

ENGLISH Magazine of ANDRITZ Hydro / №37 / 09-2023

HYDRONEWS

№37

SPECIAL TOPIC

ESG, Diverse Workforce,
Women in engineering
and in the energy
transition

SUCCESS BUILT ON SUSTAINED INNOVATION

Research & Development in ANDRITZ
Page 20

Renewable hydropower for growing energy needs
Luang Prabang, Lao PDR
Page 14

Tajikistan's power generation backbone
Nurek, Tajikistan
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Our Indonesian projects in focus
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ANDRITZ

O&M contract for Teesta Stage III in India

ANDRITZ recently signed a long-term operation and maintenance agreement with Sikkim Stage Limited (SUL) for the 1,200 MW Teesta Stage III hydroelectric power plant in Sikkim, India. This 15-year agreement reflects SUL's confidence in ANDRITZ' performance and includes advanced digital monitoring through ANDRITZ' state-of-the-art Metris DiOMera platform.

In 2007, ANDRITZ was awarded a contract for the electromechanical equipment for the project, and since its commissioning in 2017, ANDRITZ has been responsible for the plant's complete operation and maintenance. The plant achieved its highest-ever electricity generation in 2021-22, exceeding the defined targets and earning the customer's appreciation.

With an annual energy production of 5,300 GWh, Teesta Stage III is one of India's largest hydropower plants, operating under challenging hydrological conditions. This agreement highlights ANDRITZ' commitment to excellence and strengthens its position in the operation and maintenance market. The use of digital solutions underscores ANDRITZ' dedication to increase performance and reliability.



ANDRITZ' expertise and digital solutions make it a preferred partner for power plant owners and operators. This agreement showcases SUL's trust in ANDRITZ for long-term plant management and optimization.

As the world seeks cleaner energy sources, collaborations like this contribute to a greener future. ANDRITZ' commitment to sustainability ensures the continued performance of the Teesta Stage III power station and its role in India's energy security.



PSPP Forbach, Germany

Great potential for energy transition and security of supply

ANDRITZ and EnBW (Energie Baden-Württemberg AG) signed a contract for the modernization of the hydropower plant Forbach in Germany. The existing Rudolf-Fettweis-Werk, a storage and run-of-river plant, will be extended to a top-modern pumped storage power plant.

The contract includes the supply, installation, and commissioning of a 56 MW pump turbine including generator and necessary auxiliaries. The pump turbine, along with a frequency converter, offers a wide operating range and high flexibility to respond quickly to power grid demands. The existing turbine sets, after a century of service, will be decommissioned to preserve the historical power plant building and its penstock. They will be replaced by a 56 MW variable speed pump turbine and three additional turbine sets of 13 MW, 6.7 MW, and 3.1 MW, housed in a new cavern power plant.

This order is technologically significant for ANDRITZ as it involves one of the few variable-speed pump turbines in operation worldwide, providing enhanced operational flexibility and efficiency for the power plant.



Success for synchronous condensers in Brazil

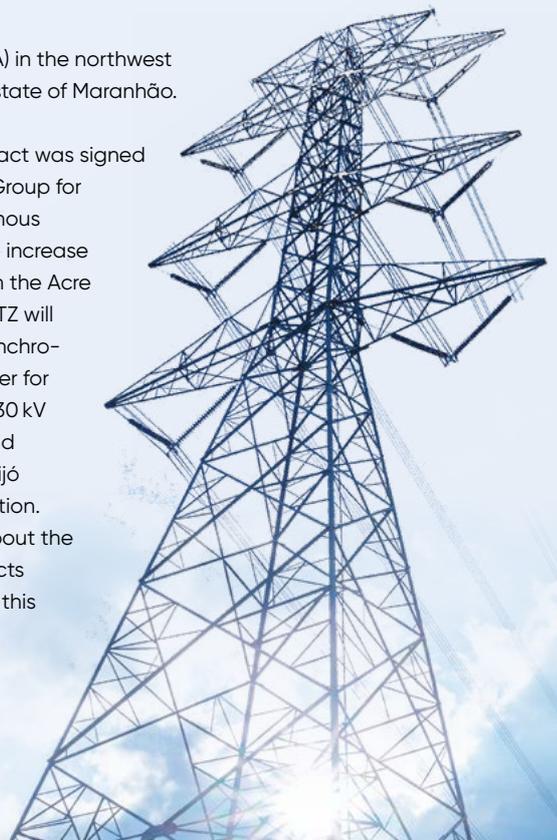
In the first half of 2023, ANDRITZ received several contracts for synchronous condensers in Brazil.

One contract was signed with Sterlite Power Brazil, an important Indian developer of integrated power transmission infrastructure projects. ANDRITZ will be responsible for the supply, installation, and commissioning of a synchronous condenser, excitation systems, control and protection systems, step-up transformers, and electrical and mechanical auxiliaries for the Cachimbo and Novo Progresso substations located in the state of Pará. The construction of these substations, each with a voltage of 230 kV, will enable the expansion of the consumer market in the regions of Mato Grosso and Pará.

In partnership with TAESA, a Brazilian company active in the electricity transmission sector, ANDRITZ will supply a synchronous condenser for the Encruzo Novo 230 kV substation. This is part of the power transmission project that will ensure energy supply to the regions of Açailândia, Buriticupu, Vitorino Freire (MA) and

Dom Eliseu (PA) in the northwest region of the state of Maranhão.

Another contract was signed with Zopone Group for three synchronous condensers to increase grid stability in the Acre region. ANDRITZ will supply one synchronous condenser for the Tucumã 230 kV substation, and two for the Feijó 230 kV substation. Read more about the last two projects on page 26 of this issue.



FROM WATER-TO-WIRE

our 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.

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.

ANDRITZ HYDRO IS PART OF INTERNATIONAL ANDRITZ GROUP



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

#ONE AN DRI TZ



More than
29,000
Employees



More than
280
Sites



More than
40
Countries

Order Intake

9,263 MEUR + 18% compared to 2021

Order backlog (as of end of period)

9,977 MEUR + 22% compared to 2021

Revenue

7,543 MEUR + 17% compared to 2021

Operating results (EBITA)

649 MEUR + 19% compared to 2021

29,094 Employees

(as of end of period; without apprentices)

EUR 53.55

ANDRITZ SHARE (closing price as of end of 2022)

ANDRITZ AG KEY FINANCIAL FIGURES BUSINESS YEAR 2022

There has been a significant change in the ANDRITZ Hydro Managing Board this year. Following the retirement of Wolfgang Semper, Frédéric Sauze took over responsibility for the Hydro business area as a member of the ANDRITZ Executive Board. With a notable track record in the hydro business, he brings valuable expertise to the position, having served in various management roles within the company since 2013. As he takes up the reigns together with Harald Heber and Gerhard Kriegler, Frédéric Sauze lays out his vision for success.



Dear valued customers,

I am honored to assume a leadership role on the ANDRITZ Executive Board and its Hydro business. As I step into this position, I am inspired by the remarkable accomplishments of Wolfgang Semper, who led the Hydro business for 12 years before me. With his retirement announcement, I am eager to take on the responsibility of driving our business forward.

At ANDRITZ, we recognize the importance of actively listening to our customers and adapting to their evolving needs. Through continuous innovation and close collaboration, we aim to address new market challenges head-on. Our commitment is to deliver world-class products and solutions while maintaining a strong global presence and fostering local engagement in all our markets.

I have complete confidence in the preparedness of ANDRITZ, and my personal goal is to work together with you to not only meet but exceed your expectations. People are at the heart of our company, and I will strive to be the voice of all our locations across the globe. By attracting new talents, developing new skills, and fostering closer partnerships, we will better serve you and enhance our project deliveries.

Embarking on this new role in such a fascinating industry fills me with excitement. However, what I look forward to the most is sharing this journey with both our customers and employees, regardless of where they may be.

The clean energy transition in the coming decades presents a significant growth opportunity, with hydropower playing a crucial role in supporting further renewable power growth for grid stability. Working together, ANDRITZ is ready to seize that opportunity by building on a rich history to forge a successful future.

Thank you for your continued trust and partnership. I am excited to embark on this journey with you.

Yours sincerely,

Frédéric Sauze

A handwritten signature in blue ink that reads "F. SAUZE". The signature is written in a cursive style and is positioned above a horizontal blue line that serves as a signature separator.

ANDRITZ Executive Board Member
CEO ANDRITZ HYDRO GmbH

**"People are at the
heart of ANDRITZ."**



Thank you, Wolfgang Semper!

Wolfgang Semper joined ANDRITZ more than 40 years ago and held management positions for decades. He has now retired. We thank him for his service.

Wolfgang Semper has been a member of the ANDRITZ Executive Board since 2011 with responsibility for the Hydro business area, Group Automation & Digitalization, and Corporate Security. After more than 40 years in the hydropower sector, he retired in March 2023.

He began his career in hydropower on completion of his mechanical engineering studies, gradually taking on more management responsibility but maintaining strong links with the operational business. Mr. Semper explained how this connection molded his career: "My principles are very much shaped by what I do. We build plants to last 50 years or more. They have to function efficiently and must never endanger people or the environment. Our actions carry great responsibility. It is important to me to consciously take on this responsibility and stand by it".

Flexible, clean, and secure, today hydropower is playing a central role in the energy transition, and he leaves the company in a strong position to take

"My principles are very much shaped by what I do. We build plants to last 50 years or more."

advantage of this trend. "The energy transformation has brought new momentum," he says.

