

HYDRONEWS

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MAGAZINE OF ANDRITZ HYDRO



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ANDRITZ
Hydro

Latest News

Hydro News goes online

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Bosnia and Herzegovina

Hidroelektrane na Vrbasu has awarded a contract to ANDRITZ HYDRO for the supply of two 5 MW ECOBulb™ turbines for the new Bočac II hydro-power plant.

HPP Bočac II is located on the Vrbas River between the cities of Banja Luka and Jajce. The turbines will be installed on an existing dam downstream from HPP Bočac, which is currently equipped with two 55 MW Francis turbines from ANDRITZ HYDRO (formerly Escher Wyss).

The proposed ECOBulb™ technology convinced the customer to assign the order to ANDRITZ HYDRO. Commercial operations are scheduled to begin in 2016.

Chile



After two years of intensive installation works, in June 2014 ANDRITZ HYDRO successfully completed the Angostura hydropower plant in Chile.

Located about 600 km south of the Chilean capital Santiago de Chile, a completely new hydropower plant was built with six spillway radial gates, roller gates, and stop logs for diversion, together with a bottom outlet, intake, and draft tube, as well as two control buildings. The whole scope of delivery was designed, manufactured and erected by ANDRITZ HYDRO.

Brazil

In July 2014, ANDRITZ HYDRO received an order to supply electro-mechanical equipment for HPP Sinop from Construtora Triunfo S.A. The end customer is Consorcio Energetico Sinop (CES), a consortium composed of Eletronorte (ELN), Companhia Hidro-Elétrica do São Francisco S.A. (CHESF), and Électricité de France SA (EDF). HPP Sinop is located on the Teles Pires River in the Brazilian state of Mato Grosso.

The scope of ANDRITZ HYDRO includes the model test, two vertical 204 MW Kaplan turbines, two 223.3 MVA synchronous generators, two excitation systems, two governors as well as transportation, erection and commissioning supervision.

France

Électricité de France SA (EDF) has awarded a contract to the consortium ANDRITZ HYDRO – ORYS for the rehabilitation of five bulb turbines at the La Rance tidal power plant.

HPP La Rance is located in north-western France, south of the city of Saint-Malo. It was inaugurated in 1968 by General Charles de Gaulle and was the largest tidal hydropower plant in the world until 2011, with 24 units (10 MW each) and an annual energy production of some 500 GWh. The exceptional tidal range at this site can reach 13 m.

The scope of the rehabilitation works includes engineering, procurement, manufacturing, dismantling, erection and commissioning of the bulbs mechanical parts and generator rotor.

Lead by ANDRITZ HYDRO Switzerland site activity is scheduled to begin in 2015.

Guatemala

ANDRITZ HYDRO has received an order from GENEPAL to supply the design, manufacture, assembly and commissioning of two horizontal 12 MW Francis turbines, including two generators, two butterfly valves, and auxiliary electromechanical equipment for HPP Recreo II in Guatemala.



The hydropower plant is located in the town of San Felipe in eastern Guatemala.



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Cover:

Nine horizontal Compact Francis turbines at
HPP Forrest Kerr, Canada



Imprint

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Dear business friend

Global project activity for electromechanical equipment of hydroelectric power plants has remained satisfying in the last few months and the global hydropower market has also proved stable, despite the restrained investment activity in Europe.

In the market for new installations the positive trend in Africa is more lasting. New projects, such as HPP Laúca in Angola, Manantali in Mali or Inga 2 in the Democratic Republic of Congo are examples. But also in the European rather tense environment projects are being realized by ANDRITZ HYDRO especially in Scandinavia, Austria, and Switzerland.

Particularly worth mentioning is the positive trend in the small hydropower sector. In addition to project activities in the classical European hydropower markets there is a high implementation potential in the emerging and developing countries.

Of particular importance for ANDRITZ HYDRO is the Canadian hydropower market. With 74 GW of installed hydropower capacity, Canada today is the fourth largest hydropower market globally. With the acquisition of the Canadian specialists AFI Hydro, ANDRITZ HYDRO was able to further strengthen its market position in the field of hydraulic steel structures.

ANDRITZ HYDRO also sees very positive developments in other business segments. For instance, energy from tidal resources such as at Sihwa, in Korea, is registering continuously increasing interest worldwide. An important technological milestone is represented by tidal current turbines. At Pentland Firth in Scotland, the world's largest commercial tidal current plant will be built with a future total capacity of 398 MW. ANDRITZ HYDRO is going to deliver – on behalf of MeyGen Ltd. – three 1.5 MW tidal current turbines for the first phase.

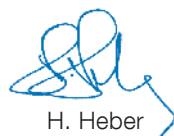
Another attractive business segment is turbo generators for thermal power plants. By establishing an additional location for the assembly of large turbo generators, ANDRITZ HYDRO is expanding its existing production potential further and is thus well equipped for future challenges.

From small hydropower plants, the renewal of existing hydropower plants up to the larger new installations, as well as additional business areas, the variety of our activities is allowing us to see – together with our motivated employees and with the confidence of our customers – the future development of the energy market and of ANDRITZ HYDRO as very positive.

With sincere thanks



M. Komböck



H. Heber



W. Semper

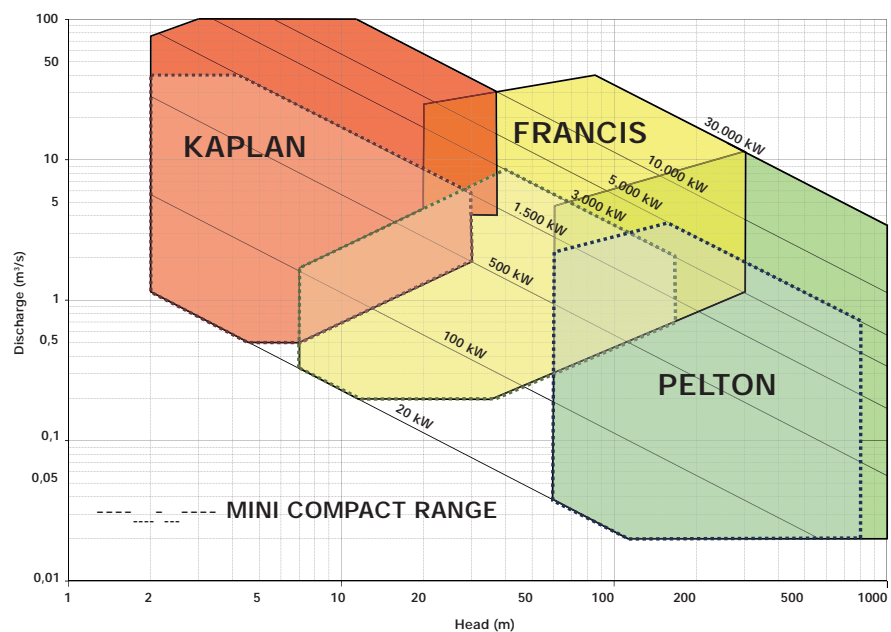
COMPACT HYDRO

More than a small solution

The COMPACT HYDRO business division of ANDRITZ HYDRO is a global leader in the market of small hydropower. Out of the dozens of units we are delivering every year, here we present a selection of projects which showcase the latest evolution of our business.

MINI COMPACT HYDRO

With the acquisition of the turbine business of Hydroeo Engineering (former THEE, located in Toul, France) in early 2013, the product portfolio of COMPACT HYDRO was expanded to offer competitive and reliable solutions for micro, mini and small hydropower plants. Together with the existing know-how from ANDRITZ HYDRO Jonschwil, Switzerland, in the field of small Pelton turbines, and with the specific development realized by ANDRITZ HYDRO Italy in automation and electrical systems, MINI COMPACT offers suitable and economical solutions for Kaplan and axial units (20 kW-1,500 kW), for Francis units (up to 3,000 kW) as well as for Pelton units (up to 5,000 kW).



Expanded range of COMPACT HYDRO: All turbine types between 20 kW and 30,000 kW (Pelton and Francis), 20 kW and 10,000 kW (Axial or Kaplan)

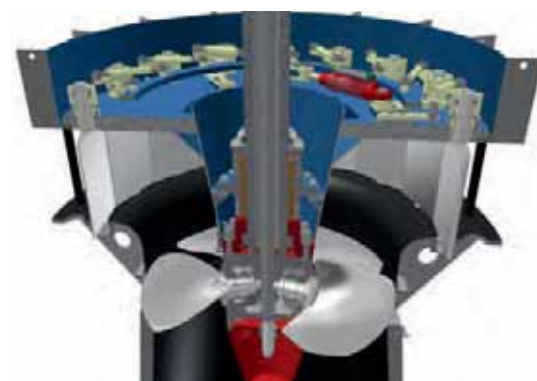
The launch of the MINI COMPACT range has been successful with the award of 46 contracts, totaling 65 units, in 2013. One good example of delivering a complete Water-to-Wire MINI COMPACT concept is the realization of the Molino Rizzoni hydropower plant

in Italy (Hydro News 25). It involved ANDRITZ HYDRO Toul, France, for the turbine, speed increaser, and mechanical Balance-of-Plant and ANDRITZ HYDRO Schio, Italy, for the automation and the complete electrical power system.

▼ HPP Malga Bissina - electrical power system (EPS)



□ HPP Molino Rizzoni - vertical Kaplan turbine



Recent success in the development of the Water-to-Wire concept

An important development focus of COMPACT HYDRO is the Water-to-Wire (W2W) concept with a single responsibility for the entire energy generation system. Two recent examples are the contracts signed with long-time customer Innergex Renewable Energy for the supply, erection, and commissioning of four horizontal Francis units (total 87 MW) for HPP Upper Lillooet and two vertical 14 MW six-jet Pelton units for HPP Boulder Creek, both located in British Columbia, Canada.

▼ HPP Kwalsa owned by Innergex



▼ HPP NW Stave owned by Innergex



For both projects ANDRITZ HYDRO will supply the penstock manifold, turbines, generators, turbine inlet valves, energy dissipation valves (HPP Upper Lillooet only), electrical protection and control for the powerhouses and intakes. The project will be realized by ANDRITZ HYDRO Canada, France, and India.

