

ENGLISH Magazine of ANDRITZ Hydro // N°36 / 12-2022

HYDRONEWS

N°36

THE AGELESS POWER OF HYDRO

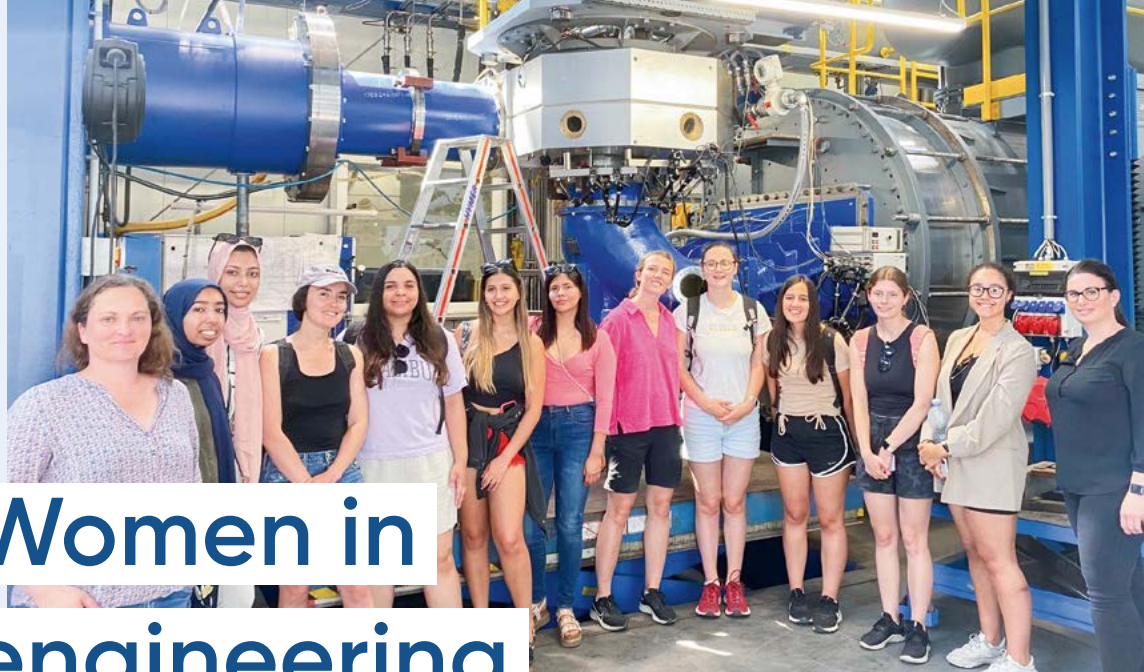
Renovate and rejuvenate
Page 16

Stabilizing the grid as India embraces renewables
Gandhi Sagar, India
Page 10

Rehabilitation resurgence
CFE's hydropower refurbishment, Mexico
Page 32

Essential safety
Dinorwig, Wales
Page 44

ANDRITZ



Women in engineering

Encouraging women to opt for a technical profession

In the ANDRITZ Hydro R&D departments we are very pleased to have many women in various technical areas. From hydraulic flow simulation to activities such as measurement technology and project management on the hydraulic test stand, the number of female employees has steadily increased over the years. Right from the start, good communication and networking among the women is particularly important in supporting one another. To further inspire women from technical areas for our work, we

“Women are connected all over the world through STEM (science, technology, engineering, and mathematics). ANDRITZ is proud to support women in engineering.”

are always looking for external contacts to various institutes and hope to recruit more female employees through this.

Therefore, ANDRITZ was thrilled to accept an invitation to give a lecture on hydropower for the University of Applied Sciences (FH Wels) at their workshop for “Women in Engineering”. We were pleased to welcome almost 30 female students from all over the world to the event in July 2022. All test rigs in Linz were inspected, and many hydraulic phenomena observed. We hope we were able to inspire the



students with the exciting world of hydroelectric engineering and perhaps we'll even get an international application sooner or later.

We are very proud to highlight that our colleague Christine Monette, Principal Engineer at ANDRITZ Hydro Canada, received the 2022 Woman for Waterpower award from the Women in Renewable Energy (WirRE) network. This award was given in recognition of her exceptional contribution to the development of technology in the hydroelectric field.

Joint development and modernization of hydropower business

Memorandum of understanding with EGAT

ANDRITZ and the Electricity Generating Authority of Thailand (EGAT) signed a Memorandum of Understanding (MoU) to jointly explore and expand business opportunities for hydropower projects in Thailand and surrounding countries. Marked with a digital signing ceremony in March 2022, the MoU will see the partners work to not only expand the digitalization of EGAT's hydropower facilities and develop rehabilitation and automation projects in Thailand, but also to explore new, joint business opportunities, including operation and maintenance services.

In August this year, a delegation of high-ranking EGAT representatives traveled to Austria and visited the ANDRITZ Hydro

headquarters in Vienna, the turbine hydraulic laboratory in Linz, the generator manufacturing facility in Weiz and a hydropower plant on the Danube River before traveling on to Italy. There the delegation visited the ANDRITZ Global Control Center in Schio, from which numerous hydropower plants worldwide are monitored by our highly trained Operation & Maintenance staff.

ANDRITZ is honored to work together with EGAT to jointly develop hydropower opportunities in the region and to support EGAT in making its hydropower fleet fit for the future.



Energy for 70,000 households

Ialy, Vietnam

ANDRITZ has won a contract for the complete electro-mechanical works and related technical services for the Ialy HPP extension project in Vietnam from Vietnam Electricity (EVN), a leading economic group in the energy sector in Vietnam. The installation of an additional 360 MW will boost the total installed capacity of the hydropower plant to 1,080 MW.

The ANDRITZ scope of supply consists of two 180 MW Francis turbine units, two 211MVA synchronous generators, control and

protection systems, additional plant auxiliary equipment, and associated technical services.

After completion of the project, which is expected in 2025, the Ialy HPP Extension plant will have an annual electricity output of about 233.2 GWh. It will provide more than 70,000 local households additionally with clean and sustainable electrical energy, as well as significantly contribute to regional grid balancing and stable operation.



"From water-to-wire" – ANDRITZ' comprehensive hydro expertise

If the concern is heads of up to 2,000 m, penstocks with a diameter of more than 13 m, turbines up to more than 800 MW, generators with 850 MVA, or multi-year construction projects, then investors, project developers, and clients rely on a partner that distinguishes itself. A partner that characterizes itself not just through its technical expertise, but also its social competence, financial strength, and solid, long-term project management experience.



More than
180 years'
experience in turbine
design



More than
471,000 MW
of installed and modernized
power capacity



More than
32,000
turbine units delivered



More than
125 years'
experience in electrical
engineering



65
locations
around the world



About
7,000
employees worldwide



More than
50 Small Hydro
units per year



Complete
design range up to
800 MW



20
manufacturing
locations



10
test benches
worldwide

Hydropower – Tackling the climate crisis

Dear Business Friends,

We continue to live in very challenging times. Aside from the pandemic and the heavy toll it has taken over the last two years, political and social conflicts are also shocking the world. Unbelievable events are taking place right within Europe that will have significant consequences for individual lives, the whole society and the global economy.



[Wolfgang Semper](#)



[Harald Heber](#)



[Gerhard Kriegler](#)

Europe is already struggling with energy independence. This is putting the 'trilemma' of security of supply, sustainability, and affordability as the prime focus of the energy industry and decision makers in Europe and worldwide. Population growth coupled with ever-increasing energy demand poses serious challenges. Now this is accompanied by a worrying disruption in the global supply chain. At the same time, we are already talking not only of climate change, but of a climate crisis.

In this context the transition to a zero-emission future becomes more important than ever. We must redouble our efforts to reduce CO₂ emissions and to reach our vital climate goals. Renewable energies like hydropower, wind and solar have to be expanded dramatically, as we need to successfully tackle the climate crisis and also ensure continued security of the energy supply.

Aside from building new hydropower plants like Nenggiri in Malaysia or the Gandhi Sagar pumped storage plant in India, modernization and upgrading of the existing hydropower fleet will also make a significant contribution. About 40% of all the world's hydropower plants were first commissioned more than 40 years ago. These plants can be refurbished to deliver not only better performance and therefore increased revenues, but also to adapt existing assets to new operating regimes and grid requirements. The world is changing, and hydropower assets must change too. This is especially important as our energy system moves to a more sustainable footing and will allow us to further secure clean energy supplies for all.

Over our long history, ANDRITZ has rehabilitated and modernized more than 10,000 hydropower units worldwide. Our rehabilitation and modernization efforts cover all types and sizes of hydropower machinery, from 1MW up to 800 MW and across every possible range of heads and flow rates. In this issue of Hydro News alone we build a bridge from a large refurbishment order in Mexico encompassing nine hydropower plants, to the largest overhaul of Francis turbines in Brazil, to an Automation upgrade in Norway and to new main inlet valves for maintaining safety at one of Europe's largest pumped storage plants. No matter what the challenge, ANDRITZ always puts all its expertise and experience forward to meet customer, social, and global requirements for clean, reliable, and affordable energy.

With kind regards and sincere thanks for your trust and confidence,


[Wolfgang Semper](#)


[Harald Heber](#)


[Gerhard Kriegler](#)



Cover Story

THE AGELESS POWER OF HYDRO

16 | Renovate and rejuvenate

Creating new plants from old with ANDRITZ. Maximizing the global hydropower capacity by modernizing the existing fleet.

MEGATRENDS

26 | Shaping the future – Megatrends and Hydropower

SPECIAL TOPICS

36 | Green financing

Generating green certificates for the modern energy market

54 | We care

Achieving sustainability and transparency through international standards

66 | #GlobalHydropowerDay

Celebrating the positive impacts of sustainable hydropower on people and communities around the world.

TECHNOLOGY

64 | Flywheels

Boosting inertia of synchronous condensers

FACTS AND FIGURES

02 | "From water-to-wire"

ANDRITZ' comprehensive hydro expertise

58 | The ANDRITZ GROUP

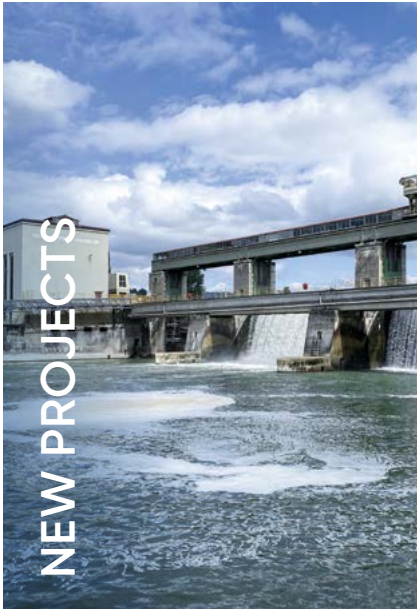
59 | ANDRITZ AG Highlights

Changes in the ANDRITZ AG Executive Board and celebrating ANDRITZ' 170th anniversary

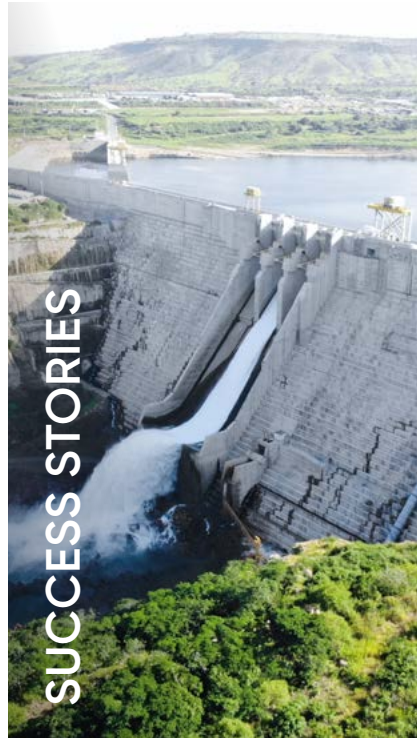
 **ihamember**
international hydropower association

 **Carbon neutral**
Print product
ClimatePartner.com/11886-2205-1008

OUR PROJECTS IN THIS ISSUE



- 08 | Nenggiri | Malaysia
- 10 | Gandhi Sagar | India
- 14 | Jebba | Nigeria
- 22 | Ryburg-Schwörstadt | Switzerland
- 24 | Sultartangi | Iceland
- 30 | Upper Trishuli 1 | Nepal
- 32 | CFE Rehab | Mexico



- 38 | Wehr | Germany
- 40 | Árlifoss and Grønvollfoss | Norway
- 42 | Foz do Areia | Brazil
- 44 | Dinorwig | Wales, UK
- 50 | Laúca | Angola
- 52 | Doan Ha | Vietnam



- 60 | Tolga | Norway
- 62 | Cikaengan 2 | Indonesia
- 63 | Nam Kong 3 | Lao PDR



HYDRO NEWS online magazine,
newsletter and contact information:

www.andritz.com/hn-36

ANDRITZ App:

Download on our website
or in the AppStore / PlayStore



Follow us on: [LinkedIn](#)

IMPRINT:

Publisher: ANDRITZ HYDRO GmbH,
A-1120 Vienna, Eibesbrunnnergasse 20, Austria
Phone: +43 50805 0

E-Mail: hydronews@andritz.com

Responsible for the content:

Alexander Schwab, Jens Paetz

Art Director and Editorship: Marie-Antoinette Sailer

Online magazine: www.andritz.com/hydronews

Published in: English, German, French, Portuguese,
Russian, Spanish, Chinese and Japanese

Design: INTOUCH Werbeagentur, Austria
Contributing Photographers & Providers:

Adobe Stock, FreeVectorMaps.com

Copyright©: ANDRITZ HYDRO GmbH 2022.

All rights reserved. Printed on FSC paper;

Printed at WGA Print-Producing, Austria; No part of
this publication may be reproduced without permission
of the publisher. Due to legal considerations, we must
inform you that ANDRITZ AG processes your data for the
purpose of informing you about the ANDRITZ GROUP
and its activities. Find out more details about our
privacy policy and your rights on our website:
andritz.com/privacy.

Malaysia – Tenaga Nasional Berhad (TNB), a government-linked company operating on the Malaysian peninsular, is developing a new hydropower project as part of its commitment to implement the government's Renewable and Green Energy Policy.

The Nenggiri hydropower plant will be located at Mukim Ulu Nenggiri, Jajahan Gua Musang, Kelantan Darul Naim, and will be one of several government-approved projects designed to meet Malaysia's growing energy demand. It will also help to meet government ambitions to increase the share of renewable energy to 40% by 2035.

In June 2021, TNB Power Generation Sdn. Bhd. (TNB Genco), a wholly owned subsidiary of TNB, received a Letter of Notification from the Ministry of Energy and Natural Resources granting the right to develop the 300 MW hydroelectric plant. TNB Genco then founded TNBPG Hydro Nenggiri Sdn. Bhd. (THNSB), a wholly owned Special Purpose Vehicle (SPV) company, as the project

company that will undertake the construction and operation of the hydroelectric plant. TNB, as the off-taker, signed a Power Purchase Agreement (PPA) with THNSB for a period of 30 years from the commercial operation date, scheduled for the middle of 2026.

"Nenggiri will ensure a stable and reliable electricity supply for the people and the country."

Datuk Baharin Din, CEO and president of TNB.

A consortium led by ANDRITZ was awarded the contract for the supply of the complete electro- and hydro-mechanical equipment for Nenggiri hydropower plant. The scope of supply comprises design, manufacture, supply, installation, and commissioning of two 153 MW turbines and two 180 MVA gener-

ators together with the auxiliary equipment, and the complete electrical and mechanical balance of plant. This includes HV switchgear, main step-up transformers, cranes, HVAC, and fire-fighting systems, among other elements. The hydro-mechanical scope of the contract includes the intake, bottom outlet, spillway, draft tube, re-regulating dam radial gates and stop logs.

MORE THAN JUST ANOTHER DAM

Once in operation, Nenggiri will deliver 300 MW to the national grid covering peak load demand for five hours a day, five days a week. It will provide fast start-up and spinning reserve duties in synchronous condenser mode when required. This function will be critical to the overall security of power supply, preventing massive blackouts arising from the sudden loss of large generators from the network.

The plant will also provide flood mitigation benefits with its ability to accommodate large amounts of rainwater during the monsoon season. The purpose of the re-regulating dam, located downstream of the main saddle dam, will be to regulate the river flow to a constant of approximately 39 m³/s. During the peak load operation, the re-regulating pond will smooth the outflows caused by short-term discharge variations in the river. Other benefits to the State of Kelantan are clean water supply and improvement of the irrigation for agriculture.

In the long term it is expected that the project will contribute to the socio-economic development of the local community in terms of tourism, aquaculture, and agriculture activities. During construction of Nenggiri, the peak demand for workers is estimated to be more than 2,000 people providing job opportunities to numerous local and Orang Asli (indigenous people in Malaysia) workers. The project will also boost local small industries by creating new economic opportunities once completed.

ANDRITZ is extremely honored to play a key role in this unique development and to be able to support TNB and the Malaysian people for a more sustainable energy future.

TECHNICAL DETAILS

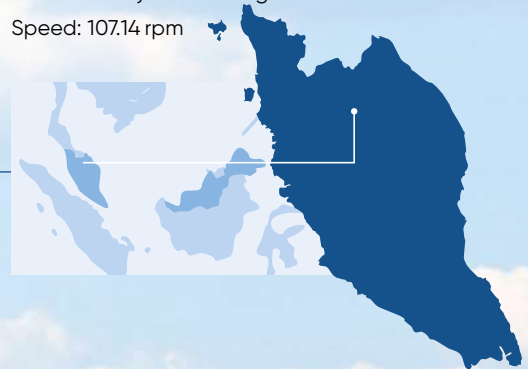
Nenggiri

Total output:

2 × 153 MW vertical Francis turbines

2 × 180 MVA synchronous generators

Speed: 107.14 rpm



AUTHOR

Philipp Schmitt
hydronews@andritz.com

GROUND-BREAKING CEREMONY – A MILESTONE TOWARDS MORE RENEWABLE ENERGY

A festive ground-breaking ceremony of Nenggiri hydropower plant took place on June 12, 2022, and was attended by high-ranking delegations of government, economy and of course the customer and owner, Tenaga Nasional Berhad (TNB).

300 MW Nenggiri hydroelectric plant will provide peak load coverage to stabilize the national grid, as well as flood mitigation benefits for the downstream areas.