Nonetheless, Mr. Semper is never complacent when it comes to technology, placing particular emphasis on research and development. Even as an Executive Board member, R&D was still his direct responsibility right up to his retirement. "As a technician, this topic is particularly close to my heart. Engineering and R&D are essential components of business success," he says.

As he reaches the end of an illustrious career, he also recognizes the importance of teamwork in building the company's future: "I have learned that you can't achieve much on your own. You need a good team".

As ANDRITZ Hydro begins the next chapter of its long story we wish to thank Wolfgang Semper for his decades of service, guidance and leadership and wish him a long and happy retirement.



Wolfgang Semper at the official inauguration of the new high-performance test rig in Linz, Austria



Wolfgang Semper at the signing of the contract for the Luang Prabang project in Laos



Wolfgang Semper visiting the site of the PSP Pinnapuram in India



Wolfgang Semper at the inauguration of the new ANDRITZ Hydro office in New Delhi, India



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TAJIKISTAN'S POWER GENERATION BACKBONE

PROJECT STORY — NUREK, TAJIKISTAN



Nurek, Tajikistan - The largest hydropower plant in Central Asia is being rehabilitated and modernized by ANDRITZ with an increase of power output to 3,400 MW.

The Nurek hydropower plant, located about 75 km from the Tajik capital, Dushanbe, has been providing clean, renewable energy to the region since 1972. It is the largest hydropower plant in Central Asia and when built had a generating capacity of 3,000 MW. It covers more than 70% of the national electrical energy demand and also provides irrigation for more than 700 km² of agricultural land in the region. In addition, Nurek supports the neighboring countries of Uzbekistan, Afghanistan and Pakistan, supplying them with energy during the peak seasons over the year. A special

grid project called "CASA 1000" connects the countries and was established for this purpose.

More than 40 years since its commissioning, no major rehabilitation of the hydro-mechanical and electrical equipment had been undertaken at Nurek.

"After modernization, the installed capacity of the generating units will be increased by about 12%."

As the plant is of the utmost importance for the security of energy supply not only for Tajikistan itself but for the whole region, in 2018 the "Nurek Hydropower Rehabilitation Project" was launched. The

objective of this program is to rehabilitate and restore the capacity of all nine power generating units, improve their efficiency, and enhance the safety of the Nurek dam. Furthermore, after the refurbishment, the total generating capacity will be increased to 3,400 MW.

MODERNIZING A KEY ENERGY ASSET

In 2018, ANDRITZ received a contract for the modernization of the entire electro-mechanical equipment of the Nurek hydropower plant, including the inspection and repair of the nine penstocks. The ANDRITZ scope of supply comprises comprehensive modernization of the existing generating units by supplying and installing new 375 MW Francis turbines, new generators, new transformers, as well as the electrical and mechanical auxiliary equipment within



→ the powerhouse. After modernization, the installed capacity of the generating units will be increased by about 12%.

The rehabilitation work will be executed in two phases. In the first, three units with their auxiliary equipment and transformers will be replaced as well as executing improvements for the dam safety. This first phase is planned to last for five years, from 2019 to 2023. The second phase of the project covers the reconstruction of six remaining units and auxiliary equipment of the station and will be implemented over six years from 2024 to 2030.

The design of the new units considers the plant's annual storage operations and will, therefore, be suitable for

operation with a wide range of hydraulic heads. This refurbishment project will also optimize water storage management on the Vakhsh River cascade, ensuring a significant increase in electrical energy production, as well as meeting changing grid demands. ANDRITZ' contract also stipulates that environmental conservation measures and water management requirements must be incorporated.

The rehabilitation of Nurek will safeguard the electrical energy supply in the Republic of Tajikistan and make an important contribution toward the strategic use of renewable energy from hydropower in Central Asia. It also offers interesting opportunities for exporting energy to neighboring countries with

related economic benefits for the countries concerned.

RECOGNIZING NUREK REFRUBISHMENT RESULTS

Work at Nurek is making good progress. In April 2022, after refurbishment of the

“As part of the modernization program, the world’s largest spherical valves to date were rehabilitated in Nurek.”

world’s largest spherical valve – with a diameter of 4,200 mm and a remarkable total weight of 780 tons – it was lifted on to its foundation and could be successfully re-installed. Following the filling of

Housing of the main inlet spherical valve after refurbishment



Installation of the turbine shaft and the guide apparatus on Unit A-1



Installation of the generator rotor into the pit of Unit A-1



the penstock in May 2022, the synchronization of the first fully rehabilitated unit with the Tajik power grid was carried out in June 2022. The unit produced its full power of 375 MW for the first time and thus helped to cover the high national energy demand seen during this period.

In October 2022, the President of the Republic of Tajikistan, Emomali Rahmon, visited the Nurek construction site and officially commissioned the first rehabilitated machine, Unit A1. The President was informed about the progress of the project and was more than satisfied with ANDRITZ' professional rehabilitation work.

The Nurek hydropower plant is of major importance to the region and is an

TECHNICAL DETAILS

- Total output: ~ 3,400 MW
- Unit rated power: 9 x 375 MW vertical Francis
- Max. head: 265 m
- Rated discharge: 170 m³/s
- Runner diameter: 4,700 mm
- Valve diameter: 4,200 mm
- Av. annual energy production: 11,250 GWh



impressive example of the value of renewable energy. It is also a testament to the power of engineering, and the dedication and expertise of

ANDRITZ in providing clean energy to the people of Tajikistan. Refurbishment of the plant will improve the lives of many people in the area for decades to come.

AUTHOR

Hubert Schönberner
hydronews@andritz.com



ANDRITZ site team together with the installation company TGEM



Site Manager Nelson Sequeira and Project Manager Hubert Schönberner on site during the official inauguration of Unit A-1.

Luang Prabang, Lao PDR – Laos has been actively pursuing its target to become the “Battery of Southeast Asia” by exploiting its vast hydropower potential. With up to 18,000 MW available, more than 9,000 MW can be harnessed from the Mekong River alone. Although developers are drawn by the vast potential for renewable energy production, they must also recognize the need for sustainable development.

Governing bodies such as the Mekong River Commission and the Lao Ministry of Natural Resources and Environment are

tasked with the challenging responsibility of striking a balance between the benefits of hydropower while mitigating its environmental impact. The key to sustainable use of renewable energy is the careful selection of the best sites and adherence to internationally recognized environmental and social standards during construction and operation of the power plants.

THE PROJECT

The Luang Prabang Hydroelectric Power Plant is located more than

25 km upstream of the Town of Luang Prabang. The site has been carefully chosen to satisfy all necessary hydrological and geological requirements.

Downstream of the project, the Mekong flows naturally towards the town of Luang Prabang with its iconic peninsula created by the confluence of the Mekong and the Nam Khan River.

In order to protect the environment, CK Power, one of the region’s largest producers of electricity from renewables, recognized



"The newly designed Kaplan runner is, in addition to delivering the highest discharge capability, one of the largest and most powerful Kaplan runners in the world."

TECHNICAL DETAILS

Total output: 1,460 MW
Head: 26 m
Voltage: 500 kV
Runner diameter: 9,100 mm
Speed: 83.30 rpm
Average Annual energy production: 6,500 GWh



Luang Prabang





Successful hydraulic model acceptance test in April 2023, witnessed by representatives of CK Power, Ch. Karnchang and consultants of AFRY, achieving all guaranteed efficiencies

“Luang Prabang is fully compliant with internationally recognized environmental and social standards, including IFC Performance Standards and the Equator Principles.”

→ early on the potential benefit of renewable hydropower for the growing energy needs of its home country, Thailand. Drawing on its expertise in the realization of large infrastructure projects, CK Power successfully completed the development and construction of the Nam Ngum 2 and Xayaburi hydroelectric power plants with the latter setting a new benchmark in regard to fish protection and socially compatible infrastructure development.

With Xayaburi as the largest hydropower plant on the Mekong up to date, CK Power took the next step by starting the development of the Luang Prabang project. As is typical of hydropower projects, Luang Prabang HPP offers its own set of unique challenges.

Having learned valuable lessons regarding the effectiveness of the environmental and social mitigation measures at Xayaburi, and seeking further optimization, CK Power incorporated proven design features and introduced new solutions into the plant design.

RECORD-BREAKING HYDRAULIC DESIGN

Based on the hydrology and powerhouse geometry, ANDRITZ took on the challenge of pushing the envelope of what is hydraulically possible. Starting with the already high-performing turbine setup of the Xayaburi hydropower plant, ANDRITZ embarked on a project-specific hydraulic development journey using computational fluid analysis tools and testing the results on the test rig in Linz, Austria. The results of these efforts are extraordinary: The new turbine design for the Luang Prabang plant features a Kaplan

turbine with a runner diameter of 9.1 m, an extremely wide operating range with a head ratio factor of 2.3 (H max/H min) and the world's largest discharge capacity of more than 950 m³/s.

Conventional design limits were redefined, and special design features were conceived and introduced during the development process. The result of this extraordinary effort is a unique Kaplan design which defines a new benchmark. The newly designed Kaplan runner is, in addition to having the highest discharge capability, one of the largest and most powerful Kaplan runners in the world. The hydraulic static and rotating components of Luang Prabang HPP exceed all expectations with respect to performance and fish friendliness.

ENVIRONMENTALLY FRIENDLY PLANT DESIGN

Highest efficiency and an excellent cavitation behavior over the entire operation range are not the only remarkable achievements of the design phase. Apart from its unique hydraulic performance, the turbine design incorporates the latest environmentally friendly design features. Besides the oil-free runner hub, fish-friendly design features are applied to hydraulic components like wicket gates and runner blades. Performance optimization goes hand-in-hand with these fish-friendly features, with smooth pressure gradients and small gaps helping in both respects. Results of actual measurements with sensor-fish performed at Xayaburi are being considered in the design of Luang Prabang HPP. As an example, the particularly inclined wicket gate design leads to a reduction in the gap between

wicket gates and the bottom ring in full load situations and substantially increases fish survival rates.

