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HYDRONEWS

THE AMERICAS



ANDRITZ
Hydro

Dear Business Friend,

Home to around one billion people, the Americas stretch from the industrialized north to the developing economies of the south and across all climate zones. Despite its rich diversity there is a common denominator – electricity production from hydropower.

With a total installed capacity of about 329 GW and a future potential of more than 4,000 TWh, including Brazil, the USA and Canada as three of the world's largest hydropower producers, it is a clear focus region for hydropower players.

The immediate demands of each country are certainly different, for example large rehabilitation projects in Canada and the USA or mid-size new plants and upgrades in Mexico and Central America. Large new installations are a major driver in Brazil and a chance to exploit the high head potential of the Andes is pushing project developments in Chile, Peru, Ecuador and Colombia.

With the development of the grid and the integration of fluctuating renewable energy sources, additional pumped storage capacity will be necessary throughout this vast region.

All these different demands have to be met by state-of-the-art technologies, tailor-made solutions, and concentrated joint development efforts with hydroelectric plant investors and operators.

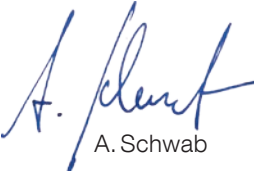
ANDRITZ HYDRO has been accepting these challenges for more than 100 years. In that time we have delivered, installed, and modernized 3,800 generat-



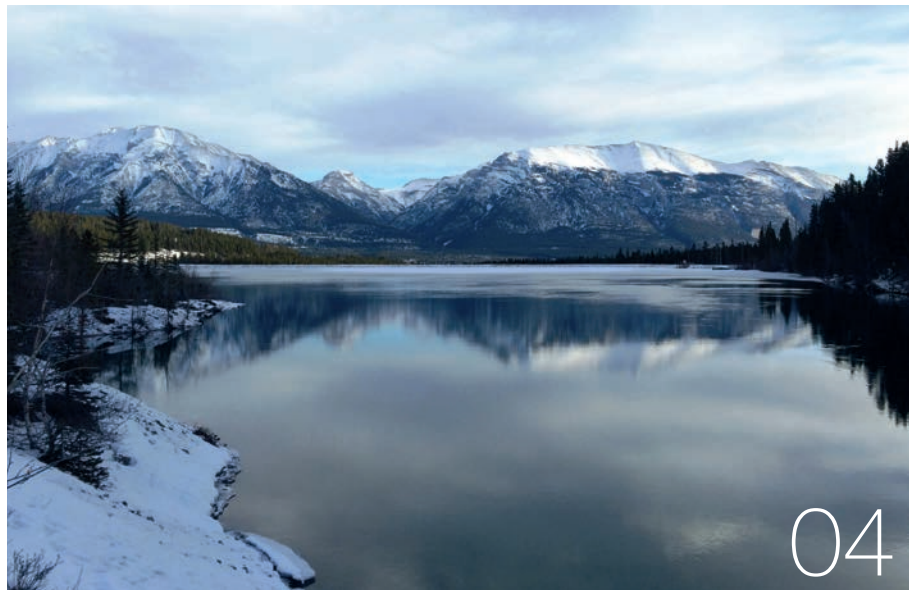
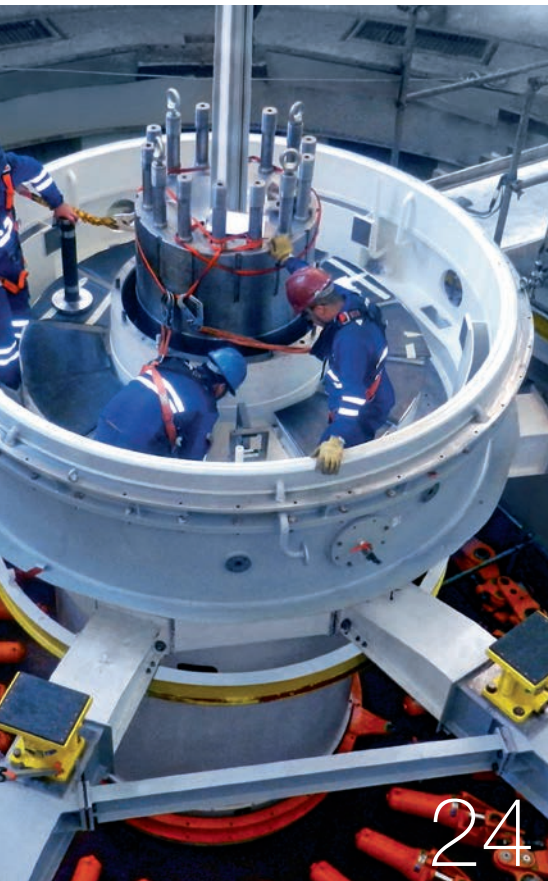
ing units with a total capacity of about 160 GW. In order to maintain our strong relationship with all our customers and partners, ANDRITZ HYDRO has established local entities in Brazil, Canada, Chile, Colombia, Mexico, Peru, the USA, and Venezuela. In many of these countries key components like turbines, generators and automation systems are manufactured in our own workshops. ANDRITZ HYDRO is capable of comprehensively serving the market needs for small hydro, as well as for new hydropower plants of all sizes and all imaginable rehabilitation work.

Hydropower is the first, largest and most efficient renewable energy source in the world. It also provides a multitude of valuable additional services, such as flood protection, irrigation, navigation, grid control, and recreation.

With the confidence and trust of our customers and a long history of continuously developed technology, ANDRITZ HYDRO and our employees are ready to accept the hydropower challenges of today and tomorrow.


A. Schwab





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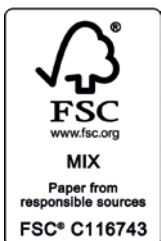
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Online magazine



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Canada

Energy from Ocean to Ocean

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Due to its geography and climate, Canada has a long tradition of electricity production from hydropower. The first Canadian hydropower station was commissioned in 1891 at Chaudière Falls, in Ottawa. Since then, more than 77 GW of hydroelectric capacity has been installed, producing some 388 TWh a year.

Today, hydropower is the leading source of electricity, supplying 60% of Canada's generation, mainly from Québec, British Columbia and Ontario. Nonetheless, an additional technically feasible hydro potential of about 240 GW still exists. Canada's aim to develop diverse energy resources while maintaining its commitment to the environment, for example by reducing greenhouse gas emissions, could see additional growth for hydropower.

ANDRITZ HYDRO in Canada

ANDRITZ HYDRO's engagement in Canada dates back to 1892. Since then, ANDRITZ HYDRO has installed or modernized more than 950 units with about 50 GW of capacity, almost 65% of the country's total.

ANDRITZ HYDRO's presence in Canada increased with the acquisition of the GE Hydro assets in 2008 and its head office and turbine technology center established in its current location of Pointe Claire, Quebec. Currently a team of 375 employees works at ANDRITZ HYDRO Canada across many locations including: hydraulic test lab in Lachine, Quebec; electrical power systems/automation design office and manufacturing facility in Chambly, Quebec; a generator technology center and bar/coil plant in Peterborough, Ontario; a regional office in Richmond, British Columbia, and the most recent addition, a gate design and manufacturing facility in Paris, Ontario (ANDRITZ HYDRO AFI).