It is the largest single renewable energy project currently being implemented in Malaysia by TNB, and ANDRITZ is extremely proud to be the preferred partner for this prestigious undertaking.



STABILIZING THE GRID Renewable

India – With India's energy scenario changing rapidly to include large volumes of renewable energy like solar and wind, the need for energy storage has come to the fore. Storage capacity helps to maintain a stable grid as variable output renewable capacity increases. Pumped storage plants are already well-proven as the most sustainable source of energy storage and India is building a number of large pumped storage plants.

With this paradigm shift on the energy scene, leading renewable energy company

Greenko led the implementation of the world's first fully integrated renewable energy storage project – the 1,680 MW Pinnapuram pumped storage plant in Andhra Pradesh.

Putting their trust in us, Greenko awarded ANDRITZ the electro-mechanical works for the Pinnapuram PSP in October 2020. Our operational excellence on the Pinnapuram project prompted Greenko to award ANDRITZ a second pumped storage contract for the electro-mechanical works on their 1,440 MW (expandable to 1,680 MW) Gandhi Sagar Pumped Storage Plant.

INDIA AS INDIA EMBRACES Renewables

Greenko already has a net installed capacity of 7.5 GW of renewables across 15 states in India. With their ambitious plans to replace fossil fuels with integrated decarbonized energy and grid assets, Greenko has now commenced the construction works on three pumped storage projects to date – the Pinnapuram and Saundatti integrated renewable energy storage projects (IRESP), and the Gandhi Sagar stand-alone pumped storage plant. Greenko has a license to build and operate IRESPs across five states, maximizing the available power of solar and wind resources with digitally

connected storage infrastructure to provide scheduled and flexible power to the grid.

THE PROJECT

Gandhi Sagar Pumped Storage Project is located in the state of Madhya Pradesh, India, and will be developed in a single phase. The hydropower project consists of five fixed-speed turbines of 240 MW each (expandable to an additional unit of 240 MW) and two fixed-speed turbines of 120 MW each. It is expected to enter into commercial operation in 2025, when the project will generate over 8,000 GWh of

electricity annually. The design life of the facility is some 50 years of operations from the commercial operation date.

Gandhi Sagar PSP will consist of an upper reservoir located in the village of Rampura Taluk in Khemla block, Neemach district, and the lower Gandhi Sagar reservoir located near Gandhi Sagar village in Mandasaur district. The Gandhi Sagar reservoir has a gross storage capacity of 7,320 million m³ while the upper reservoir has been proposed with a live storage capacity of approximately 30 million m³.



“The Gandhi Sagar project is expected to enter into commercial operation in 2025, when the project will generate over 8,000 GWh of electricity annually.”

"The black-start capabilities and reactive power compensation available from the Gandhi Sagar units are essential for grid support."



Initially, two layouts were studied. The first option was to go with a surface powerhouse. The alternative was to have an underground powerhouse along with an upper reservoir, intake structure, pressure shaft, tail race tunnel, tail race outlet and a tail race channel. After further investigation, it was decided to go for a surface powerhouse.

The electro-mechanical equipment to be supplied by ANDRITZ consists of the main inlet valves (MIVs) and their associated equipment, pump turbines, motor generators, governors, static excitation systems, static frequency converter (SFC), and

starting bus system connecting to all fixed machines with isolators. The scope also includes mandatory spares and a list of recommended spares, which are required for five years of trouble-free operation.

The PSP will also involve the construction of a rockfill dam with a sufficient embankment height to create the upper reservoir. Eight independent penstocks will draw from the intake structure located in the upper reservoir which is provided with trash racks and gates. A surface powerhouse will be equipped with eight vertical reversible Francis-type units, each composed of a motor generator and a pump turbine.



[City of Bhopal at night](#)

The eight penstocks will carry water from the reservoir to the turbines inside the power station. Each penstock will be approximately 621m long with a diameter of 7m. The main inlet valves for the large units will have a diameter of 5.3m while the ones for the smaller units will have a diameter of 3.8m. These valves will be completely designed and manufactured in ANDRITZ' Indian location in Prithla. The design means that it will be possible to start all the units simultaneously as the water systems are independent for each unit. All the auxiliary systems of the plant will therefore also be designed to support this requirement.

BENEFITS OF PUMPED STORAGE

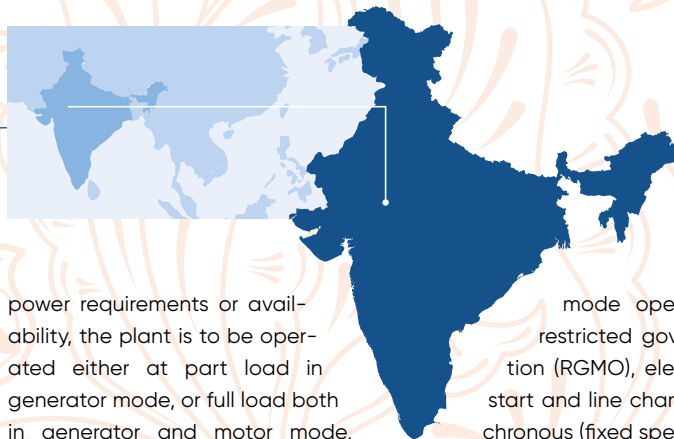
- Best-proven, low-risk technology
- Balances volatile renewable energy generation with demand
- Manages grid bottlenecks
- Supports grid stability by virtue of a quick response to changing demand or sudden outages
- Contributes to grid stability by increasing grid inertia and providing black start capability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



TECHNICAL DETAILS

Gandhi Sagar

Total output: 1,440 MW (expandable to 1,680 MW)
 Scope: 5 × 240 MW
 (expandable to 1 additional unit) / 2 × 120 MW
 Head: 122.03 m / 121.23 m
 Voltage: 11 kV / 18 kV
 Speed: 187.5 rpm / 272.72 rpm
 Av. annual energy production: 8,000 GWh



With a design discharge of 1,574 m³ per second, the installed capacity of the pumped storage scheme was influenced by the requirements of daily peaking power, flexibility in efficient operation of the units, the storage capacity available in the upper reservoir and the area's capacity characteristics. Power from the project will be evacuated through 400 kV double circuit transmission lines to Chittorgarh.

The operation of the pumped storage plant in both generation and pump mode will be determined by the Load Dispatch Center. Depending on the particular

power requirements or availability, the plant is to be operated either at part load in generator mode, or full load both in generator and motor mode, or in hydraulic short-circuit mode (meaning one unit is run in generate/consume required power), or in condenser mode to keep the machines ready and cater for various loads or to support reactive power compensation.

Active grid support will be provided, including reactive power compensation, frequency response in both free governor

mode operation (FGMO) and restricted governor mode operation (RGMO), electrical inertia, black start and line charging modes for synchronous (fixed speed) machines.

ANDRITZ is immensely proud to be part of this amazing hydropower project and to continue our excellent cooperative relationship with Greenko to develop sustainable clean energy for the Indian people.

AUTHOR
 Neelav De Samrat
hydronews@andritz.com



Visit of the ANDRITZ delegation to the Pinnapuram pumped storage site, which is also being developed by Greenko and for which ANDRITZ is supplying electro-mechanical equipment.

AFFORDABLE ENERGY FOR GENERATIONS



Commissioned in 1985, Jebba is forming a cascade together with Kainji. Both hydropower plants are generating about 20% of Nigeria's power.

Nigeria – In line with its Capacity Recovery and Expansion Programme, Nigeria's largest hydropower generation company has engaged ANDRITZ for the rehabilitation, overhaul, and modernization of two generating units (units 2G5 and 2G6) at the Jebba hydropower plant.

Mainstream Energy Solutions Limited (MESL) owns two hydropower plants – Jebba and Kainji – which currently generate about 20% of Nigeria's power. A privately-owned company governed by

a Board of Directors and an Executive Management team that oversees daily operations, MESL was incorporated in 2011 and is licensed as a power generating company.

The Kainji and Jebba hydropower plants have a combined installed generation capacity of 1,338.4 MW and were acquired through a concession agreement with the Federal Government of Nigeria in November 2013. The two plants are in a cascade 100 km apart with Kainji Dam upstream

of Jebba and are rated at 760 MW and 578.4 MW, respectively. Kainji was commissioned as Nigeria's first hydropower plant in 1968, whereas Jebba was commissioned in 1985. When the power plants were taken over, Jebba was not operating at full power and Kainji was not generating at all. As a result, the total available capacity of both plants was only 482 MW. In response, MESL introduced its Capacity Recovery and Expansion Programme to restore both generating facilities and bring them back to full power.



The powerhouse of Jebba is housing six generating units, two of which are now undergoing a general overhaul.



In July 2022, a delegation of the MESL Executive Board with Chairman Colonel Sani Bello visited ANDRITZ sites in Austria. The itinerary included the Hydro headquarters in Vienna, the hydraulics laboratory in Linz, the production site in Weiz, and the ANDRITZ headquarters in Graz. The visit was used for further discussions on cooperation between MESL and ANDRITZ.

In mid-2019, the senior management team of MESL visited ANDRITZ' locations in Austria to get an impression of our extensive R&D, manufacturing and engineering facilities. During the visit a Memorandum of Understanding was signed agreeing to negotiate the scope for the rehabilitation of unit 2G6 of the Jebba hydropower plant as well as the overhaul of units 2G5, 2G3, 2G2 and 2G1, including their associated equipment.

In February 2020, ANDRITZ received the first major contract for the 2G6 project. The scope of supply covers the entire electro- and hydro-mechanical equipment, including a 96.4 MW turbine, a 103 MVA generator, and accessory equipment, as well as the intake gate. In September 2021, a second order for the rehabilitation of the 2G5 unit with an identical scope of supply was awarded. Both units are expected to be operational in 2024.

Nigeria is Sub-Saharan Africa's largest economy and the largest oil producer

in Africa. It is also the most populous country of the continent with a growing demand for energy to support Nigeria's industrialization agenda. The successful privatization process of the hydropower sector has been ongoing and attracting companies to invest in the renewable power sector. In line with the company's ambitious expansion strategy, MESL will

also partner with ANDRITZ to provide technical services in its bid to acquire more power generation assets within Nigeria and beyond.

ANDRITZ has been active in Nigeria for more than

100 years and was involved in Nigeria's most important hydropower projects such as Kainji, Jebba, Shiroro and the recently commissioned Kashimbila project. Taking account of the development of the hydropower market and in order to strengthen its position in the very promising Nigerian region, ANDRITZ has established a legal entity (ANDRITZ Hydro Nigeria).

"Jebba is equipped with six 96.4 MW turbines and has a total generating capacity of 578.4 MW. ANDRITZ is the original equipment supplier for the turbines."

TECHNICAL DETAILS

Jebba

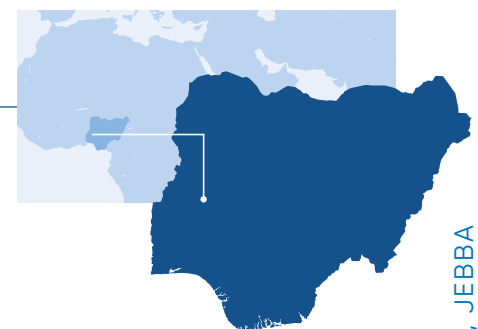
Total output: 578.4 MW

Scope: 6 × 96.4 MW / 103 MVA

Head: 27.6 m

Speed: 93.75 rpm

Runner diameter: 7,100 mm



AUTHOR

Markus Kainberger
hydronews@andritz.com



The ageless power of hydro

Renovate
and rejuvenate

Using water to produce energy is an old story, an idea that stretches back millennia, but it wasn't until the middle of the 20th century that the real renaissance of hydropower came about. Even though the 1960s and 1970s are relatively recent history in the epic chronicles of hydropower, many of those power plants are more than 50 years old and are still operating. Indeed, the vast majority of the earth's hydroelectricity is generated at power plants that are already many decades old.

About 40% of all the world's hydropower plants were first commissioned more than 40 years ago, with nearly half of the global hydropower capacity more than 30 years old.

Hydropower installations are clearly very long-lived assets but wear and tear mean that even hydropower equipment begins to show its age eventually. This can affect plant efficiency, performance and reliability, which can in turn have impacts on station output, potential revenues and even safety.

Furthermore, hydropower does not exist in isolation. The world is changing, and hydropower assets must also change if they are still to play their part.

Hydropower is by far the world's largest source of renewable electricity, producing more than half of all renewable power generation and about 16% of total generation worldwide. Hydropower is not only the world's largest contributor to renewable energy, but also a significant enabler

of other, more volatile renewables like wind and solar.

As the world accelerates the clean energy transition and turns away from fossil fuels, hydro is operating in a system that is increasingly dominated by those volatiles. This can create challenges for transmission system operators who need to maintain grid stability and places additional

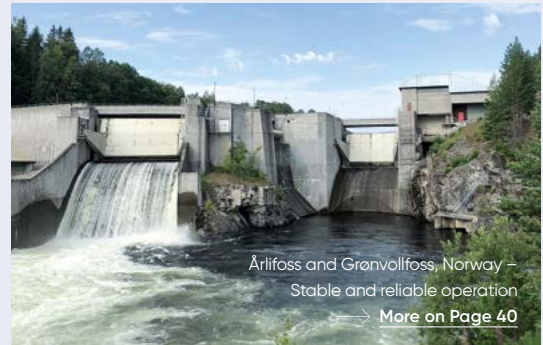
"To secure our world for future generations it is crucial to put hydropower squarely back on the energy and climate policy agenda."

Dr Fatih Birol, Executive Director, International Energy Agency

demands on hydropower assets as they are deployed in ways they were never designed for. Reliable, predictable, and flexible, hydropower lends itself to function as a balancing energy source, able to quickly respond to fluctuations in supply and demand to keep the grid stable. →



Jebba, Nigeria – Affordable energy for generations
 → [More on Page 14](#)



Arlifoss and Granvollfoss, Norway – Stable and reliable operation
 → [More on Page 40](#)

→ Hydro plants operating as spinning-reserve or fast-response capacity are critical in the modern era and this demand is only likely to get more important as we switch to a 100% clean energy world.

It's clear then that while much attention is focused on greenfield hydropower capacity, there is also a significant need to refurbish and upgrade a large portion of the existing global fleet.

“About 40% of all hydropower plants worldwide were originally commissioned more than 40 years ago, which results in high demand for modernization and upgrades.”

However, these new demands, such as more start-stop cycles and part load operation, can accelerate fatigue of equipment, in addition to wear and tear from abrasion and corrosion, for example. Furthermore, the growing calls for more sustainable energy sources involve environmental requirements too, with fish-friendly turbines and oil-free turbine runner hubs also increasingly in demand.

MAXIMIZING THE BENEFITS OF HYDROPOWER

Rehabilitation, modernization, and upgrading of installed hydropower equipment offers a host of benefits. Refurbishing existing assets by repairing and replacing components can extend the operational lifespan far beyond the original specified design. Typically, such a process maximizes potential revenue from an asset with a significantly reduced capital outlay. The efficiency of turbines and generators has significantly improved over the years. Upgrading a 40-year-old turbine runner could easily add 5% to the headline efficiency figure and an even bigger increase to annual revenues by raising peak capacity. Upgrading a plant's performance is therefore possible and very cost-effective.



Ryburg-Schwörstadt, Switzerland – Hydropower on the Hochrhein
 → [More on Page 22](#)





There are also opportunities to increase generation by modernizing existing assets to make them more compatible with today's energy system and modern requirements. This is particularly important when considering the need for greater flexibility in operations in response to variable renewables or other emerging market demands.

Components like stationary parts of turbines or other fixed elements like penstocks generally age slowly and are capable of maintaining effective operations for many decades. High voltage electrical equipment like cables, transformers and substations also age slowly but at a slightly higher rate than other stationary components. Conversely, instrumentation and control equipment rapidly become obsolete given the digital sector is experiencing an ever-faster

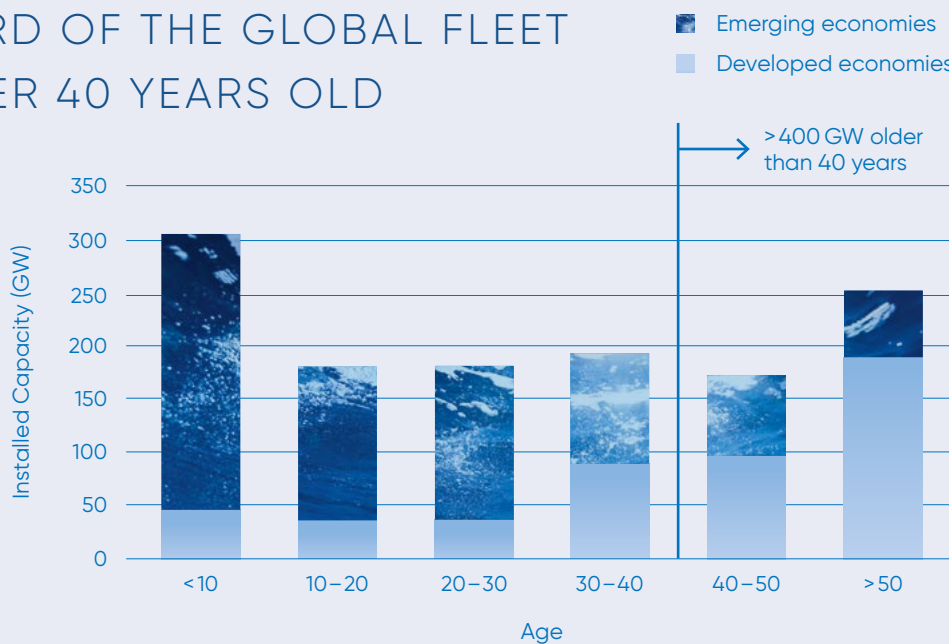
technology development. Even relatively new equipment can quickly become out of date. This is especially true when considering cybersecurity, an area that absolutely must stay up to date.

By applying such digitalization programs, not only security, but the flexibility and overall efficiency of a hydropower plant can be significantly optimized. This goes hand in hand with adopting the latest service, operations, and maintenance concepts, such as predictive maintenance based on the latest instrumentation and data analysis best practices.

Overall, modernization can greatly improve overall efficiency, reduce operational expenditures, extend lifetimes, and make hydropower plants flexible and fit for the future.



