HYDRO NEWS SPECIAL

ENGLISH Magazine of ANDRITZ Hydropower / Special Edition The Americas / 05-2024

THE AMERICAS EDITION

Brazil
Page 48

Canada
Page 12

Mexico
Page 26

The United States
Page 18

ANDRITZ

THE AMERICAS IN SHORT

TWO CONTINENTS 35 COUNTRIES

The Americas make up the largest part of the Earth's western hemisphere. Stretching approximately 15,000 km (9,320 mi) from the northernmost point, Kaffeklubben Island, which is also the northernmost point on Earth, to the southernmost point, the islands of South Thule, the American landmass spans a vast distance.

Total area
42,549,000 km²
(16,428,000 sq mi).

8.3%
of Earth surface

28.5%
of worlds' total land area

POPULATION
1.02 BILLION

About
12.83%
of the world population

United States → Third most populous country in the world
333,29 mio

LARGEST METROPOLITAN AREAS:
SÃO PAULO, MEXICO CITY, NEW YORK CITY, BUENOS AIRES

Largest country:
Canada with
9,984,670 km²
(3.8 million sq mi)

Smallest country:
St. Kitts and **Nevis**
with **261 km²** (101 sq mi)

2 OUT OF THE 10 **LONGEST RIVERS** OF THE WORLD: THE **AMAZON** AND THE **MISSISSIPPI**

The **Amazon basin** is the largest drainage basin in the world, with an area of approximately **7,000,000 km²** (2,700,000 sq mi) and the world's largest discharge of about 215,000 – 230,000 m³/s.

ANDRITZ

Locations: **106**

Employees: **8,100**

ANDRITZ Hydropower

Locations: **21** – including **7** manufacturing locations

Employees: **>1,700**

Sources: The WorldBank, Nationsonline.org,

Harnessing Hydropower:

EMPOWERING THE ENERGY TRANSITION IN THE AMERICAS

Dear valued customers,

In the wake of COP28 and growing climate concerns, the need for sustainable energy solutions has never been more evident. Against this backdrop, the great sweep of the Americas from North to South is ready to meet the challenge with a cleaner, greener future. The backbone of this transition is hydropower and pumped storage. Both enable the effective integration of the huge volumes of solar and wind generation that are needed to achieve independence from fossil fuels.

ANDRITZ is proud to be a key partner on this journey of transformation. With our unwavering commitment to innovation and excellence, we are driving the development of hydropower infrastructure across North, Central, and South America. In this special edition of our Customer Magazine, we shine a spotlight on the indispensable role that hydropower and innovative energy solutions, such as synchronous condensers, play in shaping the future energy landscape of the Americas.

Hydropower stands as a beacon of sustainability, providing a vast, reliable, and renewable energy source that is essential for meeting ambitious carbon reduction targets. As countries strive to mitigate the effects of climate change the scalability and flexibility of hydropower becomes ever more valuable.

ANDRITZ is dedicated to advancing the rehabilitation and upgrading of existing hydropower infrastructure throughout the Americas. By modernizing aging facilities and improving operational efficiency, we are extending the lifespan of critical assets while minimizing any environmental impact. Through our cutting-edge manufacturing capabilities located strategically across the region, we strengthen local economies and foster further innovation in the hydropower sector.

Energy makes a vital contribution to people's quality of life, to society and to human progress. This is the case today and will remain so in the future. Working together with the people of the Americas, ANDRITZ is committed to making that future clean, environmentally friendly, and sustainable.

Yours sincerely,

Alexander Schwab
Senior Vice President
ANDRITZ HYDRO GmbH

HydroNews App:
Download on our website
or in the AppStore/PlayStore

HYDRONEWS
online magazine,
newsletter and
contact information:
www.andritz.com/hn-americas

Follow us on: LinkedIn

iha member

Print product with financial climate contribution
ClimatePartner.com/11886-2404-1010

IMPRINT:
Publisher: ANDRITZ HYDRO GmbH,
A-1120 Vienna, Eibesbrunnergasse 20, Austria
Phone: +43 50805 0
E-Mail: hydronews@andritz.com
Responsible for the content:
Alexander Schwab, Jens Paeutz
Art Director and Editorship: Marie-Antoinette Sailer

Online magazine: www.andritz.com/hydronews
Published in: English, French, Portuguese, Spanish
Layout & Design: INTOUCH Werbeagentur, Austria
Contributing Photographers & Providers:
Adobe Stock, FreeVectorMaps.com
Printed at WGA Print-Producing, Austria;
Printed on FSC paper;

IN THIS ISSUE

EDITORIAL

HARNESSING HYDROPOWER
Empowering the Energy Transition in the Americas 03

FACTS & FIGURES

THE AMERICAS IN SHORT 02

HYDROPOWER IN FACTS 68

SPECIAL TOPICS

PUMPED STORAGE
Powering the future 06

SAFETY FIRST
Health & Safety and Employee Engagement 08

RENOVATE AND REJUVENATE
Live long and prosper with ANDRITZ 38

CUTTING EDGE MANUFACTURING CAPABILITIES
Striving for operational excellence 40

THE RENAISSANCE OF SYNCHRONOUS CONDENSERS
Renewables and power system stability 64

ANDRITZ INNOVATION: AT THE HEART OF SUSTAINABLE HYDROPOWER
R&D and fish-friendliness 66

COUNTRY REPORTS

NORTH AMERICA
Region overview 10

CANADA
Maintaining leadership in green energy 12

THE UNITED STATES
Reinvigorating hydropower for the future 18

MEXICO, CENTRAL AMERICA & THE CARIBBEAN
Region overview 24

MEXICO
Resurgence of rehabilitation 26

CENTRAL AMERICA & THE CARIBBEAN
Commitment to diversifying energy 32

SOUTH AMERICA
Region overview 44

ECUADOR
Commitment to diversifying energy 46

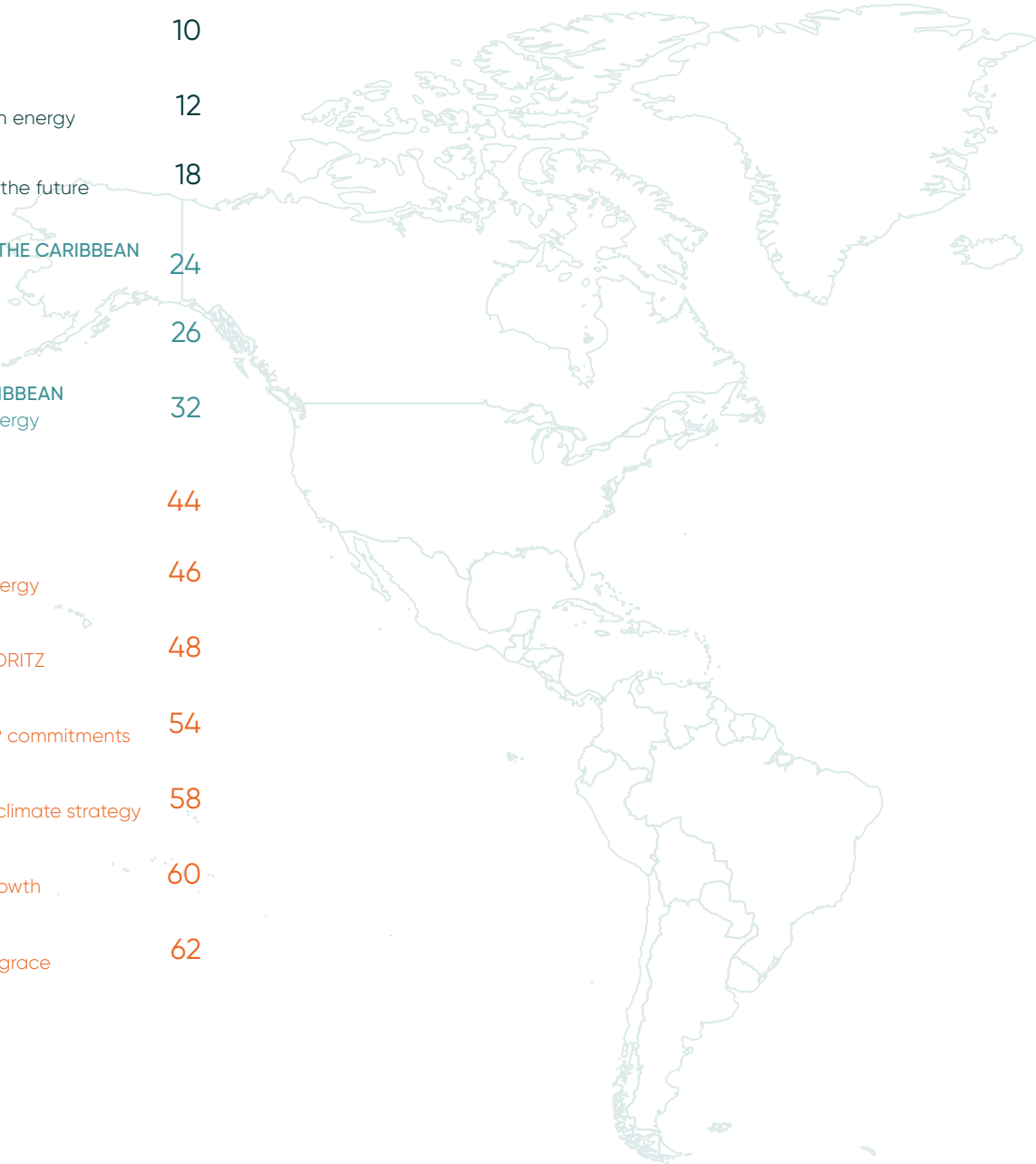
BRAZIL
Energy transition driven by ANDRITZ 48

COLOMBIA
Hydropower and national COP commitments 54

CHILE
Hydropower: The key to Chile's climate strategy 58

PERU
Ready for renewable energy growth 60

VENEZUELA
Renewable energy in a land of grace 62



PUMPED STORAGE: POWERING THE FUTURE

As the world pushes towards a net zero carbon green energy future, the need for bulk energy storage is becoming ever more apparent. Storage performs multiple functions in a grid that is dominated by variable output renewables like wind and solar, absorbing excess energy and releasing it when needed helps balance the grid. Although chemical battery technology has made great strides in recent years, it still falls far short of the world's oldest and still most successful form of energy storage – pumped storage hydropower.

According to the International Hydropower Association (IHA), some 85+% of the world's total energy storage capacity is met by pumped storage. The latest IHA figures also reveal that about 175 GW of pumped storage capacity is currently installed worldwide. About 10.5 GW of new capacity has recently been added to the global fleet. With its ability to flexibly deliver large quantities of power for extended periods and at short notice, pumped storage hydropower's unique capabilities make it the standout energy storage solution. The benefits pumped storge can bring has led to a substantial pipeline of 214 GW either in planning, permitting or already under construction. The IHA notes that the global pumped storage capacity over the next two decades is expected to double. Furthermore, while pumped storage projects have traditionally been associated with particular geographical features such as linked reservoirs in mountainous regions only, alternative solutions are now being developed too. Under certain circumstances it is possible, for instance, to retrofit pumped storage capabilities at existing facilities such as conventional hydropower plants, irrigation dams, and even disused mines and quarries.

Although much of the new pumped storage capacity developed over recent years has been developed in China, both North and South America are also looking at embracing this approach. Pumped storage already accounts for more than 95% of all utility-scale electricity storage in the United States, for example, which

BENEFITS OF PUMPED STORAGE

- Best-proven, low-risk technology
- Balances volatile renewable energy generation with demand
- Manages grid bottlenecks
- Supports grid stability by virtue of a quick response to changing demand or sudden outages
- Contributes to grid stability by increasing grid inertia and providing black start capability
- Very long facility lifetime

3D rendering of a pump turbine unit including motor generator, pump turbine, and inlet valve.

has 43 plants and the potential to at least double this capacity.

Canada has only one operating 177 MW pumped storage facility. However, last year a report by WaterPower Canada on the technical and economic potential of pumped storage hydropower plants in Canada found that potentially over 8,000 GW at nearly 1,200 sites is feasible.

So far, South America has only succeeded in installing about 1 GW of pumped storage capacity with two plants of 750 MW and 224 MW in Argentina and just 20 MW in Brazil, constructed in 1939. Nonetheless, South and Central America have huge potential for pumped storage, some estimates put that at 7,000 to 8,000 GWh per million people each, and they are seen as among the most attractive markets for pumped storage for this reason.

As a leading hydropower technology company ANDRITZ has supplied or refurbished more than 460 pumped storage units over the last century with a combined capacity of almost 40,000 MW.

ANDRITZ has played a pivotal role in developing pumped storage plants across the Americas, showcasing our expertise and dedication to hydropower. Our work on landmark projects like Northfield Mountain in the US, where we supplied four large reversible turbines capable of impressive water flow rates for a power output of 1,168 MW, and Muddy Run in the US, generating 1,070 MW from eight units, underscores our capacity to deliver high-capacity energy storage and generation solutions.

Beyond these significant projects, ANDRITZ continues to support the hydropower industry with a comprehensive portfolio of services and state-of-the-art equipment. Our local presence ensures ongoing support for projects, enhancing efficiency and sustainability in both existing and new hydropower plants. We are committed to advancing the hydropower sector as a key component of global renewable energy, working alongside developers, operators, and suppliers.

ANDRITZ stands ready to support both existing and new pumped storage projects to help the Americas meet all their bulk energy storage needs.

"Pumped storage is more than just a back-up for intermittent renewable energy resources. It offers a wide spectrum of benefits and plays a vital role within local and regional water and energy programs."

AUTHOR

Marie-Antoinette Sailer
hydronews@andritz.com

SAFETY FIRST

Health & Safety and Employee Engagement

Diligent compliance to safety requirements

ANDRITZ is unconditionally committed to all relevant aspects of occupational health and safety, environmental protection, as well as product and process quality.

Its most important resource, ANDRITZ firmly believes, is its employees, who must be protected and valued. Therefore, all employees and all those who are directly or indirectly involved in the business are provided with a safe, secure, and suitable working environment.

Research has identified the top 10 employee engagement drivers:

- My job allows me to utilize my strengths.
- I trust our executives to lead the company to future success.
- I believe this organization will be successful in the future.
- I find my job interesting and challenging.
- The executives of this organization value people as their most important resource.
- My opinions seem to count at work.
- If I contribute to the organization's success, I know I will be recognized.
- I see professional growth and career development opportunities for myself here.
- The executives of this organization demonstrate integrity.
- I have the information I need to do my job well.

Engaged employees perform better, experience less burnout, and stay in organizations longer. Employee engagement therefore has a direct impact on an organization's success, as well as employee well-being and overall work environment.

ANDRITZ has adopted several tools and routines to improve and increase employee engagement at all its locations across its global locations and project sites. One of the best examples of our commitment to well-being is evident in ANDRITZ North America.

Among the tools used to foster employee engagement are regular 'All Employee meetings' with the executive board, 'Lunch & Learn' with the senior management, and team recognition.

Good housekeeping practice – clear walkways and caution tape to delineate laydown

Good practice - Stator protection

Health & Safety

ANDRITZ North America uses the Safety Recognition Program framework across its project sites to nurture and enhance a safety culture, as well as promote employee engagement.

A highlight comes from a hydro refurbishment project in Saskatchewan, Canada. Here a strong safety recognition program is built into everyday operations. It is demonstrating substantial results.

Program foundation

Name of the initiative: 'Get Caught Working Safe'.

- Promotes a culture of safety throughout the project.
- Provides recognition for going above and beyond.
- Stimulates employees' sense of belonging and value within the project team.
- Recognition for positive workplace interactions, such as mentoring and coaching
- Observation cards – completed by all levels (worker, foreman, supervisor, safety manager, site manager)

Results

→ Strong safety culture evident throughout the project

→ Diligent compliance with safety policies and procedures

→ Satisfied customer promoting ANDRITZ initiatives

→ Engaged work crew – sense of pride in the work being performed

→ Minimal staff turnover throughout the span of a 6-year project

→ No short cuts: crew recognizes the importance of taking the time to set up all activities correctly.

→ Positive and inclusive organizational culture

→ Low incident rate

Additional tools include specially focused audits, management site visits, last minute risk assessments and meetings for safety coordination, observations, and sharing lessons learned.

"Employee engagement is the result of trust, empowerment and communication."

AUTHOR

Joanne Harte
hydronews@andritz.com

North America

Region overview and figures

The wealth of natural resources in continental North America makes it ideal for generating renewable energy. Hydropower has been a major contributor to the electricity market for many years and is still essential for supplying electricity to millions of people. The North American hydropower sector has seen positive growth in recent years, driven by regulatory approaches that will further maximize the potential for hydropower development and modernization.

Canada, which has abundant water resources, is thought to have an unexploited technical hydropower potential of 163 GW, while the United States has a remaining technically feasible capacity of about 150 GW. Across the continent, 1 GW of new hydropower capacity came online in 2022.