ANDRITZ HYDRO in Canada is a fully integrated partner with staff and experience for the complete life cycle of hydroelectric generating equipment. The

expertise and know-how extends from research and development up to full engineering, project management, sourcing, installation, commissioning, and servicing of turbines and generators. This enables full service for large new units, small hydro units including automation as well as for the rehabilitation of existing plants.

Among the biggest orders ANDRITZ HYDRO has delivered in the Canadian market are large hydropower plants such as HPP La Grande-2 (5,616 MW), HPP Churchill Falls (5,428 MW) and HPP La Grande-3 (2,418 MW). However, important generation facilities like HPP Limestone, HPP Mica Dam, HPP G.M. Shrum or HPP Sir Adam Beck can also be found within ANDRITZ HYDRO's references.

ANDRITZ HYDRO delivered 1,000 MW of small hydro generating units so far

HPP Mica Dam: ANDRITZ HYDRO recently placed into service two new complete units (2 × 520 MW) at BC Hydro's Mica hydropower plant, totaling the generating facility up to 2,840 MW. The work was executed under very high safety standards for the workers and with special care for the environment to protect the pristine region from any contamination by the works.

HPP Bighorn: The contract for the 120 MW Bighorn hydropower plant is the second – after HPP Spray – to come under the compound Master Service Agreement (MSA) with TransAlta.

ANDRITZ HYDRO's scope of works includes a complete stator replacement, a generator ventilation upgrade, the modification of the thrust bearing, as well

Bird view HPP Chaudière Falls, Ottawa City



VIDEO



HPP Chaudière Falls, oldest hydropower plant in Canada, commissioned 1891

as various inspections and instrumentation work. Closing of the project is scheduled for mid-2016.

HPP Ear Falls: In May 2015, ANDRITZ HYDRO received a contract from GDB Constructeurs for the modernization of the intake gates for the 22 MW Ear Falls Generating Station. The scope of supply for ANDRITZ HYDRO includes design, supply, installation, and commissioning of eight intake gates, embedded parts and hoists. The project is scheduled for four consecutive years, final commissioning is due to take place in September 2018.

HPP La Grande-3: At the end of 2015, Hydro Quebec awarded ANDRITZ HYDRO a contract for the modernization of the generator excitation systems at the La Grande-3 hydropower plant. The scope of supply for ANDRITZ HYDRO comprises design, supply, and delivery of 12 excitation systems, including a new HIPASE-E regulator. This order is the first high-voltage excitation project for ANDRITZ HYDRO for the North American market and the biggest to date for ANDRITZ HYDRO Chambly.

Small hydro in Canada: Compact Hydro business is proving to be very successful in Canada. So far ANDRITZ HYDRO has delivered 90 units with 1,000 MW of capacity. In the last three years alone ANDRITZ HYDRO has designed and/or delivered about 24 Compact Hydro units, projects including as HPP Upper Lillooet, HPP Boulder Creek, HPP McLymont, HPP Okikendawt, HPP Volcano Creek, HPP Long Lake, HPP Forrest Kerr, and HPP New Post Creek.

HPP Chaudière Falls: To close the loop and coming back where it all started for hydropower in Canada, ANDRITZ HYDRO was awarded in August 2014 a contract by Chaudière Hydro LP., a Hydro Ottawa subsidiary, for a complete “from water-to-wire” package for the Chaudière Falls plant. Hydro Ottawa will now build a new 32 MW run-of-river power plant with the four most powerful ECOBulb* turbines delivered to date by ANDRITZ HYDRO. ■



Unit #1 at HPP Muskrat Falls



Transportation of runner for HPP Mica Dam

More than 10,000 dams in operation in the country

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CANADA FACTS

35.85 Mio.
 100%
 77,500 MW
 6,500 MW
 60%
 388 TWh
 240,000 MW

Population
Access to electricity
Installed hydro capacity
Hydro capacity under construction
Share of generation from hydropower
Hydro generation
Technically feasible hydro generation potential



Hoover Dam, Colorado River



United States of America

Hydropower for the Pioneers of Electricity

by Jack Heaton
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The United States of America are one of the largest producers of hydropower in the world. Around 6% of the nation's electricity has been provided by conventional hydropower over the last few years, with an estimated 260 TWh/year of hydropower generation in 2014.



Rock Island powerhouse, dam and reservoir



Runner for HPP Hills Creek

While it is difficult to identify the total theoretical hydro potential in the US, if all potential sites were fully developed there would be at least an additional 512 GW of installed capacity. Estimates suggest that there is around 497 TWh/year of gross potential and some 153 GW of technically feasible hydropower potential.

Extensive and complex regulatory procedure and strong environmental conflict may seriously impede the development of new hydropower. Therefore the focus is on refurbishment and modernization of existing facilities and on adding power to non-powered dams. In addition, the government aims to promote the development of renewable energy resources, including small hydro. However, transmission issues pose a limitation to new plants and renewable energy projects. Energy storage, including pumped hydro storage, could be a possible solution.

ANDRITZ HYDRO in the US

ANDRITZ HYDRO has run an office in Charlotte, North Carolina, since the early 1990s, and the company's experience in the US market is well established. The reference list of projects includes major rehabilitation projects located on the key waterways of the US such as the Mississippi, Arkansas, Tennessee, Colora-

do, Susquehanna, and Columbia rivers. ANDRITZ HYDRO is the OEM to over 35% of the installed base of hydro units in the US and has refurbished 70 units in the US, with a combined output of more than 43,000 MW, representing about 54% of fleet share of the countries total installed capacity. In 2010, ANDRITZ HYDRO acquired the majority shares of Precision Machine and Supply Inc. in Spokane, Washington, adding a manufacturing facility to its portfolio to provide even better services to customers.

Over the years ANDRITZ HYDRO has been involved in many major US hydropower projects, such as HPP Grand Coulee (6,809 MW), HPP John Day (2,160 MW), HPP Niagara (2,515 MW), HPP Hoover Dam (2,080 MW), HPP McNary Dam (980 MW), and HPP Rock Island Dam (980 MW).

HPP Grand Coulee is the largest hydropower plant in the USA and the 6th largest worldwide

HPP Olmsted: Central Utah Water Conservancy District (CUWCD) has contracted ANDRITZ HYDRO to provide two turbine-generator units, auxiliary mechanical equipment, electrical controls, a single buried penstock, and construction of a new power transmission line for the 11.2 MW Olmsted hydropo-

wer plant. It is one of the oldest facilities in the western US and is the centerpiece of the Telluride Institute of Learning. All works will be executed whilst preserving the existing historic powerhouse. The project is scheduled to be finalized at the beginning of 2018.

HPP Lower Monumental Dam: In July 2015, the U.S. Army Corps of Engineers, Walla Walla District, awarded a contract to ANDRITZ HYDRO for generator rewind and turbine cavitation repairs at the HPP Lower Monumental Dam (810 MW). It is one of the four major hydropower plants on the lower Snake River in Washington State. The entire project is expected to be completed by May 2017.

