sound and leading technology in the tidal barrage field, starting with the Annapolis tidal plant in Canada back in 1984. Technical development continued with the Shiwa tidal plant in South Korea in 2004, and improved further during the on-going design of the units for the Swansea Bay Lagoon tidal plant in Great Britain. ▶

Installation of Compact Bulb turbine at HPP Gstatterboden, Austria



Installation works for a small Bulb turbine

Tidal energy can be used in two ways – by utilizing the potential energy of the tidal lift or the kinetic energy of the tidal stream. Both can be realized with horizontal Kaplan turbines of differing design and the push to extract energy from the tides has also prompted technical innovations.

For instance, the large head variations found during a tidal cycle initiated the introduction of variable-speed technologies which, in addition to movable guide vanes and runner blades, lead to triple-regulated machines.

ANDRITZ HYDRO Hammerfest was and is a pioneer in tidal current technology. The tidal flow turbine concept was developed in 1997; the first 300 kW prototype was installed in 2003; a 1 MW unit followed in 2011 and the first commercial array – with 265 units in total – will be started with four 1.5 MW demonstration units in 2016.

Viktor Kaplan's idea may have emerged more than a century ago, but in light of changing environmental, economic and operational needs ANDRITZ HYDRO strives to ensure that his ingenious basic idea for a low head and efficient turbine is further developed in order to fulfill today's demanding requirements and to make his legacy FIT FOR THE FUTURE. ■

TECHNICAL DATA

Gstatterboden, Austria:		
Output	1 × 1.2	MW
Head	9.5	m
Speed	250	rpm
Runner diameter	1,950	mm
Iffezheim, Germany:		
Output	1 × 38.5	MW
Head	9.5	m
Speed	83.3	rpm
Runner diameter	6,800	mm
Santo Antônio, Brazil:		
5-blade turbine	6 × 71.05	MW
4-blade turbine	6 × 74.8	MW
Generator	12 × 82.25	MVA
Speed	100	rpm
Runner diameter	7,500	mm
Sihwa Tidal, South Korea:		
Output	10 × 26	MW
Head	2–9.8	m
Speed	64.3	rpm
Runner diameter	7,500	mm

Installation of Bulb turbines at HPP Santo Antônio, Brazil

Baixo Sabor

Portugal

By Joachim Gütler
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In February 2009, the consortium ANDRITZ HYDRO and local partner Ensulmeci received a contract from Energias de Portugal (EDP) for the delivery, installation, and commissioning of the complete electro-mechanical equipment for the Baixo Sabor hydropower plant. The plant consists of two stages: Montante and Jusante both located on the lower course of the Sabor River, a tributary to the Douro in northern Portugal.

The scope of supply for each stage includes two reversible pump turbines with auxiliary systems, generators, power bus bars, transformers, switch gear, complete automation and control system, and auxiliary equipment for the turbine house. In 2012, ANDRITZ HYDRO assumed also responsibility for the contracted scope of supply and services of Ensulmeci.

Jusante stage reservoir

The Jusante stage of Baixo Sabor has been in commercial operation since April 2015. Following heavy rainfalls in early 2016, the maximum water level was reached at the Montante stage as well. This made it possible to run the remaining pre-commissioning tests. In February 2016, the Montante stage was also put into commercial operation.

Special challenges of the hydraulic development of this project were the extremely wide operation spectrum in regard to the water head and load at HPP Baixo Sabor Montante, and the use of reversible pump turbines for the unusually low water heads at HPP Baixo Sabor Jusante. With the successful commissioning of both stages, two important references were added to ANDRITZ HYDRO's list of pump turbine projects.

The Baixo Sabor hydropower facilities with their overall installed capacity of 190 MW contribute significantly to Portugal's ambitious goal of increasing the country's share of renewables to 31% by 2020. ■

TECHNICAL DATA

Jusante stage:	
Output	2 × 18 MW
	2 × 20 MVA
Voltage	6 kV
Head	30 m
Speed	150 rpm
Runner diameter	3,950 mm
Montante stage:	
Output	2 × 77 MW
	2 × 85 MVA
Voltage	15 kV
Head	94 m
Speed	214.3 rpm
Runner diameter	4,200 mm

Manufacturing of stator

Bighorn

Canada

By Pierre-Luc Boulanger
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ANDRITZ HYDRO reached a significant milestone in the Canadian market with the signature of a Master Service Agreement (MSA) with TransAlta Corporation for the modernization of their hydro fleet in October 2012.

The contract for HPP Bighorn comes under the auspices of TransAlta's Life Extension Program (LEXT) for the upgrade of their hydropower facilities. The award of the rehabilitation of one unit at the Bighorn hydropower plant in November 2014 is the second success for ANDRITZ HYDRO under this MSA after the contract for HPP Spray in 2012.

HPP Bighorn is located north-west of the city of Calgary in Alberta and is named after a lake, river, creek, canyon, and mountain range in the west of the province. The hydropower plant has an installed capacity of 2 × 60 MW and supplies about 408 GWh of electrical energy per year to the national grid.

The main challenge was the strict limitations on the unit shutdown cycle. HPP Bighorn is the highest performing hydropower plant in TransAlta's hydro fleet and supplies water to the North Saskatchewan River System.

With the customer's collaboration, ANDRITZ HYDRO performed a condition assessment of the unit, defining the scope of works as a complete stator replacement, a generator ventilation upgrade, the modification of the thrust bearing to accommodate a new oil lift system, the replacement of the main and neutral cabinets and leads, as well as various inspections and instrumentation work.

By performing the stator assembly in the service bay prior to the outage, the refurbishment and commissioning cycle is set to be reduced to only two months. Currently, the engineering and sourcing phases of the project have been completed and the on-site assembly of the stator in the service bay has started.