A THIRD OF THE GLOBAL FLEET IS OVER 40 YEARS OLD



Source: IHA & IEA, 2019

→ **CREATING NEW PLANTS FROM OLD WITH ANDRITZ**

ANDRITZ is well known as a leading global supplier of hydropower equipment and services – “from water-to-wire” – as well as rotating machinery for a diverse range of other industries. With about 7,000 employees worldwide and more than 65 locations, ANDRITZ Hydro is a global company that is always local. Since its founding in the middle of the 19th Century, ANDRITZ Hydro has rehabilitated and modernized more than 10,000 hydropower units worldwide. This experience covers all types and sizes of hydropower machinery from 1MW up to 800 MW and across every possible range of heads and flow rates. As part of its commitment to the industry, ANDRITZ Hydro has more than 50 service and rehab locations distributed around the globe. This framework of locations supports our goal of achieving proximity and reactivity while guaranteeing the rapid and smooth transfer of skills and information for even the most challenging modernization scheme.

Among the refurbishment projects that ANDRITZ has undertaken lately is Grand Coulee John W. Keys III on the Columbia River in Washington, USA. ANDRITZ is conducting a major automation modernization project installing new digital excitation systems, unit controls and governor systems for all six pumping units and the six pump-generating units. The existing pump units were installed in the early 1950s and the pump-generating units in the late 1970s.

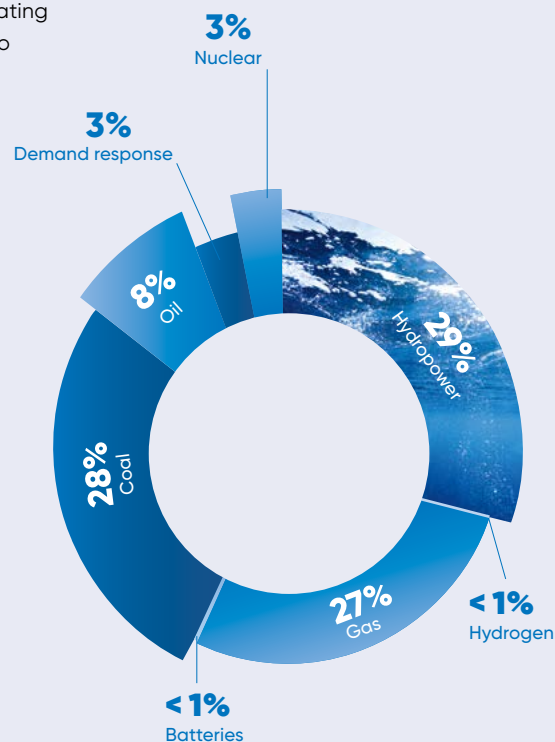
More recently, a smaller automation upgrade project was announced in Norway at the Årlifoss and Grønvollfoss run-of-river plants

dating back to 1915 and 1933, respectively. In 2020, ANDRITZ was awarded an automation rehabilitation order for both hydropower plants. For more on this project see page 40.

In Wehr, Germany, another rehabilitation project saw the installation of the world’s most powerful horizontal air-cooled motor generator with a challenging design following a failure of the original water-cooled machine that had been installed in the 1970s. This pumped storage plant provides crucial grid balancing services, and the owners wanted a unit that was capable of withstanding a large number of load changes. More details on this ground-breaking project can be found on page 38.

And, in Mexico, another major rehabilitation contract award has come from the state-owned power utility CFE. This EUR 600 million refurbishment covers nine power plants with a combined capacity of more than 4.3GW. The modernization will increase the rated capacity of these projects by 248MW, well over 5%. More on this project can be found on page 32.

Other service and rehabilitation projects covered in this issue include Jebba in Nigeria, where ANDRITZ is rehabilitating two generating units to



GLOBAL ELECTRICITY SYSTEM FLEXIBILITY BY SOURCE, 2020

“Hydropower plants currently make up almost 30% of the global flexible supply capacity based on hour-to-hour ramping needs.”

Source: IEA 2021 – Net Zero by 2050: A Roadmap for the Global Energy Sector

extend their lifetime for the next 40 years. Additional details on the refurbishment of this 578 MW plant can be found on page 14.

ANDRITZ is also executing a complete overhaul, modernization and uprating for one of the first run-of-river plants on the Rhine, which has been in operation in Switzerland since 1931. More on this project can be seen on page 22.

On page 42 we take a look at a project in Brazil where the largest overhaul of Francis turbines ANDRITZ has ever undertaken is now complete with the modernization and rehabilitation of the Foz do Areia plant on the Paraná River.

ANDRITZ is also uprating one of the largest pumped storage plants in Europe, the Dinorwig plant in Wales, UK. On page 44 of this issue, we report on a project to supply six new spherical valves to improve the safety and availability of the famous 'Electric Mountain' pumped storage plant.

These are just a few of the many refurbishment references that ANDRITZ has under its belt but serve to illustrate the breadth of our experience and our competence as a leader in the field.

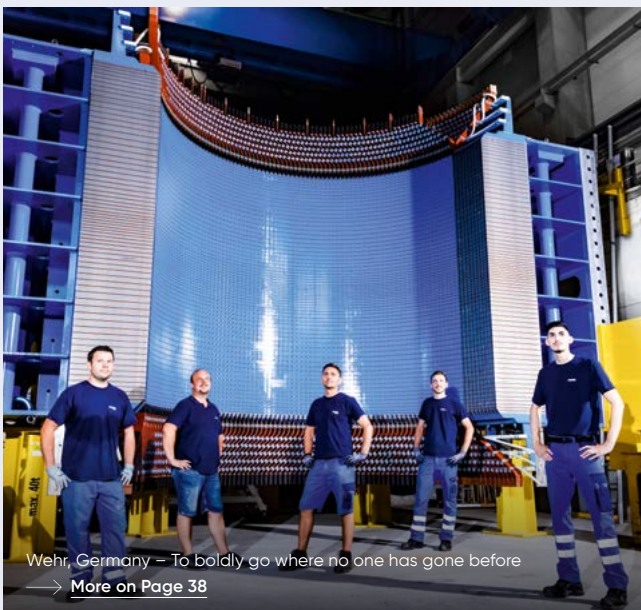
ENSURING THE FUTURE OF HYDROPOWER

With the pressing and urgent challenge of climate change there is no greater priority than the energy transition, and hydropower is a vital part of that transformation. Worldwide, hydropower already makes a huge clean energy contribution, but as an enabler of other renewables, hydropower is unsurpassed. A tried and tested technology, its role in helping to meet modern grid requirements and providing large-scale energy storage capabilities cannot be overstated. It's therefore critical that we maximize the global hydropower capacity, not just with new builds but by modernizing the existing fleet. Though much of the installed hydropower capacity is already decades old, through modernization and refurbishment even the oldest hydropower plant can sometimes perform better than new, ensuring hydropower's vital role in our clean energy future.

"Through modernization even the oldest hydropower plant can sometimes perform better than a new one."

AUTHORS

David Appleyard, journalist and writer
 Peter Stettner
 Marie-Antoinette Sailer
 hydronews@andritz.com



HYDROPOWER ON

Switzerland – ANDRITZ has received an order for the rehabilitation of four Kaplan turbines at the Ryburg-Schwörstadt hydropower plant on the Rhine River. Located about 21km upstream of the city of Basel between the hydropower plants of Bad Säckinggen and Rheinfelden, at 120 MW Ryburg-Schwörstadt is the most powerful hydropower plant on the “Hochrhein”. When first commissioned in 1930 it was also one of the first hydropower plants on the Rhine to have all the features of a modern run-of-river power plant. Two of the original units were supplied by Escher Wyss – now ANDRITZ. Thus, ANDRITZ is not only the original OEM supplier but has also now received a contract

from Kraftwerk Ryburg Schwörstadt AG for the rehabilitation of all four vertical, double-regulated Kaplan turbines and auxiliaries at the plant. The units will be renovated (one per year) between 2023 and 2027.

This rehabilitation project will increase annual energy production, as well as improve environmental performance through technical optimization and oil-free bearing systems on the wicket gates and oil-free hubs in the new runners.

The ANDRITZ scope of supply and services for the hydro-mechanical overhaul includes the hydraulic turbine governors

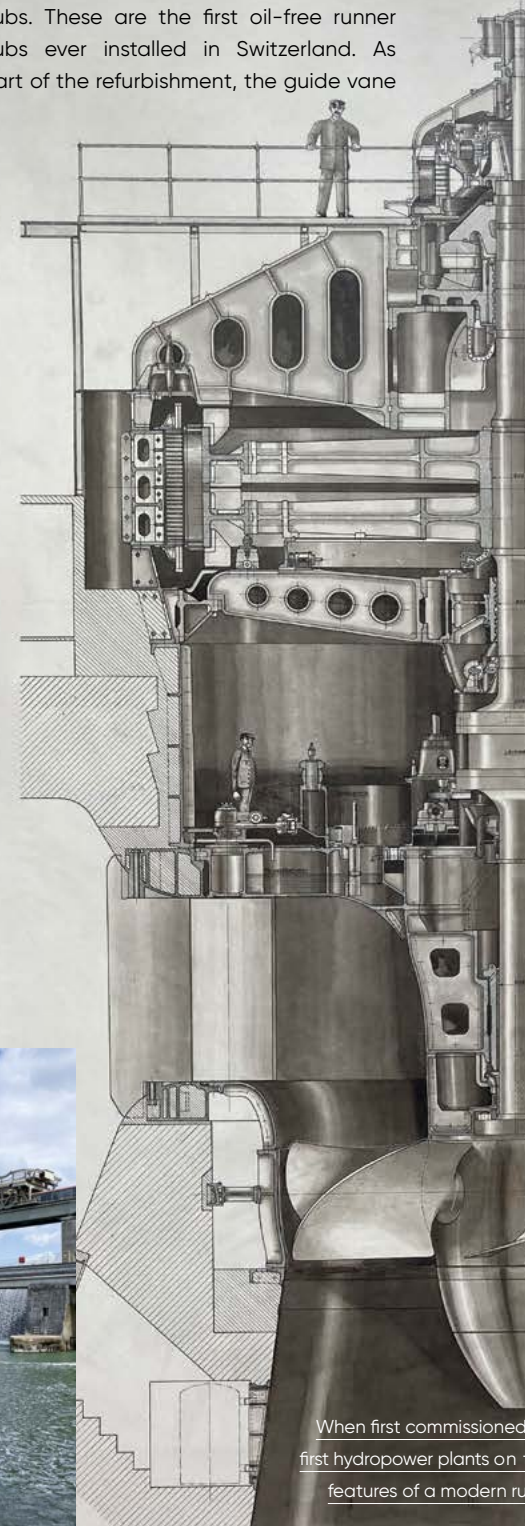
and comprises design, engineering, manufacture of new parts, factory overhaul, transport, erection, testing, and commissioning. Also worth highlighting are the homologous model testing and the delivery of four new Kaplan runners with oil-free hubs. These are the first oil-free runner hubs ever installed in Switzerland. As part of the refurbishment, the guide vane

TO KNOW:

The ‘Hochrhein’ between Lake Constance and Basel has a drop of 150 m over its length of around 150 km. A total of eleven barrages take advantage of this favorable gradient to produce environmentally friendly hydroelectricity.

The Ryburg-Schwörstadt power plant is located on the Rhine between the two power plants in Säckinggen and Rheinfelden and is the most powerful hydro station on the Hochrhein due to its sitting on the largest gradient.

[Kraftwerk Ryburg Schwörstadt AG](#)



When first commissioned
first hydropower plants on
features of a modern ru



IN THE HOCHRHEIN

and air intake valve are to be converted to maintenance-free bearings and the couplings, runner servo motor, and shaft seals are all being rebuilt. In addition, on-site armoring of the draft tube cone and corrosion protection on all turbines will be renewed on installed components such as stay vanes, upper and lower support stay vane ring, and draft tube cone.

The works will be led by ANDRITZ' Switzerland office as the contractor for this major project, which is

responsible for overall project management, logistics and transport, engineering, erection, and commissioning. Model testing and runner design will be carried out at the ANDRITZ location in Tampere, Finland, while the manufacture of the new Kaplan runners and the factory overhaul of the large turbine components will be executed at the ANDRITZ manufacturing facility in Ravensburg, Germany.

With an annual average energy production of about 760 GWh, Ryburg-Schwörstadt helps reduce CO₂ emissions by approximately 600,000 t per year.

We are pleased to be part of this rehabilitation project. Today, about 90% of the total installed turbines in Switzerland were originally installed or refurbished by ANDRITZ or its predecessor companies. ANDRITZ is committed to its customers serving the local Swiss hydropower market across the entire ANDRITZ product and service portfolio.

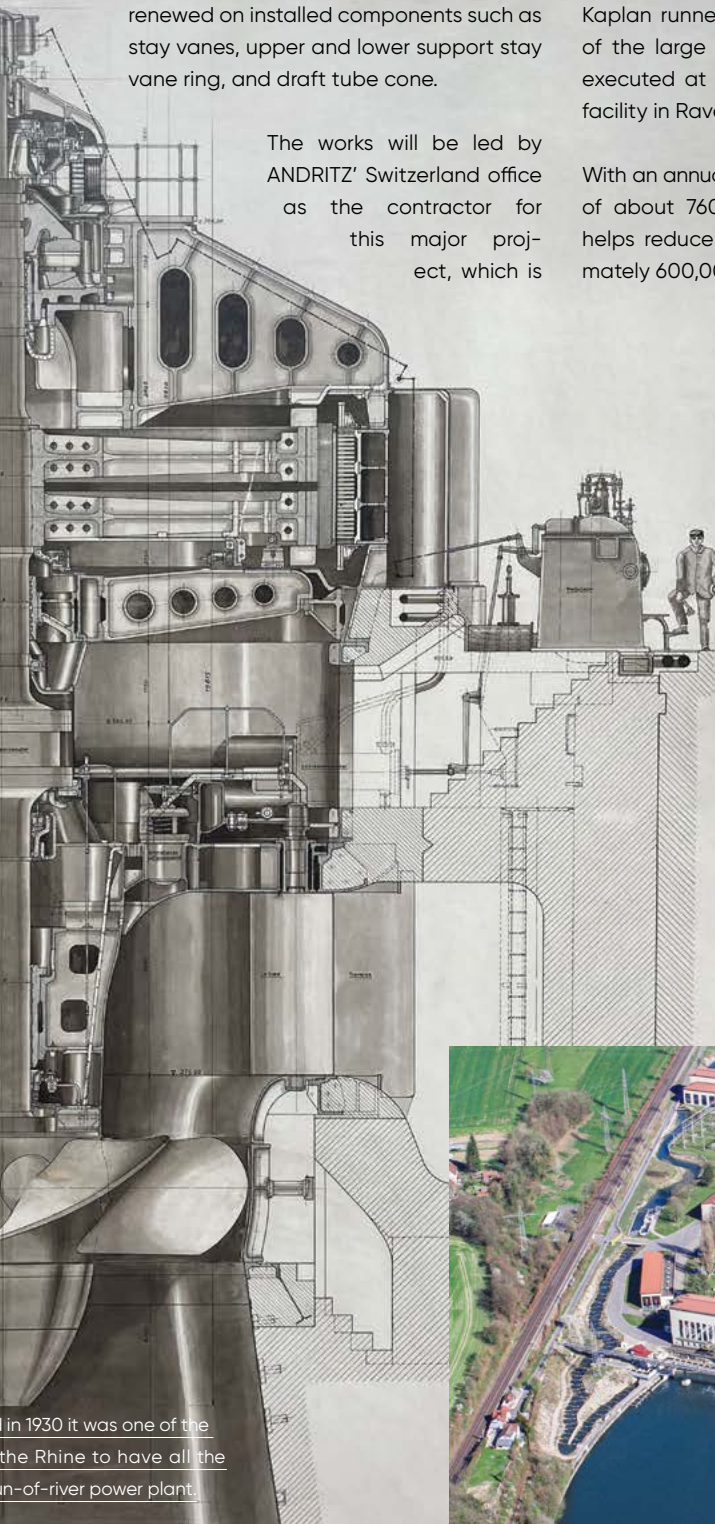
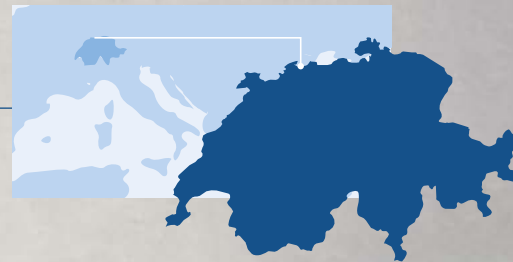
AUTHOR

Christoph Bütikofer
hydronews@andritz.com

TECHNICAL DETAILS

Ryburg-Schwörstadt

- Total output: 120 MW
- Scope: 4 x 30 MW vertical, double-regulated Kaplan
- Head: 7.6–12 m
- Voltage: 11 kV
- Speed: 75 rpm
- Runner diameter: 7,000 mm
- Av. annual energy production: 760 GWh



In 1930 it was one of the first in Switzerland to have all the turbines in a run-of-river power plant.



EXCELLENCE IN GENERATOR REHABILITATION

Iceland – Landsvirkjun, the National Power Company of Iceland, has awarded a contract to ANDRITZ for the uprating of the second generator stator at Sultartangi power station. The April 2022 follow-up contract came after the successful commissioning of the first generator stator at the plant in September 2021.

The scope of works includes the uprating of the existing generator from 75 MVA to 80 MVA by changing the complete stator. All the design and engineering works will be performed at the ANDRITZ Generator Center of Competence in Weiz, Austria. Major core components, such as the stator core sheets and the stator winding will be produced in Weiz, while the stator frame will be manufactured at ANDRITZ KFT in Hungary.

After completion of the stacking and winding works in Weiz, the stator will be shipped to Iceland in four

sections. The stator joints will be closed in the erection bay at the Sultartangi power station by ANDRITZ on-site specialists. The site works also include the complete dismantling, re-assembling and commissioning of the generating unit.

Founded in July 1965 by the state of Iceland and the city of Reykjavik, Landsvirkjun is the country's main producer of electricity. They operate 19 power stations in total, comprising 15 hydropower stations (40 units), three geothermal power stations (5 units) and two wind turbines. Total installed power capacity is 2,148 MW which generates about 14 TWh a year.