HPP Bear Swamp: ANDRITZ HYDRO was awarded a contract for a stator rewind at Brookfield Renewable's Bear Swamp Pumped Storage Plant in Florida, Massachusetts. The contract includes a 10% uprate in generating/pumping capacity. Commissioning takes place in 2016.

HPP Safe Harbor: In September 2013, Safe Harbor Water Power Corp. assigned a contract to ANDRITZ HYDRO for the refurbishment of two 80 year old generators (unit #3 and #7) at the Safe Harbor hydropower plant in Pennsylvania. This is the first large scale hydro service contract for ANDRITZ HYDRO on the Susquehanna River, one of the largest rivers in the northeastern US. ANDRITZ HYDRO will supply new generator stator frames, cores and windings, new rotor spiders and rims, refurbished rotor poles and bearings, unit disassembly, installation, and unit reassembly.

In November 2015, ANDRITZ HYDRO was awarded a refurbishment contract of two further generators (unit #1 and #2). ANDRITZ HYDRO will supply new stator cores, clamping assemblies and multi-turn windings, including rotor pole testing, bearing inspections, unit disassembly, installation and unit reassembly. ANDRITZ HYDRO is the original equipment manufacturer of all 14 units in the powerhouse.

HPP Rock Island: ANDRITZ HYDRO received an order from Chelan County Public Utility District for four units at the Rock Island run-of-river hydropower plant on the Columbia River in Washing-

Lake Mead, reservoir of Hoover Dam ist the largest reservoir in the United States by volume

ton State in 2014. ANDRITZ HYDRO is replacing four generator stators, along with new rotor rims and rotor poles, while overhauling three existing Kaplan runners. One unit will receive the new ANDRITZ HYDRO-designed stainless steel runner and wicket gates. Completion of the project is scheduled for the end of 2020.

HPP Belden: The Belden hydropower plant is owned by Pacific Gas and Electric Company (PG&E), the largest private owner of hydroelectric facilities in the US, and located in the state of California. The turbine rehabilitation proj-

ect includes a new runner, new discharge ring, upper draft tube, wear rings and wicket gates. The installation should take place end of 2016.

ANDRITZ HYDRO in the US offers expertise and know-how to fully serve the market for large new units and smaller compact hydro units including automation. Rehabilitation and upgrading of existing plants remain the core business in meeting the needs of the US market. ■

USA FACTS	321.4 Mio.	Population
	100%	Access to electricity
	79,500 MW	Installed hydro capacity
	400 MW	Hydro capacity under construction
	6%	Share of generation from hydropower
	260,000 GWh	Hydro generation
	153,000 MW	Technically feasible hydro generation potential

Hydropower & Dams World Atlas 2015 and The World Bank

The Columbia River concentrates the most important hydropower plants in the US



VIDEO



© David Gn / fotolia.com



Mexico City skyline

Mexico

An Emerging Global Player

by Carla Rosas
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In recent years, the government has introduced economic reforms with the aim of improving competitiveness and economic growth of the Mexican economy. Demand for electricity is increasing by about 2,500 MW/year, but there are still some rural regions with limited access to electricity. To meet this increasing demand, reforms of the energy sector were also implemented.

The technically feasible hydropower potential in Mexico is around 135,000 GWh and in 2014, 47 plants provided an installed capacity of 11,509 MW. Since then seven plants have been taken out of service, but more than 4,300 MW of new hydro capacity is planned by 2024. Some 3,200 MW of existing hydro capacity is at plants more than 40 years old, representing a major opportunity for the service and rehabilitation market.

ANDRITZ HYDRO in Mexico

For decades ANDRITZ HYDRO has successfully operated in the Mexican hydropower market and its office and manufacturing site in Morelia was founded in 1981. However, the company has been active in the country for far longer. First equipment deliveries date back to the beginning of the 20th century – HPP Tampico, HPP Guadalajara and HPP Gavito Puebla were all commissioned in 1909. Since then, ANDRITZ HYDRO

and its predecessor companies have delivered and refurbished more than 250 units with a total capacity of about 4,500 MW. Among these orders are major hydropower stations like HPP Chicoasen (1,500 MW), HPP Infernillo (1,120 MW), HPP Malpaso (1,080 MW), HPP Angostura (900 MW), HPP La Yesca (750 MW), HPP El Caracol (600 MW), HPP Temascal (354 MW), HPP La Villita (300 MW), HPP Zimapan (292 MW), and HPP Agua Prieta (240 MW).

HPP Temascal I: In March 2015, ANDRITZ HYDRO received a contract from the Mexican state-owned utility Comisión Federal de Electricidad (CFE) for the rehabilitation of units #1–#4 at the Temascal I hydropower plant on the Tonto River in the state of Oaxaca, Mexico.

The contract comprises design, engineering, disassembly, assembly, logistics, testing on-site, and commissioning. Part of the contract also covers financing of the goods and services supplied, as well as corresponding Preliminary Acceptance Certificates (PAC) for each unit after installation at the site. ANDRITZ HYDRO will deliver new stator windings, stator laminations, pole windings, turbine runners including fixed turbine part modifications, wicket gates, spiral cascs, and bottom rings – as well as repair works for the rotor, stator, and head

cover for each unit. The efficiency of the Francis turbines will be increased, reducing the specific consumption of water per kWh and thus enhancing the profitability of the plant.

The project shall be executed within 42 months, inauguration is planned for September 2018.

HPP La Venta: 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 October 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 CFE utility 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 won the contract from Motores e Ingeniería Mexmot, S.A. de C.V. to supply the SCADA and control systems, static excitation, protection and metering, as well as turbine governor and communication equipment. The five generating units are scheduled to re-start commercial operations in 2016.

ANDRITZ HYDRO has a strong presence in Mexico, especially for turbine and automation system modernization projects and strives to expand its portfolio of services in Latin America. ■



Reservoir and power house of HPP La Yesca



La Venta hydropower plant

MEXICO FACTS	127 Mio.	Population
	99.1%	Access to electricity
	12,269 MW	Installed hydro capacity
	1,800 MW	Hydro capacity under construction
	15%	Share of generation from hydropower
	38,145 GWh	Hydro generation
	135,000 GWh	Technically feasible hydro generation potential



Central America and Caribbean Islands

A Growing Economy through
Green Energy

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After peace came to Central America in the mid-1990s, the region experienced a lot of social reforms and transformations resulting in steady economic growth. Millions of people were freed from poverty. The population's access to electricity was increased to an average of about 85% as of today. To increase access to electricity even further electricity costs have to be reduced. With strong mandates from the government and the need to further strengthen the economy in order to stay competitive in a challenging global market, reshaping of the energy sector is required. Privatization, private investments, international loans, and the need to increase the use of renewable resources in order to become independent of fossil fuels is encouraging the development of energy projects – mainly hydropower.