Besides the applied environmental hydraulic and mechanical design aspects, provision of dedicated fish passage facilities for both up- and downstream migration are a key factor in achieving state-of-the-art fish passage rates at the Luang Prabang HPP. An attraction flow system guides fish upstream from the tailrace while producing energy via three dedicated 20 MW units, which are also supplied by ANDRITZ.

Apart from the turbine-generator units, ANDRITZ is also supplying the auxiliary equipment, as well as the automation and control systems, which are instrumental in keeping water levels within the narrow operating band and important for safeguarding habitats along the Mekong River.

DESIGN AND CONSTRUCTION WORKS

In the design process, ANDRITZ engineers are using multi-dimensional Building Information Modeling (BIM), a highly collaborative design and engineering process which facilitates collaboration between contractors, consultancy firms, and the operations and maintenance management of the plant owner.

With the access roads, a new bridge across the Mekong River, and site



© by Luang Prabang Power Company Ltd.
[Overview construction site Luang Prabang](#)



© by Luang Prabang Power Company Ltd.
[Survey work on the river bank on start of civil construction](#)

facilities completed, the EPC contractor, Ch. Karnchang Lao, is progressing with the construction of the main cofferdams and the left pier wall. This helped achieving a flood-safe construction pit before the onset of the flood season in 2023. In addition, excavation works for the powerhouse, the spillway, and the navigation lock are also progressing. Draft tube installation is scheduled for early 2024 with commissioning works anticipated to be completed by mid-2029.

AUTHORS

Alexander Bihlmayer,
 Thomas Eiper
hydronews@andritz.com

LAO PDR IN FACTS

LAO PEOPLE'S DEMOCRATIC REPUBLIC



Area

236,800 km²



Population

7.58 million



Capital and largest city

Vientiane



Total power generation

58,813 GWh

(in 2022), an increase of more than 53% since 2021



Total power capacity

11,664 MW

in 2021



Technically feasible

hydropower potential about

18,000 MW



About

95% of domestic consumption is covered by hydropower



Installed hydropower capacity

about 9,560 MW (in 2021)



About

53% of the technical potential has been developed so far

Source: Hydropower and Dams World Atlas 2022; EDL Generation Company; Laotian Times Magazine



ANDRITZ HYDRO IN LAO PDR

ANDRITZ has been present in the country for a long time and has been involved in large hydropower projects such as Nam Theun 1, Xekaman 1, Xekaman 3, and Xekaman Sanxay, as well as a number of small hydropower plants such as Nam Lik 1, Nam Kong 3, and Houay Kapheu. The supply of electromechanical equipment for the 1,285 MW Xayaburi power plant, the largest hydropower plant not only on the Mekong River but in Laos, is certainly a highlight in our reference list.



Total installed/
rehabilitated

55 units

with a total installed/
rehabilitated capacity of

about 4,700 MW



School donations as part of intercultural work



Woman Day celebration on-site in Laos

Project Interview

What is it like ...?

Interview with Jochen Pock, Laos Site Manager

Jochen Pock is site manager for ANDRITZ Large Hydro Projects and is based in Vienna. He has worked on two major hydro projects in Laos, Nam Theun 1 and Theun Hinboun, where he had responsibility for all operational site matters.



Please outline your role, Jochen

The main tasks of the site manager are the on-site representation of the project, site mobilization and demobilization, and monitoring all installation and commissioning activities in respect of technical performance, quality, health, safety, environment, cost and time schedule. It also means applying corrective measures in the case of any deviations as well as leadership and coordination of the installation supervisors and other site personnel, both internal and external.

How do you bridge any cultural gaps on a large hydro project?

I always try to find out where our cultures overlap and where they do not to establish our intercultural borders and limits. To further build bridges we establish on-site events or activities such as parties and sports activities and also respect their cultural celebrations like traditional boat festivals or other major Laotian cultural events where we come together. This mutual respect is reflected during our work activities too.

What is it like to oversee a project of this size?

It is an honor but at the same time a very big responsibility. The coordination of so many workers during peak times is very challenging, especially with the need to maintain team spirit for everyone to reach a major common goal.

Imagination is everything. It is the preview of life's coming attractions.

Of course, it needs discipline, but it also needs to be fun and culturally attractive to ensure job satisfaction for each and every team member.

Thank you, Jochen

Success built on sustained innovation

A dynamic splash of water in shades of blue and white, appearing to hit a surface from the right side of the frame. The water droplets are captured in mid-air, creating a sense of movement and freshness.

Research & Development in ANDRITZ

**"Nothing between hoping
and believing, but hands
on in every project!"**



Hydropower is a mature industry, but long-term success is still dependent on continued innovation, a strong research and development program, and a diverse, engaged workforce able to bring new ideas to fruition.

With well over 180 years of success in hydropower, there has been one constant throughout the history of ANDRITZ – a rock-solid commitment to innovation. Today, that spirit of innovation is more important than ever as we try to navigate through some of the biggest environmental challenges the world has seen.

Global warming, loss of biodiversity, and pollution of our rivers and oceans are just some of the pervasive issues we face and all are

areas where innovation in hydropower has a role to play. Even in a mature industry like hydropower, with its huge engineering legacy, research and development (R&D) remains critical to improve performance and develop solutions to new challenges as they emerge. Finding these answers relies on precise analysis of complex rotating machines and associated fluid dynamics but for solutions to be implemented they must be cost-effective, efficient, financeable and competitive, even when the best solution is a tailor-made bespoke item.





Testing for the best
MORE ON → PAGE 36

→ The innovation at the core of ANDRITZ is underpinned by vast experience in hydropower and sustained investment in building a solid foundation of R&D. However, successful delivery of such advances also requires a diverse workforce willing to bring new ideas and perspectives through from concept to completion. For this reason, our workforce is our most valuable asset.

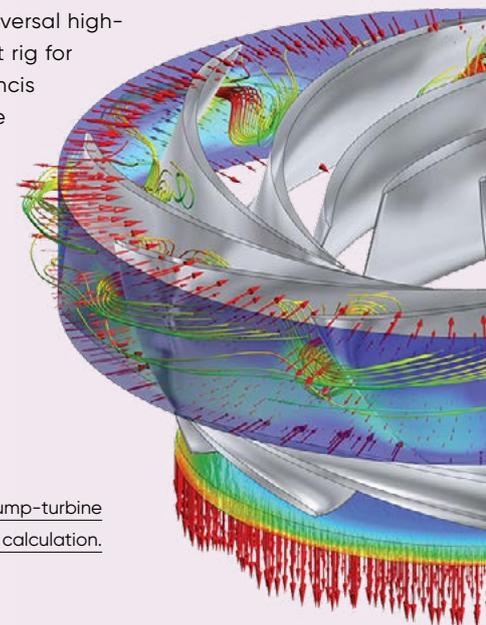
“Our R&D investment philosophy is driven not only by a requirement to meet today’s market needs, but also to prepare for the challenges of the future energy transition.”

SUSTAINED R&D INVESTMENT

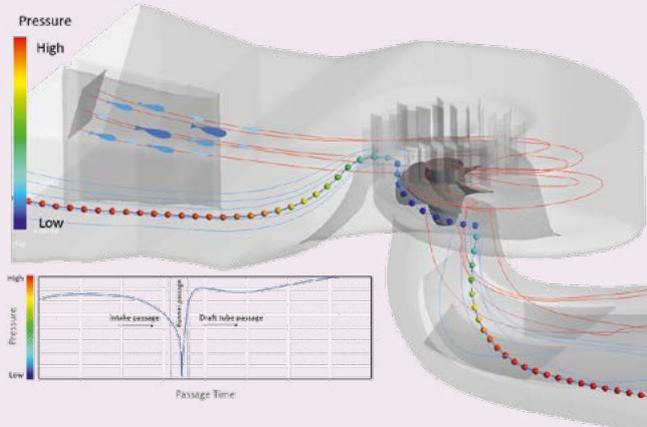
ANDRITZ considers it vital to maintain a leadership role in R&D, especially key growth markets such as pumps and pump turbines. An excellent example of

this sustained R&D investment comes from the recent inauguration of the world’s most powerful hydraulic test rig. Located in Linz, Austria, the universal test rig is fully compliant with the relevant IEC standard and can test model hydraulic machines like hydropower turbines from low head bulb units right up to multi-stage high pressure pumps at heads of up to 250 m and with flow rates of up to 1.8 m³/s.

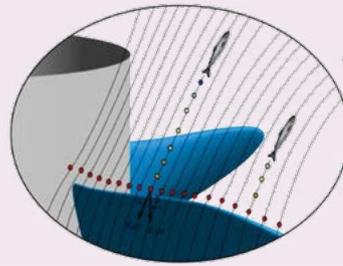
To give some idea of the scale of this investment, construction of the facility took around one year. Its operations will be matched with other advanced technology from ANDRITZ, such as the proprietary Metris all-in-one platform which will be used as a framework for the automation systems. As a universal high-performance test rig for Kaplan and Francis turbines, storage pumps and pump



Visualization of a pump-turbine
back-flow calculation.