The Sultartangi Station, located 15 km northeast of the Búrfell Station, was built at the end of the last century and was put into commercial operation in 1999. It utilizes water from both the River Tungnaá and



TECHNICAL DETAILS

Sultartangi

Total output: 125 MW

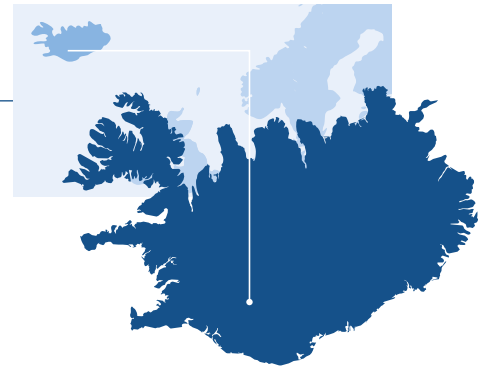
Scope: 2 × 80 MVA

Head: 44 m

Voltage: 11 kV

Speed: 136.36 rpm

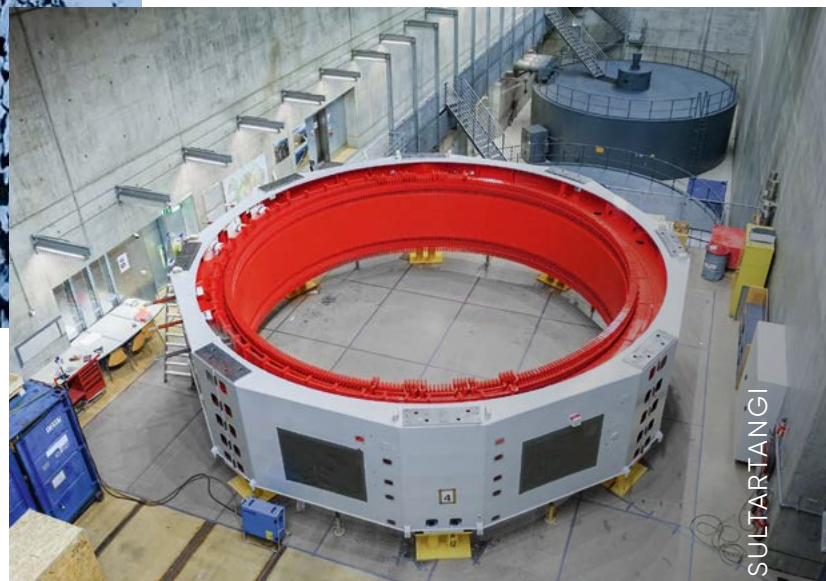
Av. annual energy production: 1,020 GWh



the River Thjórsá's as the two rivers are joined in the Sultartangalón Reservoir above the station.

At 6.1km, the Sultartangi Dam is the longest in Iceland. In conjunction with the construction of the power station, the dam crest was also raised by 1m, increasing the reservoir's surface area from 18 to 20 km². A 3.4 km-long headrace tunnel moves water from the reservoir through Sandafell Mountain to a surge basin on its southwestern side. At the end of the surge basin is the station intake, where two penstocks lead to the powerhouse. A tailrace canal just over 7 km long runs from the powerhouse at the foot of Sandafell Mountain and follows Thjórsá River almost all the way to the Búrfell Station Reservoir dam where it enters the Thjórsá riverbed.

After successful delivery and project execution for the greenfield hydropower projects Kárahnjúkar and



Búrfell Extension, the Sultartangi contract award continues our excellent customer relationship with Landsvirkjun, strengthening ANDRITZ' position on the service and rehabilitation market for future projects in Iceland and worldwide.

AUTHOR


Martin Hasenhütl
hydronews@andritz.com

Shaping the Megatrends and

Megatrends develop slowly, but they are enormously powerful. As gross global changes that affect every aspect of the economy and society, megatrends exert a profound influence on companies, institutions, and individuals. They form the basis for the evolution of entire economic sectors and are often the starting point for far-reaching strategies across governments, companies, organizations and other stakeholders.

Megatrends are interwoven too. Globalization and urbanization both have a direct impact on our environment, mobility, and connectivity, for example. They all are part of a big, interconnected whole.

Global megatrends shape not only our present, but our future too. Today, numerous global research and development projects are focused on megatrends. To face the challenges of a changing world, new concepts, innovative ideas, and alternative approaches are needed, especially in how we source, deliver, and use energy.



the future

hydropower

We live in a dynamic world and even recent events like the global pandemic and the on-going war in Europe have already had a significant impact on the development of megatrends. Some megatrends are becoming more prominent, whereas others are taking a back seat or even merging with others. We have to continually rethink how our world works and reimagine both our preferred path and our final destination. It is vital that as a society we reach a new understanding of how communities can come together to find new ways of working and new ways to localize the workforce. We must do this without losing sight of the wider globalization trend and the ultimate goal of accelerating the development of clean energy for a green, sustainable, safe and affordable future.

DEMOGRAPHIC AND ECONOMIC SHIFTS are essential and continuously evolving worldwide megatrends. War in Europe and the pandemic have both led to a serious supply chain disruption, for instance. Globalization itself is on a kind of test bench. It is necessary to rebuild local supply chains to overcome and protect businesses from supply shortages and become independent from single source suppliers. Innovative strategies are needed to alleviate global supply chain risks while securing continued cross-border collaboration.

Every minute the world's total population increases by some 150 people overall and yet there are drastic regional differences in demographic development. In industrialized nations, populations are typically shrinking, and the majority of the people will soon be over 65 years old. Meanwhile, the population of Asian and African nations is growing. This is resulting in a political and economic shift, increasing the economic power of these developing countries and their emerging markets. These changes are also having a major impact on current and future energy use in these developing regions.

Megatrends like **DIGITALIZATION** and **CONNECTIVITY**, together with **AUTOMATION** are becoming ever more important as we advance into the digital future. Networking and communication technologies are fundamentally changing the way we live, work, and do business. The digital transformation also has social and cultural impacts. Digitalization should not only be equated with technology but should also be more fundamentally understood. Transparent data governance, practiced data ethics, and ensuring cybersecurity are essential for success in the modern world. The digital transformation will play an increasingly important role in all areas of our life, resulting in a new awareness of the digital opportunities and a more reflective use of digital devices and technologies.

Europe's energy security crisis and the global **CLIMATE CRISIS** are the most important energy concerns globally. Energy security, sustainability, and affordability – not only in Europe but worldwide – are currently the prime focus of the global energy industry and the world's decision makers.

Following the 2021 United Nations Climate Change Conference (COP26), the IEA restated the need for urgent action. If we do not significantly accelerate the deployment of clean, sustainable energy, the climate goals of the Paris Agreement cannot be met.

With an increasing global population, **URBANIZATION** and the associated growth in energy demand, it is clear that conventional fossil-based energy sources will reach their limits of deployment in the very near future. Alternatives are urgently needed. Although approximately 27% of the world's demand for electricity is currently satisfied through renewable resources, much more growth in renewable energy capacity, including **HYDROPOWER**, is compulsory over the coming years if catastrophic climate change is to be avoided.

Research and development of other zero-carbon energy concepts, such as green hydrogen, is also in full swing. Integrated solutions that optimally combine various renewable technologies are emerging and will be in even greater demand in the future. Environmental awareness and sustainability are central economic factors that already influence investment decisions across all businesses and industries.

→ THE IMPORTANCE OF HYDROPOWER

Even as renewable resources like wind, biomass, solar, and geothermal energy exhibit extraordinarily rapid growth, hydropower still represents by far the largest renewable energy source with a 57% share of total production. And, although the technically feasible potential of hydropower is an almost unbelievable 16,000 TWh per year, not even one third of this potential has been exploited to date. Around the world, strategies are underway to develop this tremendous clean energy potential by building new hydropower plants, as well as modernizing and upgrading existing ones.

According to the 2022 Hydropower Status Report from the International Hydropower Association (IHA), some 26 GW of new hydropower capacity thereof 4.7 GW of pumped storage was put into operation in 2021. This is up on the 2020 installation figures of 21 GW and 1.5 GW, respectively. With these increases the total installed hydropower capacity (including pumped storage) reached 1,360 GW and hydropower produced an impressive 4,252 TWh over the year. But despite this positive progress, new installations remain short of the 30 GW a year needed to stay on

track to limit the global temperature rise to 2°C, and far below the roughly 45 GW needed for the more ambitious net zero 1.5°C target.

In regions where energy demand will increase dramatically over the next few years – such as in Asia, South America, and Africa – new large plants and a multitude of small hydropower projects will be implemented. There is also a

huge potential for additional hydropower generation in Europe and North America where around half the facilities are older than 40 years. Modernization and uprating can ensure hydro makes an even more significant contribution to sustainable power in the future. Alongside its envi-

ronmentally friendly generation characteristics, pumped storage offers benefits like providing further flexibility and cost-effective bulk storage, making it an invaluable asset for the clean energy transition by enabling other kinds of renewables like wind and solar.

The IHA has also undertaken a new analysis of its global hydropower database, which shows that there are at least 500 GW of projects in the pipeline for future hydropower

“Much more growth in renewable energy capacity, including hydropower, is compulsory over the coming years if catastrophic climate change is to be avoided.”

WORLDWIDE HYDROPOWER POTENTIAL PER REGION

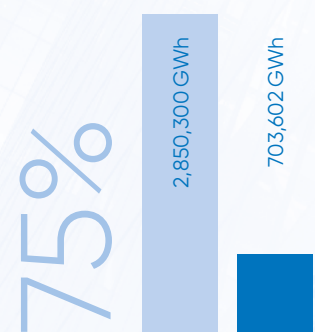
Europe



North America



South America

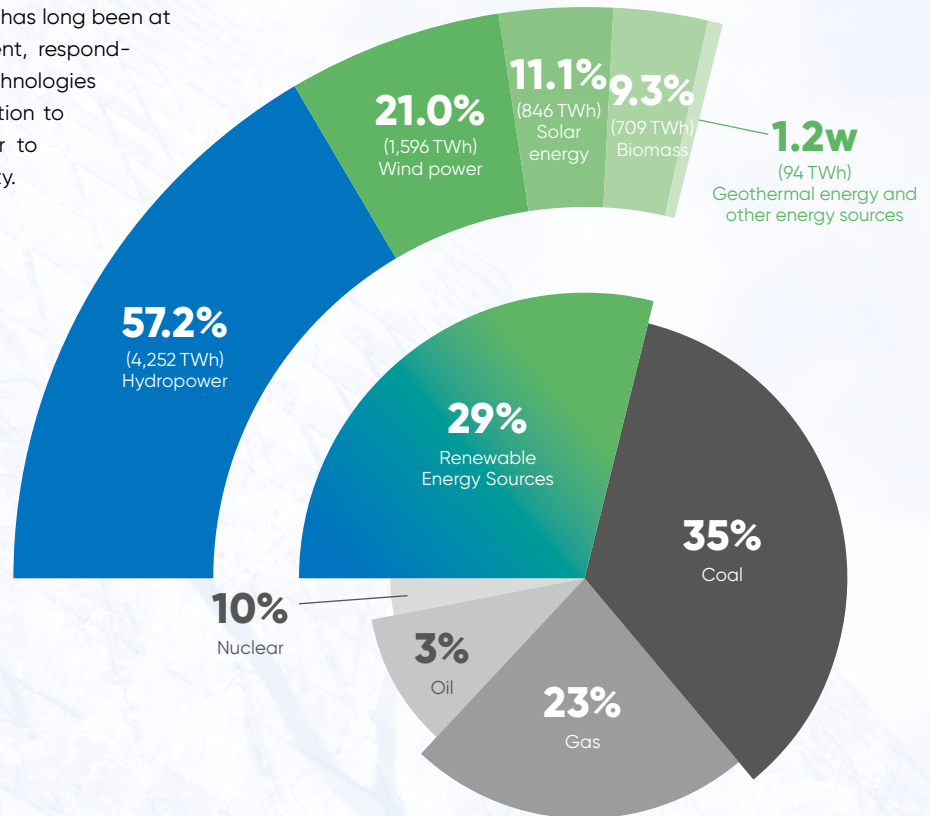


Sources: World Bank, Zukunftsinstitut, PRB Population Reference Bureau, pwc, IEA, REN-21, IRENA, IHA, Hydropower & Dams World Atlas 2021

capacity. However, of these only 156 GW is actually under construction with 165 GW approved by regulators but awaiting construction, 138 GW pending approval and 89 GW only announced. Moving these projects into construction is crucial if we are to cost effectively tackle the climate crisis.

With 180 years of innovation, ANDRITZ has long been at the forefront of technical development, responding to megatrends with pioneering technologies and concepts and leading the transition to new and better approaches in order to meet the changing needs of society. That philosophy holds as true today as it did when the company was first founded. Faced with the profound impacts of global megatrends, hydropower and ANDRITZ innovation will be a long-term megatrend too.

PERCENTAGE DISTRIBUTION OF WORLDWIDE POWER GENERATION

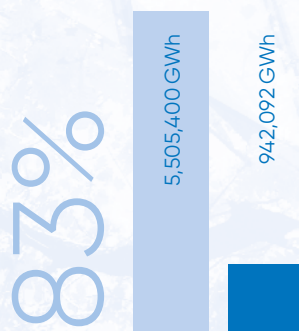


Source: IEA World Energy Outlook 2021

Africa



Asia (excl. China)



China



■ Technically feasible hydropower potential ■ Power generation from hydropower

INCREASING NEPAL'S POWER GENERATION

TECHNICAL DETAILS

Upper Trishuli 1

Total output: 216 MW

Scope: 3 × 72 MW

Net head: 327 m

Transmission Voltage: 220 kV

Speed: 428.57 rpm

Head race tunnel length/diameter:

9.7 km/6.5 m

Penstock length/diameter: 214 m/6.5 m

Av. annual energy production: 1,456 GWh



Nepal – In June 2021, ANDRITZ signed a contract agreement with Doosan Heavy Industries and Construction Company Limited (now Doosan Enerbility Company Limited) for the hydro-mechanical and electro-mechanical works for the 216 MW Upper Trishuli 1 hydropower project.

This is the first large-scale contract for ANDRITZ in Nepal where both the above key packages were awarded together to form the total scope for the project. Doosan is the EPC-contractor for the project and ANDRITZ and Power China are the sub-contractors for the hydro-, electro-mechanical, and the civil works respectively.



Camp site at the
Upper Trishuli River.

POWER NEW

Works are already in progress. The construction period for the project is estimated at five years, with completion scheduled for December 2026.



Upper Trishuli 1 is a run-of-river scheme on the Trishuli River located in Rasuwa district, approximately 70 km north of the Nepalese capital Kathmandu. The project is being developed by Nepal Water & Energy Development Company Pvt. Ltd. (NWEDC), a special purpose company with 30% equity participation from a consortium of Korea South-East Power Company (KOEN 50%) and Korea Overseas Infrastructure and Urban Development Support Corporation (KIND 25%), financial investor International Finance Corporation (IFC 15%) and a local partner (10%).

For the debt portion (70%), the project signed an agreement with nine different

International Banks including the International Finance Corporation (IFC), Korea Exim Bank (K-EXIM), Asian Development Bank (ADB), Asian Infrastructure Investment Bank (AIIB), Korea Development Bank (KDB), CDC Group PLC (CDC), the Netherlands Development Finance Company (FMO), the Proparco Development Financial Institution, and the OPEC Fund for International Development (OFID).

In 2020, NWEDC awarded the EPC contract for Upper Trishuli 1 to Doosan. ANDRITZ received the Notice to Commence (NTC) for the project from Doosan in December 2021. The construction period for the project is estimated at five years, with completion scheduled for December 2026.

ANDRITZ' scope of works includes the complete design, engineering, manufacturing, quality assurance, transportation, site installation, testing and commissioning of hydro-mechanical and electro-mechanical equipment. The hydro-mechanical scope mainly includes radial gates, vertical gates, trash rack, cranes, hoists, stoplogs and penstock with bifurcations. The electro-mechanical scope includes components for three units

each with a 72 MW vertical Francis turbine and salient pole generator, as well as electrical and mechanical balance of plant equipment and the automation system.

Once completed, Upper Trishuli 1 is expected to generate approximately 1,456 GWh of electricity per year, increasing Nepal's total power generation by approximately 20%.

The project will be operated and maintained by KOEN and will sell the power generated to the Nepal Electricity Authority (NEA), the off-taker, under a 30-year Power Purchase Agreement (PPA) that was signed in early 2018. The power bought from the project will be primarily consumed in Nepal.

ANDRITZ is proud to be part of this project, which is important to the increasing power generation in Nepal. ANDRITZ is retaining its leading position as a preferred "from water-to-wire" technology provider in the hydropower market in Nepal.

"Once in operation, Upper Trishuli 1 is expected to increase Nepal's total power generation by approximately 20%."

AUTHOR

Sameer Sahai
hydronews@andritz.com



1 HUMAYA

Total output new: 50 MW
Scope: 1 × 50 MW (one unit of the two installed)

2 ZIMAPÁN

Total output new: 304 MW
Scope: 2 × 152 MW

3 EL CARACOL

Total output new: 630 MW
Scope: 3 × 210 MW

4 INFIERNILLO

Total output: 400 MW
Scope: 2 × 200 MW
(only two units of the six installed)

5 LA VILLITA

Total output: 320 MW
Scope: 4 × 80 MW

CFE's
hydropower
refurbishment,
Mexico

Mexico – ANDRITZ is leading a consortium that has been awarded contracts for the major refurbishment of nine hydropower plants across Mexico. The contracts, worth some US\$ 892 million, came from Mexico's state-owned power producer the Comisión Federal de Electricidad (CFE) at the end of 2021.

CFE generates, distributes, and markets power to almost 100 million people and adds more than a million new customers every year. It owns 162 generating plants with an installed capacity of 43,723 MW, including

thermal, hydroelectric, and wind powered plants, as well as one nuclear power station. CFE also operates more than 992,000 km of transmission and distribution lines.

In July 2021, CFE invited companies to submit offers for the upgrading and rehabilitation of nine existing hydropower plants with a total combined capacity of more than 4,250 MW. The plants are Malpasó (1,080 MW), Dr. Belisario Domínguez "Angostura"

ABILITATION

NCE

MAZATEPEC
 Total output new: 244 MW
 Scope: 4 × 61 MW



PEÑITAS
 Total output: 420 MW
 Scope: 4 × 105 MW



MALPASO
 Total output new: 1,152 MW
 Scope: 6 × 192 MW



ANGOSTURA
 Total output new: 1,000 MW
 Scope: 5 × 200 MW



(900 MW), Ángel Albino Corzo "Peñitas" (420 MW), Mazatepec (220 MW), Infiernillo (currently only 400 MW), La Villita (320 MW), Ing. Carlos Ramírez Ulloa "El Caracol" (600 MW), Ing. Fernando Hiriart Balderrama "Zimapán" (292 MW), and Humaya (currently only 45 MW).