The Central American Electrical Interconnection System (SIEPAC) is the interconnected power grid of Panama, Costa Rica, Honduras, Nicaragua, El Salvador, and Guatemala. It connects about 40 million people and the network includes a 1,790 km-long, 230 kV transmission line with a capacity of 300 MW and with an extension potential of up to 600 MW. The goal of this network is to alleviate periodic power shortages in the region, reduce operating costs, optimize shared use of hydroelectric power, create a competitive energy market in the region, and attract foreign investment in power generation and transmission systems.

Hydropower potential on the Caribbean Islands is not very large. The focus is mainly on small hydropower plants. On average only three-fourths of the population has access to electricity. The islands depend strongly on imported fossil fuels like diesel for their energy. There is a great need to develop alternative renewable energy sources, such as wind, solar, geothermal, small hydro, and ocean kinetic.

CENTRAL AMERICA AND CARIBBEAN ISLANDS FACTS	88.5 Mio.	Population
	6,562 MW	Installed hydro capacity
	1,428 MW	Hydro capacity under construction
	23,717 GWh	Hydro generation
	106,432 GWh	Technically feasible hydro generation potential
	ANDRITZ HYDRO	
	195	Installed or rehabilitated units
	4,476 MW	Installed or rehabilitated capacity
	68.21%	Share of total installed capacity

Hydropower & Dams World Atlas 2015 and The World Bank

Central America refers to: Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama
 Caribbean Islands refer to: Lucayan Archipelago, Greater Antilles, Lesser Antilles, Windward Islands, and Leeward Antilles

EL SALVADOR

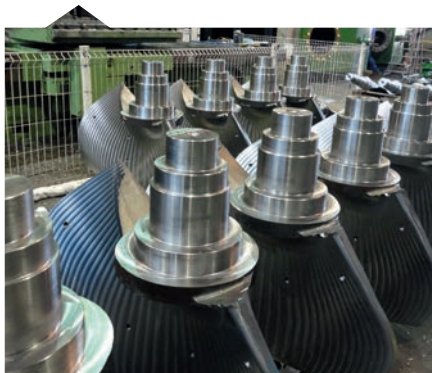
5 de Noviembre

Comisión Ejecutiva Hidroeléctrica del Rio Lempa (CEL) awarded ANDRITZ HYDRO an order for the supply of electro-mechanical equipment for the expansion of HPP 5 de Noviembre. The scope of delivery comprised two 41 MW Francis turbine units with generators, the control system, and auxiliary equipment. ■

PANAMA

Barro Blanco

HPP Barro Blanco is located on the Tabasará River, in the province of Chiriquí. ANDRITZ HYDRO is responsible for engineering, manufacturing, transportation, erection, and commissioning of two vertical Kaplan turbines and generators. For ecological flow a horizontal Francis turbine, a butterfly valve and a generator are also part of the project. The contract was awarded to ANDRITZ HYDRO by UTE Tabasará, a subsidiary of Cobra, a company based in Spain, in January 2012. The owner is Generadora del Istmo, S.A. (GENISA). The main turbine components were manufactured by ANDRITZ HYDRO Spain. ■



GUATEMALA

EL SALVADOR

NICARAGUA

PANAMA

DOMINICAN REPUBLIC

Hatillo

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

ANDRITZ HYDRO's scope of supply comprises a new penstock with a bifurcation, new gates for the spillway, a crane for the new powerhouse, and the

rehabilitation of an existing draft tube, as well as erection of the previously by ANDRITZ HYDRO delivered components such as turbine, generator and power transformer. ANDRITZ HYDRO is going to supply new hydraulic power units, control equipment, SCADA system, Electrical Power Systems, and fiber optic and lightning systems for the new powerhouse. Erection, erection supervision, commissioning, and training are also part of the contractual scope. The project is scheduled to be completed by the end of March 2017. ■

DOMINICAN REPUBLIC



GUATEMALA

Renace 4

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

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

The Provisional Acceptance Certificate (PAC) for this project is scheduled to be issued in February 2018.

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

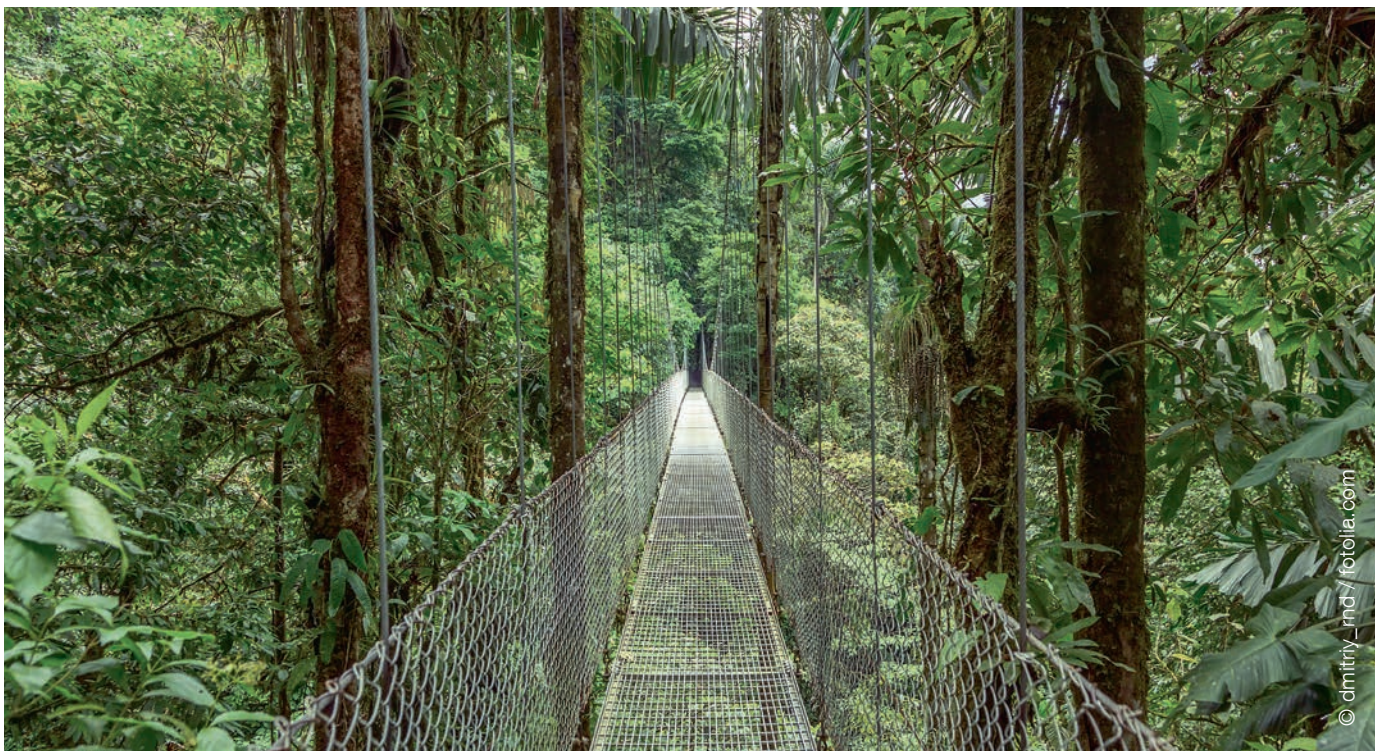
NICARAGUA

Centroamérica and Carlos Fonseca

In October 2015, the company signed a contract with Empresa Nicaragüense de Electricidad (ENEL) for the renovation of HPP Carlos Fonseca (54.4 MW) and HPP Centroamérica (50 MW), the two biggest hydropower plants in the country.