Fish-friendly designs; Tracking streamlines through the turbine



Detail of runner passage

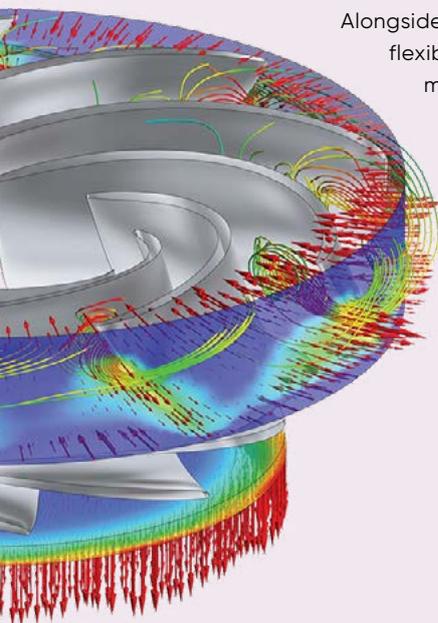
turbines, and both vertical and horizontal machines, the test rig will support hydropower advances in many fields. But it forms just part of a new high-performance cluster for sophisticated CFD simulations and the in-depth investigation of hydraulic phenomena such as accurately assessing the impact of changing operational requirements on fatigue. The test rig was delivering important customer data almost immediately for a specific customer project that had a very large model inlet structure. For a more detailed look at the new test rig please turn to the article on page 36 of this edition of HydroNews.

REDUCING ENVIRONMENTAL IMPACTS WITH R&D

Alongside more efficient and flexible machines that maximize the capacity and economic potential of hydropower plants, one

of the key areas of research concerns the environmental impact of hydro turbines. An area of particular interest are the fish-friendly designs which are becoming increasingly important considerations in hydropower investments.

Hydraulic and mechanical design decisions can have a major impact on the survivability of fish as they pass through a hydro turbine. Design changes such as reducing the gaps between stationary and rotating elements can reduce the likelihood of fish being trapped. Minimizing cavitation can also have a big impact, as do other influences such as the angle of the guide vanes and the use of a runner blade design with a blunt leading edge. Inevitably, all of these developments are underpinned by extensive CFD modelling as part of an appropriate R&D program. ANDRITZ, for instance, uses a biological assessment tool supported by CFD to record the various stressors on fish species and has been using fish-friendly designs for its equipment since the early 1990s.



“ANDRITZ focuses on fish-friendly solutions, combining hydraulic expertise and biological knowledge to ensure efficient technology and healthy fish populations.”





3D-Printing with Sauber Technologies
MORE ON → PAGE 30



ESG - The ANDRITZ approach to sustainability
MORE ON → PAGE 46

→ Reducing the potential environmental impact of hydropower was also behind a decision to create oil-free turbines. Reducing oil and other kinds of contamination in water courses is an important environmental improvement. To date, ANDRITZ has well over

130 oil-free Kaplan runner references featuring machines of the largest diameters, outputs, and heads.

Again, R&D work is essential for developing more attractive solutions that protect

the environment and further enhance the sustainability of hydropower. ANDRITZ has a dedicated research department that is wholly focused on minimizing the environmental impact of its machines during their operation.

A CULTURE FOCUSED ON SUSTAINABILITY THROUGH DIVERSITY

Sustainability is a critical factor in long-term success and ANDRITZ confirmed its commitment by launching the “We Care” sustainability program in June 2021. Combining all corporate sustainability activities under a single Environmental, Social, and Governance (ESG) banner, the program sets out defined

targets and goals, such as halving its carbon footprint by 2025 and reducing water consumption and waste. For more on the ANDRITZ ESG targets please see page 46 of this issue.

Of course, R&D will play a key part in achieving these important goals but progress will also depend on building a diverse team that can bring different perspectives and insights into play, as well as more creative solutions. A company with a diverse workforce can draw on a wide range of experiences and better understand the needs of their customers too. A key part of the We Care program and at the center of the ANDRITZ social focus is to ensure employee satisfaction, health and safety, and diversity.

With modern digital communications tools it is possible to build-in diversity across a hydraulic turbine development program by distributing different engineering, design, and test rig elements across the globe, bringing together expertise and experience between all the various teams. Our R&D departments are also key areas where we have been successful in promoting gender diversity. We are honored to have many talented women working in various technical areas. HydroNews talked with Sigrun Fugger, Hydraulic Project Engineer at ANDRITZ Hydro Austria, about her experiences, please read the interview on page 48.

“Some projects are easier, some are more challenging, but a satisfied client is always our priority!”

ANDRITZ is also very proud to bring its focus on diversity and international cooperation forward through its membership of external organizations and strong relationships with many academic institutions. For instance, the Global Women's Network for Energy Transition (GWNET) empowers women to build careers in the energy sector through interdisciplinary networking, advocacy, training, and mentoring. ANDRITZ Hydro became a Corporate Member of GWNET earlier this year and has already welcomed a group of international GWNET students to the ANDRITZ Hydro headquarters in Vienna. Young female students from the FH Upper Austria University of Applied Sciences in Wels are also regular visitors to the ANDRITZ laboratory at Linz where they are able to gain hands-on experience in hydropower engineering. In this edition of HydroNews we feature an interview with GWNET's Barbara Fischer-Aupperle and Christine Lins about their work and the importance of women in the energy transition. For more see page 52 of this issue.

PUSHING THE BOUNDARIES OF TECHNOLOGY

With its strong R&D culture, diverse and motivated workforce, and many technical advances to be proud of, ANDRITZ nonetheless continues to seek out new opportunities to further enhance the technical capabilities and attributes that can help its customers. A great example comes from the world of Formula 1 motorsport racing where ANDRITZ has teamed up with Switzerland's Sauber Technologies to advance its modelling capabilities. Model tests are a key step in hydraulic equipment development where the highest precision and high-speed manufacturing are very positive attributes. Working with the racing technology firm, ANDRITZ has brought world-class 3D printing capabilities to the hydro lab where it is paying dividends in the production of full models in which all the main components of a turbine are built, tested, and verified before prototype manufacturing can proceed. The modelling requires a great deal of precision but also quick delivery times. In a collaboration that has seen the two

companies working together for over five years now, Sauber Technologies is providing tailor-made printing routines which have been developed together with ANDRITZ to produce the required parts quickly, and precisely. No geometric details that are relevant for the flow are neglected in the model-scale tests



for turbines in hydropower. More detail on this project can be found on page 30 in an interview with Jonathan Herzog, Chief Commercial Officer at Sauber Technologies AG.

Sustained R&D is essential for technology companies looking to stay competitive and achieve long-term growth, and this is just one more example of our relentless focus on innovation. For ANDRITZ that means producing optimal hydropower turbine designs with the maximum possible power output, a high degree of operational flexibility, unmatched reliability, and superb environmental performance. To achieve that also means building and maintaining a dedicated, diverse, and highly qualified team. That really is our greatest asset.

AUTHORS

David Appleyard, journalist and writer
and Sigrun Fugger, Hydraulic Project Engineer ANDRITZ Hydro
hydronews@andritz.com

IMPROVING POWER SYSTEM STABILITY

Tucumã and Feijó, Brazil - For Zopone Group, ANDRITZ is the first choice to supply three synchronous condensers for more grid stability in the Acre region of Brazil.

ANDRITZ Hydro Brazil recently received an order to provide three synchronous condenser systems, including electrical power systems, digital control, and protection system. The contractor and at the same time our customer is Transmissora Acre II, part of Zopone Group. They are undertaking the expansion projects of the transmission grid in the northern region in Brazil.

One of the expansion projects involves the installation of one +150/-90 MVAR

synchronous condenser at the 230 kV Tucumã Substation near Rio Branco, the capital of Acre.

The other two synchronous condensers, +/- 45 MVAR each, will be installed at the 230 kV Feijó Substation, located about 360 km west of Rio Branco, halfway to the Brazilian border with Peru.

The substations, which will improve their technical capabilities to support the energy transition towards more renewable energy, are located in the state of Acre. The project supports expansion, enhancement, and increase of stability of the electric power transmission grid. The cities, villages, and farms within the region need

very long transmission lines, which end up requiring more system inertia, more system strength, and better reactive power flow capabilities.

We are proud to have been awarded this contract, which presents logistical challenges but is also important in providing electricity to the local population. This order is an opportunity for ANDRITZ to further strengthen its market position in the synchronous condenser business in Brazil and South America.