Finalization of the work and closing of the project is scheduled for mid-July 2016. ■

Downstream view of the site and dam

Tierfehd

Switzerland

By Martin Haas
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In October 2015, the Final Acceptance Certificate (FAC) for the Tierfehd pumped storage power plant was received. Delivered to the fullest satisfaction of the customer – the major Swiss utility Axpo Power AG – HPP Tierfehd was planned as an extension of the existing system of Kraftwerke Linth-Limmern AG. Located in the canton of Glarus in central Switzerland, the main production equipment of this large hydro scheme was first installed in the early 1960s.

ANDRITZ HYDRO was awarded a turnkey contract for the supply of the complete electro-mechanical package for HPP Tierfehd, including automation, EPS, and auxiliary systems. The heart of the project is a reversible pump turbine unit with a net head of more than 1,000 m. Due to the extraordinary high head for a Francis pump turbine, a design with four stages and fixed guide vanes was applied – a layout found only in very few pump turbines around the world.

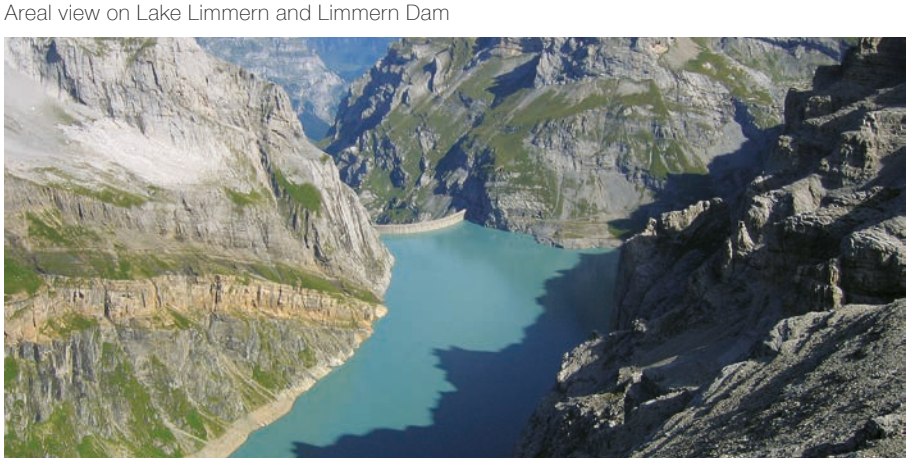
In pump mode, the unit is started by means of a six-jet-Pelton turbine before the motor-generator is synchronized to the grid. The entire system is installed in a vertical pit more than 70 m deep to provide a sufficient suction head for the pump. It is connected to the original penstock by a system of three spherical valves, which were also supplied by ANDRITZ HYDRO. The project was executed by cooperating ANDRITZ HYDRO teams from Switzerland, Germany, and Austria.

HPP Tierfehd was first commissioned in 2009. Later the motor-generator underwent some improvements so that the plant in its final configuration was put into operation in 2012. It is predominantly used in pump mode, but is also capable of switching from pump to turbine mode and vice versa in a remarkably short time. This feature proved very valuable to the customer in an increasingly volatile electricity market. ■

Pump turbine unit with four stages

TECHNICAL DATA	
Output	141 MW
Voltage	13.8 kV
Head	1,050 m
Speed	600 rpm
Runner diameter	2,260 mm

Areal view on Lake Limmern and Limmern Dam



Stator assembly

TECHNICAL DATA	
Peusangan 1:	
Output	2 × 23.1 MW
	2 × 26.5 MVA
Voltage	11 kV
Head	205.3 m
Speed	600 rpm
Runner diameter	1,200 mm
Peusangan 2:	
Output	2 × 22 MW
	2 × 25.3 MVA
Voltage	11 kV
Head	187.7 m
Speed	600 rpm
Runner diameter	1,200 mm

Peusangan 1and 2

Indonesia

By Amit Sharma
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Manufacturing of the turbine and generator components for the Peusangan 1 and 2 hydropower plants in Indonesia are at an advanced stage, with completion originally due by May 2016.

The contract for the electro-mechanical works at the hydropower plants was signed between PT PLN (Persero) and ANDRITZ HYDRO in August 2013. Jointly financed by the Japan International Cooperation Agency (JICA) and the Government of Indonesia, Nippon Koei Co. Ltd of Japan is the consultant appointed to oversee the implementation of this hydropower project.