ANDRITZ HYDRO will supply new equipment for the electrical 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. Commissioning for HPP Carlos Fonseca is scheduled for summer 2017, and for HPP Centroamérica in spring 2018. ■



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Costa Rica

The Country of Renewable Power

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Hydropower is essential to the economic development of Costa Rica. Although the electrification rate of Costa Rica is more than 99% and therefore the highest in Central America, electricity demand is continuously increasing, estimated at 4% annually over the next decade.

Costa Rica has a total installed hydropower capacity of 1,834 MW, providing about 6,720 GWh/year, which represents more than two thirds of the nation's total power production.

To meet the needs of an expanding population, increased rural electrification and growing demand for power, the further development of hydropower resources is being promoted.

COSTA RICA FACTS	4.808 Mio.	Population
	99.5%	Access to electricity
	1,834 MW	Installed hydro capacity
	421 MW	Hydro capacity under construction
	66%	Share of generation from hydropower
	6,720 GWh	Hydro generation
	30,412 GWh	Technically feasible hydro generation potential

Hydropower & Dams World Atlas 2015 and The World Bank

ANDRITZ HYDRO in Costa Rica

As far back as 1913, ANDRITZ HYDRO had already delivered electro-mechanical equipment to Costa Rica – for HPP Paraiso. Since then, most of the country's major hydropower projects could be added to the company's reference list; HPP Reventazon (305 MW), HPP Angostura (180 MW), HPP Cachi (158 MW), HPP Pirris (140 MW), and HPP Rio Macho (140 MW).

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

ANDRITZ HYDRO's scope of supply comprises the delivery of two horizontal Francis turbines, each with a capacity of 14.31 MW, including butterfly valves (DN1800), hydraulic power units, supervision of installation, as well as commissioning. HPP Los Negros II is scheduled to be put into commercial operation in 2017.

Due to the well-developed hydropower resources in the country, last year Costa Rica ran 250 days on renewable power alone, achieving an impressive goal. ANDRITZ HYDRO is proud to be able to contribute to this achievement. ■

Ecuador

Hydropower, the Energy Source of the Future

by Diego Vilanova
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Ecuador has a developing economy that is highly dependent on petroleum and agricultural products. Electricity demand is expected to increase dramatically over the next decade. The government wants up to 80% of the nation's electricity supply to be covered by renewable resources, preferably hydropower. As a result, laws and new regulations were introduced to enhance private investments in this sector. So far, only about 7% of the technically feasible hydropower potential has been developed. While 3,069 MW of hydro capacity is currently under construction, more than 7,000 MW are planned in order to end the dependency on imported fuel for power generation.

ANDRITZ HYDRO in Ecuador

ANDRITZ HYDRO has a long history in Ecuador. Electro-mechanical equipment for HPP Riobamba was delivered back in 1923. Since then ANDRITZ HYDRO delivered and rehabilitated more than 60 units with a total output of about 2,000 MW, representing an impressive 88% of the nation's hydropower capacity. Important projects like HPP Coca Coda Sinclair, with 1,500 MW the biggest hydropower plant in Ecuador, can be found on ANDRITZ HYDRO's reference list.

HPP Due: Hidroalto Generacion De Energia S.A. awarded ANDRITZ HYDRO a contract for the supply of electro-mechanical equipment for the Due hydropower plant in 2015. The order follows the successful project of HPP Calope. The scope of supply comprises two 25 MW horizontal Francis turbines, generators, inlet butterfly valves, pressure relief valves, hydraulic power units, cooling system, control and automation, as well as electrical auxiliaries. Final commissioning is expected by mid-2017.

ECUADOR FACTS

16.14 Mio.
97.2%
2,300 MW
3,069 MW
46%
11,458 GWh
133,507 GWh

Population
Access to electricity
Installed hydro capacity
Hydro capacity under construction
Share of generation from hydropower
Hydro generation
Technically feasible hydro generation potential

Hydropower & Dams World Atlas 2015 and The World Bank

The customer is planning a 15 MW extension of HPP Due.

HPP Sigchos: In April 2015, ANDRITZ HYDRO received a contract from Hidrosigchos C.A. for the Sigchos hydropower plant. The scope of supply includes design and delivery of three horizontal, three-jet Pelton turbines with a capacity of 6 MW each, synchronous generators, main inlet valves, hydraulic power units, governors, cooling water system, Elec-

trical Power Systems, automation, as well as transport, installation, commissioning, and all performance tests. Start of commercial operations is scheduled for December 2016.

ANDRITZ HYDRO looks forward to the development of hydropower in this important market and is ready to support this with state-of-the-art technology and know-how. ■



Inspection of valve for HPP Coca Codo Sinclair



Pelton injector, HPP Coca Codo Sinclair

Colombia

Clean Energy for a Green Country

by Beat Ritschard
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Electricity production in Colombia comes mainly from renewable energy sources, 71% of which comes from hydroelectric generation. Colombia's commitment to renewable energy has allowed the country to rank among the top 10 nations in the world in terms of green energy.

Following a privatization program launched in the 1990s, almost 50% of the country's hydro capacity is now privately owned. The technically feasible hydro generation potential is about 200 TWh/year, with some 140 TWh of hydro potential deemed economically feasible.

ANDRITZ HYDRO in Colombia

ANDRITZ HYDRO has been active in Colombia for more than a century – the first project was HPP Campalegre built in 1913. In 2001 ANDRITZ HYDRO established a permanent office in the capital Bogotá for better market access and project management. In total, ANDRITZ HYDRO has delivered or rehabilitated 167 units with a total output of 8,470 MW, representing 77% of the country's total installed hydro capacity.

ANDRITZ HYDRO has been involved in all the major hydroelectric projects developed in Colombia to date, including HPP San Carlos (1,240 MW), HPP Guavio (1,150 MW), HPP Chivor (1,074 MW), HPP Sogamoso (820 MW), HPP Guatape (560 MW), HPP La Miel (405 MW), and HPP Alto Anchicaya (353 MW).

HPP Luzma I and Luzma II: ANDRITZ HYDRO received an order for the supply of electro-mechanical equipment for the cascading hydropower plants Luzma I and Luzma II, one of the major Compact Hydro contracts in the region. Located near Amalfi, in the northeast of the Department of Antioquia in Colombia, the project is developed by the local

special purpose company Generadora LUZMA, owned by the construction company SP INGENIEROS, and uses the water resources of the Riachon River. For each plant the scope of ANDRITZ HYDRO's supply includes: two vertical, five-jet Pelton turbines of 11.4 MW each, generators, spherical valves, energy dissipation system, control and SCADA system, MV switchgear, electrical and mechanical auxiliaries, power transformer, transport, erection, and commissioning. Completion of the order is scheduled for the first half of 2017.