The relationship between hydropower and indigenous communities in North America is crucial to ensure we meet our energy needs while ensuring the communities play an active role in the acceptance and development of projects on their native lands.

Some government owned utilities have announced reconciliation action plans to ensure proactive engagement and involvement of indigenous communities. Collaborative efforts will be required between governments, industry, and indigenous groups to ensure a sustainable future in North America.

Furthermore, stringent measures are being implemented to protect fish populations, ensuring minimal disruption to aquatic ecosystems. The push toward sustainability in North American hydropower also favors ongoing modernization efforts. Aging infrastructure is being upgraded to enhance efficiency, safety, and environmental friendliness. Moreover, there's a growing emphasis on incorporating technological innovation to optimize operations and minimize any ecological impacts. One notable advance lies in the expansion of pumped storage facilities. They enable excess energy to be stored during periods of low demand and released during peak hours, thereby enhancing grid stability and power supply security.

COUNTRIES: 2

CANADA, THE UNITED STATES

POPULATION: 372.22 MILLION

OUR LOCATIONS IN NORTH AMERICA:

CANADA

ANDRITZ HYDRO CANADA INC.

1 Pointe-Claire (QC) - Canadian Hydro Head Office

2 Chambly (QC) - Hydro Automation & Electrical Power Systems

3 Paris (ON) - Gates Engineering & Manufacturing Plant

4 Boucherville - P&G Service and Rehab Specialists

5 Peterborough (ON) - Generator Center

6 Richmond (BC) - Regional Office

UNITED STATES

ANDRITZ HYDRO CORP.

7 Charlotte, North Carolina

8 Spokane, Washington

HYDROPOWER INSTALLED CAPACITY:

185 GW

GENERATION BY HYDROPOWER:

654 TWh

CAPACITY ADDED:

1,108 MW

PUMPED STORAGE INSTALLED CAPACITY:

22 GW

PUMPED STORAGE CAPACITY ADDED:

96 MW

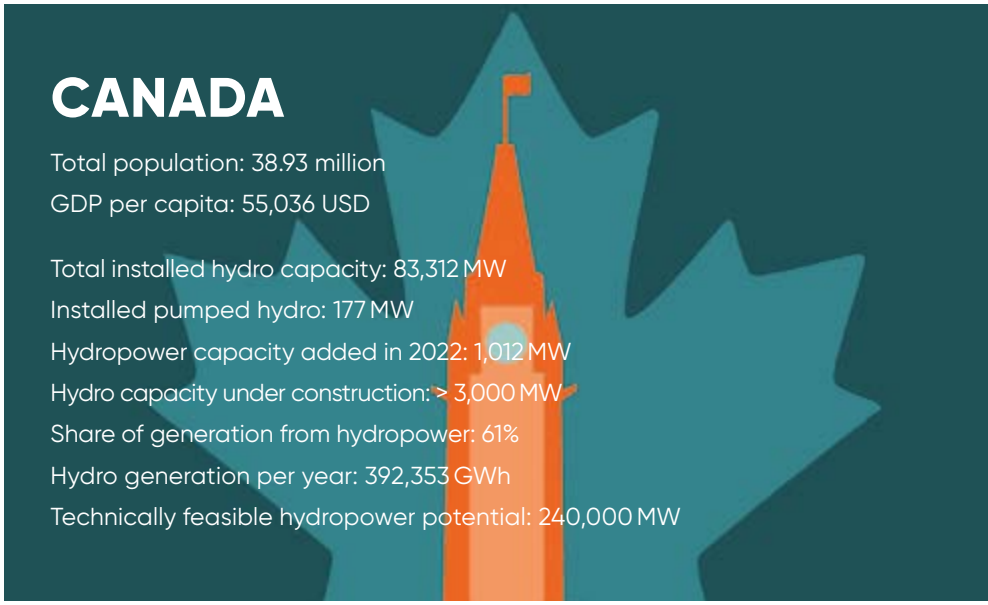
All figures concern 2022;
Sources: TheWorldBank, IMF, IHA, Hydropower & Dams World Atlas 2023

MAINTAININ LEADERSHIP GREEN ENER

Canada – With more than 83 GW of installed hydroelectric capacity, Canada has the world's fourth largest hydroelectric generation capacity after China, Brazil and the USA. Contributing approximately 8.9% to the total global hydroelectric generation, Canada's hydropower accounts for over 60% of its total national installed capacity from all generation sources.

Nonetheless, Canada is facing new power requirements and requires additional capacity to respond to the continuous growth in power demand. For example, in the province of Quebec, an additional 20 GW of new capacity will be required by 2050, equivalent to approximately 50% of the current installed capacity, which is close to 40 GW. Similarly, according to the provincial government in British Columbia, electrical demand there will increase from its current 12 GW of installed capacity by around 15% between now and 2030. Given that Canada has the potential to more than double its current hydropower

G IN GY



All figures concern 2022;
Sources: TheWorldBank, IMF, IHA, Hydropower & Dams World Atlas 2023

capacity, hydropower will certainly play a vital role in meeting national decarbonization objectives.

With this substantial increase in demand already forecast, Canada also has to address its aging hydropower fleet, which requires both maintenance and adaptation to meet changing operating requirements. In fact, most of the nation's generating stations will need to be rehabilitated as the bulk of its hydroelectric power plants were built in the early 1990s and thus require upgrades and potential efficiency improvements.

With a substantial presence in Canada supported by a highly skilled and experienced team, ANDRITZ is very well positioned to respond to this new electricity demand. With its Hydropower head office in Pointe Claire, Quebec, and other locations in Boucherville, Quebec, Chambly, Paris and Peterborough, ANDRITZ has already targeted various potential fields of work where our integrated solutions in the hydro sector "from water-to-wire" can make a significant contribution.

The company is one of the leading suppliers of electromechanical equipment and services for hydropower plants in Canada and offerings from ANDRITZ Hydropower Canada include R&D, design, project management, procurement, manufacturing, delivery, installation, and commissioning services for hydroelectric generating station equipment. This includes turbines, generators, governors, exciters, automation, all types of gates, and multiple associated auxiliary systems. More specifically, ANDRITZ' widely recognized expertise is focusing on the following sectors.

REHABILITATING AND UPGRADING THE CURRENT HYDROELECTRIC PORTFOLIO

The necessity of rehabilitating the current hydroelectric fleet has been clearly →

EB Campbell Generation Station

identified by most utilities in Canada and represents a need to replace/upgrade close to 350 generating units over the next 15 – 20 years. This work has already been initiated by many of our customers, including Hydro-Quebec, Ontario Power Generation, Manitoba Hydro and BC Hydro, Newfoundland & Labrador Hydro, Evolugen, and NB power.

In order to respond to the rehabilitation needs of all these existing facilities, ANDRITZ has accrued the staff, experience, expertise and know-how across all the required fields of engineering, project management, sourcing, installation, commissioning, and servicing. This enables ANDRITZ to provide a full service for any large hydro units, as well as small units, including automation and any related heavy mechanical components.

Some examples of rehabilitation projects carried out by ANDRITZ Hydropower in Canada:

THE EB CAMPBELL GS LIFE EXTENSION PROJECT

In April 2017, ANDRITZ won the mandate from SaskPower for a project to extend the lifetime of six units rated at 37 MW each through a refurbishment program. The scope included a successful model test, the design, and the supply of replacement runners, new distributors, new stators with new laminations and new coils. The scope of supply also included replacement of head gates, trash racks, and hoists, the installation and the refurbishment of intake gate guides, generator poles, turbine and generator shafts, bearings, and many other components. The balance of plant elements includes the assessment/replacement of selected instrumentation and controls.

Scheduled for six consecutive years starting in 2019, the entire six units will be completed in 2025.

THE SIR ADAM BECK G1/G2 UPGRADE PROJECT

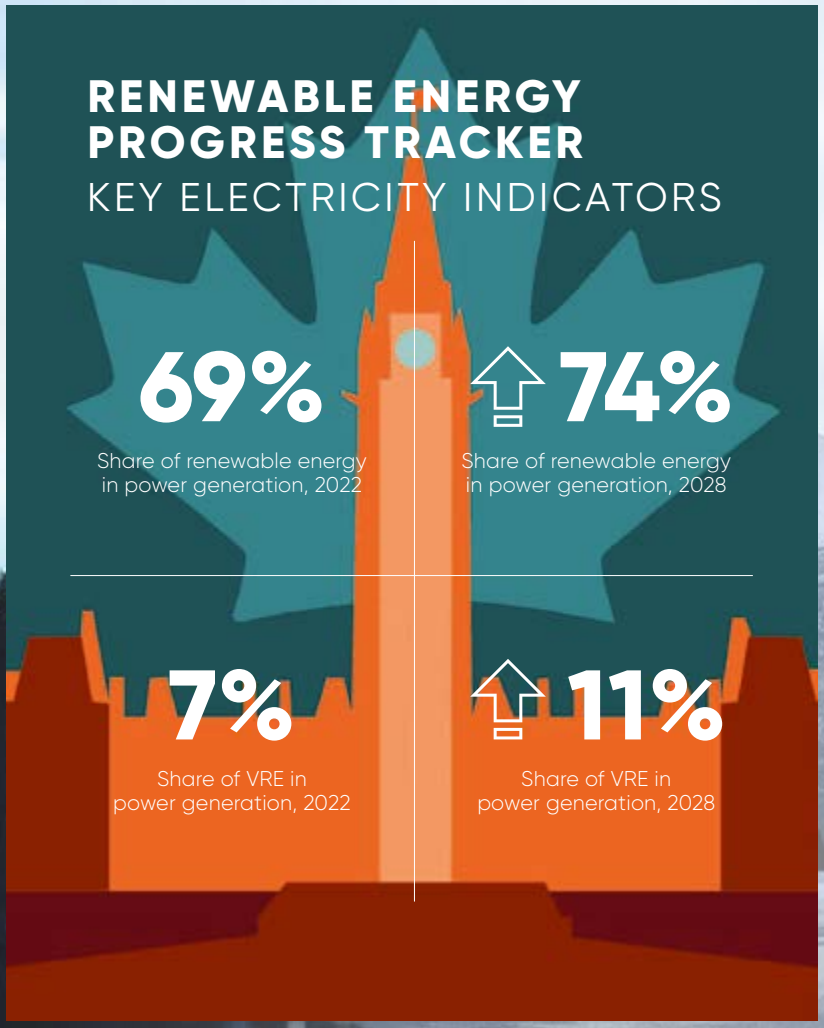
In 2018, ANDRITZ was selected by Ontario Power Generation (OPG) for the upgrade of two units (G1 and G2) at the Sir Adam Beck plant. The contract included the engineering, dismantling, and replacement of turbines and generators of the two units as well as automation, EPS, and headgate works. The Sir Adam Beck Ground Station 1 (SAB1) is a 10-unit station located close to Niagara Falls, in Ontario. The station was originally placed in service

between 1922 and 1930 and has always worked at a very high capacity.

Working collaboratively with OPG has proven to be very successful, the project also included the dismantling and replacement in situ of the spiral cases to adapt to the new configuration of the improved turbines.

THE MUSKRAT FALLS GENERATING STATION

ANDRITZ executed the contract for the 824 MW Muskrat Falls hydropower plant, owned by Newfoundland & Labrador Hydro, including the design, supply, and installation of four new vertical Kaplan units with a capacity of 206 MW each. In addition to the turbines, the project included, synchronous generators, digital governor systems with servomotors and high-pressure oil supply systems, static excitation, control, protection, and monitoring systems. ANDRITZ also supplied the hydro-mechanical works under a separate contract. The four new generating units operated by Newfoundland & Labrador Hydro were completed in November 2021 and are providing more than 800 MW of clean, renewable, and dispatchable capacity. →



Source: IEA

THE DES JOACHIMS PROTECTION AND CONTROL SYSTEMS UPGRADE

ANDRITZ completed a two-year long protection and control upgrade of eight generating units at the Des Joachims power plant in Rolphton, in February 2022. Des Joachims is a key 428.8 MW generating station in the eastern region of Ontario Power Generation's service area. The scope of work included an engineering and drawings package for the upgraded protection and control system, and associated instrumentation and manufacturing of the protection and control panels at our shop in Chambly, equipment and cables installation at the power plant and commissioning of the upgraded equipment.

PUMPED STORAGE INITIATIVES

With its unique integrated single source capability and capacity to provide all the required components, ANDRITZ is well positioned to respond to the needs of upcoming pumped storage projects currently being developed across Canada.

These pumped storage projects present themselves as a very attractive solution to meet new green energy demands with the environmentally friendly technology.

During periods of low electricity demand, pumped storage plants draw on excess electricity to pump water up to a reservoir.

61% Share of electricity generation from hydropower in total production

Like a battery, this water serves as a reserve of energy that can later be used to produce hydroelectricity during peak periods. The technology also helps provide ancillary services to help with grid operator stability requirements.

In fact, around the world pumped storage projects are expected to grow from the current 160 GW of capacity to reach 240 GW by 2030, according to the International Hydropower Association (IHA). Canada is following this trend as pumped storage hydropower is one of the fastest growing solutions to meet peak demand and to balance the grid.

Seven major pumped hydro storage projects are planned across Canada in Ontario, Alberta and Yukon. They are all planned for the 2030s and the installed capacity varies from 75 MW (Alberta) up to 1,000 MW (Ontario) with various peak production periods.

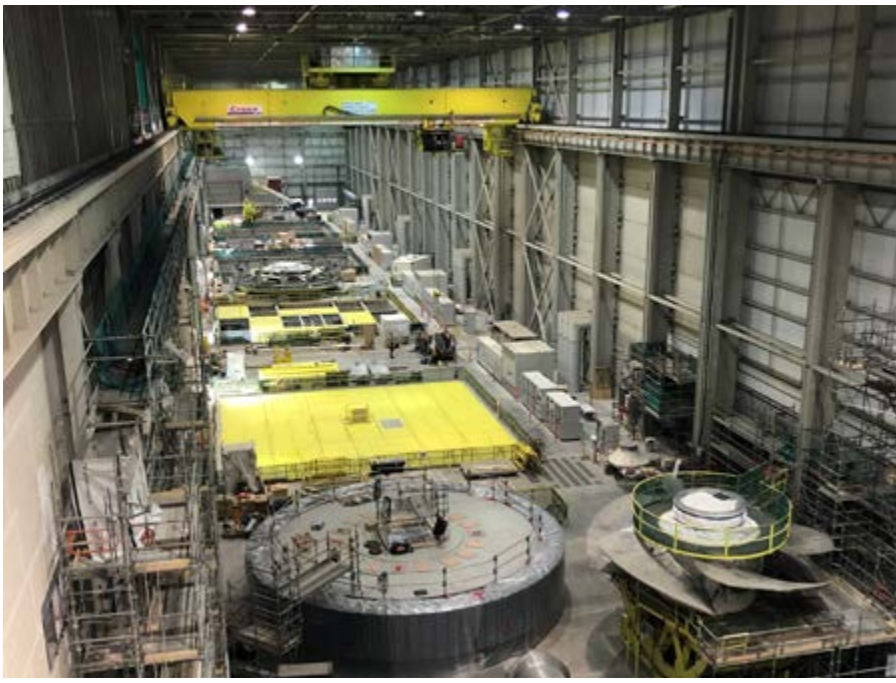
CONCLUSION

Canada's key energy objective is to maintain its leadership in the hydroelectric sector as part of its future green energy strategy. With its unique capabilities from engineering to commissioning, the know-how and agility of its Canadian management team combined with the depth of its overall resources, ANDRITZ Hydropower Canada is definitely well positioned to respond to that goal.

AUTHORS

Pierre Marquis
Hany Aoude
hydronews@andritz.com

Gates at Muskrat Falls hydropower plant



Powerhouse of Muskrat Falls hydropower plant

Accumulator instrumentation at the Des Joachims hydropower plant

Sir Adam Beck hydropower station

The United States – Hydropower significantly contributes to the US energy portfolio, representing approximately 6.2% of the nation's electricity generation in 2023. Enhanced technology, policy support, and increased installed capacity have further reinforced this sector. The US has a theoretical hydropower potential of 512 GW, encompassing about 4,488 TWh/year in gross potential and 153 GW in remaining technically feasible hydropower potential.

However, regulatory and environmental hurdles for new projects mean the focus has shifted towards refurbishing and modernizing existing facilities. Developing non-power dams and small hydro projects presents new growth opportunities, yet transmission bottlenecks pose ongoing challenges.

The Inflation Reduction Act of August 2023, primarily aimed at inflation control, holds potential implications for the energy sector. It could further incentivize the modernization of energy infrastructure, benefitting hydropower refurbishment, and possibly mitigating financial risks. Additionally, the Act may bolster energy storage solutions like pumped hydro, which can help address existing transmission constraints and foster a more integrated energy system.

ANDRITZ IN THE US

At ANDRITZ, we leverage our extensive expertise and commitment to hydropower excellence. Our approach goes beyond addressing technical challenges; we aim to set the highest industry standards.