The W2W concept offers many technical and commercial advantages to our customers. It motivated Innergex to select our solution and can be summarized as the “one supplier concept”. Having one supplier – with the qualification and experience of ANDRITZ HYDRO to deliver this large scope – optimizes the design, performance, and erection and allows our customer to minimize the technical and interface risks. This structure also supports developers to negotiate project financing with lenders, as they recognize the strength of ANDRITZ HYDRO for all elements of the scope of supply.

Compact generators

Today, the largest project using COMPACT HYDRO turbines and generators is HPP Forrest Kerr in western Canada, equipped with nine horizontal Francis units for a total installed capacity ap-

proaching 200 MW. The capacity of the units to dissipate energy at over speed and allowing a smooth ramping down of the river flow in case of load rejection from the line is only one innovative aspect. At certain times of the year, the river carries large loads of sediment. Thus critical wearing parts of the turbine, including the runner, are ceramic coated. For HPP Forrest Kerr designed, manufactured, and tested our generator factory in Bhopal, India, the nine synchronous generators. The biggest challenge was the severe shop testing of the generators, which included runaway speed tests on the shop test bed. In summer 2014 the first six units have been put in operation successfully.

Additional major hydropower projects (horizontal design) currently under execution using generators from ANDRITZ HYDRO India, are:

- ▣ McLymont Creek, Canada (3 x 26.2 MVA)
- ▣ Upper Lillooet, Canada (3 x 28.6 MVA, 1 x 10.5 MVA)

In a vertical configuration:

- ▣ Kal, India (1 x 16.6 MVA)
- ▣ Govddesåga, Norway (1 x 20 MVA)
- ▣ Sabanilla, Ecuador (2 x 17.5 MVA)
- ▣ Boulder Creek, Canada (2 x 15.6 MVA).

Bulb developments

Over the last few years the Compact Axial Bulb Turbine has become a success story in the low head market for CH. The new turbine type is available in two different direct-drive generator designs, salient poles synchronous or permanent magnet (under the brand name ECOBulb™). In the recent years,

▣ Generator for HPP Forrest Kerr on the test bench at ANDRITZ HYDRO India





▣ ECOBulb™ lifting into powerhouse

ANDRITZ HYDRO has sold 12 units featuring the classic generators and 30 ECOBulbs™, with runner diameters between 1,950 mm and 3,650 mm and outputs between 1 MW and 8 MW.

Belgian utility company EDF Luminus has awarded a contract to ANDRITZ HYDRO for delivery of the complete electromechanical equipment for HPP Lixhe on the Meuse River. The existing weir with four single regulated Straflo-turbines has been operating since 1979. In order to use extreme part-load operational ranges more effectively, two of the four Straflo-turbines were replaced by double-regulated Bulb turbines. A challenge in this project was the placing of the new Compact Bulb turbines (runner diameter: 2,600 mm) between the existing stop logs, so that the remaining two turbines could operate without interruption during the erection phase of the new turbines.

Ottawa based company Chaudière PL has awarded ANDRITZ HYDRO a W2W contract to supply four 8 MW double-regulated ECOBulb™ units to be installed downtown on the Ottawa River. This long-term development will use the water, collected by the Ring Dam, which already feeds four hydro plants in both Quebec and Ontario. The new low

visibility but high media profile power plant will be built on Chaudière Island. These units will be the most powerful Permanent Magnet units. Power converters will control the power factor and allow Low Voltage Ride Through (LVRT) conditions.

Power Electronics

Recently ANDRITZ HYDRO started using power electronics to adjust the electrical parameters of hydro generators and immediately recognized the advantages of this solution for specific projects and operating conditions.

For Francis and single runner regulated axial turbines, which see a large variation of net head, or with large flow related head variations, the unit speed can be adjusted optimal to the operating conditions by using power electronics. It has been implemented recently on HPP Malga Bissina project in Italy and on one ECOBulb™ unit at HPP Stanley Adamson in Canada.

The use of partial power electronics allows controlling some electrical parameters, like the power factor, but mainly allows smaller units to stay connected to a weaker grid by surviving LVRT events, which no standard solution will allow.

▣ Compact Axial Bulb turbines for HPP Lixhe during workshop assembly



All of the above mentioned examples of recent projects covering the extension of the range of COMPACT HYDRO in terms of technology, scope, and size and demonstrate the versatility of the business unit in adapting its structure and strategies to the effective needs of the markets and its customers. ANDRITZ HYDRO never rests on past success.

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TECHNICAL DATA

Boulder Creek

Output: 2 x 14.3 MW

Head: 294 m

Speed: 514 rpm

Runner Diameter: 1,320 mm

Chaudière

Output: 4 x 8.05 MW

Head: 11.27 m

Speed: 163.6 rpm

Runner diameter: 3,350 mm

Forrest Kerr

Output: 9 x 26.1 MVA / 9 x 23.9 MW

Voltage: 13.8 kV

Head: 103.6 m

Speed: 360 rpm

Runner diameter: 1,800 mm

Lixhe

Output: 3,410 kW

Head: 7.65 m

Speed: 176.47 rpm

Runner diameter: 2,600 mm

Malga Bissina

Output: 8 kW – 250 kW

Head: 21 m – 71 m

Speed: 550 rpm – 1,000 rpm

Runner diameter: 368 mm

Molino Rizzoni

Output: 1 x 850 kW

Head: 4.1 m

Speed: 150 rpm

Runner diameter: 2,400 mm

Upper Lillooet

Output: 1 x 8.9 MW / 3 x 26 MW

Head: 175 m

Speed: 900 rpm / 600 rpm

Runner Diameter: 850 mm / 1,410 mm



Canadian main office in Pointe-Claire

Canada

A hydropower market with long tradition

Due to its geography and climate, electricity production from hydropower has a long tradition in Canada.

The first Canadian hydropower station was installed at Chaudière Falls in Ottawa in 1881. Since that time more than 74 GW of hydroelectric capacity has been installed. This ranks Canada globally fourth in installed hydroelectric capacity and third in terms of energy generation with some 370 TWh a year. Hydropower supplies 60% of Canada's electricity generation and the province of Québec leads by generating over 96% of its electricity from hydroelectric facilities (36 GW installed).

Still, considerable further potential exists and the opportunity to more than double the installed hydropower capacity remains. Some 163 GW of technically feasible potential exists, of which around 25 GW are in various stages of planning, approval, construc-

tion or have recently been completed. Major hydroelectric projects underway in Canada include: HPP Mica units #5 and #6 (1,040 MW), HPP Muskrat Falls (806 MW), HPP Lower Mattagami (440 MW), HPP La Romaine 3 and 4 (640 MW), HPP Keeyask (695 MW), and HPP Site C (1,100 MW).

In the market of small hydropower there are active developments from independent power producers of approximately 100 MW per year. Canada is, of course, also a vibrant market for the service and rehabilitation of older facilities.

▼ Coil shop inauguration in Peterborough, Ontario



ANDRITZ HYDRO in Canada

ANDRITZ HYDRO in Canada is a “full liner” with staff and experience for the complete life cycle of hydroelectric generating equipment. This expertise and know-how extends from research and development up to full engineering, sourcing, installation, commissioning, and servicing of both turbines and generators. This enables us to fully serve our market for large new units, smaller compact hydro units including automation as well as for the service and rehabilitation of existing plants.

ANDRITZ HYDRO is the original equipment manufacturer of over 40% of the installed turbines and generators in Canada and has been present in the country since 1980. Its major development occurred with the acquisition of the assets of GE Hydro in 2008.

▼ Lower Mattagami hydropower plant



▣ Delivery of 520 MW runner for unit #5 at HPP Mica in British Columbia

Currently a team of 400 employees works at ANDRITZ HYDRO in Canada.

The Canadian head office and turbine technology center is situated in Montréal in southeastern Canada.

The hydraulic turbine test lab facility with two test rigs is central to the ongoing research and development (R&D) program for both new turbines and turbine upgrade applications. Generator engineering is centered in Peterborough, Ontario, about 110 km from Toronto, where a new generator coil winding manufacturing and insulation R&D facility was added in 2013.

Also located near Montréal, in Chambly, Québec, is an electrical power systems

engineering and manufacturing facility of ANDRITZ HYDRO Automation. This manufacturing facility specializes in the supply of excitation, governor and automation systems for hydroelectric developments.

Our Canadian footprint has recently grown this year with the establishment of ANDRITZ HYDRO AFI to serve the market for hydraulic gates and systems of all types. Located in Paris, Ontario, the company was established via the acquisition of the assets of an existing gate manufacturing company.

Our sales and project office in Vancouver in British Columbia in southwestern Canada, is supporting our western customers and is especially active in our

Compact Hydro and an expanding Automation business area.

ANDRITZ HYDRO Canada had been successful in all business units, increasing its market share and gaining visibility as the market leader.

Current projects

Currently, ANDRITZ HYDRO is supplying two 520 MW Francis turbines and generators for BC Hydro's Mica hydro-power plant in British Columbia as well as equipping Ontario Power Generation's Lower Mattagami River Project in Ontario with three 70 MW propeller units.

So far, our largest contract was signed with Nalcor Energy for HPP Muskrat Falls, Labrador, in December 2012, followed by a further contract for the powerhouse and spillway gates in December 2013 (Hydro News 25). ANDRITZ HYDRO will supply the hydro-power plant with four 209 MW Kaplan turbines and generators.

ANDRITZ HYDRO won all projects against strong competition with proven performance in our hydraulic test laboratory.

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Angola

Significant development in a highly promising market

▣ Aerial view on Luanda at sunset

Angola's economy has been growing fast over the last 12 years. Large investments have been made in the infrastructure of the country, for example in buildings, hospitals, and roads as well as water and electricity supply.

There is a huge demand for electricity due to growing urbanization, especially in the capital city of Luanda with approximately five to six million inhabitants. Angola has an electrification rate of about 30%, which will be increased to 60% by 2025. Through to 2017 the country plans to invest approximately US\$ 20 billion in the energy sector to construct new power stations, transmission and distribution networks and to rehabilitate existing infrastructure. By means of this program, Angola wants not only to improve the energy supply but also to become an electricity exporting country in the Southern African Development Community (SADAC).

Angola's electricity sector is currently organized in public companies within the Ministry of Energy and Water (MINEA).