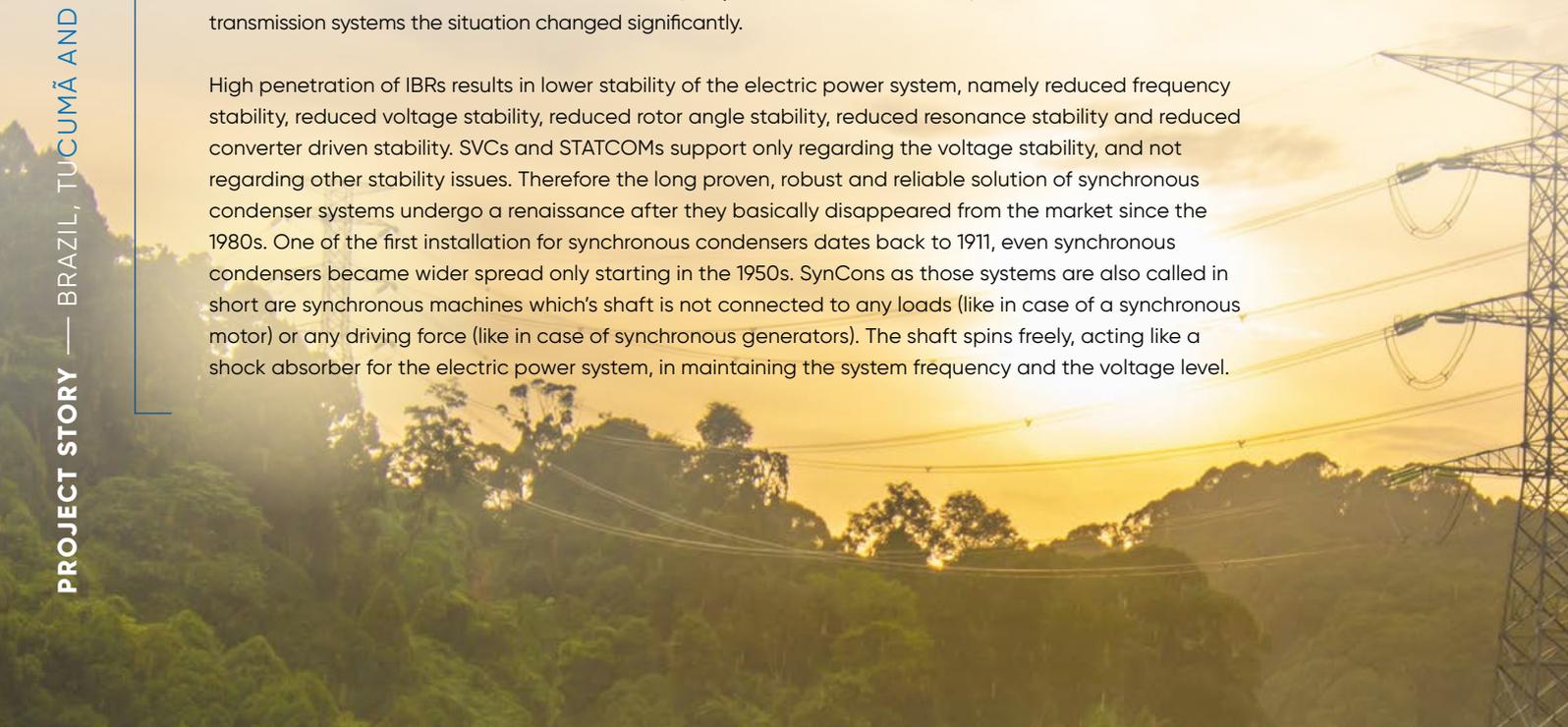
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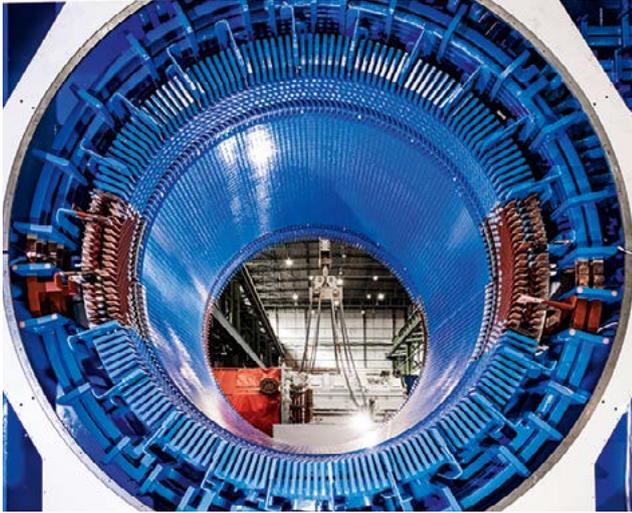
Robert Neumann
Paulo Brito
hydronews@andritz.com

SYNCHRONOUS CONDENSERS

So far SVCs (static VAR compensation) and STATCOMs (static synchronous compensator) were the preferred options for power grid compensation solutions. System strength and system inertia were not in focus, as they were available in abundance due to the so far high share of synchronous generators connected to the grid. Due to the increasing share of wind and solar generation, battery energy storage systems and direct current network lines interconnected via inverters (IBRs, inverter-based resources) with transmission and sub-transmission systems the situation changed significantly.

High penetration of IBRs results in lower stability of the electric power system, namely reduced frequency stability, reduced voltage stability, reduced rotor angle stability, reduced resonance stability and reduced converter driven stability. SVCs and STATCOMs support only regarding the voltage stability, and not regarding other stability issues. Therefore the long proven, robust and reliable solution of synchronous condenser systems undergo a renaissance after they basically disappeared from the market since the 1980s. One of the first installation for synchronous condensers dates back to 1911, even synchronous condensers became wider spread only starting in the 1950s. SynCons as those systems are also called in short are synchronous machines which's shaft is not connected to any loads (like in case of a synchronous motor) or any driving force (like in case of synchronous generators). The shaft spins freely, acting like a shock absorber for the electric power system, in maintaining the system frequency and the voltage level.





Two-element stator of a synchronous condenser preassembled at Weiz, Austria workshop for testing purposes

TECHNICAL DETAILS

Tucumã (230 kV substation)

Units: 1×165 MVA
 Speed: 900 rpm (8-pole salient)
 Short circuit contr.: 546 MVA
 Inertia time const.: 2.4 s (natural)

Feijó (230 kV substation)

Units: 2×50.5 MVA
 Speed: 1,800 rpm (4-pole)
 Short circuit contr.: 195 MVA
 Inertia time const.: 2.2 s (natural)



Technical Performance

	SYNCHRONOUS CONDENSER	STATCOM Static synchronous compensator	SVC Static VAR Compensator
Inertia	● ● ● ● High natural inertia with salient pole design	○ ○ ○ ○ No inertia provided	○ ○ ○ ○ No inertia provided
Short circuit contribution	● ● ● ● 3 - 5 p.u.	○ ○ ○ ○ 1 p.u.	○ ○ ○ ○
Dynamic reactive response	● ● ○ ○	● ● ● ●	● ● ● ○
Static VAR compensation	● ● ○ ○	● ● ● ●	● ● ● ○
VAR supply at low voltage	● ● ● ● Can increase reactive current when voltage decreases	● ● ○ ○ Linear dependency: VAR output - system voltage	○ ○ ○ ○ Quadratic dependency: VAR output - system voltage
Low Voltage Fault Ride Through (LVFRT)	● ● ● ●	● ○ ○ ○	● ○ ○ ○
Harmonics mitigation	● ● ● ●	● ● ○ ○	● ○ ○ ○
Transient distortion (Switching transients)	● ● ● ● No switching transients	● ● ○ ○ Switching transients due to power electronic circuit	● ○ ○ ○ Switching transients due to power electronic circuit

Bringing new life to ANDRITZ legacy equipment

Old Hickory, USA – U.S. Army Corps of Engineers' (USACE) Nashville District has awarded ANDRITZ a contract for rehabilitation of the turbines and generators at the 162 MW Old Hickory hydroelectric power plant.

The contract scope is to re-equip the turbines and generators for Unit 1 through Unit 3, with an option to re-equip the turbine for Unit 4 as well. The generator for Unit 4 was recently rehabilitated under a separate contract. This new contract includes the design, manufacture, transport, erection, testing, and commissioning of three Kaplan turbine generator units with a capacity of 40.5 MW each, along with associated auxiliaries and ancillary equipment.

The Old Hickory power plant is a run-of-river generating station with a 91 km² reservoir. Located on the Cumberland River in Central Tennessee, the Old Hickory Lock and Dam is located about 25 miles upstream from the city of Nashville. The dam and reservoir are named after US President Andrew Jackson whose nickname was "Old Hickory" and who had lived in the nearby area. This is the

second major contract ANDRITZ has been awarded by USACE's Nashville District, the first being the contract to re-equip the four turbine-generator units at Barkley hydropower plant in September 2020, further establishing the ANDRITZ-USACE-Nashville partnership.

Commissioned between 1955 and 1957, the original units are vertical-axis, five-bladed Kaplan turbines with diameters of 6,705 mm

"Considering the design life of the replacement equipment, ANDRITZ technology will be responsible for providing clean, renewable electricity to the region for over 115 years."

(264 inches) and a synchronous speed of 75 rpm. The turbines/generators were manufactured by the ANDRITZ legacy OEMs Baldwin-Lima-Hamilton Corporation (BLH) and General Electric Company (GE). Their original nameplate ratings are 31,250 kVA, 25,000 kW, 13.8 kV, and 0.8 pf.

ANDRITZ will replace the five-bladed Kaplan turbines with seven-bladed

machines to accomplish the 45% uprating required and meet the cavitation requirements as set out in the contract. The replacement units will have nameplate ratings of 45,000 kVA, 40,500 kW, 13.8 kV and 0.90 pf. ANDRITZ' proposed turbine design also includes increases of the rated efficiency, which results in a significant net present value saving for Nashville District USACE.

Considering the design life of the replacement equipment, ANDRITZ technology will be responsible for providing clean, renewable electricity to the region for over 115 years.

The modernization of Old Hickory is executed by an international ANDRITZ team. Five ANDRITZ locations will participate in the project. The leading company is ANDRITZ Hydro Corp. in Charlotte, North Carolina, USA. They will be supported by ANDRITZ locations in Peterborough, Canada, for generator design and manufacturing of the multi-turn coils; in Pointe Claire, Canada, for the hydraulic layout and turbine design, whereas final machining, assembly and testing of the runners will take place at the ANDRITZ workshop in Morelia, Mexico, and the



© by USACE, Lee Roberts

Powerhouse of Old Hickory on the Cumberland River

TECHNICAL DETAILS

- Total output: 162 MW
- Scope output: 4 × 40.5 MW
- Head: 13.72 m (45 ft.)
- Voltage: 13.8 kV
- Speed: 75 rpm
- Runner diameter: 6,705 mm (264 inches)
- Av. Annual production: 565 GWh



Old Hickory

model test will be performed in the high-performance test lab in Linz, Austria.