REINVIG
HYDRO
FOR THE

Our advanced runner central aeration system exemplifies our innovation drive. This cutting-edge technology stabilizes water flow during part-load operations, reducing the need for external compressors and minimizing noise and vibration.

Environmental sustainability is also at the forefront of our R&D efforts, especially regarding aquatic life. Our initiatives focus on sustainable hydropower practices, including oil-free designs and fish-friendly technologies.

Reflecting on ANDRITZ's efforts in the U.S., the Charlotte office, set up in 1991, has played a pivotal role in major rehabilitation initiatives along important waterways. In the turbine sector, our supply and →

THE UNITED STATES

Total population: 333.29 million
GDP per capita: 76,343 USD

Total installed hydro capacity: 102,900 MW
Installed pumped hydro: 22,008 MW
Hydropower capacity added: 96 MW
Hydro capacity under construction: ~ 500 MW
Share of generation from hydropower: 6.2%
Hydro generation per year: 262,000 GWh
Technically feasible hydropower potential: 153,000 MW

All figures concern 2022;
Sources: TheWorldBank, IMF, IHA, Hydropower & Dams World Atlas 2023

ORATING POWER FUTURE

Powerhouse of Robert S. Kerr hydropower station

Control and cleaning of generator stator stacking, Collierville hydropower station

6.2% Share of electricity generation from hydropower in total production

→ refurbishment of 218 units has achieved a collective output of 8,787 MW. In the area of hydro generators, our supply and revamping of 231 units has culminated in an impressive total output of 14,802 MVA. Especially noteworthy is the extensive renovation of the generator units at Grand Coulee where ANDRITZ has rehabilitated 21 of the 24 generating units.

Given our significant presence and recent string of awards, ANDRITZ is ideally positioned to offer world-class rehabilitation and services to ailing hydro plants. We have been involved in many major US hydropower projects, such as Collierville, (140 MVA), Barkley (186 MW), Keystone (70 MW), Robert S. Kerr (147.2 MW), Old Hickory (162 MW), Keys (6,809 MW), Anderson Ranch (41 MW), and offshore energy project Vineyard (342 MVA).

As we explore the evolution of hydropower and critical related projects, it's insightful to acknowledge the crucial stages that contribute to their success. The transformation of projects like Barkley, Robert S. Kerr, Old Hickory, Anderson Ranch, and Vineyard from initial concepts into substantial achievements underscores the value of strategic planning and effective communication. The process of developing proposals, engaging in thoughtful negotiation, and securing initial agreements, forms the backbone of these projects. This aspect of the journey plays a fundamental role in turning visions into reality. The contribution of proposal development and sales is an essential thread woven throughout the tapestry of each project's success, subtly guiding them from their inception through to fruition.

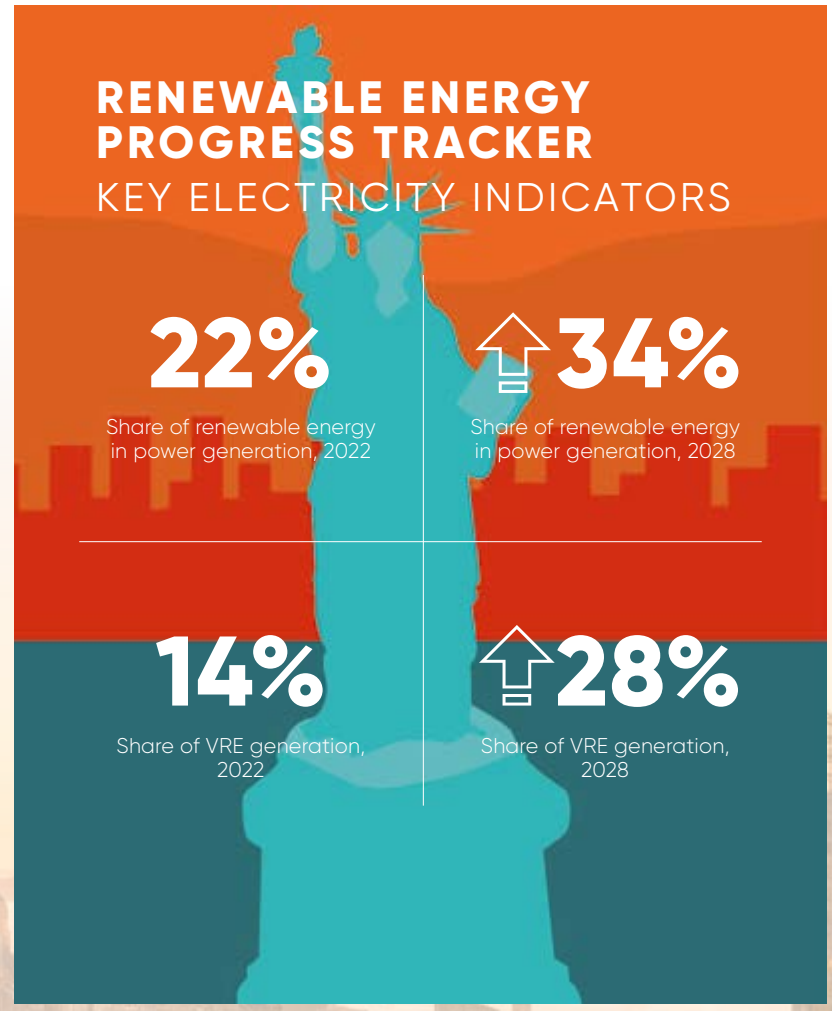
ANDRITZ Hydropower in the US caters to a diverse range of needs, from large new units to smaller, compact hydro units, including automation. Our core business remains the rehabilitation and upgrading of existing plants, aligning with the US market's demands.

Unit hall of John W. Keys III pumped storage plant at Grand Coulee hydropower complex

NEW PROJECTS SINCE 2016

Collierville (contract awarded 2018):
This project involved two generator units, each rated at 140 MVA, at the hydropower plant. ANDRITZ was responsible for the design, manufacture, and delivery of new Roebel bars. The first unit was successfully handed over and came back online in early December 2018, two weeks ahead of schedule. Besides the design and manufacturing tasks, ANDRITZ took on the removal of existing windings, inspection, and evaluation of the stator core, as well as the installation of new windings. The advanced Roebel bars installed have increased the efficiency of the generators. This project also set a precedent for future collaborations, as the successful early completion led to immediate approval for the second unit.

John W. Keys III Plant at Grand Coulee (contract awarded 2019):
The John W. Keys III pump-generating plant, part of the Grand Coulee Dam, is receiving a major automation overhaul from ANDRITZ. This upgrade is a monumental task involving the replacement of systems dating back to the 1950s and 1970s with state-of-the-art digital controls. The plant comprises six pumping units and six pump-generating units, all of which



Source: IEA

will be modernized. This will result in more efficient operations, reduced maintenance costs, and increased reliability. The project also includes the removal of existing systems and installation of new ones, making it one of the most comprehensive automation projects ever undertaken by ANDRITZ.

Vineyard (contract awarded 2019):
The Vineyard Wind 1 project sets out a new standard for offshore wind energy in the United States. ANDRITZ is contributing to this landmark initiative by supplying two state-of-the-art synchronous condenser systems. These systems will be crucial for voltage regulation and reactive power control, ensuring the reliable integration of renewable energy into the grid. The systems will have a rated condenser output of +171 / -133 MVAr and operate at 11.5 kV, 60 Hz. This project serves as a blueprint for sustainable energy solutions and is a cornerstone in the ANDRITZ portfolio of renewable energy projects.

Barkley (contract awarded 2020):
Situated on the Cumberland River in Western Kentucky, this 186 MW hydropower plant will undergo a comprehensive rehabilitation program. The work will include a turbine and generator overhaul, aiming to boost the plant's annual power generation to approximately 150 GWh. The Barkley project is more than just a rehabilitation though; it's a transformation. In a comprehensive overhaul, ANDRITZ will replace the existing Kaplan turbine generator units with new, more efficient models that will operate at a capacity of 46.5 MW each. The project also includes the installation of advanced auxiliaries and ancillary equipment. Once fully commissioned, the plant is expected to contribute significantly to the US Army Corps of Engineers' renewable energy targets.

Keystone (contract awarded 2021):
ANDRITZ was awarded a contract by the US Army Corps of Engineers for the rehabilitation of both generators at the Keystone generation station in Oklahoma. The project is part of an ongoing ANDRITZ commitment to modernize aging infrastructure. Completion is scheduled for the second half of 2024.

Robert S. Kerr (contract awarded 2021):
Located on the Arkansas River in Eastern Oklahoma, this project involves the rehabilitation and upgrade of all four turbines and generators at the hydropower plant. Once completed, the plant is expected to generate approximately 152 GWh per year.

Old Hickory (contract awarded 2023):
This 162 MW hydropower plant on the Cumberland River is slated for a major

References:
U.S. Energy Information Administration. (2023). Electric Power Monthly. Retrieved from https://www.eia.gov/electricity/monthly/
The U.S. Department of Energy. (2023). Hydropower Vision: A New Chapter for America's 1st Renewable Electricity Source. Retrieved from https://www.energy.gov/

overhaul, including the turbines and generators. The ANDRITZ scope of work involves design, manufacture, transport, erection, testing, and commissioning. The first unit is expected to be recommissioned in August 2026.

Anderson Ranch (contract awarded 2023):

In a significant new development, ANDRITZ has secured a contract from the Bureau of Reclamation's Pacific Northwest Region for the modernization and runner replacement of two turbine units at the Anderson Ranch Dam Powerplant in Mountain Home, Idaho. The comprehensive scope of work encompasses complete runner replacements, various component rehabilitations, and on-site tasks such as disassembly, alignment, and unit recommissioning. This contract serves as a continuation of a fruitful collaboration between ANDRITZ and the Bureau of Reclamation, building on the success of the earlier Palisades project. The Anderson Ranch project is designed to upgrade the existing vertical Francis runners, achieving a combined total output of approximately 41 MW.

AUTHOR

Leonel Oliveira
hydronews@andritz.com

Powerhouse, Old Hickory hydropower station

Anderson Ranch hydropower plant, dam, and reservoir

Unit hall, Barkley hydropower station

Mexico, Central America, and the Caribbean

Region overview and figures

Mexico, Central America, and the Caribbean region have seen an increase in the development of hydropower, representing a major shift towards renewable energy sources to increase energy security and reduce dependence on fossil fuels. This transition is in line with global efforts to combat climate change and achieve the Sustainable Development Goals. As a clean and abundant source of energy, hydropower plays a crucial role in diversifying the energy mix and addressing the challenges associated with climate change.

The region's rich water resources are ideal for the development of hydropower, which represents a sustainable alternative to fossil energy sources. By harnessing the power of rivers and water bodies, the countries of Mexico, Central America, and the Caribbean can not only meet their growing energy needs, but also reduce the environmental impact associated with fossil fuel power generation.

Moreover, modernizing the existing hydropower fleet is becoming a focal point in meeting new energy demands and achieving climate goals. Aging infrastructure and outdated equipment pose a challenge to maximizing the efficiency of hydropower generation. Government-owned and private companies are investing in the modernization and retrofitting of existing hydropower facilities to improve performance, increase capacity, and optimize environmental performance.

The trend of modernization includes the integration of advanced technologies such as smart grids, synchronous condenser systems, digital monitoring systems, and innovative turbine design. These upgrades not only improve power generation, but also contribute to grid stability and facilitate the integration of intermittent renewable energy sources such as solar and wind. This makes the modernized hydropower fleet a cornerstone in building a resilient and adaptable energy infrastructure for the future.

OUR LOCATIONS IN CENTRAL AMERICA:

MEXICO

1 Morelia, Michoacán manufacturing location

COUNTRIES: 32

MEXICO, GUATEMALA, BELIZE, EL SALVADOR, HONDURAS, NICARAGUA, COSTA RICA, PANAMA, LUCAYAN ARCHIPELAGO, GREATER ANTILLES, LESSER ANTILLES, WINDWARD ISLANDS, AND LEEWARD ANTILLES

POPULATION: 222.14 MILLION

HYDROPOWER INSTALLED CAPACITY: 20.85 GW

GENERATION BY HYDROPOWER: 60 TWh

CAPACITY ADDED: 34 MW

All figures concern 2022;
Sources: TheWorldBank, IMF, IHA, Hydropower & Dams World Atlas 2023

RESURGENCE O

REHABIL

Mexico – In recent years, the Mexican Government´s energy policy has been focused on the conservation and improvement of National Electric System's reliability levels. This strategy comes in conjunction with plans to advance an ordered energy transition to comply with commitments made by the Mexican State, as reflected in international agreements and treaties.

As part of the approach to meet growing electricty demand, a program is being developed for the rehabilitation, modernization, and equipment upgrade of the hydroelectric plants in operation by the Federal Electricity Commission (CFE). This state-owned Mexican company has an installed hydroelectric capacity of 12,125 MW and the program is designed to achieve the maximum utilization level of this infrastructure. Simultaneously, progress is being made on a program for the installation of new hydroelectric plants within existing civil infrastructure originally designed for other purposes, such as flood control or irrigation.

F
ITATION

The need to improve the national power grid's stability is also creating opportunities for developing new technological solutions, such as synchronous condensers.

ANDRITZ' PRESENCE IN MEXICO

ANDRITZ has had an enduring presence in Mexico since the early 20th century when its predecessor companies supplied equipment for the first hydroelectric power plants built in the country. Since then, ANDRITZ has supplied, rehabilitated, or modernized over 300 hydropower units with a total capacity of nearly 7,600 MW.

A cornerstone of his impressive record of achievement is the ANDRITZ company founded in Morelia, Michoacán, in 1981. This local company currently employs more than 400 people in engineering and manufacturing capabilities, project management, installation, and commissioning, as well as after-sales service at this location.

ANDRITZ' local operations encompass four strategic segments: Large Hydro, Compact Hydro, Service & Rehab →

MEXICO

Total population: 127.50 million

GDP per capita: 11,265 USD

Total installed hydro capacity: 12,614 MW

Hydro capacity under construction: > 840 MW

Share of generation from hydropower: 10%

Hydro generation per year: 31,848 GWh

Technically feasible hydro generation potential: ~ 135,000 GWh

All figures concern 2022;
Sources: TheWorldBank, IMF, IHA, Hydropower & Dams World Atlas 2023

Power unit hall of Angostura hydropower plant

Pelton runner at Zimapan hydropower plant

On-site installation team, Humaya hydropower station

Generator stator at Peñitas hydropower station

→ (hydroelectric plant modernization), and Automation. These segments sit at the heart of the evolution and modernization of the hydroelectric power generation sector in Mexico.

Our range of products and services spans turbines, generators, gates, and valves as well as excitation, control and protection systems, post-sales service including operation and maintenance services for assets, and small service with a focus on mechanical and electrical solutions.

Consolidating its position as a leader in Mexico's hydroelectric sector development, ANDRITZ is successfully leading a consortium that, at the end of 2021, secured strategic contracts for the renovation of nine hydroelectric power plants across the country.

These contracts, awarded by the CFE, represent a milestone in developing a

more efficient and sustainable energy system in the country.

The power plants being modernized are: Humaya (50 MW), Zimapan (304 MW), El Caracol (630 MW), Infiernillo (400 MW), La Villita (320 MW), Mazatepec (244 MW), Peñitas (420 MW), Malpaso (1,152 MW), and Angostura (1,000 MW).

The contracts for this rehabilitation form part of one of the largest modernization programs, not only for the client CFE and ANDRITZ but also for the global hydroelectric market.

The modernization of these power plants will not only strengthen the nation's generation capacity but will also play a fundamental role in ensuring a reliable energy supply for the future of Mexico.

HUMAYA

The modernization of the generator of unit 2 at the Humaya hydroelectric power plant, which has a capacity of 45 MVA, was undertaken. The installation of a new magnetic core and new winding, along with the rehabilitation of the insulation of the rotor poles, allowed for the complete transformation of both the stator and the rotor. The modernization works have increased the capacity of the Humaya hydroelectric power plant by over 20%, raising the power of the two generators in the plant to 46 MVA with an efficiency of 98%.

The improvements to the power plant will enable more reliable and efficient electricity generation, benefiting both consumers and the operating company.

SANTA MARÍA

The renewable energy field is constantly evolving, and one of the most promising projects in this energy revolution is the installation of modern equipment at the Santa María Dam in Rosario, Sinaloa. This project achieved a significant milestone →

in May 2022 with the awarding of a contract that includes two butterfly valves with a nominal diameter of 3,500 mm with double sealing.

These valves, whose workshop tests were approved for on-site installation, represent the ANDRITZ commitment to quality. The commissioning was completed in December 2023.

In May 2023, ANDRITZ was entrusted with a follow-up contract for the same hydropower plant for the supply of electromechanical equipment including two Francis-type units of 15 MW each, inlet valves, electric generators, control equipment, speed governors, excitation, protection, and assembly services. The new equipment promises to take Santa María to new levels of capacity and efficiency in renewable energy generation allowing the control of the flow of the Baluarte River and bringing us closer to the two main objectives of this multipurpose project: the irrigation of 24,250 hectares of agricultural land and the supply of drinking water to almost 430,000 inhabitants of the surrounding communities.