The major companies are ENE (generation, transmission, partly distribution), GAMEK (Kwanza River authority, generation at HPP Capanda and HPP Cambambe) and EDEL (distribution in Luanda). However, Angola is planning to open up the energy market for private investors in the near future, especially with regard to smaller hydropower projects.

Hydropower projects

A special focus is on the energy production from hydropower, as there is an estimated potential of about 72,000 GWh/year in this country, corresponding to an installed capacity of about 18,000 MW. Angola has already defined potential hydropower projects, which will increase the production ca-

capacity from the existing 1,200 MW up to approximately 7,000 MW. Possible hydropower plant sites are found especially along the Kwanza River, Angola's largest one. Currently, there are two hydropower stations in the middle Kwanza section: HPP Cambambe (operating since 1963; 280 MW) and HPP Capanda (operating since 2004; 520 MW) which mainly supply energy to Luanda and regulate the water level of the Kwanza River.

The government of Angola has decided to build multiple hydropower plants on the Kwanza River in the near future. The first and most important one is the 2,100 MW HPP Laúca. Other hydropower plants are planned for construction along the middle Kwanza section, including HPP Caculo Cabaça (2,100 MW), HPP Nhangue (450 MW), HPP Zenzo I (450 MW), HPP Zenzo II (120 MW), HPP Túmulo do Caçador (450 MW) and HPP Luime (330 MW).



▣ Kwanza River and future power house access of HPP Laúca

Opportunities for energy generation can also be found on the Cunene River, in the south of the country near the Namibian border. Both countries will cooperate to build the binational Baynes hydropower plant (500 MW - 600 MW). Further, upstream HPP Jamba ia Oma (65 MW) and HPP Jamba ia Mina (180 MW) are also planned.

▼ Middle Kwanza River area



In addition, at Keve River studies for possible hydropower plant construction for HPP Capunda (330 MW), HPP Dala (440 MW) and HPP Cafula (520 MW) have been undertaken.

With regard to small hydropower projects, amongst others identified projects include: HPP Chiumbe-Dala (26 MW), HPP Chicapa II (42 MW), HPP Luachimo II (10 MW), HPP Lupasso (26 MW), HPP Matala (40 MW) and HPP Lomaum (65 MW).

HPP Laúca

In February 2014, ANDRITZ HYDRO received a contract to supply the electromechanical equipment for Laúca hydropower plant.

This hydropower plant on the Kwanza River will comprise two power houses for which ANDRITZ HYDRO will deliver six 340 MW Francis turbines as well as generators, an eco-flow unit, and additional equipment.

ANDRITZ HYDRO Germany will be responsible for the project management as well as the design and manufacturing of the turbines. The generators will be delivered by ANDRITZ HYDRO in Austria.

During a visit by German Chancellor Angela Merkel in 2011, the Angolan

President José Eduardo dos Santos invited German companies to participate in future hydropower plant projects.

With its manufacturing facility in Ravensburg, ANDRITZ HYDRO owns the largest production site for water turbines in Europe. For ANDRITZ HYDRO Ravensburg the contract for HPP Laúca is the second largest order in their 150-year history.

ANDRITZ HYDRO in Angola

ANDRITZ HYDRO has significantly increased its activities in Angola in recent years. Back in the early 1960s ANDRITZ HYDRO delivered turbines to Angola to, among other projects, HPP Cambambe, HPP Matala and recently HPP Ruacana on the Namibian border (Site report page 26).

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TECHNICAL DATA

Laúca:

Output: 6 x 340 MW

Head: 220 m

Speed: 200 rpm

Runner diameter: 4,100 mm



Cluny

Follow-up refurbishment project in Australia

▣ Dam and hydropower station

Following the successful completion of the Paloona hydropower project (2011–2014), ANDRITZ HYDRO has now received an important follow-up contract for the rehabilitation and upgrade of one turbine at the Cluny hydropower station in January 2014.

HPP Cluny is the ninth of 10 hydropower stations in the Derwent scheme, which is located in southern Tasmania, an island southeast of Australia. The Derwent hydropower scheme is divided into an upper and a lower section. The upper section of the scheme uses larger and deeper lakes for storage than the lower, which combines run-of-river projects. HPP Cluny is part of the lower section.

By offering its successful environmental friendly oil-free Kaplan runner concept in combination with high quality equipment manufactured out of Europe, ANDRITZ HYDRO presented a compelling business case to the customer.



▣ Contract signing

Furthermore ANDRITZ HYDRO is the Original Equipment Manufacturer (OEM) of the existing unit, commissioned in 1967 and equipped with one Kaplan turbine.

ANDRITZ HYDRO will supply the complete engineering solution, including an oil-free 22.9 MW Kaplan runner, guide vanes and guide vane regulating mechanism, head cover, facing plates, shaft seal, servomotor for the runner as well as the inner top cover, the hydraulic power unit, and the digital turbine governor.

The delivery of major components for this project is scheduled for October 2015. All installation works and the refurbishment of reused components will be done by the project owner Hydro Tasmania.

Following the contract in 2011 for two Kaplan turbines at HPP Paloona and HPP Meadowbank as well as several Service and Rehabilitation orders, this award again confirms the fruitful cooperation between ANDRITZ HYDRO and Hydro Tasmania in Australia. It is an excellent opportunity to present our technology and to gain an important reference project in the Australian market.

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TECHNICAL DATA

Output: 22.9 MW / 21.25 MVA
Voltage: 11 kV
Head: 15.94 m
Speed: 115.4 rpm
Runner diameter: 4,500 mm

▼ Derwent River at the outlet of the hydropower plant



Bjurfors Nedre and Bjurfors Övre

Modernization of two units in Sweden

ANDRITZ HYDRO received an order from Statkraft Sverige AB for upgrading of unit #3 at HPP Bjurfors Nedre and of unit #3 at HPP Bjurfors Övre in Sweden.

Statkraft Sverige AB owns and operates more than 100 hydropower plants in Norway, Sweden, Germany and Finland. A considerable number of the hydropower plants in Sweden were built between 1940 and 1950 and now require rehabilitation as well as an increase in efficiency.

HPP Bjurfors Nedre was originally commissioned in 1961. As part of the modernization program, ANDRITZ HYDRO will refurbish the Kaplan turbine at unit #3 and equip it with a new runner (diameter of 4,700 mm). As a result its output will be increased from 28 MW to 32 MW.

▼ HPP Bjurfors Nedre machine hall



▣ HPP Bjurfors Övre machine hall



▣ Bjurfors Nedre hydropower plant

Also in 1961 HPP Bjurfors Övre was commissioned. Here ANDRITZ HYDRO's scope of delivery includes the refurbishment of one Kaplan turbine at unit #3 by equipping it with a new runner (diameter of 4,880 mm). Output from this unit will be increased from 17 MW to 20 MW.

Additionally, ANDRITZ HYDRO will supply a fully homologous model test, an oil-free Kaplan runner, new hydraulic oil equipment, full rehabilitation / modification of the distributor as well as the painting of all dismantled parts and waterways for both hydropower projects.

The majority of the existing turbines in Sweden were originally built by KMW and NOHAB and some of the current generators were supplied by ELIN, ASEA and General Electric.

Today all of these companies are part of ANDRITZ HYDRO and over the last few years ANDRITZ HYDRO has successfully modernized one to two units (turbines and generators) per year.

Both hydropower projects will be executed by ANDRITZ HYDRO Sweden, which is located in Nälden, only 400 km from HPP Bjurfors Nedre and HPP Bjurfors Övre. Our ANDRITZ HYDRO location in Finland will perform the model test for both projects. The HPP Bjurfors Nedre upgrade is planned to be completed by the end of 2017. HPP Bjurfors Övre will be completed in 2016.

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TECHNICAL DATA

Bjurfors Nedre:

Output: 32 MW
Head: 21.8 m
Speed: 125 rpm
Runner diameter: 4,700 mm

Bjurfors Övre:

Output: 20 MW
Head: 13.5 m
Speed: 107 rpm
Runner diameter: 4,880 mm



Manantali

Overhaul and update of five units in the Republic of Mali

In March 2014, ANDRITZ HYDRO signed a contract with La Société de Gestion de l'Énergie de Manantali (SOGEM) to perform the overhaul and update of five generating units at the Manantali hydropower plant in the Republic of Mali.

HPP Manantali is located on the Bafing River, a tributary of the Senegal River in southwestern Mali, close to the borders of Senegal and Mauritania.

All five Kaplan turbines of the Manantali hydropower plant were commissioned in 2002. Since 2013 units #2, #3 and #4 experienced successive failures of their blades internal control mechanism. After minor repairs on these units, la Société de Gestion de l'Énergie de Manantali (SOGEM) called for an international tender for the repair and general ten year overhaul of all 5 units.

The overhaul will include a detailed analysis to identify the origin of the mechanical failures and a technical update to resolve them. The success of ANDRITZ HYDRO in winning this project



Hydropower plant and spillway

was based on existing plant knowledge. ANDRITZ HYDRO was the original turbine manufacturer (OEM), understands the difficult conditions in the country and has provided excellent service support during the operation of the powerhouse. ANDRITZ HYDRO was able to work out a technologically and price competitive offer in conjunction with a relatively short planning timeframe to complete the work.

The finalization of the overhaul program is scheduled for 2017 and will benefit the populations of Senegal, Mauritania and Mali for years to come.

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During a visit at the hydropower plant: Mr. Cheikh Ould Abdellahi Ould Bedda (General Manager of SOGEM) [in the middle]



Mr. Mamadou Frankaly Keita (Minister of Energy and Hydraulic of the Republic of Mali) [right]

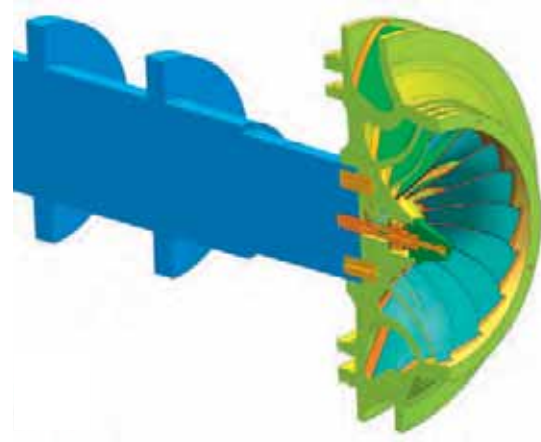
TECHNICAL DATA

Output: 5 x 41 MW
Voltage: 11 kV
Head: 46 m
Speed: 214 rpm
Runner diameter: 3,840 mm





Existing turbine hall



Connection section between runner and shaft

Ponte Gardena

Replacement and partial refurbishment of an existing Italian hydropower plant

In mid-2014, ANDRITZ HYDRO signed a contract with the South Tyrolean regional electricity company SEL GmbH / Srl for the supply and installation of the electromechanical equipment of two horizontal 7.2 MW Francis turbine units for the Ponte Gardena hydro power plant in Italy.