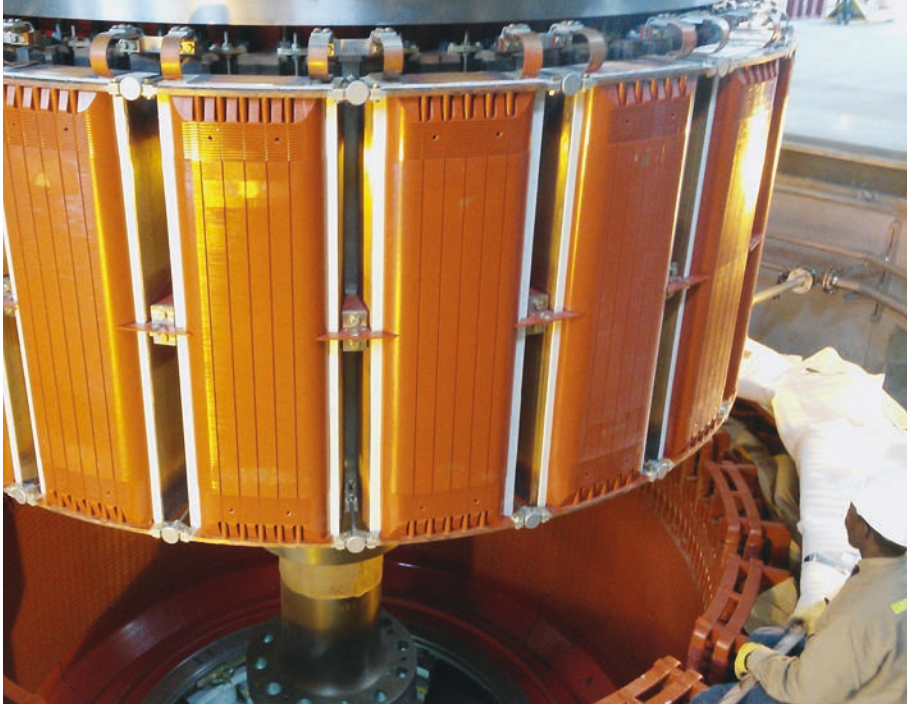
HPP Peusangan 1 consists of an underground powerhouse while Peusangan 2 has a surface powerhouse. Both are run-of-river power plants, located on the Peusangan River and adjacent to Lake Laut Tawar in the central region of Aceh Province in northwestern Sumatra.

ANDRITZ HYDRO's scope of supply for HPP Peusangan 1 and HPP Peusangan 2 comprises vertical Francis turbines, generators, transformers, 150 kV switchyards, cranes, and comprehensive mechanical and electrical auxiliaries. The supply of turbines, generators, and the high voltage system is being executed by ANDRITZ HYDRO India, whereas the supply of the low voltage system, telecommunication, and control system, as well as local transportation and installation is done by ANDRITZ HYDRO Indonesia.

Initially the contractual period was 42 months. However, due to unforeseen geological issues the civil works are being delayed by 24 months. Consequently, the revised completion date for trial operation of the last unit is now April 2019.

HPP Peusangan 1 and 2 will be the first large hydropower plants in the region, with an expected annual output of 327 GWh of electrical energy. ■

Inlet valves during manufacturing



Rotor lowering

Carlos Lleras Restrepo

Colombia

By Franco Michele Bennati
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In October 2015, ANDRITZ HYDRO received the Preliminary Acceptance Certificates (PAC) for the successful completion and commissioning of the new Carlos Lleras Restrepo hydropower plant in Colombia. The plant is located on the river Porce, in the Department of Antioquia, downstream from the city of Medellín and has an installed capacity of 80 MW.

ANDRITZ HYDRO was awarded a contract by HIDROELÉCTRICA DEL ALTO PORCE S.A.S. E.S.P for the supply of the complete electro- and hydro-mechanical equipment. The contractual scope of supply included two 39.7 MW turbines and two generators, as well as the balance of plant equipment for the hydropower plant. This included the main inlet valves, the intake gates regulating the water flow at the entrance of the 5.9 km tunnel feeding the power plant, transformers, GIS, control and protection devices, batteries, emergency generator, and auxiliary systems. Using a head of about 130 m, the diameter of the delivered new runners is 2,000 mm. The project was executed by an international ANDRITZ HYDRO team from various locations in Colombia, Austria, Germany, and Mexico coordinating not only the work of international ANDRITZ HYDRO locations, but also the contracted sub-suppliers, also from Colombia.

Colombia is a country with an enormous hydroelectric potential, mainly due to the existence of abundant water courses and the terrain. ANDRITZ HYDRO has a long history in the country, with its first equipment deliveries dating back to the early 1900s. More than 50% of the total installed hydroelectric capacity in Colombia was supplied by ANDRITZ HYDRO or its predecessor companies.

The order for the Carlos Lleras Restrepo hydropower plant underlines again the strong position of ANDRITZ HYDRO in this important hydropower market and demonstrates the technological know-how of ANDRITZ HYDRO's "from water-to-wire" turnkey solutions. ■

TECHNICAL DATA	
Output	2 × 39.7 MW
	2 × 42 MVA
Voltage	13.8 kV
Head	130 m
Speed	360 rpm
Runner diameter	2,000 mm
Av. annual generation	585.21 GWh

Powerhouse

Langen-prozelten

Germany

By Erwin Heimhilcher
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Red-hot shaft on its way to the forge process

A contract for the refurbishment of the world's most powerful single-phase hydropower motor generators at pumped storage power plant Langenprozelten has been awarded to ANDRITZ HYDRO by German-based Donau Wasserkraft AG (DWK), a subsidiary of Rhein-Main-Donau AG (99.25%) and Uniper (0.75%).

Pumped storage plant Langenprozelten is situated in the Unterfranken region in the German federal state of Bavaria. 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.

Single-phase generators are specifically designed for the railway's 16.7 Hz traction power network. The extreme forces acting on the motor generator's rotor require not only particularly precise calculations, but also special experience in selecting the proper materials.

Only a few forges in the world are able to manufacture with flawless quality the required forged shaft with a gross weight of about 170 tons.

The high mechanical stress exerted on the poles – each weighing a world record-breaking 34,000 kg – as well as the special construction of the damping winding required extensive calculations and research. Especially critical are the ultra-flexible joints that link the damper bars to the damper ring segments. The damping system was designed specifically to handle the high currents (34,000 A ring current!), mechanical stress and extensive thermal expansion. Comprehensive tests, such as centrifugal force tests monitored with a high-speed camera, were performed on all damping system components to verify the calculation results. At the ANDRITZ HYDRO balancing tunnel testing facilities, the entire rotor was tested at the run-away speed of 756 rpm. During the test, each pole on the rotor had to be held with a force equivalent to 27,000 tons, which corresponds to the weight of 70 fully loaded Boeing 747 aircrafts.