By taking advantage of the existing civil and electrical infrastructure, the aim of the comprehensive refurbishment program will be to increase the operational

lifespan of the plants by at least 50 years and to strengthen the national electricity system.

Following a rigorous technical and economic evaluation in November 2021, the CFE awarded the contract to a consortium led by ANDRITZ S.A. de C.V., working together with Generadores Mexicanos S.A. de C.V. (GENEREMEX), Hydroproject de Mexico, S.A. DE C.V. and Sistemas de Energía Internacional S.A. de C.V. (SEISA).

"The modernization of these nine plants will boost the estimated annual generation by some 1,754 GWh."





[Malpaso main transformers](#)



[Malpaso dam and spillway](#)

“The objective of the modernization is not only to increase the reliability of the power plants, but also to increase the operational life by 50 more years.”

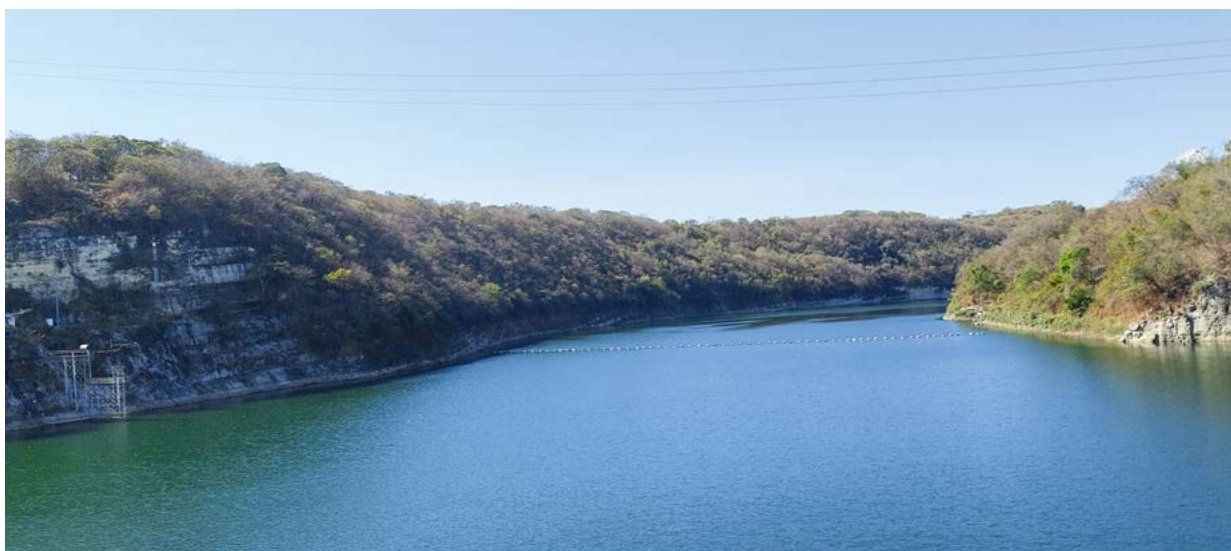
ANDRITZ S.A de C.V in Mexico has been based in Morelia, Michoacán since 1981 and offers comprehensive hydro-electric solutions for plants in Mexico, Central America, the Caribbean and South America.

The scope of supply includes design, manufacturing, supply, transportation, erection, testing and commissioning of 29 hydro generators, 17 turbines, 21 power transformers, 22 governors, three SCADA supervisory control and data acquisition systems, 27 static excitation systems and three protection systems, as well as the electrical power and associated auxiliary systems.

Since signing the contract in late November 2021, the consortium has been working on the project, which is scheduled to return the nine plants to service between 2023 and 2027.

Financial support will be provided by Agence Française de Développement (AFD), with a EUR 200 million (US\$ 232 million) of clean energy project investment over the next 25 years. This will include financial support for the rehabilitation and modernization of various hydro plants where the technology is more than 30 years old, which CFE says will “increase the generation of electricity, the useful life of the hydroelectric plants and the security of the infrastructure, as well as minimizing the environmental and social impacts

[Angostura reservoir from intake](#)





in the regions where they are located." A wider CFE investment plan includes a US\$ 4.85 billion longer-term initiative to increase nuclear, hydroelectric, wind and solar capacity, as well as a US\$ 4.46 billion overhaul of the company's transmission capacity.

With the modernization of these plants over the next five years, the total generation capacity will be boosted by 243 MW while the estimated annual generation will increase by some 1,754 GWh.

These contracts for upgrade of the units, some of them originally supplied by ANDRITZ predecessors in the 1960s and 1970s, are a further step in the long-term relationship with CFE, the largest electricity utility

in Mexico. The package of modernization of the nine power plants is representing one of the largest rehabilitation projects in the world, not only for ANDRITZ, but in the hydropower market.

ANDRITZ is very honored to be entrusted with the leadership of such a significant refurbishment program and to support CFE and the Mexican people on the path towards a more sustainable energy system.

AUTHOR

Marco Antonio Ramirez
hydronews@andritz.com

"This modernization project of all nine important hydropower plants represents one of the largest rehabilitation orders on the global hydropower market."

Angostura underground powerhouse



Green Financi

The Climate Change Conference of the Parties (COP26) in Glasgow, Scotland, confirmed the global ambition to address global warming and ANDRITZ is committed to contribute to these efforts. Along with internal measures, ANDRITZ develops and offers products that reduce or avoid emissions of greenhouse gases (GHG). But in addition to the usual technical and commercial inputs, ANDRITZ offers clients unique support in successfully implementing their projects. With energy prices sometimes bringing projects to the edge of feasibility, optimization of project costs and income is of crucial importance. As an innovative and reliable partner, ANDRITZ adds real value for our clients.

In 2018 an internal task force was established to broadly explore green financing

opportunities for hydropower projects. This small but efficient core team has investigated support schemes for sustainable projects, as well as different types of green certificates that can be generated and marketed. ANDRITZ sets up deal teams within the country or region and from the ANDRITZ locations involved with a focus on a range of activities that can make the economics of a hydropower project even more attractive.

CARBON CREDITS

According to international agreements based on the United Nations Framework Convention on Climate Change (UNFCCC), reduction or avoidance of CO₂ emissions qualifies for carbon credits also known as emission reduction certificates (ERCs). Such certificates

are issued by nominated (government) agencies in the project country. A reduction of one tonne of CO₂ is worth one credit. Calculation of reductions is rather simple: Each MWh of renewable energy is multiplied by a grid emission factor (GEF) indicating the energy mix in the specific country or region. The dirtier (in terms of coal or other fossil-fueled thermal plants) the existing energy mix, the higher the GEF.

The task force has established contacts with carbon credit and other green certificate traders in order to support ANDRITZ clients in generating and selling such certificates and we have obtained an offer and a draft offtake agreement from a prominent trader for one of our customers in Latin America, for example.

KEY STATISTICS ON REGIONAL, NATIONAL AND SUBNATIONAL CARBON PRICING INITIATIVES

65

Carbon Pricing initiatives implemented

45

National Jurisdictions are covered by initiatives selected

34

Subnational Jurisdictions are covered by the initiatives selected

In 2021, these initiatives would cover **11.65 GtCO₂e** representing **21.5%** of global GHG emissions

ng

Generating green certificates for the modern energy market

RENEWABLE ENERGY CERTIFICATES (RECS)

Producers of renewable energy can register their projects on international platforms for the issuers of Renewable Energy Certificates (RECs). Each MWh of production generates one REC.

The Japanese government has set up a program to support projects reducing CO₂ emissions, granting subsidies of 30–50% of eligible project cost in return for receiving half of the carbon credits or ERCs for a 20-year period. Due to a project-size limit, it is available for small hydro and rehabilitation schemes rather than large hydro. This program is available in 17 countries across Asia, Africa, the Middle East, and Latin America.

The ANDRITZ task force has established contacts with REC platforms and traders who are very interested in working together. ANDRITZ has already reached an agreement in principle with one client to prepare an application for two projects in Kenya, for example.

Do not hesitate to contact ANDRITZ if you have projects where ERCs, RECs or other low-carbon support measures could deliver a competitive advantage.

AUTHOR

Adolf Fraczek
hydronews@andritz.com

“ANDRITZ has set up a task force to explore green financing opportunities that can make the economics of a hydropower project even more attractive.”

TO BOLDLY GO WHERE NO ONE HAS GONE BEFORE

A daring
technological
breakthrough

SUCCESS STORIES — GERMANY, WEHR

**“Unconventional thinking
and the highest level
of technical expertise
have resulted in a unique
solution – the world’s most
powerful horizontal air-
cooled motor generator.”**

Germany – Since the end of 2021, the world’s most powerful horizontal air-cooled motor generator has been in commercial operation at the Wehr pumped storage plant in Germany. The successful commissioning of the new generator – allowing the plant to produce clean energy once again – marks the end of a very challenging project.

Providing about 1,000 GWh of clean and renewable energy per year, the pumped storage plant was originally built in the 1970s and has a total capacity of about 910 MVA in turbine mode and 980 MW in pump mode. With its four generating units, it is the biggest power plant in the portfolio of

Schluchseewerk AG and provides crucial grid balancing services for Schluchseewerk’s owners, EnBW and RWE.

A short circuit at the B09 generator occurred in September 2019 and a new generator was needed. The owners wanted a robust machine with high availability that could withstand a high number of load changes. After a long R&D design phase and numerous recalculations and simulations, ANDRITZ presented a compelling offer for a new high-efficiency generator. The new generator design was also very daring as the cooling system had been changed from water-cooled to air-cooled, lowering costs, increasing availability and improving maintenance friendliness. The design was very challenging with a nominal voltage of 21kV, unusual stator bar geometry and the re-use of the existing

TECHNICAL DETAILS

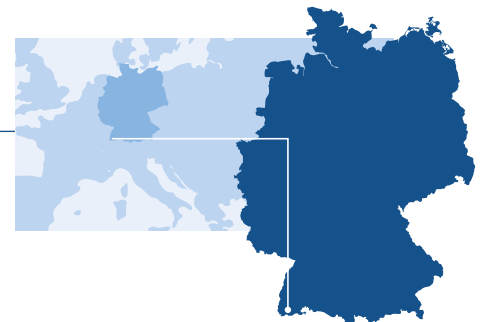
Wehr:

Total output: 980 MW / 910 MVA

Scope output: 300 MVA

Voltage: 21kV

Av. annual energy production: 1,000 GWh





In close cooperation with the customer, the ANDRITZ generator team installed the air-cooled motor generator of unit B09 in 2021.



With four generating units, Wehr is the biggest power plant in the portfolio of Schluchseewerk AG and provides crucial grid balancing services.

rotor. ANDRITZ deployed the considerable strengths of the Generator Competence Centers Vienna and Weiz, both in Austria, to enhance the project and they have demonstrated their impressive competence and willingness to think outside the box to deliver an exceptional technological solution. The result is a perfectly optimized product that meets all the customers' needs and requirements.

A PERSONAL TOUCH

A very personal touch makes this project even more appreciated. One of our project managers, who was involved in the project from the beginning and was also one of the driving forces behind this

excellent technical solution, Erwin Heimilcher, unfortunately passed away during the implementation phase of unit B09. In recognition of Erwin's contribution and both our and the customer's appreciation, the B09 generator now bears his name.

With this successful project ANDRITZ has set new records with the world's most powerful horizontal air-cooled motor generator. We are thrilled to have been part of this challenging project and to have supported the customer in restoring the power plant to its full capacity. This success speaks for itself. At the beginning of 2022 a contract for a further generator unit – B10 – was also awarded to ANDRITZ.



Name plate of unit B09

AUTHORS

Michael Fink
Marie-Antoinette Sailer
hydronews@andritz.com

GRID BOTTLENECKS AND BLACK-START CAPABILITIES

Bridging grid bottlenecks and black-start capability are two of the most important features of a pumped storage power plant, supporting grid stability with rapid response to changing demand or sudden outages.

In Wehr, state-of-the-art units move huge masses of water in a closed and weather-independent cycle between the upper reservoir, the Hornberg basin of 4.4 million m³, and the lower reservoir, the Wehra basin with a capacity of 4.3 million m³. Some 630 m of elevation separate the two reservoirs. Within seconds, electricity can be generated or stored as needed depending on what the power grids demand.

[Schluchseewerk AG](#)

“The aim is to secure reliable operation of the plants so that these ‘oldies’ can continue to generate clean hydropower for many years to come.”

Project Manager Øyvind Kristiansen.

Norway – Årlifoss and Grønvollfoss are two run-of-river plants located close to each other on the same river in Southeastern Norway. Owned and operated by Skagerak Kraft AS, a utility company with about 4% of total electricity output in Norway, both plants are equipped with Kaplan turbines and have an installed power of 26 MW and 32 MW, respectively. Årlifoss is the older of the two dating back to 1915, while Grønvollfoss began operations in 1933.

In 2020, ANDRITZ was awarded a large automation rehabilitation order for both hydropower plants. It is one of the larger ANDRITZ Hydro automation orders globally within service and rehabilitation with the project scope consisting of new control systems for the generators, common systems, water level, and gates, as well as the electric power systems (EPS). This combination of automation and EPS

is customary for hydropower contracts in Norway. The upgrades are being conducted as a single common project.

The project – compliant with the Machine Directive of the EU – is being executed as a collaboration between ANDRITZ locations at Jevnaker in Norway and Prague in the Czech Republic. A second contract for a mechanical upgrade at Årlifoss has also been awarded to ANDRITZ. Replacement of the rotor and other generator upgrades, a new Kaplan turbine, and a new high pressure oil unit for the turbine governor are included.

The project has progressed as planned with Phase 1 at Årlifoss, consisting of gate, water level, and station control completely installed and commissioned two weeks earlier than specified in the contract. Scheduled for November 2022, the second phase of the Årlifoss refurbishment is also on target with turbine controls, generator and 9.5 kV switchgear.

At the same time a full range of activities has been on-going at the Grønvollfoss site with the installation of the station supply part of the contract. To optimize logistics, the order of installation was reversed at Grønvollfoss, combining the engineering, installation,



**STABLE
RELIABLE**

and commissioning of the station controller with the water level regulator and the gate controller. The project will continue until 2024.

The project manager Øyvind Kristiansen is full of praise for the excellent level of cooperation with Skagerak Kraft: "We have been able to find good solutions with the customer during these times with high uncertainty in our sub-supplier markets. The customer was concerned that at least one generator was operating at all times as the power plants play a crucial role in supplying power to the small communities of Årlifoss and Grønvollfoss. Limited grid capacity makes it difficult to maintain stable power supply to these villages from the external grid".

Both power plants have undergone several previous upgrades since they were commissioned. Increased power output is not the objective of the ongoing effort, instead the aim is to secure reliable operation of the plants so that these "oldies" can continue to generate clean hydropower for many years to come. Although the project was planned before the current turmoil in global energy markets occurred, the circumstances make the project even more relevant. The project serves as a good illustration of the important role hydropower plays as a provider of stable and dependable clean energy.

AUTHOR

Erik Naess
hydronews@andritz.com

TECHNICAL DETAILS

Årlifoss:

- Total output: 26 MW
- Scope: 1 × 26 MW
- Head: 16 m
- Voltage: 9.5 kV
- Speed: 136.4 rpm
- Runner diameter: 4,500 mm

Grønvollfoss:

- Total output: 32 MW
- Scope: 2 × 16 MW
- Head: 23 m
- Voltage: 8.0 kV
- Speed: 200 rpm
- Runner diameter: 3,120 mm



E AND OPERATION

MORE OUTPUT

Brazil – ANDRITZ Hydro Brazil has completed the modernization and renovation of the Governador Bento Munhoz da Rocha Netto (Foz do Areia) hydro-power plant. With an installed capacity of 1,744 MW and four generating units of 436 MW each, the plant is located on the Iguaçú River in the state of Paraná in Brazil. It is owned by Brazilian utility COPEL and is the company's largest installed power station.

Work began at Governador Bento Munhoz da Rocha Netto in 1975 and commercial operation started in 1980 with the completion of the dam.

The modernization contract comprised the rehabilitation of four complete turbine units and the turbine model test in an independent lab. The scope of supply included four new Francis runners, new supply of shaft seals, auto lubricating distributor bushings, head cover drainage system, piping and valves, and aeration system through shaft. In addition, the contract included refurbishment of the draft tube cone, bottom ring, stay ring's vane profile, wicket gates, inner head cover, head cover, distributor mechanism, regulating ring, servomotor, guide bearing segments and turbine shaft run out and machining. The supply comprised further

four new turbine governors including digital governor panels, complete HPU and air compressors, four new excitation systems, and spare parts. Transportation to site, installation supervision, and commissioning was also included in the contract.

Lasting six years, the modernization and refurbishment project marked the largest overhaul of Francis turbines ever undertaken by ANDRITZ. The modernization encompassed plant engineering, field services, disassembly, assembly, and commissioning of the equipment, in addition to provision of ANDRITZ'

"Lasting six years, the project marked the largest overhaul of Francis turbines ever undertaken by ANDRITZ."



MORE ENERGY

unique automation solutions for the hydropower market. Also, to meet the contractual milestones safely, together with engineering and manufacturing from ANDRITZ Hydro Brazil in Araraquara (São Paulo), one of the rotors was produced at the ANDRITZ manufacturing site in Ravensburg, Germany.

The partnership between ANDRITZ Hydro Brazil and COPEL began in October 2015, with a major technological and logistical challenge for both companies.

The modernization of the last unit was completed

14 days ahead of the contractual deadline and, as a result of the strict safety protocols of ANDRITZ and COPEL, during the entire execution no accidents were recorded.

Upon completion of the project, there was a 12% increase in the plant output.

ANDRITZ Hydro Brazil is very pleased with the success of this modernization project which demonstrates the cutting-edge technology applied, and the strong commercial and personal relationships and shared commitment between the teams.

TECHNICAL DETAILS

Foz do Areia (Governador Bento Munhoz da Rocha Netto):

- Total output: 1,744 MW
- Scope: 4 × 436 MW
- Head: 146.5 m
- Voltage: 16.5 kV
- Speed: 128.6 rpm
- Runner diameter: 6,104 mm



AUTHORS

Karla Silva
 Ricardo Calandrini
 Marcelo Malafaia
hydronews@andritz.com



ES SD

As part of a major rehabilitation and modernization project, ANDRITZ is supplying six new Main Inlet Valves (MIV) for one of Europe's largest pumped storage projects – Dinorwig.