HPP Ponte Gardena was originally installed in 1955 along the Isarco Valley, which connects Italy to Austria and Central Europe, and it uses water from the Dolomites in the Gardena Valley near Bolzano in northern Italy. The Ponte Gardena project, actual property of SE Hydropower, is a successful follow-up of the projects HPP Lappago and HPP Molini Di Tures, which were performed in 2013 for the same client in

the same region. The scope of delivery includes supply and installation of turbines, generators, inlet valves, the intake valve, governors, HPU systems, the complete automation system on SICAM 1703, 250 SCALA platforms, THYNE1 excitation system, and low voltage equipment.

The new equipment will be designed considering the particular client's requirement for high-efficiency generating during low-flow periods, thus increasing overall annual energy production. For this reason a "pit stop" concept was developed and proposed to the client: similar to the replacement of car tyres between summer and winter, the whole mechanical concept has been developed in order to easily install a winter runner during low-flow periods.

The governor will also be switched from one season to the other in consideration of different working parameters. Besides the higher overall annual energy production, the replacement of the runner twice per year provides the basis for a maintenance program with higher reliability and safety, extending the turbine's lifetime.

This technical solution was key to the award of the order to ANDRITZ HYDRO. Unit #1 is due to be commissioned in March 2015, followed by unit #2 one month later.

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TECHNICAL DATA

Output: 2 x 7.2 MW / 9.5 MVA

Voltage: 10 kV

Head: 260 m

Speed: 1,000 rpm

Runner diameter: 615 mm / 1,022 mm



Oberver- muntwerk II

Francis turbines for an Austrian pumped storage power plant

In January 2014, ANDRITZ HYDRO received a contract from Vorarlberger Illwerke AG (a local Austrian utility) to supply two Francis turbines for the new Obervermuntwerk II pumped storage plant in the state of Vorarlberg, in western Austria.

The underground power plant will provide peak energy to improve grid stability and integrate renewable energy (wind, solar, etc.) by providing additional capacity for energy storage. The hydropower plant will utilize water from existing storage capacity, which will be connected by new tunnels. Thus, no new water resources or substantial visible changes of the landscape will be needed.

ANDRITZ HYDRO's scope of supply includes a fully homologous model test, design, manufacturing, transport, installation, and commissioning of two horizontal generating units including Francis turbines, toothed couplings, digital governors, mechanical brakes, tools, and spare parts for these systems.

The turbines at Obervermuntwerk II hydropower plant are a significant step

▣ Celebrating finalization of the cavern entrance



▣ Silvretta barrage for HPP Obervermuntwerk II

in the development of highly efficient Francis turbines and the data gathered during design, model test, and site tests will be a valuable addition to ANDRITZ HYDRO's extensive model library.

Several rather unique conditions are challenging for the planning, design, workmanship and logistics for HPP Obervermuntwerk II, including:

- ▣ guaranteed very high efficiency and stringent requirements for additional technical parameters (cavitation, vibration, noise, hydraulic stability, etc.)
- ▣ operation range from 0% – 100% load without part load stabilization (aeration) requires a special hydraulic shape
- ▣ high number of start / stops (~2,500/a)
- ▣ different operating modes (in connection with other project components) with short changeover time
- ▣ transport of very large components to the mountainous site (1,750 m elevation) using roads that are seasonally closed.

The model test will be finalized in November 2014. The first components will be delivered in early 2016 and trial operation of the first unit is scheduled for June 2018.

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TECHNICAL DATA

Output: 2 x 180 MW
Head: 240 m – 310 m
Speed: 428.6 rpm
Runner diameter: 2,320 mm



Bramois

Highlight in the French speaking Switzerland



Powerhouse

In April 2014, ANDRITZ HYDRO received a contract from Société des Forces Motrices de la Borgne (FMdB) for the supply of electromechanical equipment for the Bramois hydropower plant in the canton of Wallis, Switzerland.

This contract is the result of a common goal in the supply phase of the various locations and departments of ANDRITZ HYDRO Switzerland and its consortium partners. It reflects the confidence of FMdB and its principal engineer HYDRO Exploitation in ANDRITZ HYDRO. Furthermore, it marks the return of ANDRITZ HYDRO in this power range to French speaking Switzerland.

Commissioned in 1915, HPP Bramois was originally equipped with four horizontal Pelton units. The hydropower plant utilizes water from the rivers Borgne and Dixence, taken at around 900 m above sea level, to generate

Machine hall and existing units

around 85 GWh of energy per year, one third in winter and two thirds in summer. It is connected to the 65 kV grid.

After nearly 100 years of commercial operation, FMdB initiated an extensive program of modernization at the hydropower plant with the following objectives:

- Integrate into the template of the existing building as its architecture is classified
- Have modern units which are flexible and efficient
- Minimize production losses during construction
- Provide a competitive price of energy.

The chosen solution was a complete replacement of the four original horizontal 6.75 MW units with two new vertical 15.7 MW Pelton units.

ANDRITZ HYDRO and its consortium partners INDAR and D2FC will deliver the turbines, the speed controller, the generators and the spherical valves. The new units will provide greater operating flexibility to optimize the production in line with the market.

The first unit is due to be delivered in October 2015, the second in January

2017. During the erection works, two of the old units will operate until the commissioning of the first unit is completed. Afterwards, the first unit will operate during the commissioning of the second unit. The operation of the first unit is scheduled for April 2016, followed by the second unit 16 months later.

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TECHNICAL DATA

Output: 15.7 MW / 20 MVA

Head: 365 m

Speed: 600 rpm

Runner diameter : 1,260 mm





Inga 2

An additional order for rehabilitation of unit #27 and #28 in the Democratic Republic of Congo

Existing Penstock

ANDRITZ HYDRO Austria was awarded with an additional rehabilitation contract for the units #27 and #28 at Inga 2, one of the largest hydropower plants in Africa, in the Democratic Republic of Congo (DRC). The contract is financed by the local Kamoto Copper Company (KCC), which will operate the turbine units after its rehabilitation.

HPP Inga 2 is situated close to the mouth of the Congo River, which flows into the Atlantic Ocean, approximately 300 km downstream of the capital city Kinshasa. With its eight 178 MW turbine units, HPP Inga 2 will be a significant part of the further planned extensions of Inga, up to a total maximum capacity of 40 GW. Therefore the presence of ANDRITZ HYDRO is not only important for this strategically crucial project, but also for the ambitious plans for further hydropower development in the country.

Under the terms of the agreement the scope of delivery covers the complete renewal of the intake trashracks and the rehabilitation of the four intake roller gates, including replacement of the hydraulic drive as well as the control system and the rehabilitation of the



Aerial view of Inga 2 hydropower plant

stoplogs for the intake and the draft tube. The two penstocks with a diameter of 8 m, will be non-destructively tested and corrosion protected. Due to movements between the dam and the upper fixed point of the penstock there are large deformations in the existing penstocks. It will be a special technical challenge to cut out a 1.5 m long section of each penstock and replace it with a stress-less new one.

ANDRITZ HYDRO Switzerland is delivering the hydraulic and electronic parts for the governors for the two turbine units and will also replace the mechanical parts of the two auxiliaries.

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TECHNICAL DATA

Penstock:

Type: exposed
Diameter: 8,000 mm
Thickness: 20 mm

Intake gates:

Type: Roller Gate
Dimensions: 3,700 mm x 7,500 mm



Aldeadávila

Six new Francis runners for a Spanish hydropower plant

ANDRITZ HYDRO has signed a contract with Iberdrola Generación, S.A.U. for the supply of six new Francis runners for the Aldeadávila hydropower plant in Spain.

With a total of eight units and an installed capacity of more than 1,200 MW, HPP Aldeadávila is the largest hydropower plant in Spain and one of the

[View of turbine components](#)



largest in Southwestern Europe. It is located on the Douro river basin at the border between Spain and Portugal. Due to the importance of HPP Aldeadávila, Iberdrola Generación, S.A.U. decided to extend its lifetime by installing new runners from ANDRITZ HYDRO. Reference projects, especially those in partial load operation, played a significant role in awarding the contract to ANDRITZ HYDRO and the successful execution of HPP San Pedro II project.

As a fundamental element in the regulation of the Spanish national grid, the units operate over a very wide operation range, alternating from very low partial load to full load on a frequent basis and exposing the units to severe operational conditions. The extensive range allows the plant to stabilize the grid and compensate variations in both generation and demand.

The existing Francis runners have been operating for more than 50 years, accumulating more than 200,000 operation hours per unit. They will now be replaced by improved runners as part of a major revision. The new runners will be designed and manufactured by ANDRITZ HYDRO Germany, the hydraulic design and homologous model test will be carried out by ANDRITZ HYDRO Canada. After manufacturing, the first runner will be delivered in 2016 and the first unit will start operation in 2017.

This rehabilitation will allow HPP Aldeadávila to provide sustainable green energy for the Spanish market for many years. ANDRITZ HYDRO is strengthening its presence in the Spanish market with the execution of this project.

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[View of the reservoir from control building](#)

TECHNICAL DATA

Output: 140 MW
Head: 140 m
Speed: 187.5 rpm
Runner diameter: 4,000 mm



Uma Oya

Multipurpose development project combines energy production and irrigation in Sri Lanka

Early in 2014, ANDRITZ HYDRO and FARASAN INTERNATIONAL SDN BHD signed a contract for engineering, manufacturing, delivery, and installation of two 63 MW vertical Pelton units, including main inlet valves, governors, generators, excitation and auxiliary systems, for the Uma Oya multipurpose development project (MPP).

MPP Uma Oya is being implemented by the Ministry of Irrigation and Water Management. Wise utilization of water resources for irrigation has a long history in Sri Lanka, where water management dates back centuries.