HPP Prado Tolima: Empresa de Energía del Pacífico S.A. E.S.P. (EPSA), part of the CELSIA Group, awarded ANDRITZ HYDRO a contract for the design, supply, installation, and commissioning of three Francis runners at Prado Tolima hydropower plant. Located in the department of Tolima, approximately 200 km from Bogotá, the hydropower plant has a total installed capacity of 55.5 MW, consisting of three vertical 16.5 MW units and one horizontal 6 MW unit. As a result of the modernization the output of each unit will be increased from 16.5 MW to 18 MW, meaning an improvement of around 9%. The first unit was commissioned in April 2016; the last one is scheduled for September 2016.

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

ANDRITZ HYDRO was awarded the contract by HIDROELÉCTRICA DEL ALTO PORCE S.A.S. E.S.P for the sup-

COLOMBIA FACTS	48.23 Mio.	Population
	97%	Access to electricity
	10,919 MW	Installed hydro capacity
	3,652 MW	Hydro capacity under construction
	71%	Share of generation from hydropower
	64,327 GWh	Hydro generation
	200,000 GWh	Technically feasible hydro generation potential

Hydropower & Dams World Atlas 2015 and The World Bank

ply of the complete electro and hydro-mechanical "from water-to-wire" equipment. The contractual scope of supply comprised two 39.7 MW Francis 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, radial gates, stoplogs, trashrakes and transformers, GIS, control and protection devices, batteries, emergency generator, and mechanical auxiliary systems.

Colombia is a country with a huge hydropower potential. ANDRITZ HYDRO has a strong presence in this important market and the technological know-how to further contribute significantly to the exploitation of this valuable resource in the coming years. ■



Peru

Renewable Energy for an Emerging Country

by Peter Gnos
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and 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 or rehabilitated more than

140 units in the country, with a total output of about 2,600 MW. Some 15 years ago ANDRITZ HYDRO decided to establish a local entity in the Peruvian capital Lima.

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 auxiliaries, 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 mining company Buenaventura. 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.

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.

HPPs El Carmen and 8 De Agosto: Generadora Andina, a company owned by Union Group, 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 power units. The scope of supply for HPP 8 de Agosto comprises two 10.6 MW horizontal Francis turbines, main inlet valves, and the hydraulic power units. Commissioning of both projects will take place during 2016.

HPP Rucuy: Developed by Empresa Administradora Chungar SAC, a subsidiary of Volcan Compania Minera 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 power units. Commissioning is expected by mid 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. ■



Installation works at HPP Cerro del Águila

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PERU FACTS	31.38 Mio.	Population
	91.2%	Access to electricity
	2,842 MW	Installed hydro capacity
	1,530 MW	Hydro capacity under construction
	49%	Share of generation from hydropower
	20,551 GWh	Hydro generation
	395,118 GWh	Technically feasible hydro generation potential

Hydropower & Dams World Atlas 2015 and The World Bank



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Brazil

Hydropower Energizing People

By Cristiano del Nero
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Brazil is the second-largest producer of hydroelectric power in the world and has the largest hydropower resources in South America. About three-fourths of its electric power supply is based on hydropower. The big challenge is the country's reliance on mainly one resource for most of the country's electricity generation, combined with the distant and disparate locations of its population centers.

According to government studies, there is a technically feasible hydropower potential of about 1,250 TWh, with some 15,900 MW of capacity currently under construction.

ANDRITZ HYDRO in Brazil

ANDRITZ HYDRO has been present in Brazil for more than 100 years – the first unit delivered was for HPP São Paulo in 1906. To date, ANDRITZ HYDRO has delivered or refurbished 686 generating units with a total installed capacity of more than 30,000 MW – some of which are still under construction – out of an installed total of about 90,200 MW.

ANDRITZ HYDRO S.A. and ANDRITZ HYDRO Brasil Ltda. with office in the city of Barueri and manufacturing facility in the city of Araraquara, both in the state of São Paulo, are responsible for engineering and manufacturing of equipment for small, medium and large hydropower plants, as well as for the development of automation solutions for both new plants and modernization projects.

ANDRITZ HYDRO was involved in almost all major hydro projects in Brazil to date, such as HPP Itaipu (14,000 MW), HPP Belo Monte (11,233 MW), HPP Tucuruí (8,370 MW), HPP Jirau (3,750 MW),

HPP Ilha Solteira III (3,444 MW) and HPP Santo Antonio (3,580 MW).

HPP Belo Monte: When completed the Belo Monte Complex, under construction in Altamira, will be the largest hydropower plant in Brazil and the fourth largest in the world. The complex comprises two powerhouses. The major one will be on the Belo Monte site, consisting of 18 Francis turbines, each with an output of 611 MW. The second, complementary powerhouse will be built at the Pimental site next to the main dam, consisting of six 38.8 MW Bulb turbines.