THE PRESIDENT PLUTARCO ELÍAS CALLES THERMAL POWER PLANT (PETACALCO)

Located in the municipality of La Unión de Isidoro Montes de Oca, Guerrero, Mexico, this power plant has been a major contributor to national electricity

10% Share of electricity generation from hydropower in total production

Butterfly valve installation at Santa María hydropower plant

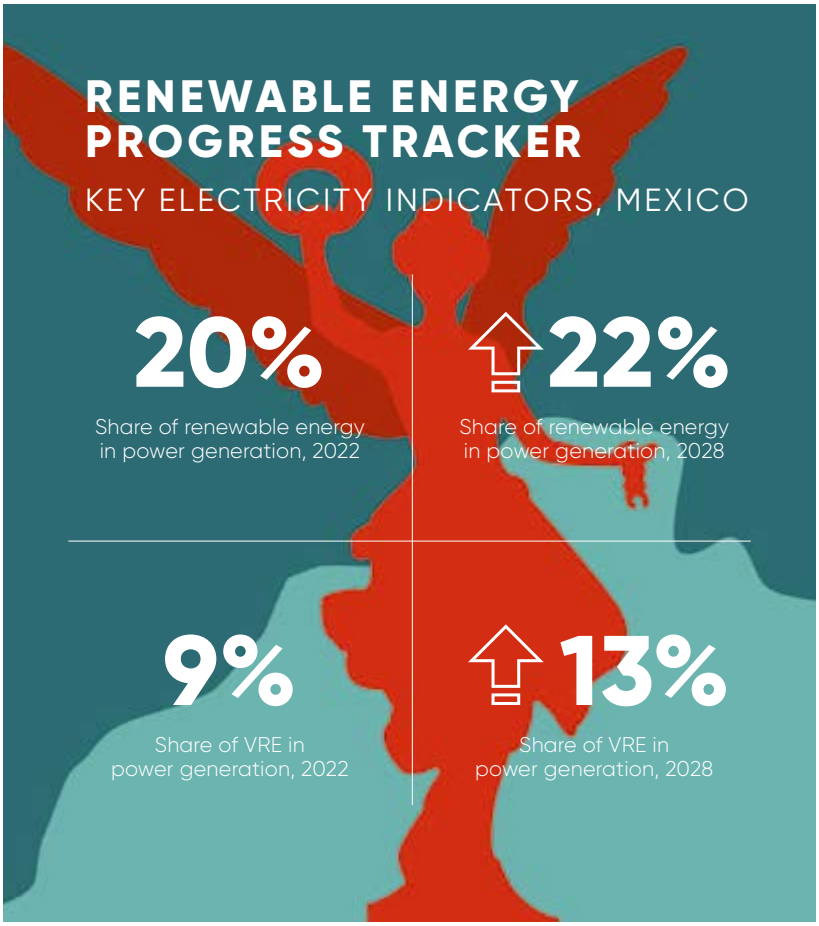
Electric cubicles at Mazatepec hydropower plant

generation since it commenced operations in November 1993. With seven generators boasting a total installed capacity of 2,778 MW, it stands out as one of the largest in Latin America.

In an ongoing commitment to efficiency and innovation, the owner of the power plant has awarded ANDRITZ an order for the acquisition, installation, and commissioning of two static excitation systems, designated for generating units 3 and 6. These systems, with advanced technical features including HIPASE-E and a redundant configuration for uninterrupted operation, reinforce Petacalco's position as a reliable and efficient energy source in the region.

AUTHOR

Aline Blanco Torres
hydronews@andritz.com



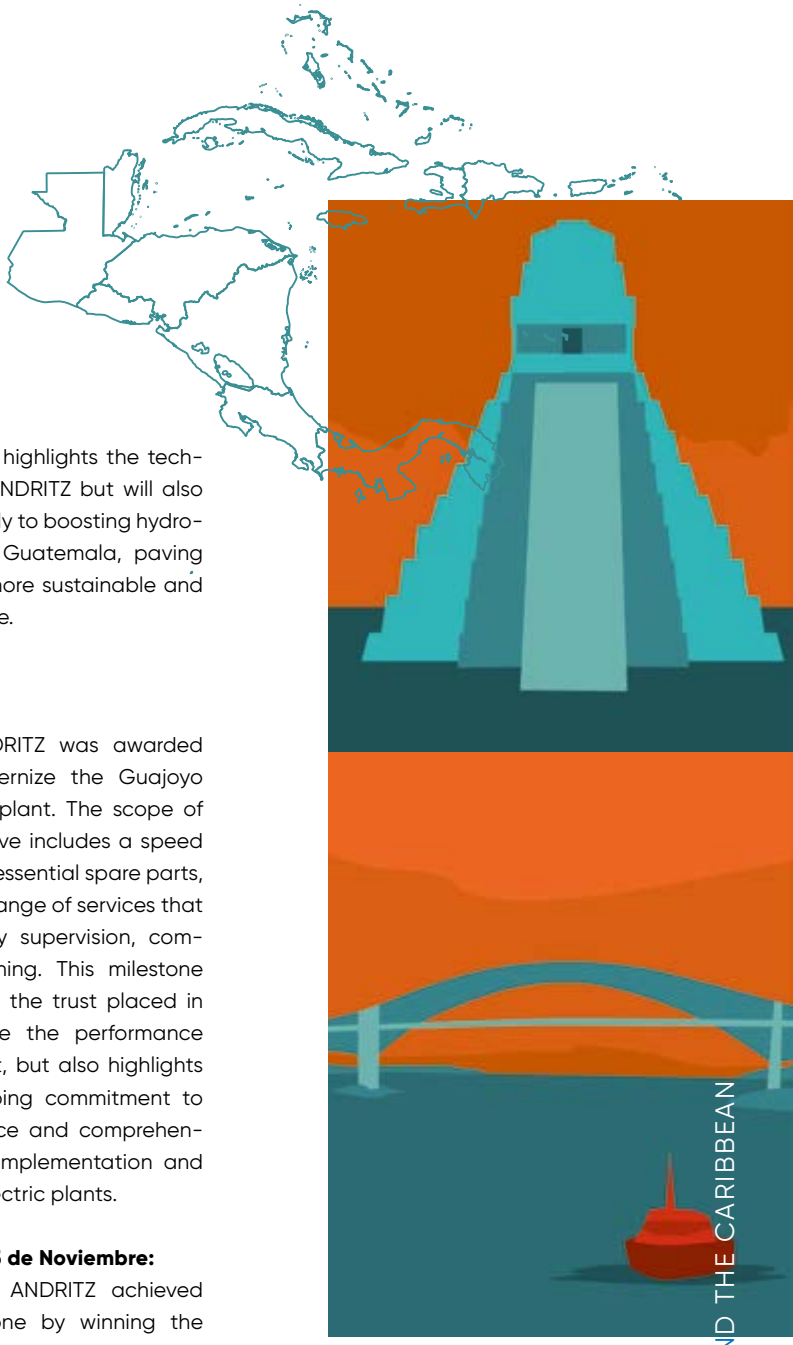
Source: IEA

Combined bearing, Unit 1, La Villita hydropower plant

Main transformers, Malpaso hydropower plant

COMMITMENT TO DIVERSIFYING ENERGY

COUNTRY REPORT — CENTRAL AMERICA AND THE CARIBBEAN



Central America and the Caribbean – In the continuous search for new sustainable energy sources, Central America and the Caribbean region has become a hub of substantial advances in renewable energy penetration supported by hydropower. This focus on renewable energy has been crucial in meeting global commitments to reduce carbon emissions and address the effects of climate change.

With significant installed capacity and a growing commitment to clean energy production, countries in this region have been primarily exploring and developing large-scale hydroelectric rehabilitation projects. Across Central America and the Caribbean, strategies to diversify energy sources and reduce dependence on fossil fuels have been driving forward plans to strengthen hydroelectric power plants.

ANDRITZ, a global company with a long history in hydroelectric plant engineering and design, has played a fundamental role in the success of these projects. Innovative solutions and cutting-edge technology have catalyzed the rehabilitation, modernization, and upgrading of high-performance hydroelectric plants in Central America and the Caribbean.

GUATEMALA

Achiguate:

In August 2023, ANDRITZ achieved a significant milestone by securing the contract for the Achiguate hydroelectric project, consolidating its position at the forefront of hydroelectric energy in Guatemala.

The project includes the supply of two 3.7 MW horizontal shaft Francis units, including the electric generator, as well as the provision of control and monitoring systems. The scope of supply encompasses a complete range of components from control panels to SCADA systems and transformers, ensuring a comprehensively efficient plant. This project not only highlights the technical excellence of ANDRITZ but will also contribute significantly to boosting hydroelectric capacity in Guatemala, paving the way towards a more sustainable and energy-efficient future.

EL SALVADOR

Guajoyo:

In March 2023, ANDRITZ was awarded a contract to modernize the Guajoyo hydroelectric power plant. The scope of supply for this initiative includes a speed governor, a batch of essential spare parts, and comprehensive range of services that encompass assembly supervision, commissioning, and training. This milestone not only underscores the trust placed in ANDRITZ to enhance the performance of the Guajoyo plant, but also highlights the company's ongoing commitment to operational excellence and comprehensive support in the implementation and operation of hydroelectric plants.

Cerrón Grande and 5 de Noviembre:

In September 2021, ANDRITZ achieved a significant milestone by winning the project contracts for the Salvadoran hydroelectric power plants Cerron Grande and 5 de Noviembre. This agreement includes the supply of two speed regulators for the Cerrón Grande hydroelectric power plant and two for the 5 de Noviembre plant, along with a batch of essential spare parts. Additionally, assembly supervision and commissioning services, as well as training, are included.

15 de Septiembre:

In April 2023, ANDRITZ achieved a significant milestone by securing the contract for the major maintenance of Unit II in the 15 de Septiembre hydroelectric power plant. This ambitious project encompasses a wide scope of supply, ranging from the renovation of runner blade bushings to the implementation of an aeration system →

All figures concern 2022;
Sources: TheWorldBank, IMF, IHA, Hydropower & Dams World Atlas 2023

→ for the turbines, including specialized supervision services and comprehensive electrical testing. Among the highlights are tasks like the comprehensive repair of generator shafts and stators, the supply of specialized tools, and the implementation of crucial systems such as the cooling and lubrication of bearings. This achievement not only underscores the technical expertise of ANDRITZ but also its steadfast commitment to efficiency and reliability in the management and maintenance of critical hydroelectric infrastructures.

HONDURAS

Francisco Morazán (El Cajón):

The modernization of the excitation systems at the Francisco Morazán hydroelectric power plant (El Cajón) was a notable success. After winning the tender in October 2019, ANDRITZ achieved a milestone by progressively commissioning the units: Unit 2 in January 2021, Unit 1 in October 2021, Unit 3 in December 2021, and finally, Unit 4 in December 2022. The project increased the reliability of the plant's units, which have a total installed capacity of 300 MW.

From the supply of excitation systems to the implementation of the advanced HIPASE-E system, ANDRITZ' comprehensive contribution has not only provided Empresa Nacional de Energia Electrica (ENEE) with more modern and efficient energy equipment but has also strengthened connectivity with existing systems. This underscores the ANDRITZ commitment to excellent and sustainable energy solutions for the development of energy infrastructure in Honduras.

COSTA RICA

La Garita:

ANDRITZ, in collaboration with the Costa Rican Institute of Electricity (ICE), is advancing the comprehensive modernization of the La Garita plant in Costa Rica. After winning the tender in June 2023, the focus is on replacing key power plant systems. With two units of 20 MW each and a strategic location one hour from San José, in the canton of Alajuela, the plant benefits from cutting-edge technologies supplied by ANDRITZ. These include the control and SCADA system, protection system,

and speed governor, with notable innovations such as HIPASE-T and HIPASE-S. The project is scheduled for delivery in June 2024, promising significant benefits for the plant's reliability and consolidating ANDRITZ' position as a leader in sustainable energy solutions in the region.

PANAMA

Estí:

Located in the province of Chiriquí, this plant experienced an operational interruption in September 2022 due to an unusual rise in the Estí River caused by heavy rains. Faced with this challenge, ANDRITZ Mexico was contacted to conduct inspections and assess potential damage to the equipment. In a collaborative effort, four specialized engineers from ANDRITZ Mexico carried out these detailed inspections.

Presenting reports and an activity schedule to the plant owner, ANDRITZ proposed ambitious timelines for the rehabilitation of the plant with a commitment to have the first unit operational by March 2023 and the second by June 2023.

ANDRITZ successfully delivered on its promise, completing the work in accordance with the schedule while reaffirming →

Control, protection, and regulation system at the 5 de Noviembre hydropower plant, El Salvador

Estí hydropower plant, Panama

Installation of turbine runner at the 15 de Septiembre hydropower plant, El Salvador

→ its commitment to quality and efficiency in the restoration of critical hydroelectric infrastructure in emergency situations.

The prompt response of ANDRITZ ensured a contract for rehabilitation of several additional elements of equipment and various systems at the power plant. These contracts highlight the efficiency and professionalism of ANDRITZ in critical situations, as well as a fundamental alignment with the plant owner's objectives.

THE CARIBBEAN

In the Caribbean, this island region has recognized the need to reduce its dependency on fossil fuels, mitigate the impacts of climate change, and ensure a reliable energy supply for its inhabitants. As a result, many nations have embarked on an exciting journey to strengthen existing hydroelectric power plants. This is an integral part of their strategy to diversify their energy matrix and mitigate any potential adverse effects of a too rapid penetration of intermittent generation sources.

The modernization and upgrading of hydroelectric power plants, as well as the execution of feasibility studies for pumped hydro storage projects, have gained considerable momentum in the Caribbean. With these projects, a new era of renewable energy is envisaged, reducing the region's carbon footprint and enhancing its energy security.

Maggotty, Jamaica:
In June 2016, ANDRITZ achieved a significant breakthrough by winning a contract for a project at the Maggotty hydroelectric power plant. The scope of supply included a comprehensive system that comprised controls, speed governor, excitation system, mounting materials, medium-voltage switchgear, AC/DC low voltage switchboards, auxiliary services transformer, battery bank, and charger.

Unit hall at Maggotty hydropower plant, Jamaica

Powerhouse and substation of La Garita hydropower plant, Costa Rica

Additionally, ANDRITZ provided essential services such as assembly supervision, commissioning, and training.

Upper White River, Jamaica:
In February 2022, ANDRITZ took on a key challenge after winning a contract for the comprehensive modernization of the Upper White River hydroelectric power plant. This ambitious project encompasses an extensive scope of supply, including the rehabilitation of the turbine and generator, implementation of a new control system, speed governor, excitation system, and protection relays.

Additionally, essential elements such as AC/DC low-voltage switchboards, gate supply, assembly supervision, commissioning, and training are also included.