Storage and irrigation facilities help to overcome the disadvantages of climatic variations and provide water when and wherever needed. When technologies for production of electricity harnessing

the powers of water emerged, this benefit was included in the development of multipurpose projects.

Subject to annual variations, hydropower contributes about one third of the power generation in Sri Lanka. The majority of the installed capacity of about 1,600 MW is owned and operated by the public utility Ceylon Electricity Board (CEB). Looking back on the long-term involvement of ANDRITZ HYDRO, together with its predecessor companies in the implementation of existing assets, we are proud that more than 50% of the Sri Lankan installed hydropower capacity relies on technology and equipment supplied by ANDRITZ HYDRO.

The Uma Oya project combines the hydropower scheme and irrigation in a sustainable way. Water will be diverted from the wet central highlands into the

dryer, southern region of Sri Lanka for irrigation and human consumption and will use the available head for energy generation. With a rated capacity of 126.6 MW an annual energy production of more than 230 GWh is expected to be supplied to the grid. The water diverted will provide irrigation to approximately 6,000 ha of land. Main features of the project include two RCC dams and more than 20 km of tunnels to connect the created reservoirs with the underground power station and to release water to the downstream Alikota Ara River. The expertise of ANDRITZ HYDRO as leader in high-head Pelton turbine technology was a decisive factor in the award of this contract. The main construction works started in early 2011, and commissioning is scheduled for 2016.

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▼ Model witness test



TECHNICAL DATA

Output: 2 x 63.3 MW / 2 x 75 MVA
Voltage: 10.5 kV
Head: 722 m
Speed: 600 rpm
Runner diameter: 1,850 mm



Taivalkoski

Contract for turbine upgrade near the Polar Circle in Finland

Hydropower plant and Kemijoki River

In March 2014, ANDRITZ HYDRO signed a contract with Kemijoki Oy for upgrading the turbines of the Taivalkoski hydropower plant in Finland.

HPP Taivalkoski is situated only 80 km south of the Polar Circle and is part of the Kemijoki River cascade. Kemijoki Oy owns 20 hydropower plants, with a total capacity of 1,000 MW, of which 16 are either located close to or north of the Polar Circle.

In this region the shortest day has just one hour of daylight in December. The longest day is in June, when the sun is constantly over the horizon for 31 days. Over the whole year, the outside temperature varies from less than -40°C to $+30^{\circ}\text{C}$ and sees open lakes transformed with more than one meter of ice cover.

Machine hall



The hydropower plant consists of three Kaplan turbines, originally built in 1972 by Tampella (now part of ANDRITZ HYDRO). ANDRITZ HYDRO will supply new four-bladed oil-free runners and service some of the existing components, like the existing guide wheel parts. After rehabilitation the new runners will significantly increase the output and efficiency of the turbines.

HPP Taivalkoski has an average annual energy production of 550 GWh. The turbines will have a maximum flow of $1,140\text{ m}^3/\text{s}$, since spring flood can exceed even $4,000\text{ m}^3/\text{s}$ of water in the river due to snow melt. One additional reason for replacing the old oil-filled runners is environmental safety. In order to protect the brittle arctic environment from any possible oil leaks, Kemijoki has done a lot of upgrading of its projects since 1999.

Engineering is going well and model tests have been successfully performed in the modern ANDRITZ HYDRO hydraulic laboratory in Tampere, Finland. The first unit will be commissioned in 2015, followed by unit #2 in 2016 and unit #3 in 2017.

By upgrading the six largest hydropower plants of the Kemijoki River cascade, ANDRITZ HYDRO could contribute to an anticipated increase in annual energy production of 240 GWh and an increase in power output of 250 MW, an increase of more than 20% per hydropower plant.

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TECHNICAL DATA

Output: 3 x 51 MW
Head: 14.5 m
Speed: 88.2 rpm
Runner diameter: 6,756 mm



Innkraftwerke

A new automation system for five run-of-river power plants in Germany

▣ Gars hydropower plant

ANDRITZ HYDRO has been awarded a contract for the delivery of fully networked secondary technology and will install a complete NEPTUN system at five hydropower stations on Germany's Inn River by 2021.

HPPs Rosenheim, Feldkirchen, Wasserburg, Teufelsbruck and Gars are part of a chain of 14 run-of-river power plants acquired by Austrian-based utility VERBUND AG from German energy provider E.ON in 2009. All of the five run-of-river power stations are located in Germany and use the water resources of the River Inn.

They are equipped with a total of 21 Kaplan turbines (master units), two Kaplan bulb turbines (at Triebwerk Wasserburg and Gars) and 19 gates. After renewal of primary equipment of "Triebwerk" units in 2009 and 2013, the secondary equipment will now be modernized.

ANDRITZ HYDRO will provide the instrumentation and control equipment (automatic control, mechanical protection), the governor and its hydraulic oil units, the excitation system based on HIPASE, and will perform a complete replacement of the machines' transducers.

▣ Rosenheim hydropower plant



The new instrumentation and controls will allow fully automated operation, with the governors ensuring optimum efficiency and maximum energy yield, thanks to their Adaptive Cam Control (AAC) and redundant water management automation.

Included in the delivery are the integration of controls for the machine-related 110 kV feeder, the 20 kV, 6.3 kV and 0.4 kV substations, the replacement of automatic control of station service, as well as the integration of control system for HPP Triebwerk and various other auxiliaries.

Based on a scalable 250 SCALA operating and monitoring system, operation of the facility will be provided by a redundant compact type SCADA system at the main control room and local operator panels at each unit and dam area.

All five HPPs will be remotely controlled and monitored via the central control room in Töging, using IEC 60870-5-104 communication protocol.

The main task and effort in this project is, to execute all modification works while proceeding operation, ensuring reservoir stability through a controlled discharge of water.

With this contract, VERBUND Innkraftwerke GmbH reconfirms its long-term partnership with ANDRITZ HYDRO.

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TECHNICAL DATA

Rosenheim (3 gates):

Output: 35.1 MW / 3 x 16 MVA

Head: 8.2 m

Speed: 88.2 rpm

Feldkirchen (4 gates):

Output: 38.2 MW / 3 x 15 MVA

Head: 8.7 m

Speed: 90.9 rpm

Wasserburg (4 gates):

Output: 24.1 MW / 5 x 5 MVA

Head: 7.15 m

Speed: 115 rpm

Triebwerk Wasserburg:

Output: 1 x 5.55 MVA

Speed: 136.48 rpm

Teufelsbruck (4 gates):

Output: 25 MW / 5 x 5 MVA

Head: 7 m

Speed: 115 rpm

Gars (4 gates):

Output: 25 MW / 5 x 5 MVA

Head: 7.4 m

Speed: 115 rpm

Triebwerk Gars:

Output: 1 x 5.5 MVA

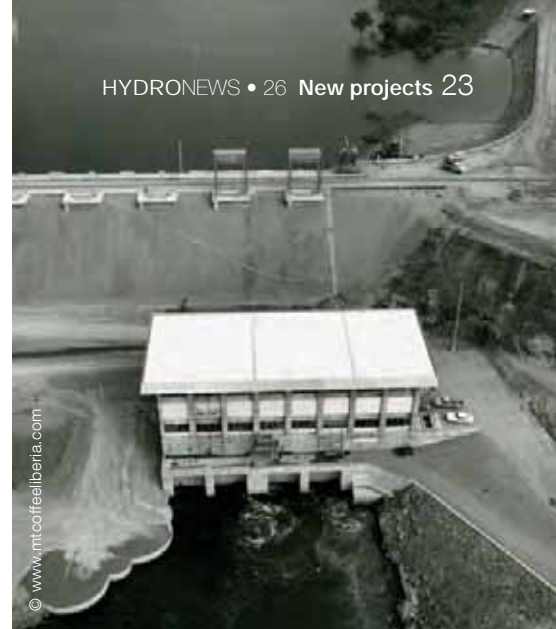
Speed: 136.4 rpm

www.verbund.com/bayern





□ Mount Coffee Dam in its original condition



□ Aerial view of the hydropower plant at its first commissioning

Mount Coffee

Rehabilitation of a run-of-river power plant in Liberia

In June 2014, ANDRITZ HYDRO was awarded by the Liberia Electricity Corporation (LEC) with a contract for the design, rehabilitation, supply and installation of hydraulic steelworks and auxiliary systems for the Mount Coffee hydropower plant in Liberia.

The hydropower plant is located on the Saint Paul River, 30 km northeast of Liberia's capital Monrovia and had been built between 1963 and 1966. It was the second and the largest hydropower plant ever built in Liberia. After its inauguration HPP Mount Coffee had an installed capacity of 30 MW, which was more than doubled to 64 MW in the 1970s. There remains the opportunity to extend the plant further with the installation of two additional turbines.

In 1990, the intake dam was breached at one end and a part of the dam wall was damaged. In subsequent years the internal plant was completely destroyed. Following the loss of this facility, electrical output plummeted and many people turned to other sources of energy such as charcoal, which underlines the necessity that this project provides renewable energy as soon as possible.

In order to maintain the target to generate the first electricity in December 2015, LEC signed a Memorandum of Understanding (MOU) with ANDRITZ HYDRO in May 2014, which enabled ANDRITZ HYDRO to promptly begin some of the early engineering works. The MOU allowed LEC and ANDRITZ HYDRO to ensure that the details of the final contract were carefully scrutinized without affecting the project schedule. LEC officially announced they were very pleased with the commitment demonstrated by ANDRITZ HYDRO throughout this process.

An important reason for awarding ANDRITZ HYDRO the contract was its highly qualified personnel and its impressive technical experience. Furthermore, ANDRITZ HYDRO's offer was the most attractive for the customer.

Due to the state of emergency declared by the President of Liberia as a result of the Ebola Virus outbreak, the progress of installation works is presently suspended for a period of some months.

ANDRITZ HYDRO's scope of supply comprises the rehabilitation of 10 radial gates at the spillway, the supply of new intake gates, trash racks, stop-logs for



□ The hydropower plant today

the spillway, intake and draft tube, four penstocks, and electric and hydraulic auxiliary systems.