Assembly at the facility required extreme precision and the know-how of experienced engineers. Since the power plant's crane was designed for a maximum load of only 110 tons, the two-part stator housing had to be assembled inside the generator annulus space before the stator lamination was stacked and the winding inserted. The rotor has to be assembled inside the stator as well.

The project is in now nearing the re-commissioning phase. ■

34 t pole for the generator

TECHNICAL DATA	
2 single-phase synchronous motor generators (vertical)	
Output	94 MW
Voltage	10.75 kV
Stator current	8,744 A
Damper current	34,000 A
Frequency	16.7 mm
Speed (2 rotational directions)	501 rpm
Shaft-generators for station supply (on a common shaft)	
Output (three phase)	1,260 kVA
Voltage	400 V
Runner diameter	50 Hz

Italy, Camaioni

By Stefano Rizzi
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In November 2015, ANDRITZ HYDRO received a contract for the supply of electro-mechanical equipment for the new Camaioni hydropower plant in Italy from HGE Srl, a private investor which has been active in the small hydro sector for many years.

HPP Camaioni is located about 30 km east of the city of Florence on the Arno River. As with most Mini Compact installations, the environmental impact is reduced to an absolute minimum and the new structure will also be utilized for educational purposes.

The scope of supply comprises a green-field power house for which ANDRITZ HYDRO deliveries will include two axial Bevel Gear Bulb turbines with a diameter of 2,150 mm and a power output of 1.05 MW, complete with synchronous generators, and mechanical auxiliaries.

Commissioning is scheduled for end of 2016 with synchronization of the first unit. ■

TECHNICAL DATA	
Output	2 × 1.05 MW
	12 MVA
Head	4 m
Speed	204 rpm
Runner diameter	2,150 mm

USA, Olmsted

By Mark Barandy
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ANDRITZ HYDRO was contracted by Utah Water Conservancy District (CUWCD) to provide two turbine-generator units, including auxiliary mechanical equipment and electrical controls, for the new Olmsted powerhouse.

The existing Olmsted hydropower plant, located at Provo Canyon near Orem, Utah, was completed in 1904 and is one of the oldest facilities in the western United States and is centerpiece of the Telluride Institute of Learning. The facility was the first corporate-sponsored school for engineering students. Now, CUWCD and the US Department of the Interior will be constructing a new hydroelectric power plant at the Olmsted site.

The project includes a new powerhouse, two new Compact units, replacing of the four existing penstocks with a single buried penstock, and construction of a new power transmission line. Operating under a net head of 102 m, the new horizontal Francis turbine units will have a nominal output of 8 MW and 3.2 MW. All works will be executed whilst preserving the existing historic powerhouse. The engineering firm, CH2M Hill, will undertake the powerhouse design.

The project is scheduled to be finalized at the beginning of 2018. ■

TECHNICAL DATA	
Output	1 × 8 MW
	1 × 3.2 MW
Head	102.5 m
Speed	514/720 rpm
Runner diameter	737/1,109 mm

Nepal, Kabeli B1

By Manoj Agarwal
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At the end of 2015, ANDRITZ HYDRO received an order for the Kabeli B1 hydropower station from Arun Kabeli Power Limited. The run-of-river power station is located in the Panchtharand and Taplejung Districts of Mechi Zone in the Eastern Development Region of Nepal, about 8 km from the city of Ganesh Chowk.

The intake site is located at Tharpu VDC and Thumbedin VDC with a gross head of 93.7 m. Discharge from the de-sanding basin passes to the powerhouse through a 4.5 km long penstock pipe with a diameter of 4,000 mm.

ANDRITZ HYDRO will supply two horizontal Francis turbines with an output of 12.5 MW each and associated equipment. The power generated from this project will be connected to the national grid system via an 84 km long, 132 kV transmission line called the “Mechi Corridor Transmission line”.

After completion, HPP Kabeli B1 will produce about 151.65 GWh of electrical energy per year. ■

TECHNICAL DATA	
Output	2 × 12.5 MW
Head	93.7 m
Speed	500 rpm
Runner diameter	1,354 mm
Av. annual generation	151.6 GWh

France, St. Christophe, Reallon, Charmaix

By Rudy Yvrard
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In December 2015, ANDRITZ HYDRO successfully commissioned two Mini Compact hydropower plants in France: HPP Saint Christophe and HPP Reallon. Both hydropower plants are located in the French Alps and are owned by SERHY Ingénierie, a company very active in hydropower development.

The Saint Christophe hydropower plant required rehabilitation of one existing unit and the installation of an additional horizontal Pelton turbine. HPP Reallon, equipped with a six-jet Pelton turbine, was a new plant with integration constraints since it is located in the middle of a village. Both projects were realized simultaneously and put into operation in less than one year. ANDRITZ HYDRO provided turbines, generators, inlet valves, and a high pressure unit (HPU).

The long-term and successful cooperation between SERHY Ingénierie and ANDRITZ HYDRO will also continue in 2016. A new Mini Compact contract for the supply of a five-jet, vertical Pelton turbine for HPP Charmaix was signed at the beginning of the year 2016.

Commissioning of all projects is scheduled for the end of the same year. ■

TECHNICAL DATA

St. Christophe:	
Output	2.31 MW
Head	400 m
Speed	1,000 rpm
Runner diameter	790 mm
Reallon:	
Output	2.72 MW
Head	154 m
Speed	600 rpm
Runner diameter	820 mm
Charmaix:	
Output	1.51 MW
Head	155.6 m
Speed	750 rpm
Runner diameter	670 mm

Ecuador, Due

By Sergio Contreras
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After the successful project execution of the 2×9 MW Calope hydropower plant in Ecuador (see Hydro News 08) in 2006, Hidroalto Generacion De Energia S.A. awarded ANDRITZ HYDRO a new contract for the supply of electro-mechanical equipment for the Due hydropower plant in 2015.