One of the many challenges to overcome during the execution of the project is to return the units to concentricity. The stationary and rotating components of Old Hickory Units 1-3 are out of concentricity by as much as 6.5 mm due to historical powerhouse movement.

Once fully commissioned, power generation of Old Hickory hydropower plant is estimated to be about 565 GWh per year. Commissioning of the first unit is expected in August 2026.

By securing this prestigious contract, ANDRITZ has further consolidated its position as a leading player in the United States' hydropower market.

AUTHOR

Darren Houghton
hydronews@andritz.com



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3D-Printing with Sauber Technologies

*Formula 1 technology accelerates hydro
model manufacturing*

One clear focus point for ANDRITZ is the continuous improvement of manufacturing processes for hydropower turbines. A key area in this respect is the production of turbine models, where speed and accuracy are decisive. New technologies, especially where they can help us meet customer needs more effectively, are always explored thoroughly.

“As the complexity of turbine geometries increases, new approaches are needed, so we turned to additive manufacturing through 3D printing.”

With the constant emphasis on further hydraulic development, as part of the design and manufacturing process, model tests are executed prior to manufacturing of the component parts. In these experiments, a full model with all main components of a power plant is built, tested, and verified. In addition to precise model manufacturing, there is a demand for short delivery times for model components.

In general, model turbines are manufactured with traditional techniques like milling and other machining processes. However, as the complexity of the turbine geometries increases due to demands

Interview with Jonathan Herzog

Jonathan Herzog began his career as a race mechanic and as a young man he worked for various teams in Switzerland and abroad. At the start of the 2012 season, Jonathan joined the Sauber F1 Team, where he worked for four years as a race mechanic and member of the pit stop team. He then moved to China where he worked for two years in a management position for a German automotive manufacturer. After returning to Switzerland, he rejoined the Sauber Group and took over Sales Management for customer projects in additive manufacturing. Just over a year later, he was appointed Head Of Sales and in 2022 he was promoted to the Executive Board as CCO (Chief Commercial Officer), where he manages the commercial fortunes of Sauber Technologies AG. Today, Jonathan lives in Northern Switzerland with his wife and their two children.



→ for increased efficiency, new approaches are needed. Working on a project together with Sauber Technologies, we turned to 3D printing. Together with ANDRITZ, Sauber helped develop tailor-made printing routines which are used in the 3D printing process. HydroNews spoke with Mr. Jonathan Herzog from Sauber Technologies about the collaboration:

How did Sauber and ANDRITZ begin working together?

The initial contact was made by phone. Mr. Christian Redl, former Group Manager of Model Construction at the test rig in Linz, Austria, at that time had previously become aware of Sauber Technologies through a trade

“In general, no geometric details that are aerodynamically relevant for the flow are neglected in the model-scale tests for Formula 1. This approach is the same for model turbines in hydropower.”

show. During the first few projects, I had direct contact with ANDRITZ. Now, due to my job change to CCO, I'm no longer directly involved in the individual steps of the joint project. Nevertheless, I always have an overview of ongoing projects with ANDRITZ.

How long has the collaboration existed and how is it from your perspective?

We've been working together for over five years now, and it's a great experience for us. Both the inter-personal aspects and the joint development work for the model parts are excellent. By collaborating with ANDRITZ, we were able to learn a lot about our own processes, which meant that the gained knowledge also flowed directly back into Formula 1. The tests with the scale model parts of Formula 1 cars are then also tested in our wind tunnel. We were able to benefit from the collaboration, especially with

regard to accuracy in the model manufacturing process and the precise surface qualities of ANDRITZ model parts. Even though the material used for 3D printing is different from that normally used for the model turbines.

Why is ANDRITZ Hydro a good partner?

The requirements for the wind tunnel tests in Formula 1 are very similar to the test rig requirements at ANDRITZ. As a result, the understanding for the essential attention to detail is mutual and you can develop together. You speak the same language, and you are on an equal footing with regard to the joint development goals. Step by step, we want to get to the limit of what is possible, just like ANDRITZ. The focus for us, and for ANDRITZ, is therefore on being the global number one in development in each respective industry.

What is the potential for future collaboration?

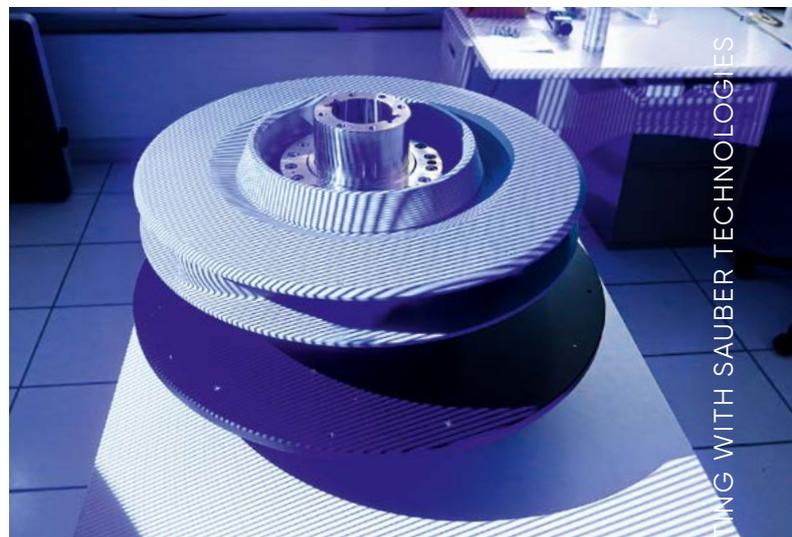
A highlight of the collaboration was certainly the first printed runner, which was used on the test rig in Linz. Printing a model turbine, with special geometry for ventilation during the tests, was also a super part of the collaboration so far. Sauber Technologies is ready to take part in all the various development steps and relevant tests. Using these new processes together in the hydraulic model test is something very special. Runner production should be organized even more efficiently and should be even faster with stable print quality. Therefore, the printing processes currently used will continue to be developed and various new material compositions are being designed and tested for the future. Our collaboration means that we, as Sauber Technologies, get an outside view and, conversely, ideas from our side also lead to improvements at ANDRITZ. We would also like to establish other links within ANDRITZ to make strong connections where Formula 1 technology makes sense.

What other sectors does Sauber serve?

In general, Sauber's task is to make these kinds of technologies available to everyone. We come into play in those areas where the focus →



Experienced staff operating the 3D printer at the most modern additive manufacturing facility in Hinwil, Switzerland



Turbine runner model for ANDRITZ after additive manufacturing in Hinwil, Switzerland



is on performance. Most customers and partners who come to us have an issue. That means they wouldn't have reached their goal without Formula 1 technology.

One part of Sauber Technologies is focused on production, where we develop and manufacture the model parts for ANDRITZ. Another part is engineering and development and, finally, there is the aerodynamic development

“You never know until you try.”

area for the high-end automotive sector. Our engineers also support and guide companies towards innovative solutions with agile approaches to development. The great advantage of Sauber Technologies is that we only develop on a target-oriented basis and with hardly any bureaucracy. Our motto is, “You never know until you try.” In additive manufacturing, we have SLA*, SLS* and DMLS* processes available for various developments. We've got our own in-house lab where the properties of the powders, such as moisture and flow characteristics, are measured before printing. We have appointed ourselves as the number one powerhouse of additive manufacturing.

Just like ANDRITZ, Sauber Technologies has a test rig: the wind tunnel. How are tests performed there?

On the one hand, model tests are carried out with our Formula 1 vehicles, but also using customer models, which we can build ourselves if required. Finally, so-called 1:1 tests are carried out with full-size vehicles. We can test up to three subjects in any 24-hour period. Similar to the tests on the hydraulic rig, preparations for the tests are challenging and this is where a lot of work is invested.

*SLA: Stereolithography

*SLS: Selective Laser Sintering

*DMLS: Direct Metal Laser Sintering

Where are the limits for size and speed in 3D printing and what are the limitations for tests in the wind tunnel?

For the individual parts, the maximum size is currently 650 × 550 mm and, if necessary, these separate manufactured parts are then assembled and joined together for testing. The Formula 1 car is tested with 60% of full size, which is specified in the rules. Likewise, there are specifications for Formula 1 as to the maximum number of tests that may be conducted and at which point on the vehicle something may be changed. These specifications can always change and have done many times over the years. In a 12-hour shift in the wind tunnel, up to 200 options are tested on the car. The optimization of the geometries is also done in house with numerical flow simulation, as is the case at ANDRITZ. This means that the calculation groups develop details on the car and these are then tested in the wind tunnel. After feedback from actual test measurements, the findings can, again, be implemented at 1:1 scale in development. The software for flow simulation is also programmed in house, and

“Speed and accuracy are decisive in the manufacturing methods for model parts on the hydraulic test rig.”

the number of calculations is limited by the FIA (Fédération Internationale de l'Automobile), although it's not unusual for a check to be made during an unannounced visit from an employee. At Hinwil here in Switzerland there is a dedicated team which is solely responsible for the further development of the wind tunnel. It is constantly being further developed and adapted to meet or exceed the latest standards. Wind speeds of up to 288 km/h can be generated for testing.