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TECHNICAL DATA

10 radial gates: 11.5 m x 11 m

4 intake gates: 5.5 m x 5.8 m

Total weight of supply: 900 tons



Teesta Stage III

Challenging generator transportation in India



Challenging transportation

In October 2007, ANDRITZ HYDRO signed a contract with Teesta Urja Limited for the six 200 MW units of Teesta Stage III project in India.

HPP Teesta Stage III is one of the largest hydropower plants in India with a head of 800 m. It is located in the northeastern Indian state of Sikkim. After completion, the run-of-river power plant will generate 5,269 GWh of electricity annually, dependable for 90% of the year.

ANDRITZ HYDRO's scope of supply includes model testing, design, procurement, and manufacturing of the six units, as well as all equipment, materials and mandatory spares for the complete electromechanical works, including 400 kV GIS, XLPE cables, and mechanical balance of plant equipment. Furthermore, ANDRITZ HYDRO will provide all serv-

ices, like inland transportation for delivery to the site, unloading, storage, handling on site, installation, testing and commissioning, including performance testing in respect of all supplied equipment.

One of the main challenges of the project is to preserve and store components for an extremely long duration at various locations near the project site.

Furthermore, the transportation of heavy consignments in an extremely hostile terrain is another mammoth task, which is currently being executed.

The hydropower project had an initial contractual duration of 46 months up to commissioning of the last unit, which had to be revised due to a massive earthquake with its epicenter right at the project site in September 2011. This was followed by the collapse of

one of the bridges on the main road to the project site. The collapse of the bridge impeded the transportation of heavy consignments for a period of 23 months.

The key task of lowering the rotor into each of the first three units has been completed. The first unit is already boxed up and the erection activities post rotor lowering are continuing for two units. The erection work in the remaining three units is proceeding as well, under the supervision of a diverse team of Indian and European supervisors.

The first unit is expected to be commissioned in January 2015, commissioning of the full plant will follow in June 2015.

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Rotor lowering in unit #2



TECHNICAL DATA

Output: 6 x 200 MW
Head: 800 m
Speed: 375 rpm
Runner diameter: 3,020 mm



Upper Tamakoshi

Electromechanical equipment for the largest hydropower project in Nepal

▣ Valve at the workshop

In February 2012, ANDRITZ HYDRO signed a contract with Upper Tamakoshi Hydro Power Limited in Nepal, a subsidiary company of the Nepal Electricity Authority, for developing and managing the 456 MW HPP Upper Tamakoshi.

HPP Upper Tamakoshi is the largest hydroelectric project in Nepal. It is located in the Dolakha District, 197 km east of the capital Kathmandu.

The project was conceived as a peaking run-of-river project with an 822 m gross head, a design discharge of 66 m³/s and an installed capacity of 456 MW.

▣ Spherical valve



The major components of this project are the intake, a 22 m high concrete dam, twin de-sanding basins, a 7.86 km long headrace tunnel, a 360 m high surge shaft, a 495 m long penstock pipe, an underground powerhouse with six Pelton turbines, a 2.9 km long tail-race tunnel, and a 47 km long 220 kV transmission line to Khimti substation.

ANDRITZ HYDRO's scope of supply includes the design, manufacturing, supply, erection, testing, and commissioning of the complete electromechanical equipment, including a 220 kV GIS and the mechanical balance of plant equipment.

The Upper Tamakoshi hydropower plant also has a 85.6 bar pressure rating, 170 tons spherical valve as the main shut-off valve. This is one of the largest spherical valves (P x D factor) manufactured by ANDRITZ HYDRO.

Because of heavy contractual penalties the project is very challenging. Another challenge is the transportation of consignments to the site on weak infrastructure such as poor roads and bridges, as well as manufacturing and supplying of the spherical main shut-off valve.

Recently, ANDRITZ HYDRO commissioned powerhouse crane number one and is executing the installation works of mechanical equipment from unit #1 through unit #6.

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TECHNICAL DATA

Output: 6 x 76.5 MW / 90 MVA

Voltage: 11 kV

Head: 805 m (rated)

Speed: 600 rpm

Runner diameter: 1,944 mm

Step-up transformers:

Output: 19 x 30 MVA

Voltage: 11 kV / 220 kV

Main shut off valve:

Diameter nominal: 2,500 mm

Pressure: 85.6 bar



Ruacana

Installation starts on site in Namibia

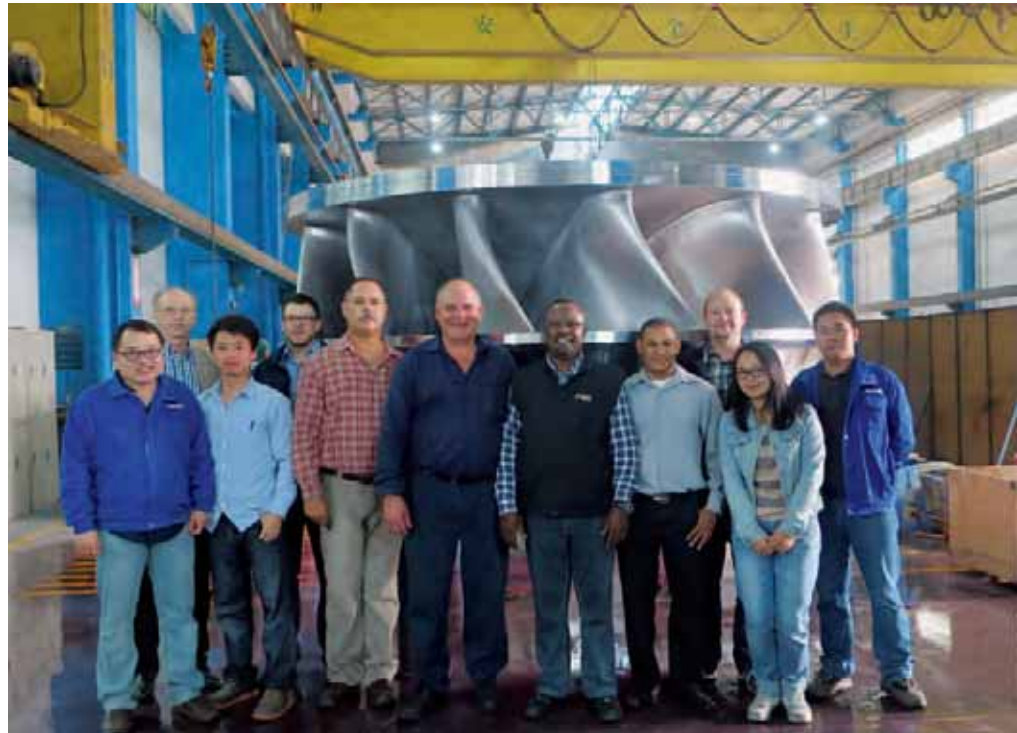


□ Aerial view on Ruacana hydropower plant

HPP Ruacana is situated on the Kunene River, representing the border between Angola and Namibia.

Originally commissioned in 1978, the underground power plant consists of three Francis turbines with a total installed capacity of 240 MW. The initial plant was designed and prepared for the installation of a fourth unit, successfully supplied by ANDRITZ HYDRO a few years ago.

After more than 33 years of operation, NamPower decided in 2013 to refurbish the turbines (unit #1 to #3) at Ruacana underground power plant. Therefore, ANDRITZ HYDRO was awarded a contract for improving the hydraulic performance of the runners in terms of efficiency, maximum power output, and vibrational behaviors in part load operation.



□ Ruacana Francis runner in Foshan, China

□ New inlet valve control unit



□ New inlet valve by-pass lines



Based on the open cooperation during the project, ANDRITZ HYDRO was approved to manufacture the runners at its location in Foshan, China. The highly motivated team in Foshan delivered excellent quality ahead of schedule.

ANDRITZ Graz, Austria, supplied bottom, discharge and wearing rings, which came on time with proven quality and confirmed by customer factory acceptance tests.

Currently, an ANDRITZ HYDRO installation supervisor is supporting NamPower to complete the refurbishment at the Ruacana hydropower plant by end of the year 2014.

TECHNICAL DATA

Unit #1 – #3:

Output: 87 MW
 Head (rated): 134 m
 Speed: 230.8 rpm
 Runner diameter: 2,840 mm

Unit #4:

Output: 92 MW
 Head (rated): 131 m
 Speed: 272.7 rpm
 Runner diameter: 2,691 mm



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ANDRITZ HYDRO Mexico manufacturing team - proud to achieve this important challenge



Assembled butterfly valve at ANDRITZ HYDRO manufacturing center in Mexico



Preparation for transportation of the 80 tons valve rotor

Reventazón

A new butterfly valve for the penstock of the largest hydropower project in Costa Rica

ANDRITZ HYDRO Mexico recently manufactured a new butterfly valve for the penstock of Reventazón hydropower plant in Costa Rica.

HPP Reventazón is located about 8 km southwest of the city of Siquirres, mid-stream on the Reventazón River, which rises in the Orosí Valley and flows to the Caribbean Sea. With an installed capacity of about 300 MW, it is the largest hydropower project in Costa Rica.

In December 2011, ANDRITZ HYDRO was awarded the contract from Instituto Costarricense de Electricidad (ICE) for the supply of the electromechanical equipment for Reventazón hydropower plant (Hydro News 22). The order included four 74 MW Francis turbines, four butterfly inlet valves, mechanical auxiliaries, four generators, and automation control and protection systems, as well as low- and medium-voltage electrical power systems and one butterfly valve for the penstock.

ANDRITZ HYDRO Mexico manufactured the butterfly valve in cooperation with ANDRITZ HYDRO Italy. The detail engineering for valve manufacturing was developed at our ANDRITZ HYDRO location in Schio, Italy, and its basic design in Linz, Austria. With an inner diameter of 6,000 mm and a design pressure of 10 bar, it is the largest butterfly valve ever built by ANDRITZ HYDRO Mexico.

Recently, our customer was invited to attend and witness the final pressure and operational test for the component acceptance. The test was performed without incident and to the full satisfaction of the customer. Finally, the valve was accepted and released for shipment. The transportation of the valve was very difficult and challenging due to the valve components size and weight.

The successful manufacturing of the butterfly valve for HPP Reventazón constitutes an important reference for ANDRITZ HYDRO Mexico and moreover

helps Costa Rica to meet its future electricity demands.