Wales – Located under an abandoned slate quarry in Elidir mountain near Llanberis in North Wales in the UK, Dinorwig pumped storage plant (PSP) has a capacity of about 1,728 MW, making it one of the biggest pumped storage plants in the world. The station complex consists of a series of caverns excavated within the slate mountain and the main cavern is considered to be the biggest man-made cavern in Europe. These caverns house the mechanical and electrical equipment, as well as operational rooms including the control room.

"Dinorwig pumped storage plant has a capacity of some 1,728 MW, making it one of the largest pumped storage plants in the world."

Fully commissioned in 1983 after a construction period of 10 years, the plant provides balancing services, including reserve and response, for the UK grid system and plays a vital role in the safeguarding of the national grid.

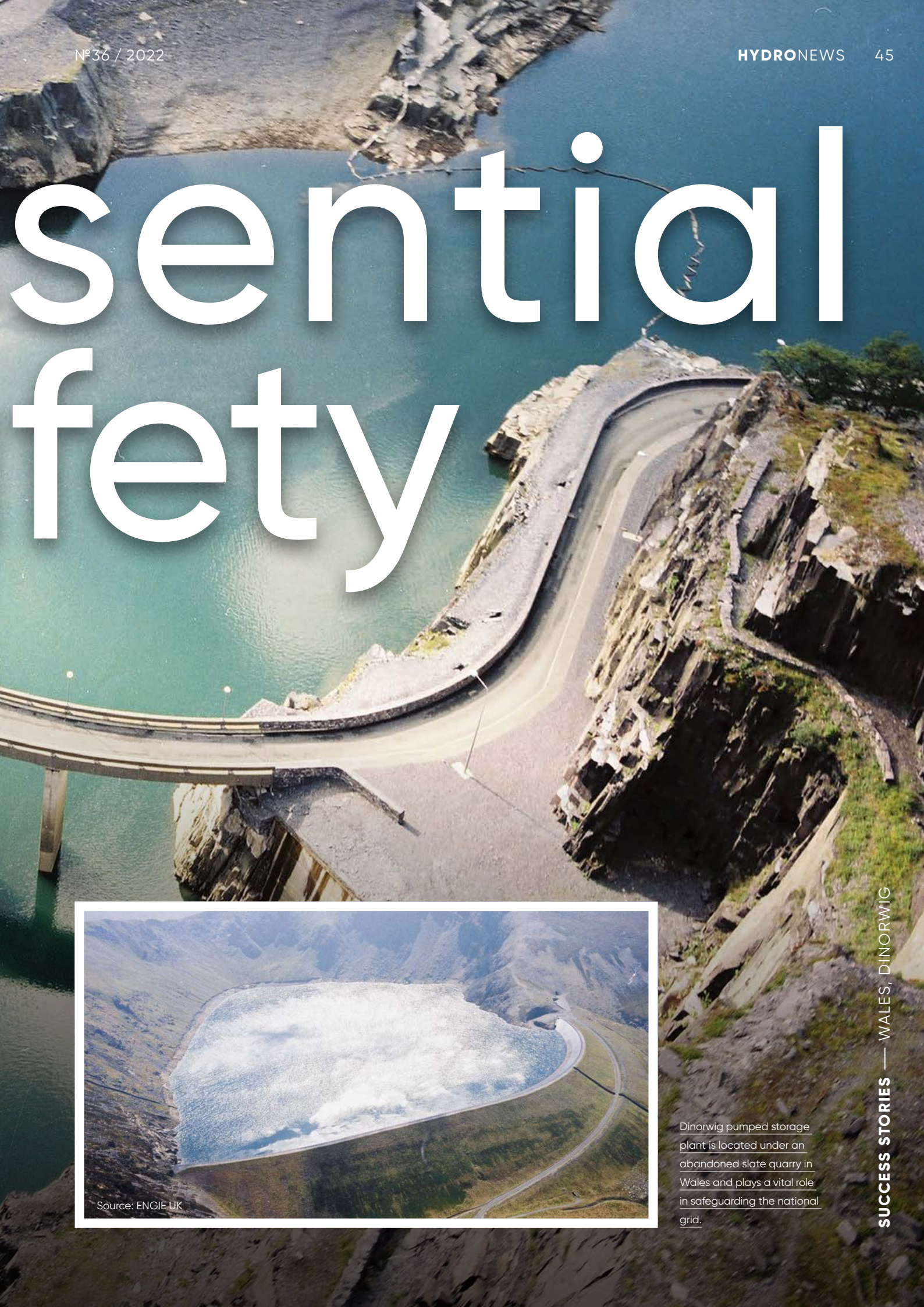
Power at the Dinorwig complex is generated by six vertical reversible Francis-type pump turbines,

each rated at 330 MVA. The exceptional characteristics of the PSP complex can also be found in the configuration of the hydraulic system.

With a maximum gross head of 546.7m between the upper and lower reservoir, the plant features a single concrete lined pressure shaft tunnel with a diameter of up to 10.5m. A high-pressure manifold divides this tunnel into six concrete lined branches to serve each machine. A steel shaft lining and a reduction in the shaft diameter to that of the MIV begin shortly before reaching the underground station complex.

Main inlet valves fulfill various important tasks in hydropower applications. From ensuring safety in powerhouses to tightly sealing waterways for maintenance on hydraulic machinery, they have to cope with a lot of conditions and need to be resilient for the intended duty at all times.

essential fety



Source: ENGIE UK

Dinorwig pumped storage plant is located under an abandoned slate quarry in Wales and plays a vital role in safeguarding the national grid.

→ However, when mechanical components of this importance are approaching the end of the design life, replacement or rehabilitation is mandatory.

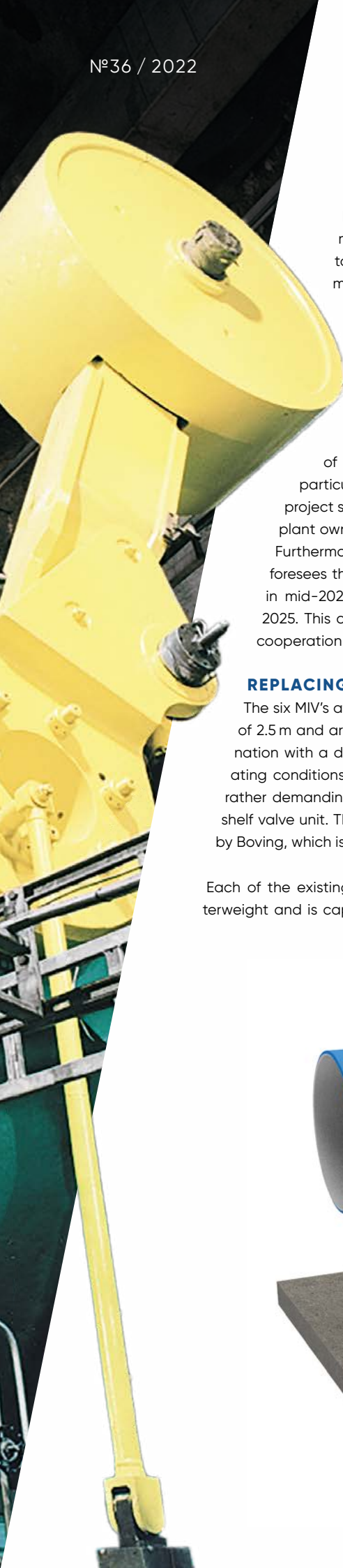
PLANT OVERVIEW

As all six hydraulic units are supplied by a single hydraulic system and six penstocks, at Dinorwig the role of the main inlet valves is of utmost importance for the maintenance of the turbine units. They are the only point of isolation between the pump turbine and high-pressure penstock. Simultaneously, this implies that none of the main inlet valves can be replaced without shutting the plant down and draining the entire 1,728 MW complex. Consequently, the operator is extremely focused on the reliability of critical,

non-replaceable components and efficient maintainability of MIV components. Since commissioning, the hydraulic system upstream of the main inlet valves has never been fully drained down.

Nonetheless, after nearly 40 years of operation, the main mechanical components of the MIVs are approaching the end of the design life. Rehabilitation of the MIVs or partial replacement of components was not possible for technical and business reasons. Consequently, international technology group ANDRITZ received an order for the supply of six new spherical valves. The ANDRITZ scope of supply comprises the design, manufacture, supply, installation, and commissioning of six spherical valves including governors.





This contract was placed by First Hydro Company, one of the UK's most dynamic electricity generators and which is responsible for the management and operation of the pumped storage plants at Dinorwig and Ffestiniog in the Snowdonia region of North Wales. First Hydro Company is itself owned 75% by ENGIE and 25% by Brookfield.

The outstanding characteristics of this power plant complex with its particular boundary conditions make this project special for both the pumped storage plant owner and the valve supplier, ANDRITZ. Furthermore, the ambitious project timetable foresees the installation of the first two valves in mid-2023, and the remaining four in mid-2025. This can only be achieved through close cooperation and collaboration.

REPLACING DINORWIG'S MIVs

The six MIV's at Dinorwig have a nominal diameter of 2.5m and are of spherical valve type. In combination with a design pressure of 80 bar, the operating conditions of the valves can be classified as rather demanding. Clearly, they are not an off-the-shelf valve unit. The original equipment was supplied by Boving, which is now part of ANDRITZ.

Each of the existing valves is equipped with a counterweight and is capable of being opened from a fully

closed position within 10 seconds. As might be expected, the valves are executed in a rather robust manner with a core weight of some 150 t. However, the main bearings were not designed sufficiently to the task and faced some issues. This facilitated the decision to fully replace all six units instead of choosing a rehabilitation or partial replacement approach.

"Supplying all six hydraulic units with a single penstock, at Dinorwig the role of the main inlet valves is of utmost importance for the maintenance of the turbine units."

For the replacement valves the following mandatory minimum requirements are in place:

- Maintain existing interfaces, including MIV plinth
- Minimize overall penstock drain down period
- Applied operational forces must not exceed the capacity of the existing system
- Achieve rapid opening of 10 seconds or less
- MIV components designed for continuous operation of 30 years without major rehabilitation requiring penstock drain down
- Ensure ease of maintenance of wearing components
- Respect existing crane constraints →



The new MIV will be equipped with a more robust and larger main bearing, resulting in a re-evaluation of the drive concept.

“The new MIVs of Dinorwig are the first spherical valves of ANDRITZ, which are intended for condition monitoring right from the beginning.”

→ The new MIV will be equipped with a more robust and larger main bearing, resulting in a re-evaluation of the drive concept. Double oil-controlled servomotors instead of counterweights reduce overall dynamic load, directly mounted servomotors instead of floor anchored ones avoid time-consuming civil works. The corresponding oil control and supply concept is specifically designed to reduce the amount of oil used during movement, ensuring not only safe operation but also considering modern operation requirements while guaranteeing the MIV opening time.

The new MIVs of Dinorwig are the first spherical valves of ANDRITZ, which are intended for condition monitoring right from the beginning. Through integration of additional sensors in the mechanical, oil and water hydraulic system, a condition monitoring of the equipment will be enabled. A modern local SCADA-system and the integration to the ANDRITZ Metris DiOMera platform are key to enabling condition-based or predictive maintenance of components. Regular processing of the

evaluated data and information provided by ANDRITZ to the customer helps to prevent a system failure and extend its service life through specific measures.

To meet all these core requirements, the overall concept must be evaluated by both the customer/operator and the supplier, bringing together operational and maintenance experience and design know-how from the equipment manufacturer. In order to complete this technically and commercially demanding project in a timely manner and in a way that is acceptable to both parties, coordination from the earliest stages of the project was of utmost importance. Using this collaborative approach, targets could be defined at an early stage and corresponding concepts developed in advance of the contract signature.

ANDRITZ is very honored to be awarded this key contract for this important pumped storage plant. With our extensive experience of spherical valves and pumped storage technology, ANDRITZ is committed to supply the new main inlet valves for Dinorwig in a timely fashion and to the utmost satisfaction of the customer. In doing so, Dinorwig will continue to fulfill its vital role in maintaining the UK's national electricity system for decades to come.

Assembly of valve rotor into MIV housing



Crack inspection on sealing surfaces of the valve rotor



TECHNICAL DETAILS

Dinorwig

Total output: 1,728 MW

Head: 546.7 m



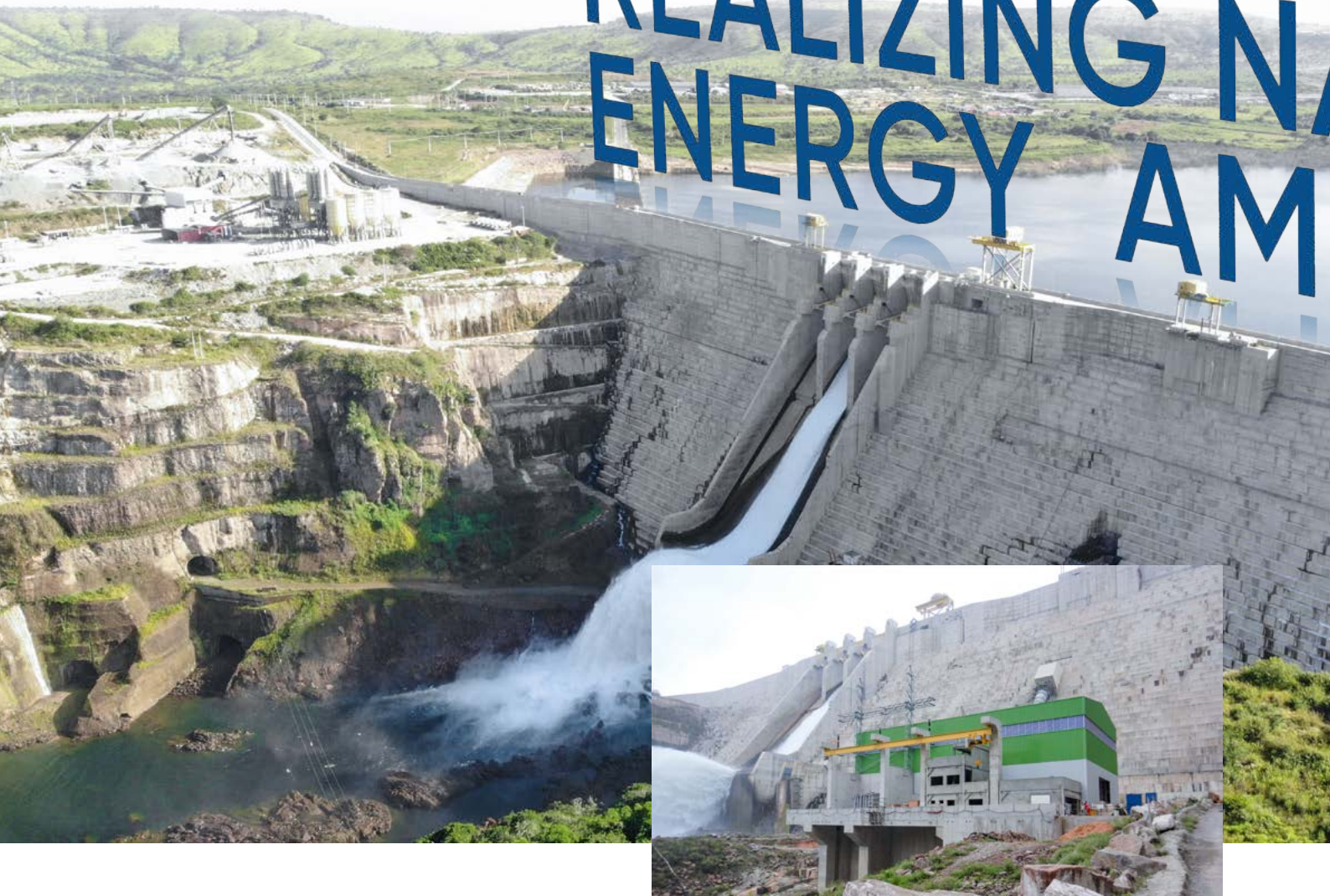
AUTHOR

Benjamin Roelle
hydronews@andritz.com

Photogrammetric
measurement of the
machined spherical
valve body



REALIZING NATIONAL ENERGY AMBITIONS



All units of Laúca are running smoothly to the satisfaction of the owner and operator, stabilizing the national grid and meeting dynamic changes in power demand.

Angola – With a capacity of more than 2 GW, Laúca is the largest hydroelectric power plant in Angola and the second biggest hydroelectric power facility in Africa. Located nearly 300 km away from the capital city Luanda and on the border between the provinces of Kuanze-Norte and Malanje, construction of the dam created a reservoir with an area of nearly 200 km² holding about 5.5 billion m³ of water.

The main powerhouse is over 270 m long and features six units designed, built and installed by ANDRITZ. Each has a rated power of 335 MW. A separate smaller powerhouse includes an ECO-flow unit which produces about 70 MW.

Nearly a decade in development, construction on the Laúca hydropower plant started in July 2013. At the beginning of 2014, ANDRITZ was contracted to provide the complete electro-mechanical scope of both powerhouses, transformers, and additional components for the switchyard.

Developed in the context of a rapidly growing economy – Angola at that time had one of the fastest

growing economies in the world – the development also had to support and respect the environment, the fauna and flora, social aspects and more.

The first turbine was commissioned in July 2017, with the sixth and final turbine beginning operations in December 2020. Now able to provide approximately 8,640 GWh per year, Laúca not only increased the available electrical power, it is also the backbone of modern grid regulation in Angola. The power capacity and the number of units permit the local operator to stabilize the grid across a large part of the country and to meet dynamic changes in power demand. Furthermore, the excess capacity available also allows the operator to effectively schedule equipment maintenance without impacting the network, permitting much more efficient administration of Angola's power system.

“Laúca is providing about 8,640 GWh per year, enough electrical energy to serve the demand of about 8 million households.”

ATIONAL BITIONS



Laúca increases not only the available electrical power, it is also the backbone of modern grid regulation in Angola.