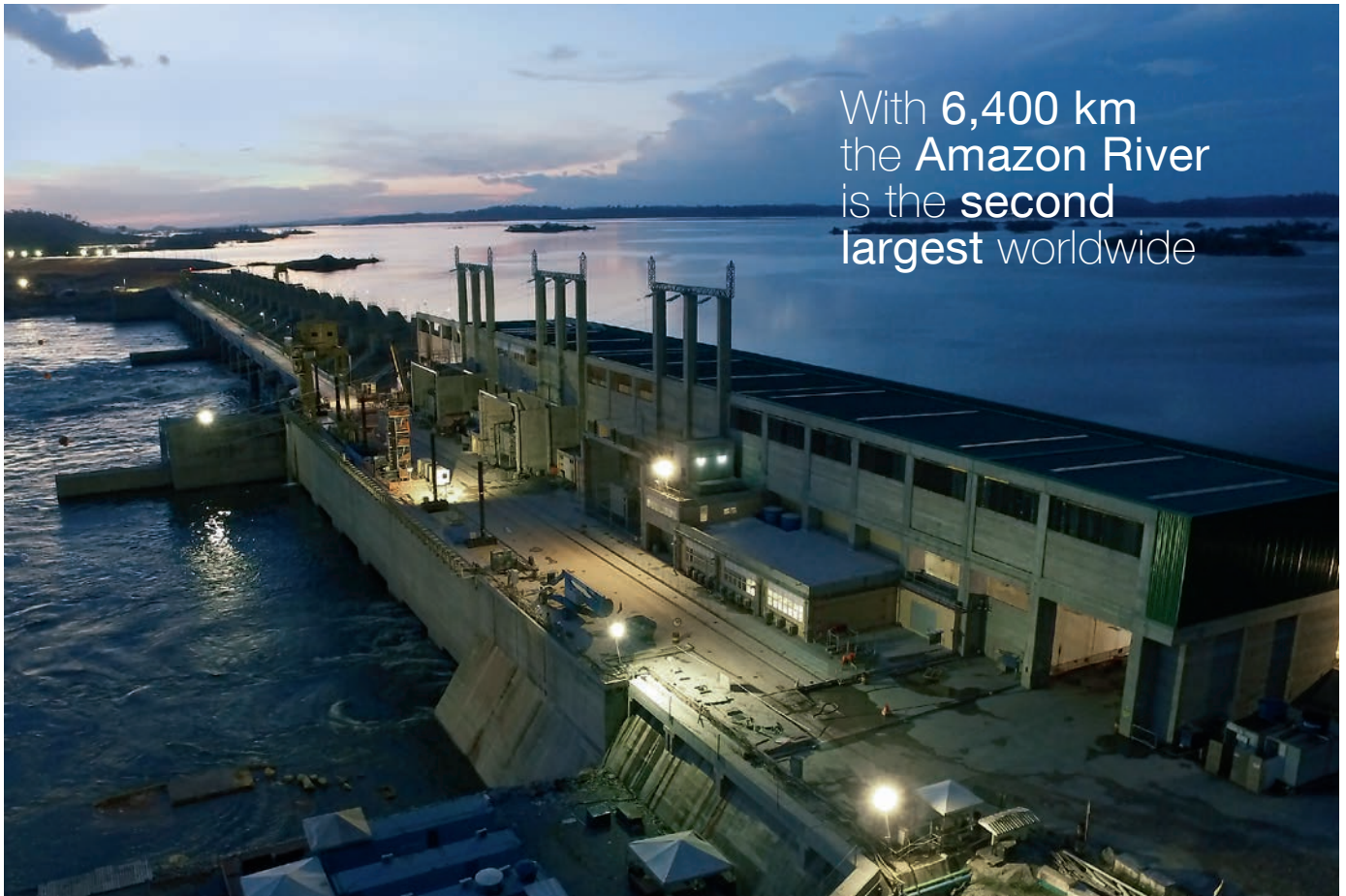
The ANDRITZ HYDRO scope of supply for the Belo Monte powerhouse includes four vertical Francis turbines and generators, one blow-down system, as well as 18 excitation systems. For the Pimental powerhouse ANDRITZ HYDRO will supply the entire electro-mechanical equipment consisting of six Bulb turbines with horizontal generators, electrical power systems, mechanical auxiliaries and automation, protection and

control systems equipment, and one of the world's largest spillway gates. With a total length of 445.5 m, it holds 18 radial gates, each 20 m long and 22 m high.

Iguazu is one of the biggest and most spectacular waterfalls

HPP Foz do Areia: 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 Iguazu River. The contractual scope comprises the supply of four new turbine runners, including turbine governors, complete hydraulic power unit and air compressors, four new excitation systems, shaft seals, auto lubricating distributor bushings, head cover drainage system, pipes, valves, as well as transportation, installation, and commis-

HPP Pimental



With 6,400 km
the Amazon River
is the second
largest worldwide



Aerial view of HPP Irara

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

HPP Serra da Mesa: CPFL and Furnas have awarded ANDRITZ HYDRO a contract for the modernization of the

Installation of generator at HPP Mauá



Itaipu is the world second largest hydropower plant

Serra da Mesa hydropower plant, an embankment dam on the Tocantins River. The contractual scope for ANDRITZ HYDRO comprises design, supply, delivery, and commissioning of three excitation systems, including the new HIPASE-E regulators in redundant configuration. This order represents an important excitation reference for the new HIPASE platform of ANDRITZ HYDRO. The commissioning of the first unit is planned for the end of 2016.

HPP Sinop: In 2014, ANDRITZ HYDRO was sub-contracted by Construtora TRIUNFO SA to supply the electro-mechanical equipment for the Sinop hydropower plant on the Teles Pires River. The final customer is a consortium composed of Eletronorte, Companhia Hidro-Elétrica do São Francisco S.A. (Chesf S.A.) and Électricité de France (EDF). ANDRITZ HYDRO is supplying the hydraulic engineering, model testing, turbine and generator engineering, two vertical Kaplan turbines, two synchronous 223.3 MVA generators, two excitation systems, and two governors, as well as transportation to the site, erection supervision, and commissioning. At 204 MW each, the units installed at HPP Sinop will not only be the largest Kaplan turbines in Brazil, but the third largest such machines in the world. The start of commercial operations is scheduled for January 2018.

With its skilled staff and high quality manufacturing ANDRITZ HYDRO has a leading role in the Brazilian market covering the full range of solutions for new hydropower plants, for small hydropower plants, and for modernization projects. ■

BRAZIL FACTS

207.8 Mio.	Population
99.5%	Access to electricity
90,200 MW	Installed hydro capacity
15,900 MW	Hydro capacity under construction
60%	Share of generation from hydropower
373,000 GWh	Hydro generation
1,250,000 GWh	Technically feasible hydro generation potential



VIDEO

Spillway at HPP Angostura, the third hydropower plant in a cascade at the Bío Bío River

Chile

Enriching a Stable Economy

By Leonardo Sepulveda
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Chile is one of South America's most stable and prosperous economies. The energy sector is largely privatized, particularly the power industry. Chilean electricity demand has been growing rapidly over the last decade, averaging more than 7% annually. A significant portion of this growth has come from increased power demand from the mining sector – the country's single largest industry – and by large urban areas such as Santiago, which alone contains almost 40% of Chile's population. To meet this increasing demand Chile will have to develop its hydropower potential in the coming years.

ANDRITZ HYDRO in Chile

ANDRITZ HYDRO is very successfully active in Chile and has been since the beginning of the 20th century. The first project, HPP Santiago, was completed in 1908. Since then ANDRITZ HYDRO has delivered or modernized about 140 units in Chile with a total output of 1,365 MW. Among these references are major hydropower plants such as HPP Pangué (467 MW), HPP El Toro (484 MW), HPP Angostura (316 MW), HPP Alfafal I (188 MW), HPP Higuera (182 MW), and HPP Chacayes (130 MW). During recent years ANDRITZ HYDRO has been involved in a lot of projects, recognizing



CHILE FACTS	17.95 Mio.	Population
	99.6%	Access to electricity
	6,200 MW	Installed hydro capacity
	350 MW	Hydro capacity under construction
	27%	Share of generation from hydropower
	17,400 GWh	Hydro generation
	162,232 GWh	Technically feasible hydro generation potential

Hydropower & Dams World Atlas 2015 and The World Bank

increasing investment in small hydro development. In the last two years alone, equipment for nine small hydropower plants has been delivered and commissioned. The modernization works for five further small hydropower plants are ongoing.

HPP Embalse Ancoa: In April 2015, ANDRITZ HYDRO signed a contract with Hidroelectrica Embalse Ancoa S.p.A. for the supply of electro-mechanical equipment for the new Embalse Ancoa hydropower plant located 200 km south of Santiago. The planned project will comprise a new power house, for which ANDRITZ HYDRO will deliver

two horizontal 13.75 MW Francis turbines, generators, mechanical auxiliaries, electrical power systems (EPS), automation, as well as a tele control center. Commissioning is scheduled for January 2017. HPP Embalse Ancoa will provide about 86 GWh per year of clean energy to the Chilean Central Interconnected System (SIC).