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TECHNICAL DATA

Output: 4 x 74 MW / 86.2 MVA
Voltage: 13.8 kV
Head: 133.4 m
Speed: 300 rpm



Scotland Cia Aig

In April 2014, RWE Innogy UK awarded a contract to ANDRITZ HYDRO Germany for the delivery of the complete electromechanical equipment for the new Cia Aig hydroelectric scheme in Scotland.

The run-of-river power plant is located on the Abhainn Chia-aig River, approximately 15 km north of Fort William and will be constructed with an intake weir and a 3.2 km of buried pipeline.



The scope of supply for ANDRITZ HYDRO comprises two vertical five-nozzle Pelton turbines, two synchronous generators, hydraulic pressure units, main inlet valves, as well as the complete electrical control equipment, high-voltage switchgear, transformer, erection, and commissioning.

Following orders from RWE Innogy UK in 2009 and 2010 for HPP Selset and HPP Blackrock, HPP Cia Aig marks another success for Compact Hydro in the United Kingdom.

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TECHNICAL DATA

Unit 35 / Unit 36

Output: 1.99 MW / 1.01 MW

Head: 185 m / 194 m

Speed: 750 rpm / 1,000 rpm

Runner diameter: 720 mm / 540 mm

Indonesia Cibalapulung 2 & 3



In February 2014, ANDRITZ HYDRO received an order from PT Sangsaka Hidro Barat, a subsidiary of MEDCO POWER INDONESIA, for HPP's Cibalapulung 2 (2 x 3.4 MW) and Cibalapulung 3 (2 x 3.15 MW).

Both compact hydropower plants are located in the city of Sukabumi in West Java, Indonesia.

In August 2012, ANDRITZ HYDRO won a contract from PT Sangsaka Hidro Barat for HPP Cibalapulung 1 (3 x 3.39 MW), so the ensuing orders strengthen our Compact Hydro pres-

ence in Indonesia. As offshore contractor ANDRITZ HYDRO India will supply electromechanical equipment while ANDRITZ HYDRO Indonesia, as the onshore contractor, will deliver the control and protection system and provide onshore services like transportation, erection, and commissioning.

HPP's Cibalapulung 2 & 3 are expected to start commercial operations by the end of 2015.

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TECHNICAL DATA

Cibalapulung 2 / Cibalapulung 3:

Output: 2 x 3.4 MW / 2 x 3.15 MW

Voltage: 6.3 kV / 6.3 kV

Head: 58.39 m / 57.8 m

Speed: 600 rpm / 500 rpm

Runner diameter (approx.): 925 mm / 975 mm

China Sanchahe

In February 2014, ANDRITZ HYDRO received a contract for the supply of three turbine-generator units for the Sanchahe hydropower plant. The contract was awarded from Yunnan Baoshan Binlangjiang Hydro Power Development Co. Ltd.

HPP Sanchahe is located near the city of Baoshan in the province of Yunnan, P.R. China. Our scope of supply includes design, manufacturing, transportation as well as site supervision and commissioning of the units.

The new contract is another example of the good cooperation between ANDRITZ HYDRO China and our customer, looking back on many years of cooperation on hydropower projects, for example the Sujiahekou hydropower project (3 x 105 MW).



Commercial operation of unit #1 at Sanchahe is scheduled to start in November 2015.

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TECHNICAL DATA

Output: 3 x 24 MW

Voltage: 10.5 kV

Head: 148 m

Speed: 500 rpm

Runner diameter: 1,450 mm

Russia Lykovskaya

ANDRITZ HYDRO has signed a rehabilitation contract for the electromechanical equipment at HPP Lykovskaya in Russia.

The existing hydropower station is located approx. 300 km south of Moscow, near the city of Mzensk on the Zusha River. It was originally built in 1953.

The owner, Lykovskaya HPP Ltd., discovered the potential of the location and pushed on the revitalization of the power station, which has been out of operation for several years.

ANDRITZ HYDRO's scope of supply comprises one vertical Compact Kaplan turbine, a direct-coupled synchronous generator, electrical control equipment, as well as the supervision of erection and commissioning. The hydraulic water passage of the existing building, especially the spiral intake and the draft tube, shall be retained as far as possible.

The start of commercial operation is scheduled for July 2015.

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TECHNICAL DATA

Output: 1.3 MW
Head: 5.6 m
Speed: 176.47 rpm
Runner diameter: 2,150 mm



Azerbaijan Şemkirçay



In April 2014, the Turkish construction company Cengiz İnşaat and ANDRITZ HYDRO Turkey signed a follow-up order for the Şemkirçay hydropower plant in Azerbaijan.

The scope of the contract includes design, manufacturing, and transporta-

tion of electrical power systems, as well as commissioning and installation of all electromechanical equipment.

In September 2011 ANDRITZ HYDRO won its first order from Cengiz İnşaat for the design, manufacturing, supply, transportation, site installation supervision, and commissioning of six 6.07 MW horizontal Francis turbines and six 6.18 MVA synchronous generators for HPP Şemkirçay. The consortium, led by ANDRITZ HYDRO, won the turnkey contract against international competition.

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TECHNICAL DATA

Output: 36.4 MW
Voltage: 10.5 kV
Head: 125.98 m
Speed: 600 rpm
Runner diameter: 625 mm

Malaysia Bintang and Hulu Terengganu

In 2014, ANDRITZ HYDRO successfully entered the Malaysian Compact Hydro market with two new orders.

In April 2014, ANDRITZ HYDRO received the order for supply, transportation, erection and commissioning of the complete electromechanical equipment for HPP Bintang from M/s Emrail Sdn. Bhd., one of Malaysia's leading diversified conglomerates. HPP Bintang is located in the Malaysian state of Perak.

After the success of HPP Bintang, in June 2014, ANDRITZ HYDRO, in consortium with the Malaysian organization System Protection & Maintenance Sdn. Bhd., was awarded the order for HPP Hulu Terengganu by Tenaga Nasional Berhad (TNB), the largest electricity utility in Malaysia. HPP Hulu Terengganu is located north west of

the Kenyir reservoir in the state of Terengganu.

The scope of supply of ANDRITZ HYDRO is based on the "water to wire" solution and comprises core equipment consisting of turbine, generator, governing system, spherical valves, SCADA and mechanical auxiliaries.

These two important projects mark the entry of Compact Hydro into the Malaysian hydropower market and open up the possibility for further growth.

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TECHNICAL DATA

Bintang / Hulu Terengganu
Output: 2 x 3.85 MW / 2 x 7.5 MW
Head: 238 m / 132.57 m
Speed: 500 rpm / 600 rpm
Runner diameter: 1,220 mm / 1,001 mm

France and Georgia MINI COMPACT

ANDRITZ HYDRO has continued its success with MINI COMPACT HYDRO solutions. In the last few months we received new orders for Pelton, Francis and Kaplan turbines.

With a head ranging from 3 m to over 626 m and a power output from 144 kW to 2,770 kW, this selection of awarded projects represents the range of solutions offered by ANDRITZ HYDRO for any kind of small hydropower plant.

Depending on the project, ANDRITZ HYDRO can provide either the turbine and generator only or can deliver a turnkey package, including electrical and control equipment.

HPP Brienne and HPP Gignac consist of low head Kaplan turbines with a runner diameter of 1,200 mm but dif-

ferent arrangements: a slanted axis for HPP Brienne and vertical axis for HPP Gignac. The turbine and generator will be delivered within seven months.

As a result of the highly satisfactory technical and economic performance of the Akhmeta hydropower plant, the first ANDRITZ HYDRO project in Georgia, GeoEnergy LLC decided to assign ANDRITZ HYDRO its new project, the Stori hydropower plant, consisting of a turnkey package with a small Francis turbine.

While the configuration is the same, both horizontal Pelton turbines, for HPP Les Encombres and HPP La Revolleyre are quite different projects in terms of power output and the size of the installation. Both hydropower plants will be installed in the French Alps, close to Grenoble.

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TECHNICAL DATA

Brienne:

Output: 2 x 144 kW

Head: 3.4 m

Speed: 274 rpm

Runner diameter: 1,200 mm

Les Encombres:

Output: 1 x 2,770 kW

Head: 626 m

Speed: 1,500 rpm

Runner diameter: 660 mm

La Revolleyre:

Output: 1 x 230 kW

Head: 190 m

Speed: 1,500 rpm

Runner diameter: 360 mm

Gignac:

Output: 1 x 320 kW

Head: 6 m

Speed: 363 rpm

Runner diameter: 1,200 mm

Stori:

Output: 1 x 1,880 kW

Head: 40.7 m

Speed: 600 rpm

Runner diameter: 888 mm

Ecuador Sabanilla

In February 2014, a contract for supply of the complete electromechanical equipment for the Sabanilla hydropower plant in Ecuador was awarded to ANDRITZ HYDRO.

The scope of delivery includes two 15.7 MW vertical Pelton turbines, generators, inlet valves, governors, control and SCADA system, medium voltage switchgear, auxiliary services, and cables.

This hydroelectric project will be a special milestone, since it represents the first infrastructure project developed by FCME (Fondo de Cesantia del Magisterio Ecuatoriano), a fund, capitalizing savings and economies of the teachers in Ecuador.

The HPP Sabanilla project will be carried out entirely by the involvement of several ANDRITZ HYDRO subsidiaries.

As part of our "water to wire" solution, ANDRITZ HYDRO France is responsible for the turbines. The generators are manufactured by ANDRITZ HYDRO India, while the automation and the electrical equipment will be supplied from ANDRITZ HYDRO in Colombia.

The project is scheduled to begin commercial operation by the end of 2015. The Sabanilla hydropower plant will provide sustainable revenues to the teach-

ers as well as clean and renewable energy for Ecuador.

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TECHNICAL DATA

Output: 2 x 15.7 MW

Head: 355 m

Speed: 600 rpm

Runner diameter: 1,260 mm



Switzerland Göschenen

In April 2014, ANDRITZ HYDRO Automation received from Kraftwerk Göschenen AG a contract for the complete secondary equipment rehabilitation at HPP Göschenen.

Originally built in early 1960s, HPP Göschenen comprises six units and produces electricity for approximately 100,000 households. Due to the new Swiss legal requirements to fulfill environmental conditions (e.g. residual flow through the power plant) a complete rehabilitation of the hydropower plant was necessary.