TECHNICAL DETAILS

Laúca:

Total output: 2,070 MW

Scope: 6 × 338 MW (Main) / 1 × 72 MW (Eco)

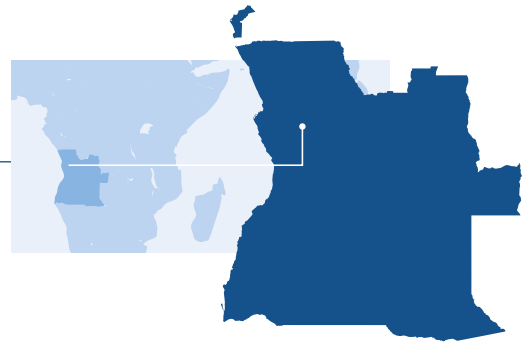
Head: 200 m (Main) / 118 m (Eco)

Voltage: 6 × 18 kV (Main) / 1 × 15 kV (Eco)

Speed: 200 rpm (Main) / 233.77 rpm (Eco)

Runner diameter: 4,790 mm (Main) / 3,220 mm (Eco)

Av. annual energy production: 8,640 GWh



The main powerhouse is over 270 m long and features six units, each with a rated power of 335 MW.

To support the development of a local skilled workforce, ANDRITZ supplied a new technical training center that includes modern laboratories. The positive impact of such social aspects also allows the development of more infrastructure like schools and hospitals and presents a benefit for all the people that live in the region.

And by the way, ANDRITZ' Metris DiOMera system is able to support superior management of the power plant by offering remote monitoring and enhanced functionality capabilities such as predictive maintenance. Correctly performed, such an approach can allow maintenance intervals to be considerably extended. And, because of its remote capabilities, these outcomes can be achieved without the need to travel to the powerhouse, resulting in both environmental and economic gains.

In the specific case of Laúca, a software update and partial commissioning of supplied components

was urgently needed in the middle of the Covid 19 pandemic when restrictions on travel were in place. This task was completed from the ANDRITZ location in Germany, assuring the safety and reliability of the plant even when achieving physical access was extremely challenging.

Today, all units are running smoothly. The owner of Laúca – Gabinete de Aproveitamento do Médio Kwanza (GAMEK) – is very pleased with the performance. Angola is among the countries with the largest hydroelectric potential in Africa and aims to have two thirds of national generation capacity coming from hydropower by 2025 as part of its vision to achieve much greater energy access for its people.

ANDRITZ is very proud to play a role in reaching that goal with its work supporting the development of clean sustainable hydropower and plants such as the beautiful hydropower giant that is Laúca.

AUTHOR

Franco Bennati
hydronews@andritz.com

PUMPS TO PROTECT FARMLA

TECHNICAL DETAILS

Doan Ha:

Scope: Two concrete volute pumps

Head: up to 8.2 m

Flow rate: up to 100,000 m³/h

Efficiency: up to 88%



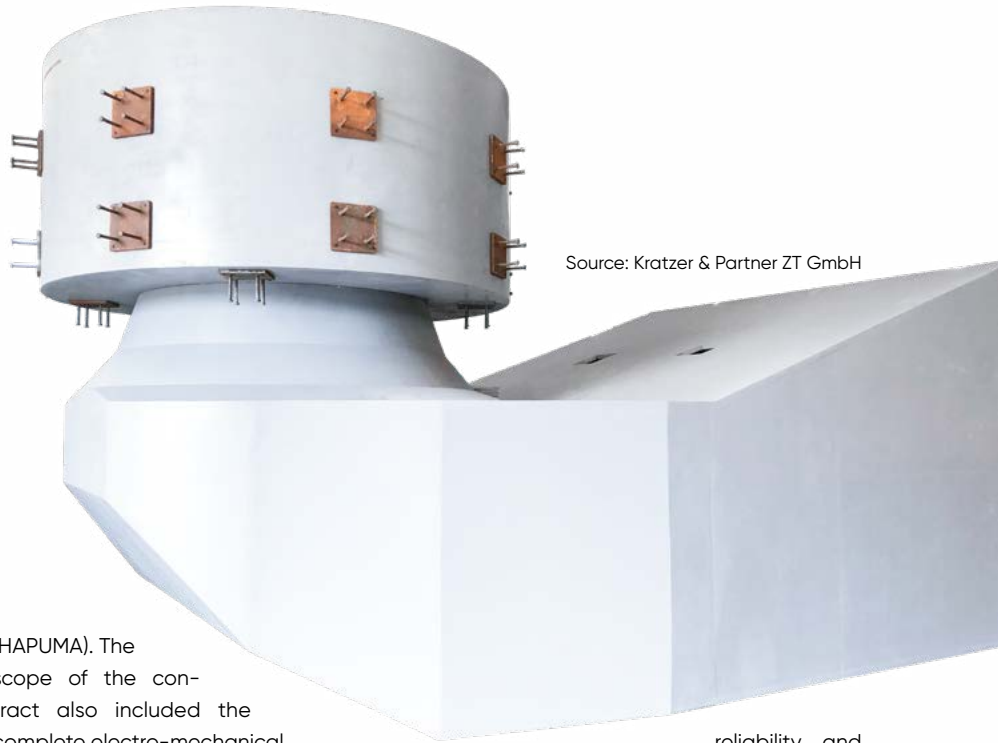
Vietnam – As the value of agricultural exports rose significantly beginning in the 1980s, Vietnam became the world's top exporter for black peppercorns and cashew nuts. In addition, the country ranks among the top 10 exporters of coffee, coconuts, rice, rubber, sweet potatoes, and tea. Agriculture is therefore not just an important part of the country's GDP, but also continues to be one of its most important employment sectors. However, with a total annual precipitation of some 640 billion m³, Vietnam is one of the rainiest countries on earth. This rainfall is not always distributed ideally over time and between regions. Heavy incessant rain has resulted in rivers and

streams bursting their banks, regularly causing flooding, and damaging agricultural productivity. Climate change is making this situation continually worse.

As a result, different strategies have been developed in the past few decades to deal with not only these challenges, but also with the dynamic economic growth in the water sector. In addition to refurbishment and expansion of existing irrigation systems, these strategies also include building flood protection systems. Among them is the pumping system in the Thanh Thuy district of Phu Tho Province, situated in the north-eastern part of the country. The most important industry in the region is the cultivation of tea, producing about 100,000 t per annum.



ND



Source: Kratzer & Partner ZT GmbH

In order to increase productivity and crop yield, improve living standards and the environment, and reduce poverty in the region, a new pumping station was built. The Doan Ha station has the capacity to reliably irrigate up to 672,000 m² of paddy land creating the infrastructure needed for the formation of large fields. In addition to irrigation, the two pumps installed in the station can also drain up to 2,122,000 m² of agricultural land if necessary.

In 2018, after equipping the largest flood protection plant in Vietnam – Yen Nghia, near Hanoi – with 10 vertical line shaft pumps, ANDRITZ was awarded the contract to supply two concrete volute pumps in a joint venture with a Vietnamese partner, Haiduong Pump Manufacturing JSC

(HAPUMA). The scope of the contract also included the complete electro-mechanical equipment for the Doan Ha pumping station.

The pumps were designed especially for this project. Each has a 1,000 kW motor and achieves a rated flow of 12.5 m³ per second. The pumps reach an efficiency of up to 88%, while the motors can achieve efficiencies of up to 96% at 100% output.

The pumps transport rainwater, river water and contaminated flood water, for example. Both pump-motor units are also equipped with a fully automated monitoring and control system to ensure highest

reliability and round-the-clock operational readiness. The pumps and their components are designed to achieve more than 70,000 operating hours.

The commissioning and start-up of both units was successfully completed in 2021. Since then both units have continued to meet all customer expectations and make a significant contribution to securing productive farmland in Vietnam.

AUTHORS

Klara Gölles
Alois Bacher
hydronews@andritz.com



WE CARE

ACHIEVING SUSTAINABILITY AND TRANSPARENCY THROUGH INTERNATIONAL STANDARDS

Sustainability has always been an integral part of the ANDRITZ GROUP'S corporate philosophy. It is a critical factor for long-term success and is an important element of the company's corporate strategy. This is reflected in the daily work of every employee, as well as the management principles and business relationships across the Group.

Part of our sustainability program is a structured certification process for our products and services. International standards benefit us all by ensuring consistency and safety and also facilitate

better global collaboration and compatibility. Achieving ISO standards means ANDRITZ can not only meet growing customer requirements, but also steadily improve its processes, products, and services. ISO certification ensures quality and consistency across the group and, as a solid foundation for international business, supporting our long-term continuity. As the standards are accepted and integrated worldwide, being ISO certified ensures credibility and compatibility. These characteristics are also better understood and more easily communicated to customers and employees alike.

QUALITY MANAGEMENT

Standards are all about quality. Quality Management at ANDRITZ Hydro means quality of products, quality of processes, and quality in safety and environmental issues.

Besides a Quality Management System supported through ISO 9001:2015, the Environmental Management System backed by ISO 14001:2015, and the Occupational Health and Safety Management System based on ISO 45002:2018, ANDRITZ Hydro has also focused on two further ISO certifications, ISO 55001:2014 for asset management and ISO 27001:2013, which relates to information security.

"An ISO management system allows us to become better and to prove progress towards our goals."

**ISO 55001:2014
ASSET MANAGEMENT SYSTEM**

ANDRITZ positions itself as a top-tier partner for the operation and maintenance of hydropower plants and is also steadily expanding its service business. To better support this approach, a decision was taken to implement ISO 55001 certification for our O&M asset management system.

This standard establishes the requirements to guarantee an asset management system

capable of maximizing performance and mitigating risks. It supports the reliable and safe operation of plants and drives efficient functioning in accordance with all regulations despite the aging of the installations, changing rules and regulations and the evolution of the economy and performance demands on the plant. It also helps to identify critical assets within a plant, evaluate their condition and performance, and support appropriate investment strategies for their maintenance and/or replacement.

Today, several international ANDRITZ Hydro locations have already achieved ISO 55001:2014 certification. With fully functional local monitoring centers, O&M teams in Italy, India and Indonesia are proud to be able to optimize the perfor-

"The ISO 55001 certification is an important milestone for our O&M services helping to optimize hydropower assets and maximize customer revenues."

mance of our clients' hydropower assets and, by doing so, increasing their revenue.

To learn more about ANDRITZ Hydro's O&M business see our web page www.andritz.com/products-en/hydro/products/hydropower-services

or read the cover story of Hydro News issue No.33 www.andritz.com/hydro-en/hydronews



→ ISO 27001:2013 INFORMATION SECURITY MANAGEMENT SYSTEM

Often working on critical infrastructure, ANDRITZ Hydro's Automation business demands an elevated standard of information security for our customers. Increasingly, this means meeting or exceeding industry standards like ISO 27001, which led to the decision to establish an Information Security Management System (ISMS).

As of February 2022, after more than a year of elaboration and documentation,

we are proud to report that the initial certification of ANDRITZ Hydro Austria has been achieved. This will allow us to quickly respond to our customers' security requirements and abbreviates any need for discussion of the details and further evidence of our established standards.

Of course, we are always working to improve our standards further and to drive the certification process for IT-Security Management System forward in other locations across the global ANDRITZ GROUP.

All ISO certifications work together and are complementary. They also contribute to the Sustainable Development Goals

“Meeting ISO 27001 guarantees that we will manage the security of assets in a safe and controlled way.”

established by the UN. With its commitment to sustainability and transparency, ANDRITZ' pursuit of certification to ISO standards ensures the quality of our processes, products, and services. It proves beyond any doubt that we care.

To find out what else ANDRITZ Hydro is doing to keep your assets cybersecure, please read the article on Cybersecurity of Hydro News issue No.35.

www.andritz.com/hydro-en/hydronews

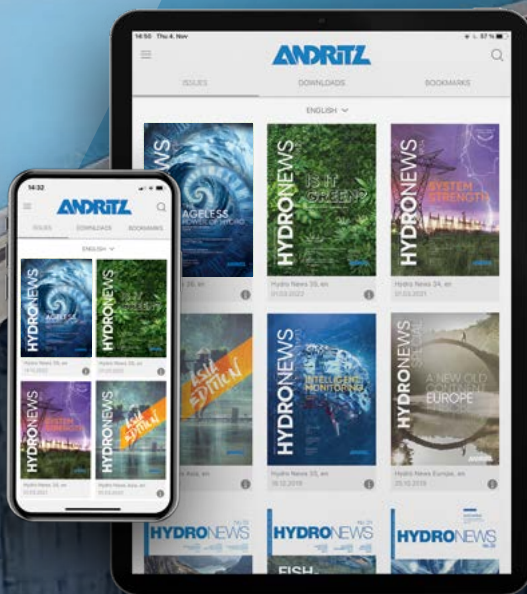
AUTHOR

Marie-Antoinette Sailer
hydronews@andritz.com



HYDRO NEWS

NOW ON YOUR MOBILE



TAKE YOUR HYDRO NEWS WITH YOU WHEREVER YOU GO

Hydro News is published on a regular basis and for more than 20 years has continued to provide the latest news about ANDRITZ hydropower projects and special topics such as key market trends and technology developments.

Now, by downloading the free Hydro News app you can immediately access not only the latest edition of our customer magazine but also our archive. Additionally, we are providing all our brochures in all available languages as well as Flash News related to selected projects.

Available on both Android and Apple mobile devices, now you can get Hydro News on the go.

Free – always available – all issues – all languages

Just one click away



The ANDRITZ GROUP

ANDRITZ is an international technology group offering a broad portfolio of innovative plants, equipment, systems and services for the pulp and paper industry, the hydropower sector, the metals processing and forming industry, pumps, solid/liquid separation in the municipal and industrial sectors, as well as animal feed and biomass pelleting. Plants for power generation, flue gas cleaning, recycling, and the production of nonwovens and panelboard complete the global product and service offering. Innovative products and services in the industrial digitalization sector are offered under the brand name Metris and help customers to make their plants more user-friendly, efficient, and profitable. With headquarters in Graz, Austria, the Group has more than 280 production sites and service and sales companies worldwide.



More than
26,800
Employees



More than
280
Sites



More than
40
Countries

OUR VISION

In our chosen markets, we are global leaders with a passion for innovative engineering solutions. As a technology and quality leader, we create sustainable value for our customers and shareholders, thus ensuring the continuation of our long-term profitable growth.

OUR ESG VISION

We are among the best in class regarding sustainability in the markets we serve, and we create maximum value added for all our stakeholders. As a leader in sustainability, we focus on responsible corporate governance and on ensuring a safe and viable future for society, our employees, and all other stakeholders. We take pride in creating sustainable and durable products that contribute towards conserving natural resources and protecting the environment and climate.

OUR MISSION

We drive the success of our customers through innovative and quality engineering and services, and we form strong and sustainable relationships with a positive impact for key industries and for the planet. The world keeps changing, our passion stays the same.

ANDRITZ
SHARE PRICE:
(as of August 31, 2022)
EUR 46.38

KEY FINANCIAL FIGURES BUSINESS YEAR 2021

Order Intake

7,879.7 MEUR

Order backlog (as of end of period)

8,165.8 MEUR

Revenue

6,463.0 MEUR

Net income (including non-controlling interests)

321.7 MEUR

26,804 EMPLOYEES

(as of end of period; without apprentices)

Changes in the ANDRITZ AG Executive Board



Wolfgang Leitner,
new member of
the Supervisory
Board of
ANDRITZ AG

At the annual meeting of shareholders in April 2022, Wolfgang Leitner was elected as new member of the Supervisory Board of ANDRITZ AG. He was a member of the ANDRITZ AG Executive Board for 35 years, thereof 28 years as President and CEO. Under his tenure, ANDRITZ developed to a successful global market leader in all of its business areas. The all-time record year for ANDRITZ in 2021 marks the absolute peak of his successful leadership.



Joachim Schönbeck,
new President
and CEO of
ANDRITZ AG

The new President and CEO of ANDRITZ AG – Joachim Schönbeck – has taken over for Wolfgang Leitner.

Joachim Schönbeck joined ANDRITZ as member of the ANDRITZ AG Executive Board in October 2014. Since then, he has made a substantial contribution towards the very successful development of the Pulp & Paper Capital Systems and the Metals Processing segments for which he was responsible. In his new function, Joachim Schönbeck oversees several Group functions and continues to be responsible for the Pulp & Paper Capital Systems segment.



Domenico Iacovelli, newly
appointed
member of the
Executive Board
of ANDRITZ AG

Domenico Iacovelli, who has held various management positions in the ANDRITZ GROUP since 2011 and been chairman of the Schuler AG Executive Board since April 2018, was appointed as a new member of the Executive Board of ANDRITZ AG as of April 2022. Domenico Iacovelli has successfully adjusted the Schuler Group to the very challenging market conditions over the past few years and thus laid the foundation for positive development of the company. In addition to his tasks on the Executive Board of ANDRITZ AG for the entire Metals business area, Domenico Iacovelli will continue in his function as chairman of the Schuler AG Executive Board.



ANDRITZ AG
celebrating its
170th anniversary

What began in 1852 with the production of metal goods such as wire nails, chains, iron gratings and grave crosses developed into a market-leading, globally operating technology group.

170 years ago, the Hungarian Josef Körösi established the "k. k. privilegierte Maschinenfabrik und Eisengießerei" in ANDRITZ near Graz, thus laying the foundation for today's ANDRITZ GROUP.

SUPPLYING MORE HOUSEHOLDS WITH

Tolga, Norway

SMALL HYDRO

HIGHLIGHTS

Following successful commissioning, in May 2021 the Tolga hydropower plant in Norway was handed over to the customer. Located in the municipalities of Tolga, in the community of Innlandet some 360 km north of Oslo, this new run-of-river power plant is equipped with three identical 15 MW compact Francis turbines. Although there is no intake dam the power plant does have a threshold dam and utilizes a fall of 88 m in the Glomma River through the center of Tolga from Hummelvoll and down to the foot of Eidsfossen. In the threshold pond there are three fishing runs so that fish can migrate both up- and downstream at all water flows.

Back in 2018, ANDRITZ was awarded a contract to supply the complete electro- and hydro-mechanical equipment for this project as a "from water-to-wire" concept. The extensive contract comprised design, manufacturing, and delivery of electro-mechanical equipment, including turbines, main inlet valves, inlet pipes, hydraulic pressure units, electronic turbine governor, and generators including excitation systems. The contract further included the complete electrical system

with automation and electrical power systems (EPS). Mechanical equipment installed in the waterways included trash racks, intake gates, draft tube gates as well as cooling and bilge systems, and a 70 t overhead crane. Installation, supervision, and commissioning rounded out the scope of the contract.

The power plant's owner, AS Opplandskraft DA, is itself owned by Hafslund Eco with a 75% stake and Akershus Energi with the remaining 25%. Tolga is operated by Hafslund Eco's personnel in Nord-Østerdal.