HPP Ñuble: Hidroelectrica Ñuble SpA, a subsidiary of the Chilean power holding company Electrica Puntilla S.A. and ANDRITZ HYDRO have signed a contract for the complete electro- and hydro-mechanical equipment of the new Ñuble hydropower plant.

The Ñuble run-of-river power plant is located 4.8 km upstream of the town of San Fabian in the Bío Bío region and uses the water of the Ñuble River and its tributaries.

ANDRITZ HYDRO's scope includes supply, installation, supervision, commissioning, and on-site training for two vertical 71 MW Francis turbines and governors, two butterfly inlet valves including hydraulic control, two synchronous 75 MVA generators with static excitation systems, the electrical power systems, the mechanical auxiliary systems, as well as the complete systems for automation, control and protection (ACP), including communication with the national dispatch center. Furthermore, six spillway radial gates (head: 22.4 m), two channel radial gates (head: 8.2 m),

one intake wagon gate, and two draft tube gates are also part of the delivery.

The start of commercial operation is planned for July 2019.

HPP Convento Viejo: 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 project will comprise a greenfield 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 a 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 for the SIC.

As a result of water shortages and increasing power demand, major hydro projects will be developed and reservoirs will be needed in Chile. ANDRITZ HYDRO is ready to support its clients with state-of-the-art technology and know-how. ■

Bolivia

Great Prospects for Hydropower

By Diego Vilanova
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In 2015, the Bolivian government passed an investment law in order to improve the investment climate and hence boost energy production. It set a target that by 2025 70% of domestic electricity should be generated by renewable energy sources, mainly hydropower. Estimates suggest a hydropower potential of more than 38,000 MW, almost 80% of which is found in the Amazonian region. Possible sites for hydropower facilities are being investigated and some major plants are planned. The aim of the government is to generate enough energy to export it to the neighboring countries Brazil, Peru and Chile.

ANDRITZ HYDRO in Bolivia

As far back as 1910 ANDRITZ HYDRO delivered electro-mechanical equipment to Bolivia for HPP Potosi. In the fol-

lowing 106 years the company has installed or modernized more than 60 units with a total capacity of 400 MW. This represents almost three-quarters of Bolivian's hydropower fleet.

HPP San José I and II: In February 2015, the EPC contractor POWER-CHINA Kunming Engineering Corporation Limited awarded a contract to ANDRITZ HYDRO for the San José hydroelectric complex in Bolivia. The run-of-river plants San José 1 (two 28 MW Pelton units) and San José 2 (two 35 MW Pelton units), owned by Bolivia's state-owned power utility Empresa Nacional de Electricidad (ENDE), are part of the expansion plan for the Corani Basin. ANDRITZ HYDRO will supply design, manufacturing, delivery, installation supervision, and commissioning supervi-

BOLIVIA FACTS	10.73 Mio.	Population
	90.5%	Access to electricity
	563 MW	Installed hydro capacity
	247 MW	Hydro capacity under construction
	32%	Share of generation from hydropower
	2,515 GWh	Hydro generation
	126,000 GWh	Technically feasible hydro generation potential

Hydropower & Dams World Atlas 2015 and The World Bank

sion of the four Pelton turbines. The project is scheduled to be put into operation by the end of 2017.

ANDRITZ HYDRO was involved in most of the major hydropower projects in Bolivia such as HPP Rio Taquesi, one of the major projects of Hidroeléctrica Boliviana, or the modernization of various other important HPP's, which the company has successfully finished and commissioned in the last years. The expansion project of the fifth unit of HPP Santa Isabel of Corani Company – currently the biggest hydropower plant in Bolivia – and the order for the new HPP Huaji in the Zongo Valley near La Paz for customer COBEE underlines the continued success of ANDRITZ HYDRO in the country. ■



FOCUS ON: The Americas

with a length of **14,000** km the Americas build the **LONGEST NORTH-SOUTH LANDMASS** in the world

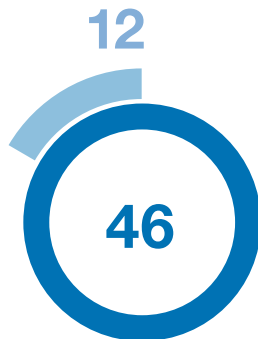
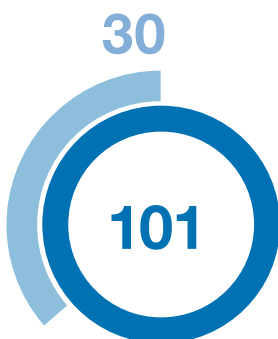
4,000 TWh technically feasible
POTENTIAL ON THE CONTINENT

11
TIME ZONES

47 COUNTRIES in North, Central, and South America altogether are **COVERING 28%** of the habitable **EARTH SURFACE**

all
CLIMATE ZONES

ANDRITZ Group has established **101 locations** and **46 manufacturing sites** in the Americas from which **30 locations** and **12 manufacturing sites** are **ANDRITZ HYDRO**



ANDRITZ HYDRO delivered, and modernized **3,800** **UNITS** in the Americas

160 GWh

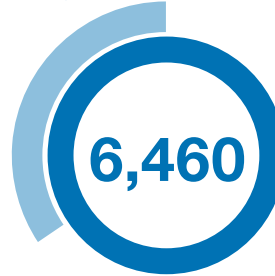
ANDRITZ HYDRO covers 49% of the **TOTAL installed CAPACITY** in the Americas



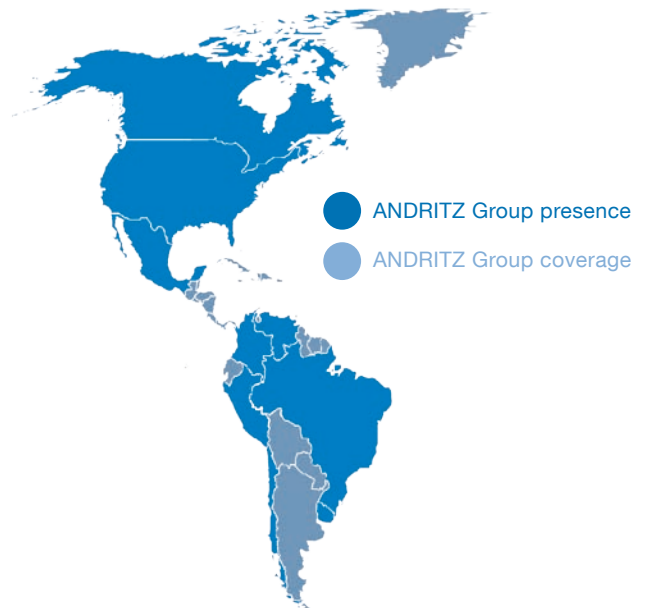
1,385 GWh of electrical energy are **GENERATED** from **HYDROPOWER** in the Americas annually

almost **ONE BILLION** people

2,220



out of **6,460** **EMPLOYEES** of **ANDRITZ Group** **2,220** are part of **ANDRITZ HYDRO**





ANDRITZ
Hydro



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