AUTHOR

Interview conducted by Sigrun Fugger,
Hydraulic Project Engineer ANDRITZ Hydro
Copyright pictures: Sauber Technologies



SAUBER Technologies



FIND OUT MORE:

www.sauber-technologies.com

TESTING FOR

OPERATING THE WORLD'S



After a planned construction time of about a year, the new high-performance test rig in Linz, Austria, has been inaugurated. This new ANDRITZ test rig is the most powerful universal test rig in the world and the inauguration marks a new milestone in R&D history. It is able to test any turbine type from a low head bulb unit up to high head multi-stage pumps.

The launch of the new test facility took place at the beginning of March 2023 with an employee celebration in the presence of Wolfgang Semper, former member of the Management Board of ANDRITZ HYDRO GmbH and member of the Executive Board of ANDRITZ AG.

In the future it will be possible to test model turbines for hydropower plants with a particularly high head of up to 250 m and a maximum flow rate of 1.8 m³/s. Meeting the very highest standards, it will also be possible to implement special customer requests regarding larger models and extended test conditions. Test rig operations will be supported by the ANDRITZ all-in-one

Metris platform, which will be used as a framework for the automation. The high-performance test rig was designed as a universal test rig for Kaplan turbines, Francis turbines, storage pumps and pump turbines. It is able to assess these designs across a broad range of conditions from low to high head, and in both vertical and horizontal arrangements.

Immediately after the inauguration ceremony, the high-performance test rig was put into commercial operation and is already providing test-specific spectra for different customers, as well as internal R&D requirements for model testing. Directly after the festivities concluded, a reference test setup was changed to

a specific customer project, which had a very large model inlet structure and a bigger-than-standard model size. This large size was established under the terms of the contract, and the customer's request also ended up with a higher-than-standard Reynolds* number for the testing conditions.

Despite challenges due to supply chain issues during the COVID pandemic, the team was able to successfully commission the test rig. The facility thus achieves all the required performance metrics and meets the very high expectations that were set out internally. We are proud that we can offer these new capabilities to clients, bringing additional capacity to our

*Reynolds number:

The Reynolds number is a dimensionless ratio named after the physicist Osborne Reynolds, used for fluid mechanics.

FOR THE BEST

MOST POWERFUL R&D TEST RIG



PERFORMANCE DATA

- Maximum testing head: 250 m
- Maximum discharge: 1.8 m³/s
- Maximum testing power: 1.3 MW
- Maximum torque: 8,500 Nm

Fully compliant with the relevant IEC standard, 60193 Hydraulic turbines, storage pumps and pump-turbines

“With the inauguration of this testing facility, ANDRITZ has turned its vision of building the world’s most powerful test rig into reality.”

worldwide laboratories and increasing the physical size of possible testing ranges.

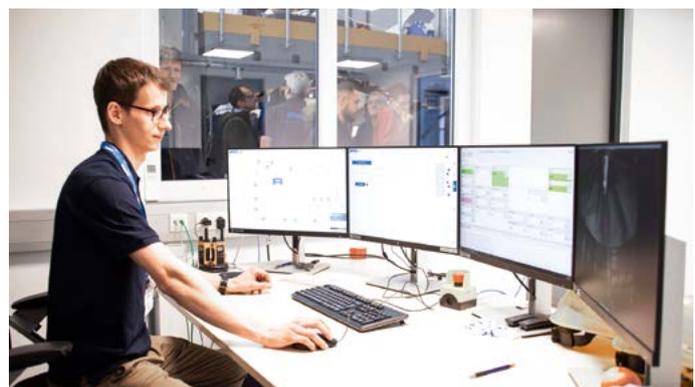
As one of the world's major turbine manufacturers, ANDRITZ considers it vital to maintain a leadership role in research and development. This substantial investment once again illustrates ANDRITZ' on-going commitment to that goal, particularly in areas related to key markets such as pumps and pump turbines.

AUTHOR

Sigrun Fugger
hydronews@andritz.com



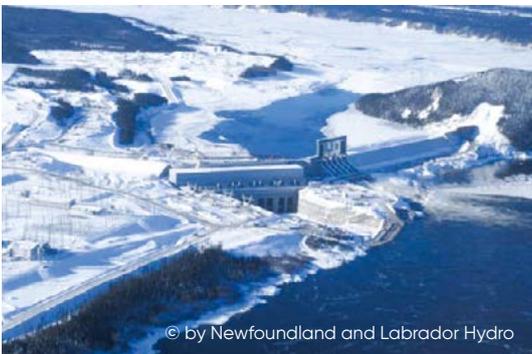
Official inauguration of the high-performance test rig in Linz, Austria



Precision at work. Specialists are overseeing the tests in the new test rig.

A RENEWA

Energy Gem in Newfoundland and Labrador



© by Newfoundland and Labrador Hydro

[Muskrat Falls power plant in winter](#)



© by Newfoundland and Labrador Hydro

[Intake gates including trash racks](#)

Muskrat Falls, Canada - Construction of the 824 MW Muskrat Falls mega-project on the lower reaches of Canada's Churchill River began in 2013 and was completed in November 2021. The plant,

located about 30 km west of Happy Valley-Goose Bay, Labrador, consists of a spillway, three dams and a powerhouse. It is the second-largest hydroelectric facility in the province. The project includes a 1,000 km transmission line and a 32 km subsea cable, which links the hydroelectric dam

with the island of Newfoundland, providing energy for more than 60,000 people locally.

“Muskrat Falls delivers a reduction in greenhouse gas emissions that is equivalent to taking about one million cars off the road for one year.”

ANDRITZ' scope of supply comprised the design, supply, and installation of four new units with a capacity of 206 MW each, including four vertical 8.8 m diameter Kaplan turbines, synchronous generators, digital governor systems with servo motors and high-pressure oil supply systems, as well as static excitation,

ABLE



Muskrat Falls

TECHNICAL DETAILS

Total output: 824 MW
 Scope output: 4 × 206 MW
 Head: 35 m
 Voltage: 15 kV
 Speed: 90 rpm
 Runner diameter: 8,820 mm

control, protection, and monitoring systems. ANDRITZ also supplied hydromechanical works, including spillway gates and stop logs, intake gates including trash racks and bulkhead and tailrace stop logs. Several ANDRITZ locations were involved in this 10-year project, with ANDRITZ Hydro Canada leading the project execution.

The project required execution excellence in many regards, especially with the remoteness of the site in northern Canada. The difficult weather conditions with lots of snow, ice and wind, required tremendous focus on safety, such as all the measures needed to withstand the low temperatures and snowstorms, and to secure access to the stored parts. The ANDRITZ team received the Power Safety Award for Excellence in Safety after over 5.2-million-person hours were recorded without a lost time injury. The pandemic brought another wave of challenges. However, the team rose to the occasion and adapted to work safely under the conditions. This situation also required new technologies to

support remote work, such as the use of a drone for the runner and intake inspection, and an ROV to inspect the underwater intake gate and tailrace.

The project also required a lot of flexibility, adaptability, and tenacity from the team. For example, special efforts were required to clean and conserve parts that had been delivered to the powerhouse five years previously.

ANDRITZ Hydro Canada is proud to have contributed to the training and development of workers in Newfoundland and Labrador. Some of these people are even currently working outside the province. Of particular note, the addition of Native Nation workers to our team is part of this success story. In partnership with Newfoundland and Labrador Hydro, ANDRITZ directly hired some indigenous workers to execute tasks for the project.

It is estimated that the project will replace 3 to 4 million tons of carbon dioxide from thermal power plants annually. This will

significantly reduce the carbon footprint of northeastern Canada and is equivalent to taking about one million cars off the road for one year. ANDRITZ is honored to have contributed to this clean, green, and sustainable development.

The four units of Muskrat Falls have been in commercial operation for more than a year and fully meet Newfoundland and Labrador Hydro's expectations. The generating units are and will be providing clean, renewable, and dispatchable energy for years to come. ANDRITZ is immensely proud of this achievement, which was made possible thanks to our employees, craft labor, partners, and the leadership demonstrated by Newfoundland and Labrador Hydro. We are looking forward to further cooperation with Newfoundland and Labrador Hydro and will continue to support the Muskrat Falls hydropower plant in the future.

AUTHOR

Eric Crucerey
hydronews@andritz.com

Power the mo

PROJECT INTERVIEW — UK, WALES, DINORWIG



Powering the electric mountain



Dinorwig Pumped Storage Power Plant, Wales, UK

Dinorwig, known as the electric mountain, is among the largest pumped storage projects in Europe, but after 40 years of operations the plant was in need of refurbishment. Making it fit to serve the needs of our future energy system meant replacing the main inlet valves and in 2021 ANDRITZ secured the contract from First Hydro for six new spherical valves and governors. HydroNews spoke with First Hydro's Tom Hay and Mike Jones about the importance of pumped storage hydro in powering the energy transition.

With a maximum gross head of close to 550 m, Dinorwig features a single pressure shaft with a diameter of up to 10.5 m that feeds all six Francis turbines. The main inlet valves are the only isolation point between this high-pressure shaft and each of the pump turbines. Their function is safety critical, but also vital for the power plant maintenance program. The main inlet valves are crucial to the plant's performance, too. ANDRITZ is therefore very proud of its important contribution to making Dinorwig fit for the future with six new spherical main inlet valves.



Interview with Tom Hay & Mike Jones

from First Hydro, responsible for the management and operation of PSP Dinorwig

Tom Hay is Head of Business Development and Strategy UK Flexible Generation and commercial lead for the First Hydro refurbishment program.

Mike Jones is the Engineering and Development Manager leading the engineering and execution phases.