AUTHOR

Aline Blanco Torres
hydronews@andritz.com

RENOVATE AND REJUVENATE

Live long and prosper with ANDRITZ

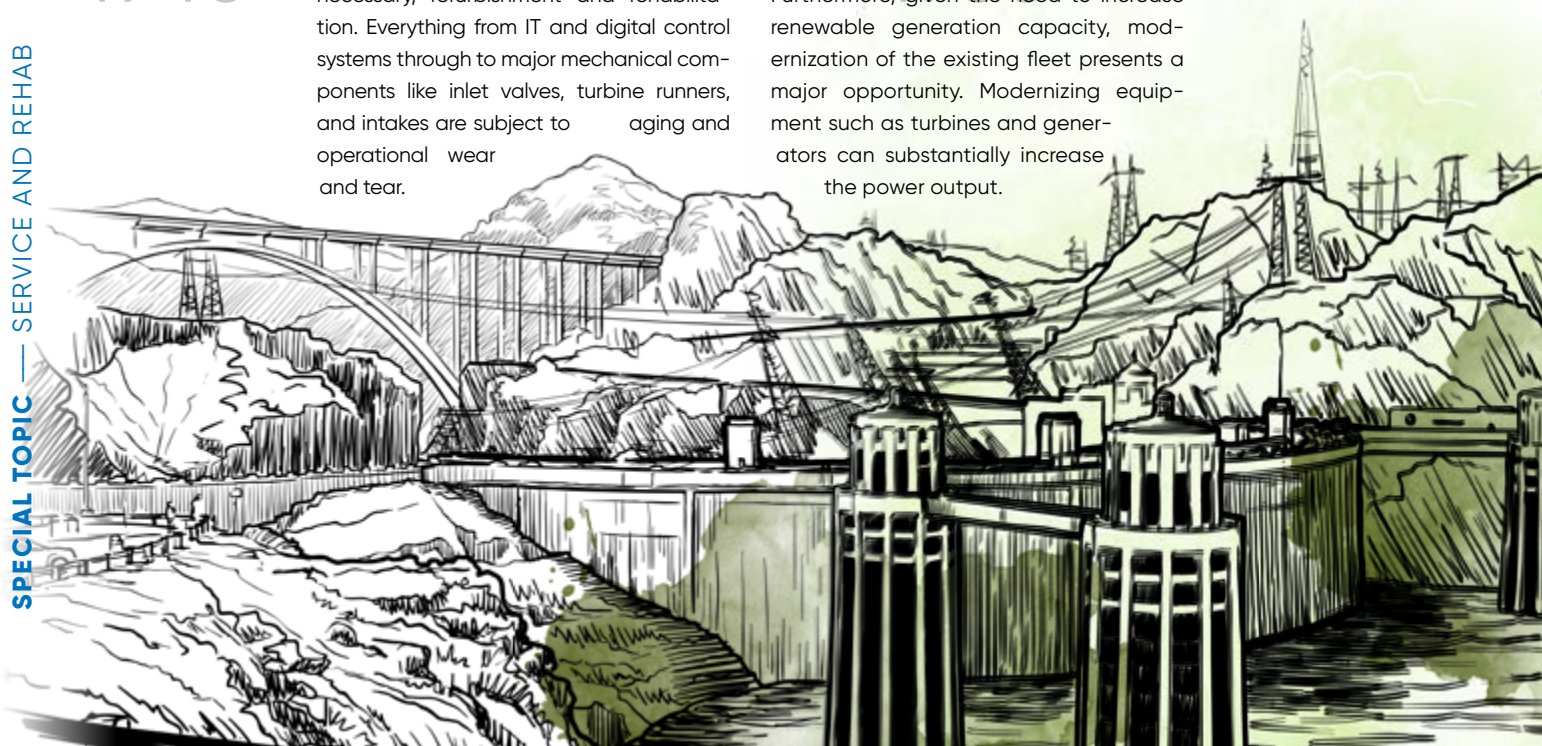
Among the biggest advantages of hydropower is its renowned longevity. Thousands of hydroelectric facilities are still operating more than a century after they were commissioned resulting in high demand for modernization and upgrades.

Today many of the world's power plants are already decades old. Indeed, according to a recent report from the International Energy Agency, the average age of a hydropower plant in North America is nearly 50 years. And, although civil structures like dams and embankments could easily stand for more than 100 years, the electromechanical equipment has a typical operational life-span of far less given factors like abrasion and corrosion. To get the best out of these long-lived clean power generating systems therefore means a strong commitment to servicing and, when necessary, refurbishment and rehabilitation. Everything from IT and digital control systems through to major mechanical components like inlet valves, turbine runners, and intakes are subject to aging and operational wear and tear.

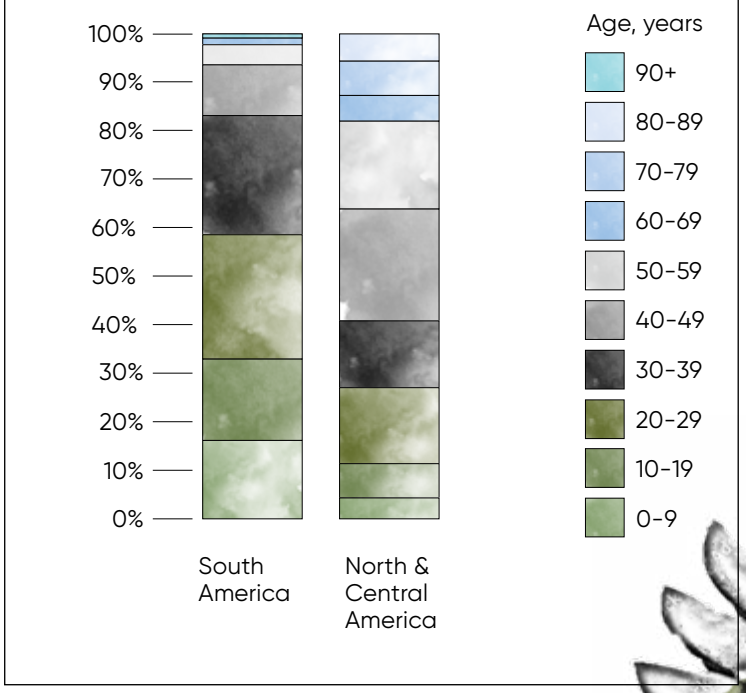
The demand for modernization and upgrading of these assets is rapidly growing given the advancing age of the global fleet. In addition, though, changes to operational requirements in response to the evolving demand for flexible generation are also increasing the need for improvement. Hydropower is well suited to match fluctuations in other renewables like wind and solar by operating as spinning-reserve or fast response capacity. This places new operational demands on these assets though.

Furthermore, given the need to increase renewable generation capacity, modernization of the existing fleet presents a major opportunity. Modernizing equipment such as turbines and generators can substantially increase the power output.

1940 1960 1980 2000



AGE PROFILE OF INSTALLED HYDROPOWER CAPACITY 2022



Source: Hydropower.org

"Modernizing existing hydropower plants boosts performance and yields benefits for owners and the regions they serve."

Turbine and generator efficiency have seen dramatic improvements over the years so that upgrading a 40-year-old turbine runner could add 5% or more to the headline efficiency figure. New demands like reducing the environmental impact of hydropower plants are another opportunity. Solutions like fish-friendly turbine technology and oil-free turbine runner hubs represent a new era of environmental stewardship that is possible through modernization of existing installations.

As a leading supplier and partner to the hydropower industry, ANDRITZ has an extensive catalog of impressive project references across North, South, and Central America. Last year, for instance, ANDRITZ Hydro Canada signed a contract for the refurbishment of four generating units at the Otter Rapids station. Across the border in the USA, ANDRITZ has refurbished some 70 units representing about 54% of the national fleet. These projects include, for example, modernizing the turbine generator units at Old Hickory hydropower plant and the automation modernization of the pumped storage plant John W. Keys III, part of the Grand Coulee hydropower complex.

In South America, ANDRITZ is executing the general overhaul and digitalization of the turbines of the 1,050 MW Sobradinho hydropower station and has recently signed a contract for a comprehensive refurbishment of the generating units of the 424 MW Jaguara hydropower plant. A current highlight is in Mexico, where ANDRITZ is leading a consortium refurbishing nine hydropower plants with a combined capacity of more than 4,250 MW. The modernization of these plants will boost generation capacity by 243 MW and increase annual generation by some 1,754 GWh.

Modernization can update the performance of old assets through new technologies that will make these assets more efficient and profitable for their owners. An increased level of automation and monitoring will result in better asset management, consequently reducing maintenance costs and downtime. The modernized assets can operate for another 30 years, bringing benefits to their owners and to the regions where these plants are installed.

With services ranging from operation, maintenance and repairs, digitalization, control and automation right through to full refurbishment of complete electromechanical systems, whatever the future holds for even the oldest hydropower plants, ANDRITZ has the solution.

AUTHOR

Marie-Antoinette Sailer
hydronews@andritz.com

CUTTING EDGE MANUFACTURING CAPABILITIES

Striving for operational excellence

ANDRITZ relies on the highest manufacturing standards to ensure that all our solutions are optimized to meet exacting customer requirements, protect the environment, and support operational management. This is achieved through robust compliance across all the various process steps in the value chain: planning and design, manufacturing of key components, in-house assembly, shipping, on-site assembly, service support.

ANDRITZ Hydropower operates at seven manufacturing locations across the Americas and our teams collectively perform nearly 500,000 direct labor hours annually. At all these workshops, the hydropower business area delivers high quality components, products, and services, utilizing the experience and expertise of our top qualified employees.

In addition, all these sites are focused on further improvements with the goal of achieving operational excellence supported by an ANDRITZ Production System (APS). This is a system designed to define, describe, quantify, and increase the performance levels of production organizations, as well as generate a common understanding of manufacturing principles and methods. A business-specific handbook is available, while training of employees is continuous, ensuring the competitiveness of each of the manufacturing and service locations by increasing their productivity and performance.

CANADA

Peterborough provides manufacturing services for the supply of new generator stator windings, either bar or coil windings, and their connections. These elements are defined as core components within ANDRITZ and account for about 70,000 working hours per year. The production line comprises up to 15 workstations, including electrical testing to guarantee high quality products.

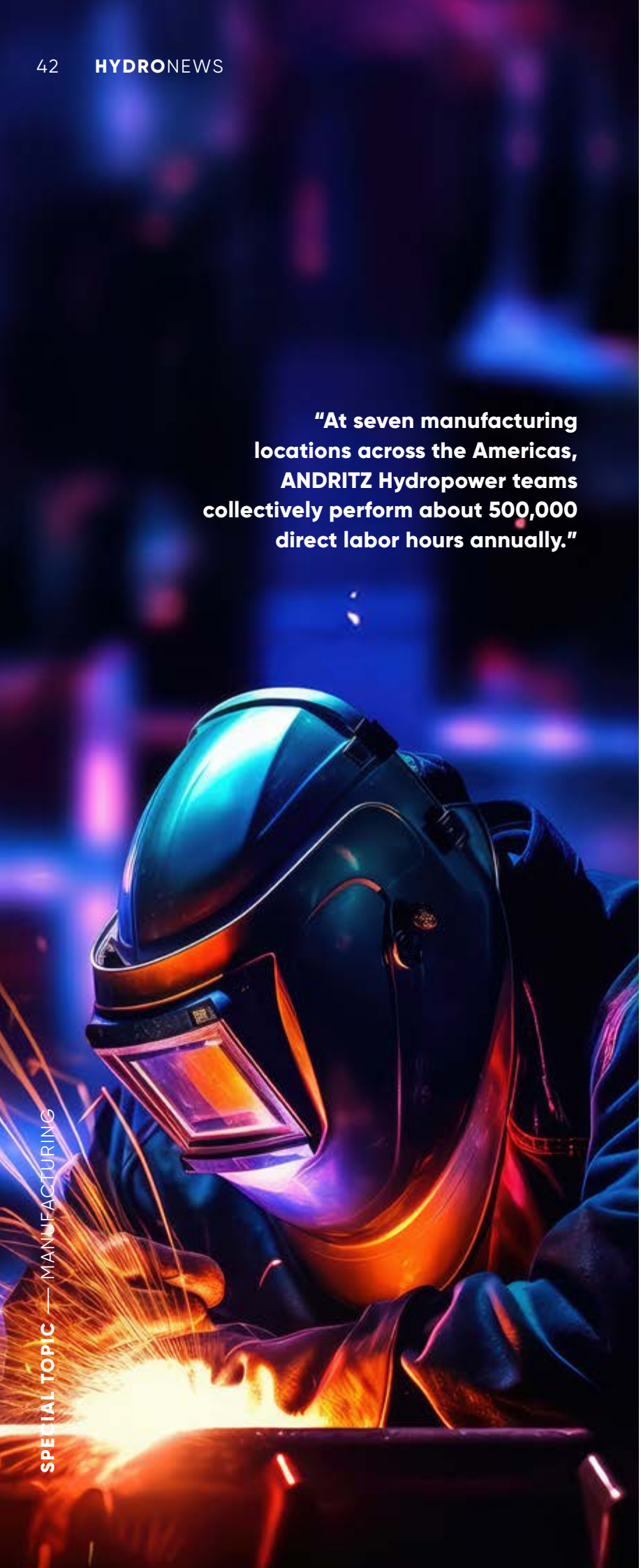
Paris provides manufacturing services for the supply of different types of gates as well as intake trash racks and associated embedded components and hoists. It's a

complete solution provider, including mainly welding, with some machining capacity to ensure exacting tolerances for critical component dimensions. Additionally, blasting, painting and equipment assembly are key functions at this site. The location provides services mainly for Ontario Power Generation, one of the largest electricity generators in North America.

Chambly provides manufacturing services for the supply of new electrical cabinets, for various automation and electrical power system products, such as excitors, governors, protection and control panels, and junction boxes. It is primarily an assembly and testing shop using components and parts supplied by third parties. This process requires substantially more ability than may be apparent at first sight because each cabinet is custom designed and produced.

UNITED STATES

Spokane provides manufacturing services related to the refurbishment and modernization of turbine and generator components. It is primarily a machining →



"At seven manufacturing locations across the Americas, ANDRITZ Hydropower teams collectively perform about 500,000 direct labor hours annually."

shop with some welding capacity for the repair of these components when required. It also performs disassembly and reassembly of turbine and generator systems. Its goal is to refurbish these components as quickly as possible without compromising on safety and quality.

Recently, the Spokane manufacturing facility was involved in the success of major projects in the US such as those at Hoover Dam, Fort Loudoun, and Taum Sauk.

MEXICO

Our Mexican hydro workshop is located in Morelia. A key highlight of this location is its more than 40 years in the market and constant evolution of the product portfolio over that period. At this location mechanical components of up to almost 100 tonnes can be produced. Currently the workshop is operating at its maximum capacity of 250,000 labor hours annually, especially because of a series of hydropower plant rehabilitation projects for the customer CFE (Federal Electricity Commission). In close cooperation with other ANDRITZ units the location is acting as an inter-company manufacturing partner for turbine runners, as well as other heavy-duty components.

BRAZIL

The Araraquara site was acquired in 2018 and has been continuously developed since then. This location acts mainly in brownfield projects and focuses on core component production (turbine runners, generator poles and windings – press cured technology) as well as heavy-duty steel components and synchronous condensers. Since the acquisition, this workshop location has ramped up from 60,000 to 180,000 labor hours of operations annually. Based on the available space, the location could be further utilized. In addition, part of the ANDRITZ Hydropower Brazil workshop is currently rented out to

a third party – so there is still space for further growth if required in the future.

The electrical workshop is dedicated to the manufacturing of active generator components. They run a production line for stator windings of up to 21 kV, starting with the production of green bars and the application of MicaTec R insulation by automated machines. In addition, a pole production line is in operation. To ensure that quality requirements are invariably met, a full quality control laboratory is deployed on site, ranging from controlling resins and other inputs to short and long-term electrical testing.

Specialized in the manufacturing and refurbishment of hydraulic turbines, the Araraquara mechanical workshop is dedicated to the manufacturing of large and heavy components and contains areas for steel fabrication, assembly/disassembly, blasting, painting, and heavy machining, as well as ovens for heat treatment, and compatible cranes. In addition, there is a complete quality control laboratory, including linear measurement platform, an interferometric laser, and other testing and analysis equipment.

CHILE

The Metaliza company located in Colina was acquired by ANDRITZ in 2016 and is the base for our hydro workshop in Chile. With around 25,000 working hours per year, Colina acts as a service location, which delivers component repair, ranging from welding and machining through to HVOF coating. In synergy with our global locations, ANDRITZ Chile continuously invests in the training and development of its personnel. Highlights include internships at workshops in Ravensburg, Germany, training and certification of welders in Mexico, and ongoing training in non-destructive testing techniques.

AUTHOR

Verena Maier
Gerald Kraxner
hydronews@andritz.com

Araraquara, Brazil – Synchronous condenser stator for Tucuma project

Morelia, Mexico – Francis runner for Infiernillo hydropower plant

Peterborough, Canada – Coil spreading process for Carillon hydropower project

South America

Region overview and figures

Hydropower plays a central role in the Latin American energy landscape, accounting for almost half of the region's electricity generation and even more in some countries. With leading countries such as Brazil, Colombia, and Peru, hydropower has seen a significant boost in development in the region. Renewable energy has become a cornerstone of the region's energy strategy and has seen a significant increase in capacity in recent years.

Climate change projections indicate an increase in extreme weather phenomena, bringing with them increased risks of flooding, drought, and heavy rainfall, and ultimately jeopardizing hydropower generation. In addition, the ageing infrastructure of hydropower plants with a typical lifespan of 30 - 80 years is a cause for concern, especially as more than 50% of installed capacity in Latin America exceeds the 30-year mark.

The commitment to renewable energies in Latin America went hand in hand with the implementation of supporting measures. Countries with support policies are 30% more likely to invest in renewable energy. The region has gradually adopted a more or less uniform legal framework that takes advantage of its geographical and topographical diversity to tailor support strategies to the energy needs of each country. This cohesion in legislation, driven by common energy needs, has facilitated the introduction of auction systems and tax incentives as organic methods of diversifying renewable energy sources.

While hydropower remains a cornerstone of the Latin American energy matrix, the region's proactive approach to renewable energy and the implementation of supportive policies demonstrates a collective resilience in the face of climate challenges and aging infrastructure that ensures a sustainable and diversified energy future.

COUNTRIES: 14

ARGENTINA, BOLIVIA, BRAZIL, CHILE, COLOMBIA, ECUADOR, GUYANA, PARAGUAY, PERU, SURINAME, URUGUAY, VENEZUELA, AND THE TERRITORIES OF FALKLAND ISLANDS AND FRENCH GUYANA

POPULATION: 437,23 MILLION

OUR LOCATIONS IN SOUTH AMERICA:

ARGENTINA

ANDRITZ HYDRO LTDA.