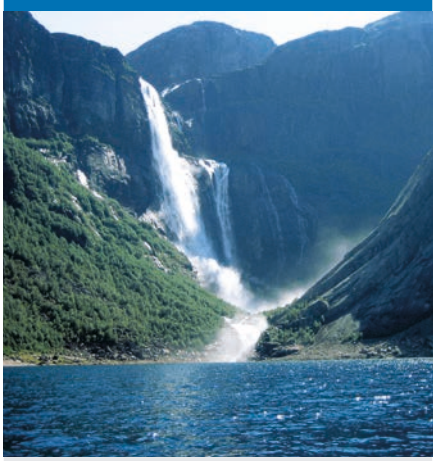
The project is located on the Due River in the Province of Sucumbios, Ecuador. ANDRITZ HYDRO's scope of supply comprises two horizontal Francis turbines with an output of 25 MW each, as well as generators, inlet butterfly valves (DN2200), pressure relief valves (DN1100), hydraulic power units, cooling system, control and automation, MV switchgear, and electrical auxiliaries. This project is being executed by an international team from ANDRITZ HYDRO France delivering the turbines, ANDRITZ HYDRO India supplying the generators, and ANDRITZ HYDRO Colombia responsible for control and electrical equipment.

This contract confirms again the confidence this customer places in ANDRITZ HYDRO and strengthens its position in the Ecuadorian market. Final commissioning is expected by mid-2017. ■

TECHNICAL DATA

Output	2×25 MW 2×28 MVA
Head	111.12 m
Speed	450 rpm
Runner diameter	1,681 mm

Norway, Ringedalen



By Kristian Glemmestad
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Statkraft has awarded a contract to ANDRITZ HYDRO for the supply of the electro- and hydro-mechanical equipment for the Ringedalen hydropower plant in Norway.

HPP Ringedalen is located in the municipality of Odda in Hordaland County and will utilize the head between lakes Mosdalsvatnet and Ringedalsvatnet, which is the reservoir of the existing Oksla Power Plant.

The scope of supply for ANDRITZ HYDRO includes two Pelton turbine units with associated generators and a total combined capacity of 23 MW. ANDRITZ HYDRO Germany in cooperation with ANDRITZ HYDRO Norway will provide the turbine equipment, whereas ANDRITZ HYDRO Bhopal, India will deliver two 13.5 MVA generators.

Completion of HPP Ringedalen is scheduled for 2017, providing then an average annual production of about 60 GWh to supply about 3,000 Norwegian households with electricity. ■

TECHNICAL DATA

Output	2×11.5 MW
Head	511.7 m
Speed	750 rpm
Runner diameter	1,230 mm
Av. annual generation	60 GWh

Switzerland, Rhone Oberwald

By Hans Wolfhard
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Utility company FMV SA based in Sion, Switzerland, awarded a contract to a consortium under the leadership of ANDRITZ HYDRO for the delivery of the complete electro-mechanical equipment for the new HPP Rhone Oberwald in December 2015.

The new run-of-river power station will be built in the region of Gletsch-Oberwald in the Swiss canton of Wallis. The water intake is located in the village Gletsch at an altitude of 1,750 m and has a design capacity of 5.7 m³/s. The main powerhouse is situated in a cavern with a return gallery into the river Rhone.

ANDRITZ HYDRO's scope of supply includes two vertical, six-jet Pelton turbines, two spherical valves with a diameter of 700 mm and a pressure of 40 bar, the entire control and automation system, medium voltage switchgear, transformers, and the powerhouse crane.

With a total installed power output of 15 MW the new hydropower plant will produce about 41 GWh of energy per year. Start of commercial operations is planned for mid-2017. ■

TECHNICAL DATA	
Output	2 × 7.5 MW
Head	287.5 m
Speed	600 rpm
Runner diameter	1,150 mm
Av. annual generation	41 GWh

Turkey, Okkayasi

By Alp Töreli
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ANDRITZ HYDRO has received an order from Okkayası Elektrik Üretim ve İnşaat Anonim Şirketi for the supply of electro-mechanical equipment for the Okkayasi hydropower plant, located in Kahramanmaras Province of Turkey.

The contractual scope for ANDRITZ HYDRO comprises the delivery of two vertical, four-jet Pelton turbine units for the small hydropower plant, including design, manufacturing, supply, transportation, installation, and commissioning.

Turbines, generators, and related equipment will be supplied by ANDRITZ HYDRO France. The electrical power systems (EPS), the turbine housings and the distributors, as well as the installation of all electro-mechanical equipment will be the responsibility of ANDRITZ HYDRO Turkey.

Commercial operation of the plant is expected in the second quarter of 2016. ■

TECHNICAL DATA	
Output	2 × 11.7 MW
Head	479.4 m
Speed	750 rpm
Runner diameter	1,150 mm

Chile, Convento Viejo

By Stefano Rizzi
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Sociedad Concesionaria Embalse Convento Viejo S.A. has awarded ANDRITZ HYDRO a contract for the supply of electro-mechanical equipment for the new Convento Viejo hydropower plant. The power plant is located 150 km south of Santiago de Chile in the region of Libertador Bernardo O'Higgins. It will use the environmental flow released from the Convento Viejo reservoir, which collects the waters from the Chimbarongo River and the Teno Channel.