Despite the challenges due to COVID-19 and all related security and health measures, the project was completed in May 2021 and handed over to the customer five months earlier than originally scheduled.

ENVIRONMENT AND SUSTAINABILITY – A FISH-FRIENDLY HYDROPOWER PLANT SOLUTION

The powerhouse of Tolga is a compact station built without the "four-floor" solution found at traditional power plants of this size. The facility has three identical

TECHNICAL DETAILS

Tolga:

Scope: 3 × 15.41 MW / 3 × 20 MVA

Head: 88 m

Voltage: 13.2 kV

Speed: 428.6 rpm

Runner diameter: 1,500 mm

Av. annual energy production: 205 GWh



THAN 10,000 TH ENERGY

compact Francis turbines installed. The units are defined as compact “standard turbines” by ANDRITZ. This results in significant savings in design hours and tonnes of steel needed. Rock extraction within the power station area was also reduced by approximately 25% when compared with a traditional solution.

“This type of intake trash rack has never been built in Norway before. It prevents fish from swimming into the turbine at all.”

In order for a hydropower plant to qualify within the sustainability criteria of the EU taxonomy system, requirements are set that the natural migration routes for fish in the watercourse are maintained past the power plant. In traditional power plants, fish will swim into the intake and can be harmed in encounters with turbines.

The Tolga power plant is unique as the intake structure is built in such a way that the fish are completely prevented from swimming into the turbine. Its intake trash rack has openings of only 15 mm width and is at a low angle to the water flow. Such intake racks have never been built in Norway before but make it possible for the fish to be led safely past the intake to a bypass passage. This arrangement allows migrating fish to pass the structure completely unharmed.

With an estimated annual production of approximately 205 GWh, Tolga supplies enough power for over 10,000 households. ANDRITZ is proud to have been part of this environmentally friendly project.

AUTHOR

Håvard Haugstulen
hydronews@andritz.com



Powerhouse of Tolga. The new run-of-river power plant is equipped with three identical 15 MW compact Francis turbines.

A fish-friendly hydropower plant solution. The intake racks make it possible for the fish to be led safely past the intake to a bypass passage.



SMALL HYDRO

INCREASING INDONESIA'S RENEWABLE ENERGY CAPACITY

Cikaengan 2, Indonesia

The commissioning and handing over of two 3.65 MW horizontal Francis units signals the completion of works for the Cikaengan 2 hydropower plant in Indonesia.

Located 265 km from Jakarta in Garut, West Java, Cikaengan 2 is a run-of-river mini hydropower scheme using the flow from the Cikaengan River. Commercial operations at the plant began in December 2021 and it now produces renewable and sustainable electrical power for the region.

ANDRITZ was awarded this contract by PT Cikaengan Tirta Energi, a subsidiary of Nippon Koei Co. Ltd., Japan. The contract covered design, manufacturing, transportation, installation, and commissioning of the penstock, gates, the complete electro-mechanical equipment, as well as the electrical and mechanical balance of plant. Communication, control, protection, and excitation systems completed the scope of the contract. Cikaengan 2 is the first hydropower plant ever built by Nippon Koei Co. Ltd and the project was executed by a consortium of ANDRITZ Hydro India and ANDRITZ Hydro Indonesia.

The scheme included a diversion of the Cikaengan River inflow through a waterway via an open-type sand trap. The flow subsequently passes through a power tunnel and up to a forebay, where it leads to the powerhouse through a surface penstock.

A 20 kV transmission line connects this plant with the JTM PT PLN (Persero) network and to the Garut Regency of Indonesia. The estimated energy production of the plant is 46.7 GWh of renewable and sustainable power every year.

AUTHOR

Manoj Agarwal
hydroneews@andritz.com



TECHNICAL DETAILS

Cikaengan 2:

Total output: 7.3 MW

Scope: 2 × 3.65 MW

Head: 101.55 m

Voltage: 6.6 kV

Speed: 750 rpm

Runner diameter: 780 mm

Av. annual energy production: 46.7 GWh



GOING THE EXTRA MILE

Nam Kong 3, Lao PDR



ANDRITZ has successfully commissioned and handed over the 54 MW Nam Kong 3 project. Nam Kong 3 is a storage hydro-power plant located in the Lamong village in the Attapeu Province in southern Laos. The December 2021 commissioning and hand over is in line with the power evacuation plan of the owner Chaleun Sekong Energy Co., Ltd (CSE).

CSE is one of the leading independent power producers in Lao PDR and in 2018 awarded ANDRITZ a contract for the whole electro-mechanical package of Nam Kong 3. The contract scope comprised design, supply, transportation, installation, and commissioning of three compact vertical Francis units with a capacity of 18 MW each, including main inlet valves, generators, electrical power systems and the entire balance of plant.

This project embraced multi-cultural participation in the form of Poyry Energy Limited as owner's engineer, China Ghezuba Group Company as civil contractor, Whessoe as hydro-mechanical contractor, and ANDRITZ as the contractor for the entire electro-mechanical equipment.

As entry into Laos was restricted at that time due to COVID-19, in order to meet the customer's deadline, ANDRITZ went the extra mile and arranged for commissioning engineers from locations such as China, Indonesia and Bhutan to meet the

project requirements. In addition, ANDRITZ supported client requirements by arranging local manpower. Furthermore, deliveries of equipment were kept in place despite the severe impact of COVID, and commissioning was still achieved within the given deadline.

Power generated from the project is delivered to Électricité du Laos (EDL), a state corporation that owns and operates the country's electricity generation, transmission, and distribution assets.

ANDRITZ takes immense pride in the fact that the client's targets could be met despite COVID-related restrictions and is glad to further contribute to Laos' hydro-power sector.

AUTHOR

Pankaj Sharma
hydronews@andritz.com

TECHNICAL DETAILS

Nam Kong 3:

- Total output: 54 MW
- Scope: 3 × 18 MW
- Head: 96.4 m
- Voltage: 11 kV
- Speed: 500 rpm
- Runner diameter: 1,534 mm



FLYWHEELS – BOOSTING SYNCHRONOUS CONDENSERS

The era of power systems dominated by centralized large power plants and plenty of inertia is ending. There is a significant share of inverter-based generation from wind and solar. However, the rotating masses of generators provide essential grid services proportional to their rated power capacity. One of these grid services, inertia, relates to the stored rotational energy of synchronous generators coupled to the grid. With the phase-out of thermal and nuclear power plants, the available inertia of the grid is declining, and this makes maintaining grid stability a challenge.

While generation and consumption are balanced, the frequency of a power system remains stable. However, whenever there is a little difference between consumption and generation, the frequency starts to drift from its nominal value (e.g. 50 Hz in Europe). The inertia of the power system counteracts these potential changes in frequency and limits the speed of frequency movements (rate of change of frequency – RoCoF). As the inertia of power systems decreases, the RoCoF could become more critical. These conditions could present power system operators with a dilemma. Given that sufficient inertia is necessary at all times to ensure the proper operation of the grid, it could mean that fossil-fueled thermal plants must continue to run to provide those inertia-related services. This might also mean that inverter-based generation, if not able to provide inertia similar services, need to be curtailed to maintain supply and demand equilibrium.

An alternative solution to ensure sufficient inertia levels on the grid is the installation

of synchronous condensers (SCs). SCs are a proven and cost-effective solution to replace grid services that were previously provided by thermal power plants and their rotating machines. One of the advantages of synchronous condensers coupled with flywheels is that the

mechanically stored energy is increased without significantly influencing the electrical design of the synchronous condenser.

SCs can be designed either as round rotor machines (turbo generators) or salient pole machines. Tailor-made solutions can be designed with salient pole machines in which the inertia can be significantly higher when compared to synchronous generators with the same nameplate rating.

For medium-sized SCs, the achievable inertia time constant, H , for various SC configurations are shown in the graph. It can be seen that round rotor machines typically have an inertia time constant of between 1.5s and 2s and when coupled to a flywheel, this can reach between 2s and 5.5s. However, salient pole machines can be designed with an inertia time constant of between 2s and 7s. Thus, the inertia of a round rotor and flywheel combination can be achieved with the natural inertia of a salient pole machine alone. Moreover, with the addition of a flywheel,



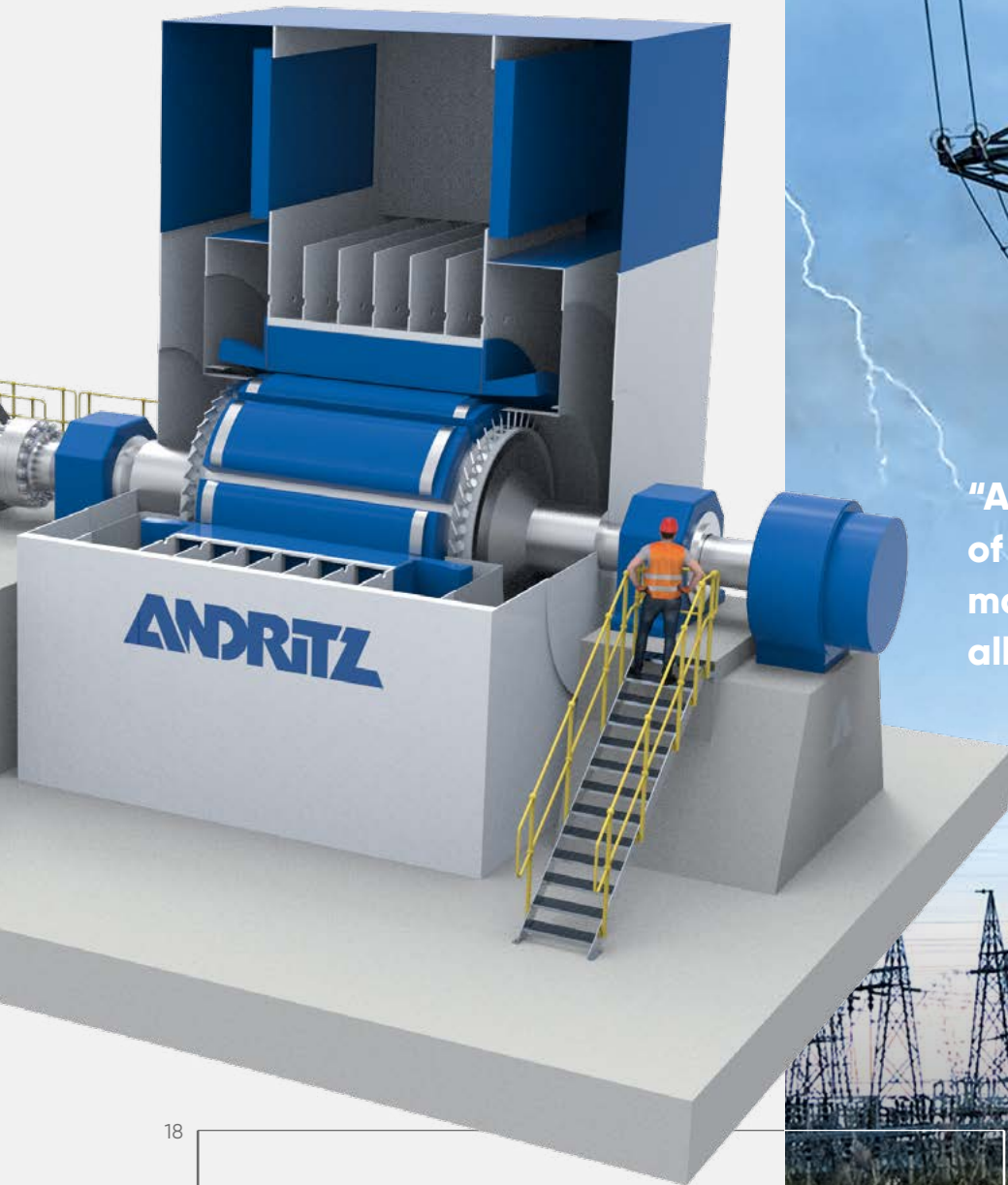
the inertia of the salient pole design can be more than doubled to reach up to 16s. For a medium-sized SC, this equals a stored energy of up to 3,100 MWs. Clearly, flywheels are an effective solution to boost the inertia of SCs even further.

Given that a minimum inertia level must be maintained at all times to ensure stability in power systems, transmission system operators around the world are currently evaluating the minimum amount of inertia required. Salient-pole synchronous condensers, with or without flywheels, are a competitive solution to meet those needs as the clean energy transition continues to gather pace and the available inertia from traditional rotating machines declines further.

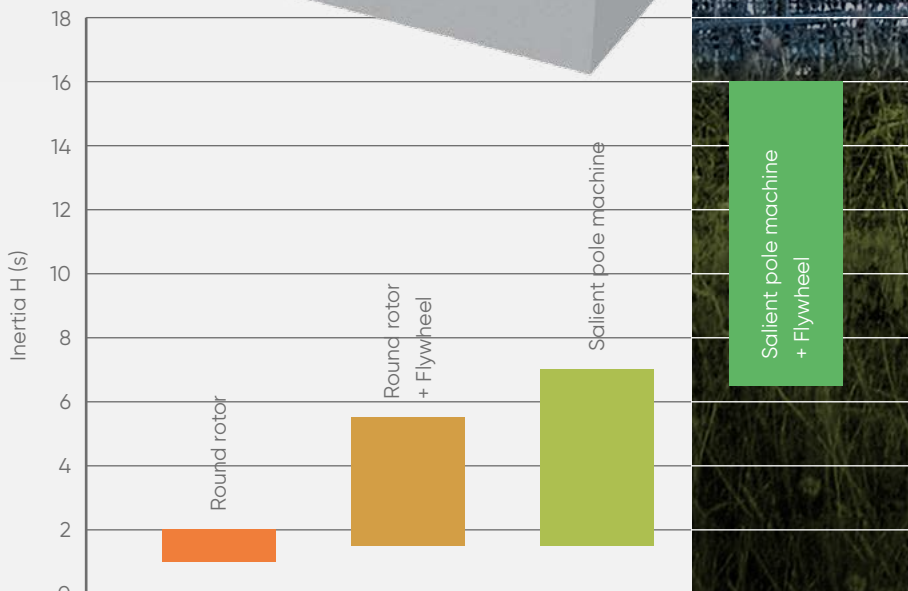
AUTHOR

Serdar Kadam
hydroneWS@andritz.com

INERTIA OF



"A minimum level of inertia must be maintained at all times."



Achievable inertia time constant, H, the ratio of stored energy to the Synchronous Condenser's nameplate rating

**ACHIEVABLE INERTIA
CONSTANT H**

TECHNOLOGY — FLYWHEELS



#GLOBALHYDRO

On October 11, 2022, together with the IHA (International Hydropower Association) and the whole hydropower community we celebrated the positive impacts of sustainable hydropower on people and communities around the world.



TRANSFORMING LIVES AND COMMUNITIES #WITHHYDROPOWER

Hydropower, a sustainable and renewable form of power generation, has many benefits and great potential.

Approximately 70% of the Earth is covered with water, which means that there are 14.3 billion m³ of a renewable, clean energy source. Electricity from hydropower is cost-effective and not subject to price volatility, unlike fossil fuels.

In addition, more than two million people are employed in hydropower worldwide. But the benefits of sustainable hydropower reach far beyond the people who work in the sector.

It offers socio-economic benefits because the construction of hydropower plants also creates local jobs, supports the regional economy, guarantees the water supply and flood protection, and can be used for irrigation and shipping navigation. This brings many positive impacts to communities worldwide.

#WITHHYDROPOWER WE CAN MAKE A DIFFERENCE

We continue to live in very challenging times. Aside from the pandemic and the heavy toll it has taken over the last two years, political and social conflicts are also shocking the world and have had significant consequences for individual lives, society as a whole and the global economy. In this context, the transition to a zero-emission future becomes more important than ever. We must redouble our efforts to reduce CO₂ emissions and to reach our vital climate goals. Renewable energies like hydropower, wind and solar have to be expanded dramatically, as we need to successfully tackle the climate crisis and also ensure continued security of energy supply independent from fossil fuels.

Hydropower – a technology with a vision – is the most proven and best developed form of renewable electricity generation, successfully deployed at hundreds of thousands of sites worldwide. Hydropower does not end with power generation. Instead, it offers a wide spectrum of applications, including energy storage for grid stability and peak load coverage, providing the tools to reach global sustainable climate goals.



HYDROPOWERDAY

#WITHHYDROPOWER WE CAN ...

... KEEP THE LIGHTS ON WITH GREEN ENERGY

Wind and solar need the flexibility and stability that hydropower offers to keep the lights on. Ensuring a stable and secure energy supply is one of the biggest challenges we face in the transition from fossil fuels to renewable energy.

... DEVELOP RENEWABLE ENERGY SUSTAINABLY

When hydropower projects are sited, planned, and built sustainably, they can have tremendous positive impacts on local communities.

... DECARBONIZE INDUSTRIES WITH CLEAN ENERGY

Green hydrogen is poised to play a significant role in decarbonizing heavy industries around the world. Hydropower is well suited to green hydrogen production and has the potential to provide 13% of the demand required by 2050 to meet net zero goals.

... PROVIDE AFFORDABLE ENERGY FOR GENERATIONS

Hydropower has provided affordable energy to homes and business across the world for decades. We can create an affordable green energy grid powered by renewables.

... STORE WIND AND SOLAR ENERGY IN WATER

Don't fall back on fossil fuels. We can keep green grids of the future reliable with hydropower using "water batteries" to store renewable energy to use when the wind isn't blowing, and the sun isn't shining.

... PROTECT COMMUNITIES FROM FLOODS AND DROUGHTS

As climate change accelerates, extreme weather events like floods and droughts are becoming more frequent. Hydropower can help protect communities by providing vital water management services.





HYDRO

MODERNIZATION AND RENOVATION OF HYDROPOWER PLANTS

ANDRITZ is a global supplier of electro-mechanical equipment and services ("from water-to-wire") for hydropower plants. With over 180 years of experience and more than 32,000 turbines installed, we are constantly striving to create top modern technological innovations to meet our customer's needs and

requirements. Utility companies from all over the world value our expertise and commitment, and they trust in the safety and reliability of our tailor-made energy generation solutions.

For maximum customer benefit, ANDRITZ develops solution-oriented service and rehabilitation concepts, ones that offer

a short return on investment. Innovative modernization measures and cutting-edge technologies increase profitability and extend system life span, always taking into account basic economic, ecological, and legal conditions.

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

ENGINEERED SUCCESS

ANDRITZ HYDRO GmbH / www.andritz.com/hydro

ANDRITZ