1 Sucursal Argentina, Partido de Moron

BRAZIL

ANDRITZ HYDRO LTDA.

2 Araraquara
3 Barueri
4 Governador Valadares

CHILE

ANDRITZ CHILE LTDA., DEPT. ANDRITZ Hydropower

5 Colina

6 Santiago de Chile

COLOMBIA

ANDRITZ HYDRO LTDA.

7 Bogota

8 Madrid Cundinamarca

PERU

ANDRITZ HYDRO S.A.

9 Lima

VENEZUELA

ANDRITZ HYDRO C.A.

10 Caracas

HYDROPOWER INSTALLED CAPACITY: 180 GW

GENERATION BY HYDROPOWER: 712 TWh

CAPACITY ADDED: 1,525 MW

TOTAL PUMPED STORAGE INSTALLED CAPACITY: 994 MW

All figures concern 2022;
Sources: TheWorldBank, IMF, IHA, Hydropower & Dams World Atlas 2023

ECUADOR: MUCH MORE THA IMAGINARY L

Ecuador – Although Ecuador is crossed by the equator and its name alludes to this fact, it is far more than this navigational concept would suggest.

Renowned for its biodiversity – inspiring the young Charles Darwin to develop his theory of evolution – Ecuador's natural resources are also a wonder to behold. Derived from the different climatic levels present from the sea to the 6,262 m elevation of El Chimborazo, Ecuador's landscape defines the conditions for the development of responsible hydroelectric projects. Today these hydropower projects are complementing the non-conventional renewable energies which are in full implementation in Ecuador.

74.6% Share of electricity generation from hydropower in total production

According to the historical account of the Electric Company of Quito, it was 1895 when electric light first arrived and just a few years later, in 1899, when the first hydroelectric plant began operations in the city of Loja with 212 kW machines. Not long after that, in 1923, ANDRITZ arrived in Ecuador with a 250 kW power plant for the city of Riobamba.

In more recent years, ANDRITZ completed the Sigchos project of 18 MW (with three Pelton units), the 50 MW Due I project (with two Francis units) and Due II with a third unit of 15 MW. In addition, ANDRITZ installed electromechanical equipment in the emblematic 1,500 MW Coca Codo Sinclair plant (eight Pelton units). In 2022, this plant managed to generate 6,828 GWh, representing around 25% of the total electrictiy produced in the country. Furthermore, being located on the Pacific slope of Ecuador, it became a very important energy contributor during the last months of 2023 as it helped to overcome the low runoff on the Amazon slope as a result of the 'El Nino' phenomenon that is currently affecting the countries of the region.

Ecuador currently has 5,191 MW of hydroelectric capacity in operation from 71 plants and has plans to increase the supply of electricity, given that it requires about 400 MW of new generation each year to safely meet the growth in demand. Ecuador is promoting the participation of private companies and is also seeking to incorporate new renewable energy sources. ANDRITZ is participating in several of these initiatives, additionally offering services and technical support, proposing - in a proactive manner

ECUADOR

Total population: 18 million
GDP per capita: 6,389 USD

Total installed hydro capacity: 5,191 MW
Hydropower capacity added: 84 MW
Hydro capacity under construction: 303 MW
Share of generation from hydropower: 74.6%
Hydro generation per year: 24,635 GWh
Technically feasible hydro generation potential: 189,300 GWh

All figures concern 2022;
Sources: TheWorldBank, IMF, IHA, Hydropower & Dams World Atlas 2023

– initiatives for the modernization of some power plants that will require important interventions in the coming years.

According to Generation Expansion, Chapter 4 of the Electricity Master Plan, Ecuador has a technically feasible hydroelectric potential of 31,000 MW distributed across 11 basins. Ecuador's CELEC EP Electrical Corporation has produced definitive studies and structuring for large-scale hydropower projects such as Abitagua (165 MW), Cardenillo (600 MW), Santiago Zamora (2,400 MW). In addition, CELEC have started contracting conceptual engineering studies for the implementation of pumped storage solutions with reference to some of the reservoirs that already exist in the country.

ANDRITZ trusts in the establishment of adequate mechanisms by the Ecuadorian authorities to allow the future development and financing of new power generation projects. Those projects that are responsible, sustainable, and in harmony with development objectives of the millennium and the conservation of the environment will ensure that ANDRITZ will continue to contribute its experience in their development and execution.

Inspection of main inlet valve, Coca Codo Sinclair hydropower plant

Unit hall, Sigchos hydropower plant

AUTHORS

Carlos Sgro
hydronews@andritz.com

BRAZIL'S ENERGY TRANSITIC DRIVEN BY ANDRITZ

COUNTRY REPORT — BRAZIL

New technologies and a reorganization of the power sector bring opportunities.

Brazil – Famous for football, Brazil is also recognized as a hub of innovation. ANDRITZ is one of the companies contributing to this success.

Despite the introduction of other generation sources such as wind and solar, hydroelectric generation still forms the basis of Brazil's electric matrix. ANDRITZ Hydropower is delivering new solutions, enabling the successful integration of these intermittent sources.

The energy transition underway in Brazil means changes to the generation profile and the integration of intermittent renewable energy sources. It brings new demands, as well as new business opportunities. President Dieter Hopf explains, "Hydroelectric plants provide predictable energy to meet demand, due to the water stored in the reservoirs, which brings a great benefit to the stability of the system, unlike the intermittent sources that provide energy spontaneously according to the weather conditions. Up to a certain point, hydroelectric plants managed to compensate for this intermittent generation from wind and solar, but it seems that the system needs new solutions to maintain stability."

When Brazil's large hydro plants were constructed, they were not built to compensate for intermittent sources. Due to the stresses associated with these new modes of operation, the lifespan of these plants is being curtailed. As a result, a wave of refurbishment projects has been generated in which ANDRITZ participates very successfully. For example, the Sobradinho and Jaguara hydroelectric power plants, in Bahia and the interior of São Paulo, respectively.

Having developed a new generation of machines and solutions that can rapidly respond to these load variations, ANDRITZ is currently the market leader. Using these new generations of machines, hydroelectric plants can operate across the entire range of heads for energy production, thus making operation more flexible.

Another core product from ANDRITZ is reversible pump turbine technology, a model that is mainly used in Europe, North America, China and Japan and which functions as a 'mega-battery'. This technology has not yet arrived in Brazil. However, according to Dieter Hopf, pumped storage hydropower plants will be needed in the country soon.

The Synchronous Condenser is another solution offered by ANDRITZ that is in high demand. It is extremely valuable in stabilization of the transmission system. Currently, the company has six units in production at the Araraquara factory, which serves a large part of the global market.

BRAZIL

Total population: 215.31 million
GDP per capita: 9,455 USD

Total installed hydro capacity: 109,778 MW
Installed pumped hydro: 20 MW
Hydropower capacity added: 332 MW
Hydro capacity under construction: 463 MW
Share of generation from hydropower: 63.1%
Hydro generation per year: 427,114 GWh
Technically feasible hydro generation potential: 1,250,000 GWh

All figures concern 2022;
Sources: TheWorldBank, IMF, IHA, Hydropower & Dams World Atlas 2023

"It is important that regulatory bodies reassess the tariffs of hydroelectric plants considering these ancillary services, compensating for intermittency in addition to promoting power auctions, and encouraging additional functionality of facilities with reservoirs and/or reversible plants in order to maintain a secure and fault-free electrical system," Hopf says.

63.1% Share of electricity generation from hydropower in total production

ANDRITZ is also a pioneer in the green hydrogen sector, with three contracts already underway in Europe. To showcase this technology, the company recently opened its headquarters in Austria to a delegation of Brazilian businessmen, members of the Ministry of Mines and Energy, and the national energy regulatory authority ANEEL, where, in addition to getting acquainted with technologies for the production of green H_2, they could also see reversible plant solutions and multi-purpose power stations.

"ANDRITZ, as a technology company, is extremely well-prepared to play a prominent role in the energy transition and has been working intensely with various stakeholders in the electric power generation and transmission market to promote increasingly innovative solutions," Hopf concludes.

ANDRITZ CONSOLIDATES ITS PRESENCE IN LATIN AMERICA

ANDRITZ Hydropower Brazil set out a strategic goal to remain integrated within the energy markets of Latin American countries and, in 2023, the company consolidated itself as a leader in solutions and new technologies in the hydroelectric sector. This is evident through a new contract signed for the modernization of the Baygorria hydropower plant in Uruguay. ANDRITZ is also actively involved in projects such as the Salto Grande hydropower plant and the Yacyretá hydropower plant, both located between Argentina and Paraguay.

The scope of the Baygorria project involves increasing generation output by supplying new Kaplan runners and generators. In November 2023, the model test of the turbines was conducted in the ANDRITZ laboratories in Linz, Austria, which confirmed technical guarantees

Belo Monte hydropower complex; with two powerhouses and a total installed capacity of 11,233 MW providing enough clean and renewable energy for about 60 million people.

for the client. Once the scale model tests are approved, the project is released for execution.

These tests simulate the operation of the rotor at various blade opening angles and heads, validating the efficiency of the new rotor. They also guarantee minimum operation levels, minimize cavitation, and ensure established hydrulic standards are met for maximum system efficiency.

Future projects, such as those in Salto Grande and Yacyretá in Latin America, are pivotal in the region's energy outlook, and the active presence of ANDRITZ is crucial in supporting customers with information about the modernization of hydroelectric plants.

Regarding Salto Grande, in April 2023, the client defined the modernization phases of the plant, prioritizing automation as the next step. ANDRITZ is involved in this process.

Meanwhile, at the Yacyretá project, ANDRITZ is in the final phase of delivering excitation systems, as well as exploring prospects for new contracts related to the continuous modernization of the plant.

ANDRITZ' scope of works in these projects encompasses a diverse range of elements, focusing on automation, generators, and turbines. However, the company is open to expanding its activities according to viability and specific customer demands.

In addition to its direct involvement in these projects, ANDRITZ Hydropower Brazil has established itself as an essential partner in the group. This unit is actively supporting projects not only in Brazil but also playing a significant role in other ventures in Latin America, with activities in Chile, Colombia, El Salvador, Peru, and Mexico.

"These binational projects represent not only significant milestones for ANDRITZ but also underscore the company's continued commitment to leading the way towards excellence and innovation in the Latin American energy market, reinforcing its position as a key figure in the transformation and modernization of hydroelectric plants in the region," stressed Dieter Hopf.

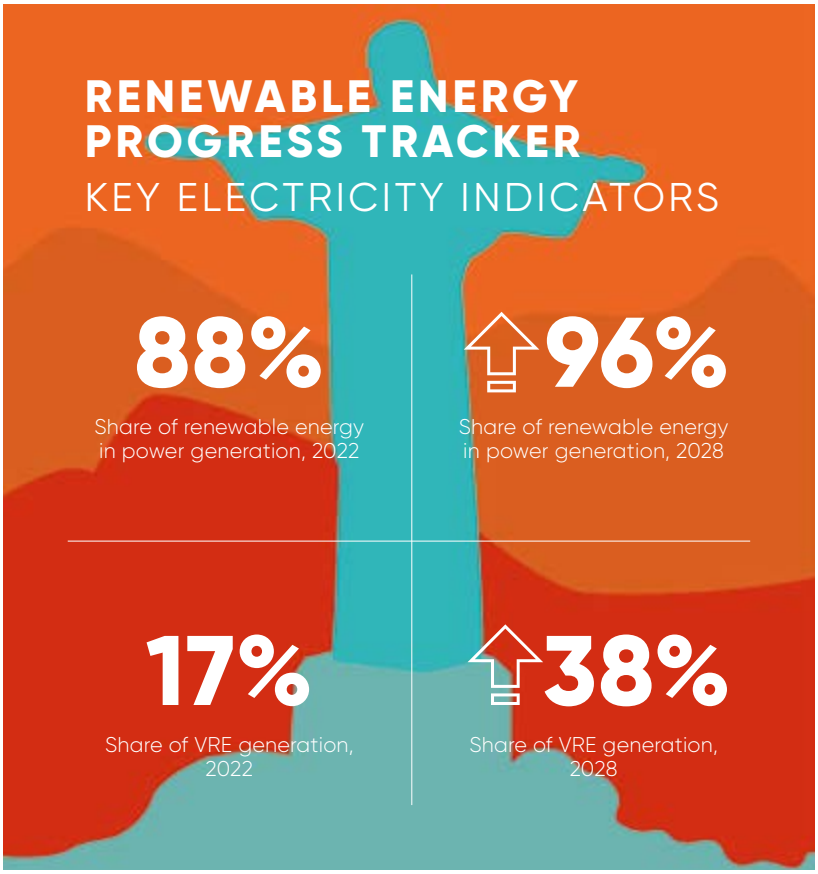
→

Installation team of the rehabilitation of the generator of Unit 1 at Jaguara hydropower plant

Generator of Unit 1 in the pit of Jaguara hydropower plant on the Rio Grande

Successfull model test of the Kaplan turbine for the Baygorria hydropower plant, Uruguay

Outside view (right) and installation work of Kaplan turbine (above) at Sobradinho hydropower plant on the São Francisco River, Brazil



Source: IEA

EXPLORING NEW OPPORTUNITIES IN ARGENTINA - ANDRITZ AND THE POST-CONCESSION SCENARIO

In the dynamic transformation of Latin America's energy sector, Argentina emerges as a focal point, offering fertile ground for innovation and market advances. ANDRITZ has thus directed its attention to new opportunities and strategic partnerships in this country. After identifying industry needs, ANDRITZ promoted its supply potential to enable future projects.

In the context of awarding concessions, Argentina has adopted a stringent approach, implementing a 'Due Diligence' process to assess the current state and magnitude of necessary investments. Currently, these concessions are under review by the Federal Government. It is important to note that the dynamics and strategies adopted in managing concessions in Argentina are distinct and decentralized.

"ANDRITZ, with its experience and innovative capabilities, is ready to navigate the new energy landscape of Argentina, contributing to progress

and sustainable development and strengthening its position in the region," noted Hopf.

Regarding energy generation, both Brazil and Argentina have similar systems, blending private and public generation. Both have a centralized control agency regulating price policies through the market. These similarities establish a strong foundation for ANDRITZ' activities in both countries.

INTERNATIONAL FORUM IN URUGUAY FOR THE ENERGY SECTOR IN LATIN AMERICA

In September 2023, Uruguay hosted a significant gathering: the International Forum on Challenges and Strategies in the Renewal of Hydroelectric Plants. This event not only provided a crucial space for discussions about the future of energy in the region but also served as a strategic meeting point for leaders and professionals in the sector. After identifying industry needs, ANDRITZ promoted its supply potential to enable future projects.

The ANDRITZ presence at the forum not only consolidated its position as a segment leader but also strengthened the company's connections with various energy market sectors across Latin America. Alongside renowned competitors, important suppliers, and major clients like EBY (Entidad Binacional de Yacyretá), CTM Salto Grande, and EBI (Empresa Binacional de Itaipú), ANDRITZ highlighted its presence and competitiveness and demonstrated its complete readiness to offer excellent services and products with full regional support while presenting the second stage of the Salto Grande Rehabilitation project.

The forum comprehensively covered diverse topics. From digitalization of plants and diagnostics, through to project management methodologies focused on plant modernization, the event served as a melting pot of ideas and innovation for the energy sector. International consultants shared valuable perspectives, contributing to advances and enhancement of the sector's and emphasizing the importance of collaborative work and innovative solutions in the context of hydroelectric energy in Latin America.

Yacyretá hydropower plant on the Paranâ River, Brazil

AUTHOR

Cleania Barros
hydronews@andritz.com

HYDROPOWER AND NATIONAL COMMITMENTS

Colombia – Colombia was a very active participant during 2022's COP26 in Glasgow and committed to very ambitious and specific targets. By 2030, it must reduce its atmospheric greenhouse gas (GHG) emissions by 51%.

Renewable energy represented more than 75% of electricity generation and more than 25% of total energy consumed in 2021 and 2022. According to the 2023 Energy Policy Review, these impressive figures are supported especially by the role of hydroelectricity.

To that end, Colombia is expanding its hydroelectric capacity with the third and fourth units of Hidroltuango adding 600 MW to the installed capacity. Upon completion of Hidroltuango with eight units in operation, Colombia's hydroelectric capacity will be increased by 2.4 GW (8 × 300 MW). However, Colombia's hydroelectricity has a low storage capacity and extreme weather events (droughts or rains) put the availability of hydroelectricity to the test.

While Colombia has substantial wind and solar resources a barrier for development is the lack of transmission capacity. This situation, together with the age of some generation assets, has led certain energy producers to make the decision to modernize or repower some of their hydroelectric plants. Framed within these initiatives, ANDRITZ has been developing support for these producers and has multiple reference examples executed in Colombia in recent years.