The project will comprise a green field power house, for which ANDRITZ HYDRO is going to deliver two 9 MW Compact axial turbines, generators, mechanical auxiliaries, electrical power systems, transformers, as well as substation, unit and plant automation, and the tele-control center.

Commissioning and handing over of the whole plant to the customer is scheduled for the first quarter of 2017.

HPP Convento Viejo will have a total output of 18 MW, providing about 68 GWh per year of clean energy f or the Chilean Central Interconnected System (SIC). ■

TECHNICAL DATA	
Output	2 × 9 MW
Head	28.3 m
Speed	300 rpm
Runner diameter	2,150 mm
Av. annual generation	68 GWh

Costa Rica, Los Negros II

By Sergio Contreras
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In 2015, ANDRITZ HYDRO won a contract for the supply of turbine equipment for the new Los Negros II hydropower plant, owned by ESPH (Empresa de Servicios Publicos de Heredia, S.A.). After the successful realization of HPP Los Negros in 2004, also equipped by ANDRITZ HYDRO, and its reliable operation since then, the owner decided to build a second power plant in this region as part of a strategy to expand its energy sources.

HPP Los Negro II is situated near Cuatro Bocas in the province of Alajuela, in the north-central part of the country and near the border with Nicaragua. It uses the waters of the rivers Negros and Jalapiedras.

ANDRITZ HYDRO's scope of supply comprises the delivery of two horizontal Francis turbines, each with a capacity of 14.31 MW, including DN1800 butterfly valves, hydraulic power units, supervision of installation, as well as commissioning.

HPP Los Negros II is scheduled to be put into commercial operation in 2017. ■

TECHNICAL DATA	
Output	2 × 14.31 MW
Head	125.85 m
Speed	600 rpm
Runner diameter	1,195 mm

DR Congo, Koni

By David Cirjanic
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Koni hydropower station, owned by SNEL (Société nationale d'électricité) is located in Kantanga Province of the DR Congo and has a total installed capacity of 42 MW and is equipped with three vertical Francis turbines. The project is supported by private founding partner ENRC PLC.

After being in operation for almost 60 years, the existing turbines, originally supplied by EscherWyss (today ANDRITZ HYDRO), were in poor condition. In 2010, due to defective inlet valves of units #1 and #3 HPP Koni had to be put out of operation. ANDRITZ HYDRO received a contract for the replacement of these inlet valves in 2012. Unit #1 was successfully reconnected to the grid and dismantling of unit #3 started in 2015.

On drawing-up the expertise for unit #3, it was discovered that more extensive repair work is necessary. Subsequently, ANDRITZ HYDRO was awarded the order to execute a comprehensive rehabilitation. The contractual scope of supply comprises changing major components, such as fixed labyrinth and turbine shaft, set of upper stop lock, one set of new draining pumps, and rehabilitation of the cooling water system, as well as installation and commissioning.

Closing of the project and recommissioning of unit #3 is scheduled for summer 2017. ■

TECHNICAL DATA	
Output	3 × 14.2 MW
Head	55 m
Speed	333.33 rpm
Runner diameter	2,063 mm

Turkey, Yusufeli Barajı ve HES İnşaatı

By Uygur Aydin
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At the end of 2015, the Limak-Cengiz-Kolin consortium awarded ANDRITZ HYDRO a contract for the supply of electro-mechanical equipment for the Yusufeli Dam and hydroelectric power plant.

Situated on the Çoruh River 70 km southwest of the city of Artvin, the Yusufeli Dam and hydroelectric power plant is owned by DSI (General Directorate of State Hydraulic Works). The dam will be a double-curvature arch dam with a height of 270 m and will be the third highest of its kind in the world. With a total storage capacity of 2.2 billion m^3, the reservoir will have a surface area of 33 km^2.

ANDRITZ HYDRO will supply design, manufacturing, and installation of hydro-mechanical equipment, including intake structure, penstock, gates, embedded parts, grip beams, trash racks, spillway, radial gates, hydraulic lifting systems, cranes, and slide valves.

In September 2018, on-site manufacturing is due to be finished, installation and closing are scheduled for May 2019. Equipped with three 180 MW vertical Francis turbines, the powerhouse will generate 1,800 GWh of electrical energy annually. ■

TECHNICAL DATA	
Output	3 × 180 MW
Voltage	13/380 kV
Head	223 m
Penstocks	3,000 tons
Gates	2,350 tons
Av. annual generation	1,800 GWh

Mexico, La Venta

TECHNICAL DATA	
Output	5 × 6 MW
Head	37.5 m
Speed	300 rpm
Runner diameter	1,640 mm

By Raul Casas
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The hydroelectric power plant La Venta is located on the river Papagayo, near of the city of Tierra Colorada, Guerrero in Mexico. It was first inaugurated in 1965.

In September 2013, during the tropical storm Manuel, the hydropower plant was flooded and the radial gates, automation, and electrical equipment were destroyed.

The Mexican state owned utility Comisión Federal de Electricidad (CFE) launched a tender for the rehabilitation of the complete hydroelectric power plant in 2014. Motores e Ingeniería Mexmot, S.A. de C.V. was awarded the full contract for rehabilitation of civil works, access roads, mechanical repair, automation, and electrical equipment.

ANDRITZ HYDRO Mexico won the contract from Motores e Ingeniería Mexmot, S.A. de C.V. to supply SCADA and control systems, static excitation, protection and metering, as well as turbine governor and communication equipment.

The five generating units are scheduled to start commercial operation in 2016. ■

New Zealand, Aratiatia

By Georg Wöber
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New Zealand power company Mighty River Power has contracted ANDRITZ HYDRO to refurbish the Aratiatia hydropower station on the river Waikato on the North Island.