The scope of supply for ANDRITZ HYDRO Automation includes the rehabilitation of the existing secondary equipment consisting of unit control systems, turbine controller, unit protection and excitation systems as well

as their integration into the existing SCADA systems.

The main reasons for awarding ANDRITZ HYDRO the contract have been the good and long-term cooperation with the customer (first delivery of automation systems in 1997), as well as the best technical and economic solution on offer. Commissioning of the first unit is planned for October 2015, while the project will be completed with the last unit commissioning in May 2020.

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TECHNICAL DATA

6 Pelton units

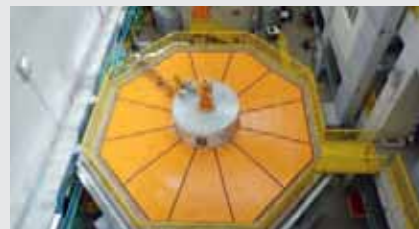
Output: 2 x 46 MW (50 Hz)
2 x 46 MW (16.7 Hz)
1 x 18.7 MW (50 Hz)
1 x 18.7 MW (16.7 Hz)

Brazil Batalha

In Brazil, ANDRITZ HYDRO successfully put two units at HPP Batalha in commercial operation.

The contract for supply and installation at the HPP Batalha Complex (total output: 53.74 MW) was awarded to the consortium Consórcio Fornecedor Batalha in April 2009 by FURNAS – Centrais Elétricas S.A. The hydropower plant is located in the center of Brazil at the border between the two states of Minas Gerais and Goiás.

ANDRITZ HYDRO Brazil has supplied and installed two 26.87 MW vertical Kaplan turbines, two 29.17 MVA generators, governor and excitation system, gates and cranes for upstream, downstream and spillway structure, the main penstock (weight around 600 tons), the auxiliary penstock, the complete EPS and PPS systems of the plant, automation, the 138 kV



switchyard, transmission line (82 km / 138 kV) as well as erection and site installation supervision and commissioning of the related scope.

Furthermore, ANDRITZ HYDRO is responsible for project management and the consortium lead. HPP Batalha will supply electricity to more than 130,000 Brazilian citizens.

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TECHNICAL DATA

Output: 26.87 MW / 29.17 MVA
Voltage: 13.8 kV
Head: 36.9 m
Speed: 240 rpm
Runner diameter: 3,400 mm

Austria Spielfeld



ANDRITZ HYDRO has been awarded a contract from VERBUND Hydro Power GmbH for the rehabilitation of the complete secondary equipment at the Spielfeld hydropower station in Austria.

The run-of-river power station was originally built between 1980 and 1982 by Steirische Wasserkraft- und Elektrizitäts AG. It is located at the northern end of the eponymous valley at the Mur River, in the Austrian state of Styria. The power house comprises two horizontal units, consisting of one 7.6 MW Kaplan bulb turbine and one directly connected 10 MVA three-phase synchronous generator. The three radial gates include supporting valves and have a clear span of 22 m, as well as a closure height of 6 m.

ANDRITZ HYDRO's scope of supply covers refurbishment and erection of the secondary equipment at both units, including excitation, electrical protection and governors, gates, the redundant water economics component, and the inclusion of general equipment.

With HPP Spielfeld another hydropower station on the Mur River will be equipped with products and know-how from ANDRITZ HYDRO.

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TECHNICAL DATA

Output: 2 x 10 MVA
Voltage: 6.3 kV

Araraquara

New ANDRITZ HYDRO INEPAR Instrumentation Laboratory in Brazil

In March 2014, operations began at the ANDRITZ HYDRO Inepar's new Brazilian Instrumentation Laboratory in Araraquara, in the state of São Paulo. The laboratory will assist field crews and allows to test and validate new instruments.

Constant innovation in engineering technology in search and development of intelligent solutions has ensured the continued success of ANDRITZ HYDRO in Brazil. The company has the preference of clients, who are attracted by competitive advantages that weigh at

the moment of decision making in a market where the competition is increasingly fierce. Thus the department of turbine and generator engineering developed and assembled the Instrumentation Laboratory to overcome the challenges seen in that field.



Test benches for instrumentation, PLCs, and communication networks



Mobile bench for training of ASi network and bench of instruments for supporting to the field

This facility has many advantages:

- reduced internal transportation costs
- an increased number of specialists trained in instrumentation
- proven agility in presenting solutions step-by-step
- instruction, testing, simulation and equipment testing on communication platforms used in worksites, including the ASi (Actuator Sensor-Interface) network, equipment developments, modifications of PLCs (Programmable logical Control) software and HMI (Human Machine Interface) screens and preventive actions.

The new laboratory allows ANDRITZ HYDRO to test and validate new instruments to be used at generating units on calibration desks, instrument fault detection and simulation, boosting client confidence.

Moreover, this new system of work provides sound integration between the technical proposals department and those of turbine and generator engineering as well as quality and supervision within the field, making it the current benchmark in the use and performance of instrumentation for hydro-power generating units.

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Assembly hall in Linz

Delivery of first hydrogen-cooled turbogenerator from Linz, Austria

Transport of turbogenerator from the assembly hall in Linz, Austria

In January 2014, the first hydrogen-cooled turbogenerator, successfully assembled and tested was delivered by ANDRITZ HYDRO.

This machine successfully performed a first piece qualification test program, which is a precondition for future serial production. Core components such as stator sheets, stator bars, as well as the finished rotor were manufactured in the main ANDRITZ HYDRO generator shop in Weiz, Austria. After their transportation to the new assembly and test shop in Linz, Austria, core stacking, stator winding, generator assembly and running tests followed. In parallel, engineering, manufacturing, and component qualification of this first unit was conducted. This short cycle was enabled by successful project management, close monitoring of all project steps and good between the specialists of ANDRITZ HYDRO and its partners.

Assembly hall in Linz

Beside our established generator shops in Weiz, Austria, and Bhopal, India, the assembly hall in Linz, Austria, is ANDRITZ HYDRO's third turbogenerator factory. It was officially inaugurated in July 2014. Until recently, ANDRITZ HYDRO concentrated on turbogenerators with a low and medium output range from around 7 MVA to 200 MVA. With the direct access from the new as-

sembly hall to the heavy duty port on the Traun/Danube River it is now possible to deliver larger generators with a maximum weight of 800 tons.

The assembly shop will be used for stacking and winding of stators, as well as final assembly of heavy generators. Furthermore it is equipped with a prototype test field.

This new investment marks an important milestone for ANDRITZ HYDRO, helping to expand the turbogenerator product range and therefore the ability to offer the best possible solution to our customers.

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Hydrogen-cooled turbogenerator in test field

TECHNICAL DATA

Hydrogen cooled turbogenerator

Output: 350 MVA

Voltage: 15.75 kV

Weight: 285 tons



Opening of assembly hall in Linz, Austria



Powertage 2014

Zurich, Switzerland

The “Powertage”, which took place in Zurich in June 2014, are a leading event for the Swiss energy industry. More than 2,200 market specialists and interested delegates from politics, industry and utilities used the opportunity for an intensive information exchange.

ANDRITZ HYDRO participated with a booth, presenting the whole product portfolio, and a paper presentation at the specialist forum with the title “New requirement on the hydropower technology – development for the electricity system in the future”.

The event organizer as well as all 162 exhibitors were very pleased with the high level of interest in the successful fair and both, the specialist forum in the mornings as well as the evening events were highly attended.

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Small Hydro Technology Day 2014

Belgrade, Serbia

In May 2014, ANDRITZ HYDRO hosted the first Small Hydro Technology Day in Belgrade, capital of Serbia. More than 170 representatives from industry, banks and financial institutions, as well as from consulting companies participated.

The program consisted of several presentations about dedicated products for the small hydropower market, a customer's experience on the largest HYDROMATRIX® power plant at Ashta, Albania (supplied by ANDRITZ HYDRO), and two financial partner presentations.

In addition, dedicated product presentation islands offered the opportunity for an information exchange between all participants. To further involve the audience, for the very first time an interactive voting system was used.



The high level of interest and positive feedbacks at the end of the conference underlined the strong market position of ANDRITZ HYDRO in South East Europe.

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Important Brazilian events in 2014

Throughout 2014, ANDRITZ HYDRO was participating in some major events of the electrical market in Brazil, with highlights in the presentation of papers at various technical seminars as well as institutional lectures.

For ANDRITZ HYDRO global as well as local events are means of communication that regularly prove to be an important tool for brand awareness and consolidation of the company's know-how with those of customers and suppliers.

In May 2014, ANDRITZ HYDRO visited

the SEPOPE XIII, a symposium of specialists in operation planning and electrical expansion, held in the city of Foz do Iguaçu, in the state of Paraná.

ANDRITZ HYDRO also participated in the IX SPMCH, a symposium on small and medium-sized hydropower plants, held in Curitiba, Paraná, as well as the VI ENAM, a national meeting on rotating machinery, which was held in Taubaté, state of São Paulo.

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FILDA 2014

Luanda, Angola

This year, ANDRITZ HYDRO participated for the first time at FILDA, the Luanda-based international business fair, which took place between July 22–27, 2014.

FILDA, being the most important international exhibition of Angola, attracted significant political and media interest. All major national and many international companies were represented at FILDA, where both capital goods – such as agricultural machinery, construction machinery and industrial equipment – and consumer goods are exhibited each year.

ANDRITZ HYDRO joined the German group stand together with 17 companies. For ANDRITZ HYDRO, FILDA offered an excellent platform to strengthen its image in Angola. Our booth attracted various business as well as political visitors, amongst others the Minister of Economy, H.E. Abrahão Pio dos Santos Gourgel, and the Minister of Energy and Water, H.E. João Baptista Borges. During an evening ceremony, our booth even won the FILDA Golden Lion award.

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EVENTS:

Viennahydro
26 – 28 November 2014
Vienna, Austria, [Booth 16](#)
www.viennahydro.com

COMPACT HYDRO

More than a small solution



ANDRITZ HYDRO supplies solutions for small hydropower up to 30 MW branded as COMPACT HYDRO for more than 30 years. The small hydropower market is an essential business area of ANDRITZ HYDRO. More than 3,000 units with a total output of 9,300 MW are installed globally. Every month, another

eleven COMPACT HYDRO units start producing renewable clean energy. Our COMPACT HYDRO program combines environmental-friendly solution with high efficiency.

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