COP

COLOMBIA

Total population: 51.87 million
GDP per capita: 6,658 USD

Total installed hydro capacity: 12,563 MW
Hydropower capacity added: 618 MW
Hydro capacity under construction: 1,200 MW
Share of generation from hydropower: 73.4%
Hydro generation per year: ~ 65,700 GWh
Technically feasible hydro generation potential: 200,000 GWh

All figures concern 2022;
Sources: TheWorldBank, IMF, IHA, Hydropower & Dams World Atlas 2023

CHIVOR HYDROELECTRIC PLANT LIFE EXTENSION

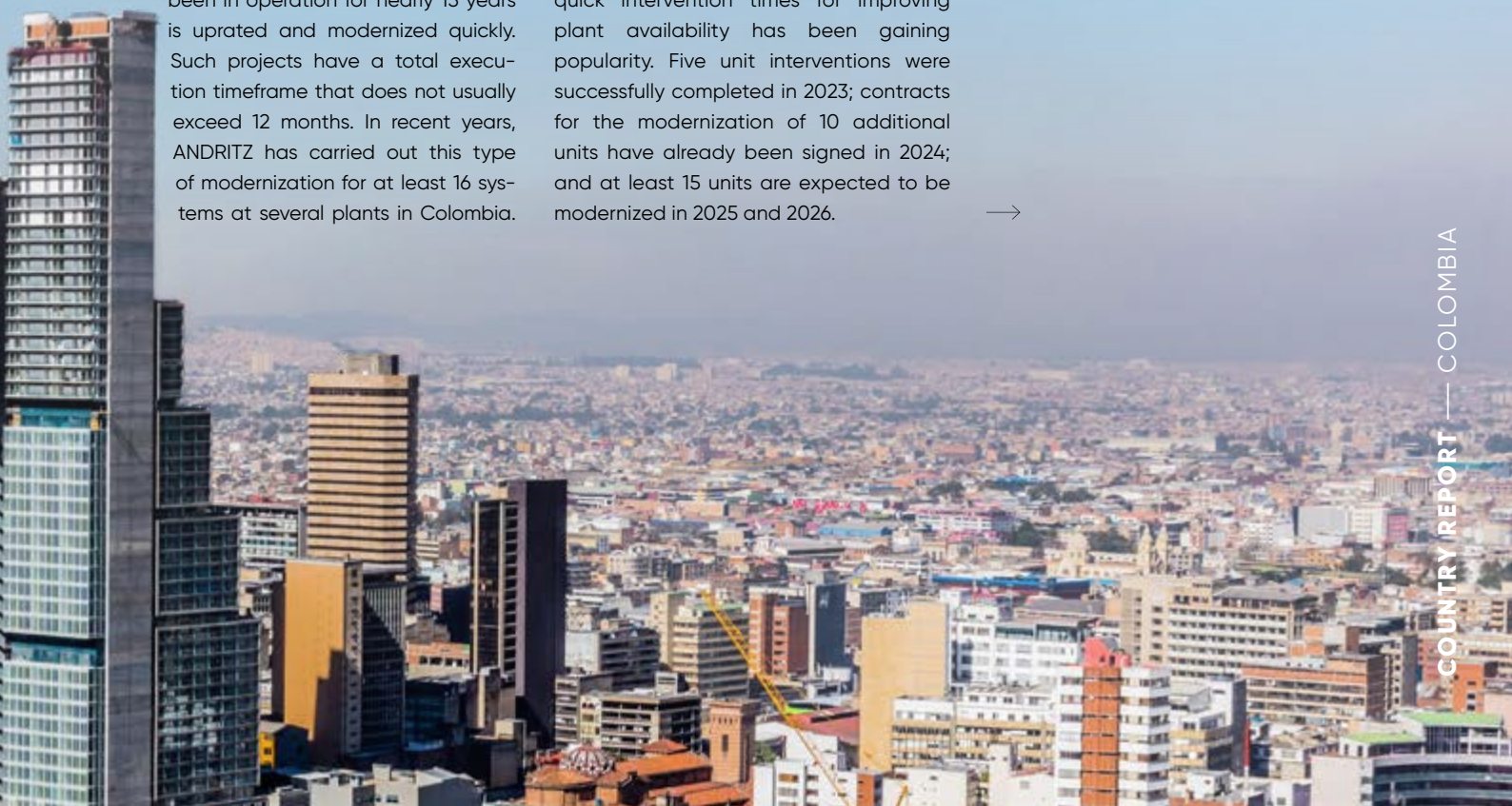
In this project, the client built a new intake structure with ANDRITZ participating in the design, manufacturing, factory testing, assembly, and on-site testing of the equipment for the new valve chamber. This contract included four new DN 4,000 butterfly valves together with their respective drive, control units, and crane bridge.

TECHNOLOGICAL UPDATE OF VOLTAGE REGULATORS

Through this initiative, equipment that has been in operation for nearly 15 years is uprated and modernized quickly. Such projects have a total execution timeframe that does not usually exceed 12 months. In recent years, ANDRITZ has carried out this type of modernization for at least 16 systems at several plants in Colombia. ANDRITZ is currently executing the modernization of seven further systems, the completion of which is scheduled for the first half of 2024.

MODERNIZATION OF SPEED GOVERNORS

In these projects, modernization of the electronic governor control panels is planned sequentially, validating simultaneously the mathematical models of the governors, thus improving the operational indicators. In the Colombian market, this modernizing approach which involves quick intervention times for improving plant availability has been gaining popularity. Five unit interventions were successfully completed in 2023; contracts for the modernization of 10 additional units have already been signed in 2024; and at least 15 units are expected to be modernized in 2025 and 2026. →



On-site team at the supply of the new Pelton runner at the Guatepè hydropower plant

Guatepé hydropower plant, spherical valve DN 1.100 originally manufactured in 1965 and rehabilitated by ANDRITZ Colombia

MAJOR MAINTENANCE THROUGH OVERHAUL OF VALVES

Through works that involve spherical valves, butterfly valves, and pressure relief valves we have achieved the recovery of these safety devices. These works made it possible to return this equipment to initial operating conditions and reliability, thus re-establishing the high levels of safety required. At ANDRITZ, we estimate that the local rehabilitation of these devices will continue to be a requirement for the hydroelectric plants in operation in Colombia.

Work on this equipment requires very high levels of precision, demanding dimensional and geometric control, use of specialized equipment, and highly qualified and experienced personnel.

GUATAPÉ AND GUAVIO, REPAIR OF ADMISSION VALVES.

The admission valves of these hydropower plants (nominal diameter 1,000 mm, 90 bar and nominal diameter 1,400 mm, 126.7 bar) are nearly 40–50 years old respectively. Comprehensive repair works has been carried out, successfully extending their operational life.

GUADALUPE, PRESSURE RELIEF VALVE REPAIR.

Pressure relief valves suffer significant wear due to being exposed to very high operating pressures. The pressure relief valves at this plant also underwent comprehensive repair.

MODERNIZATION OR REPOWERING OF HYDROELECTRIC POWER PLANTS

Knowing the challenges that the construction of new hydroelectric plants entails today, it is important to identify existing facilities that have the potential for improvements in performance. Improvements could increase power output, efficiency, and availability through the incorporation of new materials, coatings, new hydraulic profiles, and online monitoring systems. In addition, operational assistance through platforms based on 'Machine Learning' and 'Condition

73.4% Share of electricity generation from hydropower in total production

Based Maintenance' offer substantial gains and this segment has the greatest potential in Colombia. Currently, ANDRITZ is executing a project in Colombia where the increase in power output from each rehabilitated unit will be around 10% of the original nominal power.

Colombia has a unique potential to expand hydropower generation thanks to its extensive river water resources. The country has a hydropower potential of more than 50 GW of which nearly 11 GW (22%) are being used. Currently, the Mining and Energy Planning Unit (UPME) has recorded more than 46 hydroelectric developments equivalent to 1,870 MW of capacity that are in the initial stages.

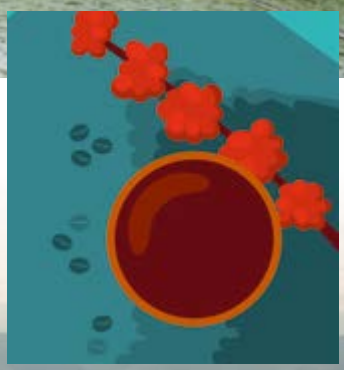
Existing hydroelectric capacity is at the heart of the energy transition in Colombia. Hydropower not only contributes with its generation of clean and sustainable electricity but also provides new services related to the stability of the grid. Modernization is therefore a key task and at ANDRITZ we are ready to continue supporting these initiatives.

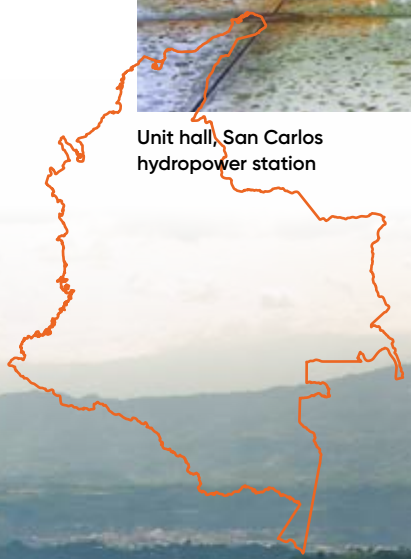
AUTHORS

Edwin Sierra
hydronews@andritz.com

Alto Anchicayá hydropower plant

Unit hall, San Carlos hydropower station





21.8% Share of electricity generation from hydropower in total production

HYDROPOWER: THE KEY TO CHIL CLIMATE STRATE

Chile – More than 130 years have already passed since the arrival of electric power in Chile and in 1908 ANDRITZ successfully commissioned its first plant in the country. Since then, ANDRITZ has delivered more than 140 generating units in Chile with a combined capacity of more than 2,400 MW.

In recent decades ANDRITZ has also modernized more than 50 units with a total output of more than 1,450 MW. Among these references are large hydropower plants that continue to play an essential role in Chile's electricity system. These plants include Pangue (568 MW), El Toro (484 MW), Alfalfal I (188 MW), Higuera (182 MW), Rucue (180 MW), and Chacayes (130 MW). ANDRITZ has also successfully participated in numerous small hydroelectric power plant development projects, as well as in hybrid irrigation and generation projects like Embalse Ancoa, Embalse Convento Viejo, and Embalse Digua where the water supply for farm irrigation is combined with power generation for the grid. ANDRITZ has also participated in the construction of substations for the national grid and in tenders for equipment to support grid stability and strengthening.

Despite the lack of new hydroelectric investment projects in Chile in recent years, ANDRITZ has had many successes in the modernization of existing plants. These include projects such as the hydropower stations Antuco, Pangue and Pehuenche, Blanco, and Queltehues, new butterfly valves for Ralco, spherical valves to protect the penstocks of the Alto Maipo complex, and the centralized remote monitoring and control systems for all the plants in the Aconcagua Valley for one of our customers. These successes came alongside service activities to support customers in scheduled and emergency maintenance of their plants, component recovery and restoration in our Colina workshop. In addition, predictive monitoring services were delivered from our Operations and Maintenance division to support customer operations.

PROJECT REFERENCES:

Pehuenche: Maule Region; 568 MW; contract won in 2023 for the rehabilitation of one vertical Francis turbine with major new components. Completion: August 2025.

Pangue: Biobío Region; 466 MW; contract won in 2023 for the rehabilitation of one vertical Francis turbine with major new components. Completion: April 2026.

Hornitos: Los Andes, Valparaiso Region; 61 MW; contract won in 2023 for one new Automatic Voltage Regulator (AVR) using ANDRITZ HIPASE-E. Completion: first quarter of 2024.

Ralco: Municipality of Los Angeles, BioBio Region; 689 MW; contract won in 2022 for the supply of one butterfly valve. Completion: second quarter of 2024.

Substation Guindo: Biobío region; 220 kV; contract won in 2019; ANDRITZ signed a contract for the supply of the electromechanical equipment for the Guindo Substation, which will connect the 220 kV system to the 66 kV system to strengthen the electrical system in Chile.

Francis turbine, Central Ancoa hydropower project

E'S GY

Alto Maipo: Colorado and Rio Maipo; 531 MW; contract won in 2020 for the supply two new spherical valves (DN3400 PN22 and DN2200 PN73).

Embalse Digua: Longavi, Perquilauquén; 20 MW; contract won in 2018 for the supply of two new 10 MW Compact Francis turbines, Howell Bunger valves for irrigation; generators, mechanical auxiliaries, electrical power systems, transformers, as well as a substation and plant automation.

SCADA Aconcagua: Aconcagua valley; > 200 MW; contracts won in 2016, 2019, and 2020 for the supply of the SCADA control system for the control and supervision of the Aconcagua valley cascade power plants (Hornitos, Juncalito, Los Quilos, Aconcagua, Chacabuquito). All the power plants can now be controlled from the Los Quilos Telecontrol system developed with our 250 SCALA platform.

AUTHOR

Diego Pigozzo
hydronews@andritz.com

RENEWABLE ENERGY PROGRESS TRACKER

KEY ELECTRICITY INDICATORS

53%
Share of renewable energy in power generation, 2022

93%
Share of renewable energy in power generation, 2028

25%
Share of VRE in power generation, 2022

69%
Share of VRE in power generation, 2028

Source: IEA

CHILE

Total population: 19.60 million

GDP per capita: 15,166 USD

Total installed hydro capacity: 7,289 MW

Hydropower capacity added: 477 MW

Hydro capacity under construction: ~ 202 MW

Share of generation from hydropower: 21.8%

Hydro generation per year: 19.620 GWh

Technically feasible hydro generation potential: 162,232 GWh

All figures concern 2022;
Sources: TheWorldBank, IMF, IHA, Hydropower & Dams World Atlas 2023

READY FOR RENEWA ENERGY GRO

Peru – The first evidence of a power industry in Peru dates back to 1884 with the implementation of the first hydroelectric power station for a mining company in Huaraz. Only a couple of years later, there is evidence of the first public lightning. Not long after, ANDRITZ successfully installed its first hydroelectric turbines in Peru during 1913 at the privately-owned Caxias I and II plants.

Since then, ANDRITZ has delivered or rehabilitated more than 190 generating units in Peru with a total combined capacity of more than 3,800 MW. Among these plants are large references which are still essential for Peruvian electricity generation, including Cerro del Águila (540 MW), Cañon del Pato (240 MW), Chimay (144 MW), Santa Teresa (118 MW), and Yuncán (134 MW). More recently, ANDRITZ has successfully participated in numerous small hydropower projects including Manta, Angel 1, 2, and 3, Carhuac, 8 de Agosto and Rucuy. To consolidate its leading position in the country, about 20 years ago, ANDRITZ decided to establish a local entity in Lima. Our specialized team supports customers in Peru, as well as other ANDRITZ divisions.

Peru's installed generation capacity is almost equally divided between thermal and hydroelectric power sources. Beyond hydropower, other renewable energy resources are still limited to less than 7% of the total. Peru has abundant natural resources for energy production, including solar and hydropower potential. The country's geography and climate make it particularly suitable for renewable energy projects that could shift the country's energy matrix towards a greener footprint.

With several of Peru's main hydropower plants reaching the end of their natural useful life, ANDRITZ Peru has completed many successful modernization and rehabilitation projects in recent years. A key focus here has been on extending their operational life and utility with renewed equipment reaching higher efficiencies. Among these are the hydropower stations Cañon del Pato, Platanal, Callahuanca, Huanza, and the Rio Mantaro complex. In parallel, long-term integrated operation and maintenance contracts have been developed, for example for the Cerro del Águila and Santa Teresa hydropower plants, or predictive monitoring systems for the equipment fleet of one of our customers. In addition, these businesses are supported by our customer support and service for scheduled and emergency maintenance of their equipment, spare parts, and recovery of damaged components.

Unit hall, Cerro del Águila hydropower plant

BLE
WTH

PERU

Total population: 34.05 mio
GDP per capita: 7,158 USD

Total installed hydro capacity: 5,515 MW
Hydro capacity under construction: 230 MW
Share of generation from hydropower: 50.7%
Hydro generation per year: 28,486 GWh
Technically feasible hydro generation potential: 360,000 GWh

All figures concern 2022;
Sources: TheWorldBank, IMF, IHA, Hydropower & Dams World Atlas 2023

50.7% Share of electricity generation from hydropower in total production

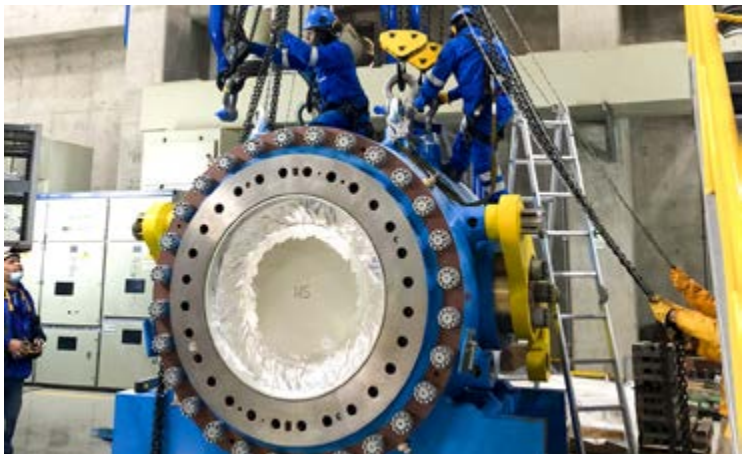
PROJECT REFERENCES

Recent project references include a contract for special erosion-friendly injectors for the Pelton units of the 260 MW Canon del Pato hydropower plant, the supply of new runners for the 227 MW Platanal power plant, two new spherical valves for the Huanza hydropower station and the rehabilitation of the Callahuanca hydropower plant after it suffered flood damage, including a new generator.