Aratiatia, a run-of-river station located 13 km upstream of Lake Taupo, is the first of nine hydropower plants with a combined installed capacity of 1,052 MW on the river Waikato, New Zealand's longest. All nine plants have been owned and operated by Mighty River Power since 1999.

Under the terms of the contract announced in December 2015, ANDRITZ HYDRO will design, deliver, install, and commission three generators, one Francis runner including model test, and three turbine governors for HPP Aratiatia. The first unit is due to start commercial operation in 2018. Refurbishment of the plant, which was first commissioned in 1964, will result in a significant increase in efficiency and reliability.

The company, which also operates five geothermal power plants with total capacity of 334 MW, is a pure renewable energy producer following the closure of its 140 MW gas-fired power station at the end of 2014. Mighty River produces an average annual output of 6,800 GWh, representing 15–17% of New Zealand's national electricity supply. About 60% – an average of 4,000 GWh – is produced by its hydropower assets. ■

TECHNICAL DATA	
Output	31.4 MW
	35 MVA
Voltage	11 kV
Head	33.5 m
Speed	136.4 rpm
Runner diameter	3,831 mm

China, Da A Guo

By Yong Ma
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ANDRITZ HYDRO has been awarded the supply of electro-mechanical equipment for HPP Da A Guo, located downstream of HuoQu River, 600 km west of the city of Chengdu in Sichuan Province, PR China.

It is the last step in the development of hydropower stations on the HuoQu River. The contract includes two Pelton turbine units with an output of 130 MW each. Project execution will be handled by joint order teams from ANDRITZ HYDRO China, Austria, and India. Commissioning is scheduled for May 2017.

The electrical energy produced by HPP Da A Guo will be fed to the Sichuan Grid.

With the award of this project ANDRITZ HYDRO will further strengthen its position in the Chinese hydropower market. ■

TECHNICAL DATA	
Output	2 × 130 MW
Head	605.4 m
Speed	375 rpm
Runner diameter	2,707 mm

Austria, Kaunertal

By Werner Wagner
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In April 2012, ANDRITZ HYDRO received an order from Tiroler Wasserkraft AG (TIWAG) for the renewal of the existing penstock at the 395 MW Kaunertal hydropower plant, located in western Austria in the state of Tyrol.

The main installation works at the penstocks, including the filling test, were finished on time in May 2015. In total, about 9,100 tons of steel of different grades and thicknesses have been used and welded during this project. Connection work from the old to the new pressure shaft was carried out between March and April 2016, when the seal on the disc valve was also replaced.

At the beginning of 2016, the reservoir level was lowered for rehabilitation works on the intake structure. It is currently being refilled with melt- and rainwater and the hydropower plant will resume operations by June 2016.

At the end of 2015, ANDRITZ HYDRO completed rehabilitation of two out of five 100 MVA synchronous generators at HPP Kaunertal (see Hydro News 27).

After more than 50 years in operation, new stators, new pole windings, new shafts with in-depth assessment were delivered, as well as a refurbishment of the remaining rotor components was executed. The generator components were designed and manufactured by ANDRITZ HYDRO in Weiz, where also the over-speed tests were performed.

These two contracts confirm the confidence Tiroler Wasserkraft AG places in ANDRITZ HYDRO. ■

TECHNICAL DATA	
Output	395 MW
Head	793–895 m
Speed	500 rpm
Runner diameter	2,858 mm

Hydrodynamic screw turbines

Centrifugal Pump and Screw Turbine

More green energy with innovative technology

By Bruno Mellacher
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One turns an ancient Archimedean principle around, while the other runs in reverse. Both generate energy in an innovative way from sources that have barely been tapped so far: the hydrodynamic screw turbine and the centrifugal pump – two technologies from ANDRITZ HYDRO with a lot of green potential.

Low investment costs and the opportunity to use even small hydroelectric potential and "wasted" energy are benefits offered by the ANDRITZ HYDRO hydrodynamic screw turbine and centrifugal pump. Both solutions have already proved successful in numerous applications and convinced customers of their merits with their high energy yield.

Modernizing an old principle

Inspiration for the hydrodynamic screw turbine technology was an ingenious idea from ancient Greece: the Archimedean screw, which enables water to flow uphill. Turning this principle around, the hydrodynamic screw turbine uses flowing water to generate electricity. What's special about this? Efficient use of hydropower is possible even at very low heads and water flows.

The hydrodynamic screw turbine adapts easily to existing conditions, ensuring no major interference with the surrounding landscape. Fish and other aquatic animals can pass through unharmed. In addition, the screw enriches the oxygen content in deeper bodies of water, resulting in improved water quality.

To date, there are around 200 ANDRITZ HYDRO hydrodynamic screw turbines installed worldwide.

Centrifugal pumps for energy recovery

Energy-efficient in forward and reverse mode

ANDRITZ HYDRO centrifugal pumps operate worldwide, conveying many different kinds of liquids. The pumps feature high efficiency and low energy consumption and recover energy in industrial processes or generate electricity from low hydroelectric potential.

In many industrial processes energy is lost, for example, when pressure has to be generated ahead of a filter, before being released without use as it is no longer needed later in the process. This energy can be recovered efficiently with two coupled pumps. The pump running in reverse absorbs the excess pressure and assists the pump running in normal operation. This way, more than 50% of the energy that would otherwise be lost is recovered, thus reducing energy costs.

Hitherto untapped hydropower potential is used profitably in numerous other areas, such as pressure-reducing stations in water pipelines or residual water outputs from hydropower stations and to produce electrical energy up to 1 MW per unit.