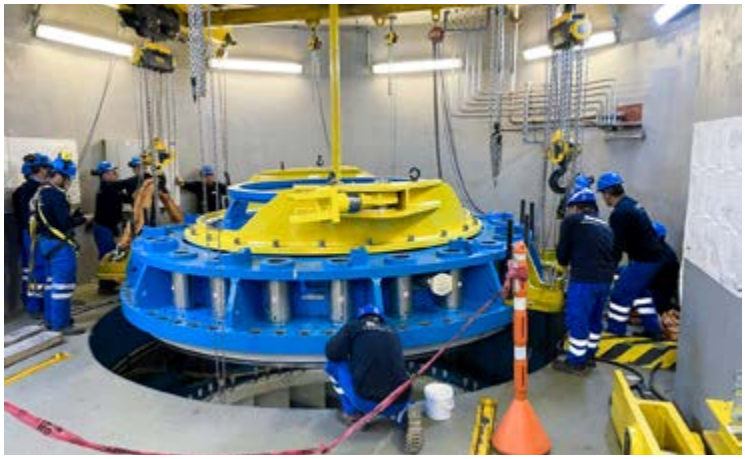
For the 592 MW Cerro del Águila hydropower station on the Río Mantaro, ANDRITZ signed a 10-year contract for integrated maintenance including repowering of units, erosion prediction, innovative Metris DiOMera digital predictive services, and global control center remote monitoring and assistance. Especially noteworthy is the innovative business model based on an 'efficiency guarantee'. In this case ANDRITZ guarantees a maximum efficiency reduction between the first and the second major overhaul due to erosion. Contract remuneration is aligned with the generation from the power plant with the price based on unit generating hours over the year.

AUTHOR

Diego Pigozzo
hydronews@andritz.com



Installation of spherical valve at Huanza hydropower plant



Installation of guide vane apparatus at Cerro del Águila hydropower plant

RENEWABLE LAND OF

60%

Share of electricity generation from hydropower in total production

Simón Bolívar 'Guri' hydroelectric power plant

Installation of one of the world's largest Francis runners (770 MW) in Simón Bolívar 'Guri' hydroelectric power plant in 2012.

Venezuela – In 1498, Christopher Columbus reached the coast of a land that enchanted the navigator because of the deep and green nature of its jungle and "an imposing river that fought against the sea". In a letter to the Monarchs Columbus referred to this place as "The Land of Grace".[1] This land of grace was the coast of what today is Venezuela, and the imposing river is the Orinoco.

Abundant in fossil fuels such as coal, oil, and gas, now Venezuela is looking at meeting the demands of the energy transition with its own resources too. Blessed with water, Venezuela has the second largest installed hydroelectric capacity in South America.[2] It is easy to conclude that the country has exceptional conditions to face this new energy era and ANDRITZ is a key partner organization in helping Venezuela meet its clean energy goals.

(1) Letter from Columbus written from the island of Hispaniola about the third voyage to the Americas in 1498. ('Cristobal Colón y Lope de Aguirre: La otra Historia' por Rita Jáimez)
(2) 2023 World Hydropower Outlook, IHA 2022, Venezuela 16,827 MW (second after Brazil)
(3) EUROBRAS Consortium is made up of 50% ANDRITZ Hydro Germany and 50% Voith Brazil

ENERGY IN A

F GRACE

JOSÉ A. RODRÍGUEZ 'PEÑA LARGA' HYDROELECTRIC POWER PLANT REHABILITATION

In 2006, ANDRITZ received a contract for the modernization of this plant located near the city of Barinas. The update included two vertical Francis turbine generation units (2 × 40 MW), with the total scope including the design, manufacturing, and assembly of new runners for the two turbines, new speed governors, excitation, protection, and control systems. This is in addition to a proprietary monitoring and diagnosis system.

SIMÓN BOLÍVAR 'GURI' HYDROELECTRIC POWER PLANT REHABILITATION

Barinas was the prelude to modernization contracts for other vertical Francis machines. However, the extraordinary dimensions of these machines required the implementation of new designs to solve a cavitation problem. The cavitation phenomenon affected the units in their normal range of operations and increasing power and efficiency represented a significant engineering challenge for the ANDRITZ Germany-led EUROBRAS Guri Consortium.[3] The EUROBRAS Consortium was commissioned to modernize the five units in powerhouse No. 2 of the Simón Bolívar hydropower plant.

After the rehabilitation program, the Francis turbines have a nominal power of 710 MW (previously 635 MW) and a maximum power of 770 MW (previously 710 MW). The cavitation problems were solved, power increased, and all efficiency requirements were reached.

PROSPECTS FOR HYDROELECTRICITY IN VENEZUELA

Considering the national power capacity of 16,829 MW and the dominance of hydroelectricity, ANDRITZ recognizes an important future potential associated with modernization of the hydropower fleet. Major equipment such as valves, turbines, and generators, together with technological updates that requires the digitalization of the electronic systems, represent a substantial opportunity. At ANDRITZ, we are ready to meet all future requirements of local authorities in relation to the modernization of Venezuela's hydroelectric fleet.

AUTHOR

Carlos Sgro
hydronews@andritz.com

VENEZUELA

Total population: 28.30 billion
GDP per capita: 3,421 USD

Total installed hydro capacity: 16,829 MW
Share of generation from hydropower: ~62%
Hydro generation per year: 80,000 GWh
Technically feasible hydropower potential: 62,400 MW

All figures concern 2022;
Sources: TheWorldBank, IMF, IHA, Hydropower & Dams World Atlas 2023

The renaissa synchronous

Renewables and power system stability

The transition from fossil fuels to renewable energy sources also entails a fundamental transformation of the transmission and distribution grids. The electric power system is shifting from a rotating mass-dominated system to a power converter-dominated system. Without the appropriate measures, this will have a negative impact on power system stability.

Over the past 20 years, the global share of renewable energy in new generation plant additions increased from 15% in 2002 to 83% in 2022. This growth is primarily driven by photovoltaics and wind power, and both depend on the instantaneous supply currently available (solar irradiation and wind). They are therefore referred to as Variable Renewable Energy (VRE).

"Synchronous condensers are an effective solution for the new requirements of the grid."

As soon as renewable energy sources feed into the grid, they supersede conventional thermal power plants due to common regulatory framework conditions. As a result, the rotating mass in the system decreases as the proportion of wind and solar increases, which are coupled via inverters.

Grid-connected inverter-coupled generation equipment does not provide an instantaneous reserve, so-called inertia, which is inherently provided by the rotating masses of synchronous generators. Inverter-coupled generation equipment also provides no or very little, short circuit power. High penetration of inverter-coupled generation equipment therefore leads to lower stability of the electric power system, manifesting itself in reduced frequency stability, voltage stability, rotor displacement angle stability, resonance stability, and inverter-based stability.

Possible consequences include wide-scale, undamped voltage and power oscillations, degradation of generator performance during faults, malfunctions or failures of protective equipment, Fault Induced Delayed Voltage Recovery (FIDVR), greater voltage jumps after capacitor banks are connected or disconnected, increased harmonics, deeper voltage sags, and higher voltage transients. Furthermore, due to higher frequency gradients, i.e., RoCoF (rate of change of frequency), increased frequency instability occurs, which leads to a deterioration of the system protection fault detection. All of these impacts result in limited power system hosting capacity for new renewable wind and photovoltaic units.

In light of these challenges and new regulatory requirements the electricity grid operators' main task is maintaining a stable energy supply at all times. For this, the synchronous condenser is a reliable, proven, and cost-effective solution.

nce of condensers

MAIN FUNCTIONS OF SYNCHRONOUS CONDENSERS

Synchronous condensers are extremely valuable grid-serving systems whose main functions are:

- Improved frequency stability
- Improved transient stability
- Improved steady-state voltage support

Frequency stability and transient stability are necessary whenever faults occur in the synchronous grid. These can be events like shedding large loads or the failure of a large power plant leading to an abrupt change of frequency, or short circuits on a transmission line leading to an abrupt change of voltage.

Instantaneous reserve and short-circuit power are essential system services when there is a high penetration of wind and photostatic generation. Previously common compensation devices such as SVCs and STATCOMs cannot supply both. They do little, or nothing to improve either frequency stability or transient stability.

As a consequence, synchronous condensers are continuously gaining importance in managing grid stability in the face of the accelerating energy transition.

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

The ANDRITZ Synchronous Condenser portfolio covers a range of standardized air-cooled systems from 50 to 330 MVAr.

Independent power producers (IPPs) and project developers for wind and photovoltaic plants are generally operating smaller rated systems. Strict grid regulations require them to use a modern synchronous condenser to gain grid access. These cylindrical rotor solutions are very cost-efficient and offer the shortest delivery times due to a high degree of standardization.

The higher rated systems with salient pole design are intended for transmission grids where high inertia, low losses, and dynamic behavior are crucial. With its high robustness, the salient pole design is best suited for transmission grid applications.

Engineering excellence from ANDRITZ is focused on the entire power train, from the synchronous condenser unit with its mechanical and electrical auxiliaries right up to the defined Point of Common Coupling (PCC) with the high voltage transmission system.

AUTHOR

Robert Neumann
hydronews@andritz.com

ANDRITZ INNOVATION:

AT THE HEART OF SUSTAINABLE HYDROPOWER

Hydropower may well be the longest-lived energy asset class but that doesn't mean it is a static industry. In fact, innovation flows through the whole sector as it responds to changing needs and demands.

ANDRITZ, a leader in sustainable hydropower for over 180 years, stands as a testament to the ongoing commitment to innovation and environmental protection within the hydropower industry. Throughout its long history, ANDRITZ has always prioritized innovation and the fundamental research that drives it, positioning itself at the forefront of the industry's transformation.

REDUCING ENVIRONMENTAL IMPACT

A major focus of ANDRITZ innovation efforts is to reduce the environmental impact of hydraulic machines, particularly on fish migration. Various mechanisms, both direct and indirect, can harm aquatic life passing through turbines. Direct impacts may include extreme changes in hydraulic pressure, turbulence-induced sheer stress, crushing, and collisions. Indirect effects encompass disorientation and stress, which can increase downstream predation rates even if the fish remain uninjured. Recognizing the importance of sustainable operations, ANDRITZ actively researches methods to enhance fish survival during turbine passage. This research aims to understand the complex interplay of forces and geometries within turbines, and to model these characteristics to enable iterative design improvements that ensure the safety of aquatic life and maximize the operational performance of the power plant.

SUSTAINABLE HYDROPOWER

Furthermore, ANDRITZ extends its commitment to sustainability beyond mitigating fish survivability. By developing and deploying machines with innovative features such as oil-free runners, the company aims to reduce pollution and minimize the environmental footprint associated with operating hydro turbines. Additionally, advancements in turbine blade technology, such as novel abrasion-resistant coatings, contribute to enhanced machine longevity and efficiency, thereby, reducing the need for costly repairs and replacements.

The company's dedication to innovation is demonstrated by the construction of the world's most powerful test rig in Linz, Austria. This investment represents a significant milestone and underlines ANDRITZ' ongoing commitment to technological excellence and sustainability. The newly developed test rig is characterized by its exceptional application possibilities and the flexibility of turbine models. This enables ANDRITZ to test and further optimize the performance and reliability of hydraulic developments under the most demanding conditions. This investment sets new standards in the development of state-of-the-art solutions tailored to the specific needs and challenges of customers.

ANDRITZ' commitment to sustainability also extends to the collaboration with leading research institutions, facilitating the rapid development and deployment of environmentally friendly turbine technology with minimal impact on natural resources. By integrating protocols for fish survival assessment into turbine design phases, ANDRITZ ensures that its technology meets today's needs without compromising the ability of future generations to meet their own needs. This holistic approach underscores ANDRITZ' long-term dedication to sustainable energy solutions and the protection of precious natural resources, ensuring a brighter, more sustainable future for generations to come.

AUTHOR

Sigrun Fugger
Marie-Antoinette Sailer
hydronews@andritz.com

"Water is among the most precious of the earth's resources. ANDRITZ innovation means all those who use and need water can continue to benefit from it - from the fish swimming in it to the people who are powering their homes with it."

HYDROPOW

THE AMERICAS

NORTH AND CENTRAL AMERICA

COUNTRY/ TERRITORY	TOTAL INSTALLED CAPACITY* (MW)	PUMPED STORAGE (MW)	GENERATION (TWh)
BELIZE	55	0	<1
CANADA	83,312	177	392
COSTA RICA	2,331	0	9
CUBA	65	0	<1
DOMINICA	7	0	0
DOMINICAN REPUBLIC	623	0	1
EL SALVADOR	572	0	2
GUADELOUPE	11	0	0
GUATEMALA	1,513	0	7
HAITI	78	0	<1
HONDURAS	849	0	4
JAMAICA	30	0	<1
MEXICO	12,614	0	35
NICARAGUA	159	0	<1
PANAMA	1,845	0	8
PUERTO RICO	98	0	0
SAINT VINCENT AND THE GRENADINES	6	0	0
THE UNITED STATES	102,009	22,008	262
TOTAL	**206,175**	**22,185**	**723**

*Including pumped storage

Generation by Hydropower
1,435 TWh

Total installed capacity
386.1 GW

Population
1.02 billion

Capacity added in 2022
2,536 MW

Pumped storage installed capacity
23.2 GW

Pumped storage capacity added in 2022
96 MW

Technically feasible hydropower potential
4,704 TWh
per year

Hydropower potential already harnessed
31%

Remaining hydropower potential
69%

The WorldBank; IHA 2023 World Hydropower Outlook; Hydropower & Dams World Atlas 2023

VER IN FACTS

SOUTH AMERICA

COUNTRY/ TERRITORY	TOTAL INSTALLED CAPACITY* (MW)	PUMPED STORAGE (MW)	GENERATION (TWh)
ARGENTINA	11,359	974	31
BOLIVIA	759	0	3
BRAZIL	109,778	20	423
CHILE	7,289	0	20
COLOMBIA	12,563	0	64
ECUADOR	5,191	0	25
FRENCH GUIANA	119	0	1
GUYANA	3	0	0
PARAGUAY	8,810	0	41
PERU	5,515	0	30
SURINAME	180	0	1
URUGUAY	1,538	0	6
VENEZUELA	16,829	0	68
TOTAL	**179,933**	**994**	**712**

*Including pumped storage

ANDRITZ HYDROPOWER

Installed and/or rehabilitated:

about 3,880 units

with more than

160 GW

total capacity

"Energy makes a vital contribution to people's quality of life, to society and to human progress. This is the case today and will remain so in the future. With all its experience and expertise, ANDRITZ is committed to a clean and environmentally friendly future and to the people of the Americas."


Hydro-
power
FOR THE
CHANGE
OUR RENEWABLE SOLUTIONS
FOR STRONG AND STABLE GRIDS
Learn more!
ANDRITZ
ENGINEERED SUCCESS

CHANGE ISN'T COMING – IT'S HERE.

We are not waiting for the future of sustainability – we're shaping it now.

At ANDRITZ, we believe in the power of innovation to bring about positive change. That's why we're pleased to launch our latest FOR THE CHANGE initiative, which aims to strengthen our commitment to sustainable technologies and solutions. As a global leader in engineering excellence, we are committed to making a tangible contribution to shaping a cleaner and greener future for generations to come.

Hydropower, a cornerstone of renewable energy, is at the heart of our mission. With FOR THE CHANGE, we are not only promoting hydropower, but we are also pioneering it by using it as a driver for environmental improvement. By harnessing the potential of water resources, we are creating a sustainable energy future that is both efficient and environmentally friendly.

FOR THE CHANGE is not just a slogan - it's a promise. It represents our unwavering commitment to environmental, social and governance (ESG) principles, with an emphasis on the 'E' for Environment. Through our innovative environmental products and solutions, we support our customers in achieving their sustainability goals while reducing their environmental footprint.

Our commitment goes beyond providing cutting-edge technologies; we are actively shaping a positive impact on our planet and society. With solutions for decarbonization and the circular economy, we are driving significant change that goes beyond industry standards.

FOR A BETTER FUTURE.
FOR A GREENER PLANET.
FOR THE CHANGE.

ANDRITZ HYDRO GmbH
hydronews@andritz.com

ANDRITZ.COM/HN-AMERICAS

ANDRITZ