In addition, ANDRITZ HYDRO centrifugal pumps are used in micro hydropower plants, helping foresters' lodges or mountain refuges, private households, and commercial or industrial plants to generate their own electricity or supply it to an existing power grid. ■

Hydro Automation Day

Vienna, Austria

By Jens Päutz
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HYDRO AUTOMATION DAY 2015 took place at "Palais Ferstel" in Vienna, Austria in November 2015. More than 300 delegates from 37 countries participated in this long-established and very important customer event.

The occasion was opened with a keynote speech from the ANDRITZ HYDRO management team. Three esteemed customers presented their good experiences in project execution with ANDRITZ HYDRO, emphasizing the good relationship. The highlight of the day was the presentation on the latest developments of HIPASE – the new platform from ANDRITZ HYDRO. HIPASE is the first product in the hydropower market to integrate protection, excitation, synchronization, and turbine governor into a single platform. The presentation was supported by a specific HIPASE product show and six live presentation islands.

With customer presentations, the presentation of HIPASE and an afternoon of technical sessions, the event offered a very good opportunity for the exchange of experience between all participants.

The final highlight of this very successful day was a gala-dinner at the Viennese Sofiensäle, completed with a performance from renowned illusionist Lucca, after which all participants could let the day end in an enjoyable and relaxed atmosphere. ■

Customer Day

Hanoi, Vietnam

By Martin Koubek
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In October 2015, more than 130 customers and partners participated in the ANDRITZ HYDRO Customer Day Vietnam. The event was officially opened by His Excellency, the Austrian Federal Minister for Transport, Innovation and Technology, Mr. Alois Stöger.

This year, the event was focused on environmentally-friendly technical solutions, for example oil-free hubs for Kaplan and Bulb turbines, as well as the benefits of HIPASE – the new platform and engineering tool for protection, excitation, synchronizing, and turbine governor. The ANDRITZ Pumps product portfolio was also thoroughly explored.

As a special highlight, the General Director of Song Da Corporation, Vietnam's largest construction company, expressed his thanks to ANDRITZ HYDRO for the cooperation on 10 projects, including Na Loi, Thac Trang, Ry Ninh, Ea Krongrou, Tra Xom, and Nam He.

ANDRITZ HYDRO is looking forward to a new event in 2016. ■

EXPO Energia

Lima, Peru

By Peter Gnos
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The most important energy fair and conference in Peru – the EXPO Energia Peru – was held on February 17th and 18th, 2016.

Located for the first time at the Dolphin Hotel in Lima, delegates from large Peruvian and international companies working in the electricity sector met to exchange experiences and discuss developments in the Peruvian and international energy market.

ANDRITZ HYDRO presented its newly-designed booth and participated in the conference with a presentation titled: "Turnkey solutions for hydropower plants from 20 kW up to the biggest installations worldwide", focusing on the mini turbine product line, but also the extensive range of ANDRITZ HYDRO's product portfolio.

Throughout the two-day exhibition delegates from customers, consultants, and engineering companies visited the ANDRITZ HYDRO booth to get in touch with the ANDRITZ HYDRO team in Peru to exchange experience on executed projects, and to obtain the latest news on ANDRITZ HYDRO developments.

Once again, the EXPO Energia Peru was a big success. ■

Events in Laos

By Jens Päutz
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Customer Day Laos

In March 2016 ANDRITZ HYDRO has organized the first Customer Day Laos. More than 140 delegates from governmental institutions, hydropower plant operators and private investors attended this event, which was opened by keynote speeches from the Lao Deputy Minister of Energy and Mines, Mr. Viraphonh Viravong and the Autrian Trade Commissioner in Thailand, Mr. Guenther Sucher.

Office opening

ANDRITZ HYDRO has opened a representative office in the capital Vientiane. The opening ceremony took place on March 2nd, 2016, with the participation of the Lao Deputy Minister of Energy and Mines, Mr. Viraphonh Viravong, the Director of the Lao state utility Electricite de Lao (EDL), representatives of the ANDRITZ HYDRO management, and a number of valued guests. With the opening of the office ANDRITZ HYDRO is looking forward to an improved and direct customer care in this fast growing market.

Asia 2016

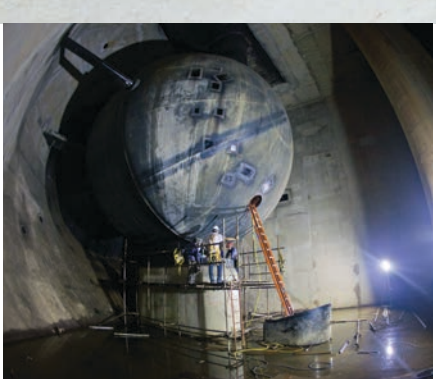
This year the ASIA 2016 conference took place in Vientiane, capital of Laos. More than 700 delegates from all over the world attended. ANDRITZ HYDRO was present with a booth, two paper presentations and was co-host of the welcome reception. The Asia 2016 offered a good opportunity to promote the competence of ANDRITZ HYDRO, improve existing customer relations, and detect new future potentials in the Asian markets. ■

Bulb Turbines

Best solution for low heads

ANDRITZ HYDRO is the worldwide leader in Bulb turbine technology with a global market share of more than 70%. Bulb turbines are horizontal Kaplan turbines with extraordinary flexibility in their application. From small to large size and output, from run-of-river to tidal power plants, with and without gear box, and from fixed to variable-speed – all within a head range between 1.5–35 m. The installed Bulb turbines of ANDRITZ HYDRO represent more than 12,000 MW worldwide, covering runner diameters up to 8,200 mm and outputs up to 76.5 MW per unit.

We focus on the best solution – "from water-to-wire".



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