Tom Hay



Mike Jones



→ *Please introduce yourselves and First Hydro.*

Tom Hay, Head of Business Development and Strategy UK Flexible Generation and commercial lead for the First Hydro refurbishment program and Mike Jones, the Engineering and Development Manager leading the engineering and execution phases. First Hydro Company is responsible for the management and operation of the 1,728 MW Dinorwig power station and the 360 MW Ffestiniog power station. Both are pumped storage power plants.

“Pumped storage plants are highly flexible and can provide a wide range of services adapting to a wide range of market conditions.”

How supportive is the present national and global market environment for your business objectives?

As renewables penetration increases and thermal capacity retires there is expected to be an increased demand for flexible generation and storage such as that provided by pumped storage. The revenue streams for flexible generation are often unpredictable and high risk, and this increases the importance of long-term revenue structures to underpin the investment. The current UK Capacity Market provides such a structure, allowing the possibility of 15-year contracts for new build and refurbishment investment programs, although the main inlet valve replacement is not supported by such a contract.

How important is this hydropower project in supporting First Hydro's plans to transform the energy sector?

When it was commissioned in 1983, Dinorwig Power Station was regarded as one of the world's most imaginative engineering and environmental projects. It is still one of the largest pumped storage plants in Europe. Dinorwig remains key to First Hydro's portfolio and plays a vital role in balancing the UK

National Grid. The main inlet valves are critical for operating the units and their replacement is a key part of extending the life of Dinorwig beyond 2050.

What are the main drivers for your organization to rehabilitate large-scale hydropower assets?

Dinorwig remains competitive against other forms of flexible generation and storage, including Lithium-ion batteries. Pumped storage plants are highly flexible and can provide a wide range of services adapting to a wide range of market conditions. Dinorwig was commissioned in 1983 and is 40 years old. Now it requires a major refurbishment program to stay operational and meet future expected demand.

Does First Hydro have plans to expand its footprint beyond Wales?

First Hydro is focused on Dinorwig and Ffestiniog. First Hydro is owned by ENGIE (75%) and Brookfield (25%), and both owners already have much wider international participation in electricity generation assets.



With a total capacity of 1,728 MW, Dinorwig is one of the largest pumped storage power plants in Europe.



For more details on the project and the technical specifications please see the article about Dinorwig in the latest issue of HydroNews, No. 36.

“Liaison at an early stage remains the best control measure available to mitigate risk to both parties in designing a safe plant that meets operational requirements.”

Do you see an advantage in working with major contractors or suppliers in the early stages of project development to optimize the overall plant concept and implementation schedule?

First Hydro has collaborated with ANDRITZ since the early stages of the design of the main inlet valves. Liaison at an early stage remains the best control measure available to mitigate risk to both parties in designing a safe plant that meets operational requirements. It also permits the development of realistic delivery programs and balanced terms and conditions, whilst allowing the team to build trust and to develop a project which is mutually beneficial over time.

How do you see your collaboration with ANDRITZ, and how would you assess this partnership?

The collaboration with ANDRITZ on the main inlet valves has been very positive. The First Hydro and ANDRITZ teams have worked closely together to develop a detailed design and to meet a challenging timeline. The open collaboration, with both parties providing competent resources, has enabled inclusion of several design improvements, optimization of the construction and installation program, and quick solutions to arising issues.



Pressure test and Factory Acceptance of the first of six spherical valves for Dinorwig in the presence of the customer in autumn 2022

AUTHOR

Interview conducted by Marie-Antoinette Sailer, Editor HydroNews, Market Management ANDRITZ Hydro hydronews@andritz.com

The Transport

In the autumn of 2022, Factory Acceptance of the first of the spherical valves for Dinorwig was completed at the ANDRITZ manufacturing facility in Ravensburg, Germany. Transporting the 160-ton valve

to the destination of Llanberis began in January 2023. Dimensions of 5.56 × 4.80 × 3.95 m meant the transport vehicle could only use roads at night, so completing the challenge took several days. In April 2023, the first two spherical valves arrived safely in Wales. Installation and commissioning took place subsequently.

The new components were specifically designed to meet daily operational requirements in ensuring grid stability.

To further ensure reliability, the SCADA control system and the connection to ANDRITZ' own Metris DiOMera platform provide condition-based and predictive information on the status and maintenance needs of the installed components.



The first spherical valve on its way to installation

Highly flexi



Scheme of Limberg 3, owned and operated by VERBUND

“Limberg 3 is designed very specifically to meet the future needs of the energy transition, making it Austria’s most modern pumped storage power station.”

Limberg 3, Austria - Following the successful engineering contract of the Limberg 3 pumped storage power station owned by VERBUND in Austria, ANDRITZ received a contract extension for the complete supply, erection, and commissioning of two variable-speed, asynchronous motor-generators for the plant. The contract, awarded in spring 2022, also includes three-phase excitation equipment.

Limberg 3 is an extension of the Glockner-Kaprun power plant group in the heart of the Austrian Alps. Like the previous Limberg 2, this new Limberg 3 plant will be built completely underground between the two existing storage lakes – Mooserboden and Wasserfallboden – as a further cavern-based storage power plant. In order to achieve additional storage capacity and flexibility, the dam of the existing Wasserfallboden reservoir will be raised by a further 8 m.

With a total capacity of 480 MW in both turbine and pumping mode, Limberg 3 is designed as a modern, flexible, and high-capacity pumped storage power

ble

pumped storage capacity

TECHNICAL DETAILS

Total output: 480 MW
 Scope output: 2 × 280 MVA
 Speed range: 450 rpm – 550 rpm
 Head: 360 m
 Voltage: 15 kV



Limberg 3

station. It is specifically designed to meet the needs of the current energy transition and associated grid stability requirements. ANDRITZ is supplying the heart of this high-performance complex plant with the manufacture and installation of two double-fed induction motor generators (DFIM), including the AC excitation system.

DFIM TECHNOLOGY SPECIAL FEATURES

In contrast to the synchronous machine, in which excitation takes place with direct current, in DFIM systems the rotor is supplied with a low-frequency, three-phase alternating current by means of a frequency converter. Control of this frequency enables the use of a variable rotor speed in the range from 450 to 550 rpm. In addition to controlling the reactive power, this capability can also be used to regulate the active power in both pump and turbine mode. DFIM achieves higher overall plant efficiencies and safe operation of the turbine and allows adjustment to power consumption under different operating conditions.

The design of the rotor in a DFIM differs significantly from that of a synchronous motor-generator and is the key challenge for this type of machine. The 3D view of the Limberg 3 rotor, seen below, shows the rib shaft with the laminated rotor core, in which a three-phase high voltage winding is inserted. High-strength rings are shrunk onto both rotor ends as a retaining and supporting system for the rotor winding head. This compact and efficient approach to the rotor winding head is a patented ANDRITZ design which has already been successfully implemented in the reference plants Goldisthal in Germany and Fengning II in China.

The two variable-speed, asynchronous motor-generators make Limberg 3 extremely flexible.

Due to the increasing use of new energy sources like wind and photovoltaics, flexibility in terms of balancing and stabilizing the grid is of great interest to energy supply companies such as our customer VERBUND. Limberg 3 is thus another state-of-the-art pumped storage power plant in Austria that is ideally suited to the especially demanding requirements of the energy transition.

ANDRITZ is proud to support the customer VERBUND in realizing this important pumped storage project in the heart of the Austrian alps.

On-site assembly works of both machines will be carried out in 2024 followed by commissioning test and completion of both units in mid of 2025.

AUTHORS

Johann Pössinger
 Stephan Scheidl
 Werner Ladstätter
hydronews@andritz.com

3D view of the
 Limberg 3 rotor





THE ANDRITZ APPROACH TO SUSTAINABILITY

In the face of the current climate crisis, ANDRITZ recognizes the urgency of the fight against global warming and is firmly committed to reducing our carbon footprint and actively developing solutions that help our customers minimize theirs. In response, in June 2021 the company launched the “We Care” sustainability program. The program combines all ANDRITZ sustainability activities and defined targets under a single Environmental, Social, and Governance (ESG) banner.

Within the broad ESG topic, ANDRITZ is focusing on key areas where we can make the maximum contribution. For the environment, our focus is on technologies that support decarbonization and reduce resource consumption. In addition, we have set the goal of halving our own carbon footprint by 2025 and reducing our water consumption and waste volume, too. For example, last year all German locations switched from renewable sources to electricity, with more locations to follow. The installation of photovoltaic systems at several sites also started this year. Employee satisfaction, health and safety, and diversity are at the

center of our social focus, while our governance-related efforts focus on compliance and ethically correct behavior, risk management, and responsible supplier management.

Across the social and governance areas, ANDRITZ Group Corporate Compliance monitors ethical business conduct, while Group Quality and Safety Management takes the initiative to make work safer, and Group Supply Chain Management ensures that we buy from suppliers who meet the requirements of our Supplier Code of Conduct.

At ANDRITZ, we are committed to addressing decarbonization, embracing the circular economy, and contributing to a better world.

Through our We Care sustainability program, we focus on reducing our carbon footprint, saving resources, and developing sustainable technologies that help our customers achieve their sustainability goals. By positively impacting our planet, we strive to create a brighter future for all,” says Joachim Schönbeck, President and CEO of ANDRITZ GROUP.

“As an international technology group, ANDRITZ has a strong focus on sustainable solutions which help to protect the environment, contribute to decarbonization, reduce resource use, and foster a circular economy.”

As an international technology group, ANDRITZ has a strong focus on sustainable solutions that help to protect the environment, contribute to decarbonization, reduce resource use, and foster a circular economy. By 2025, every second Euro of ANDRITZ' revenue is to be generated by these sustainable solutions.

SCIENCE-BASED GREENHOUSE GAS EMISSION TARGETS

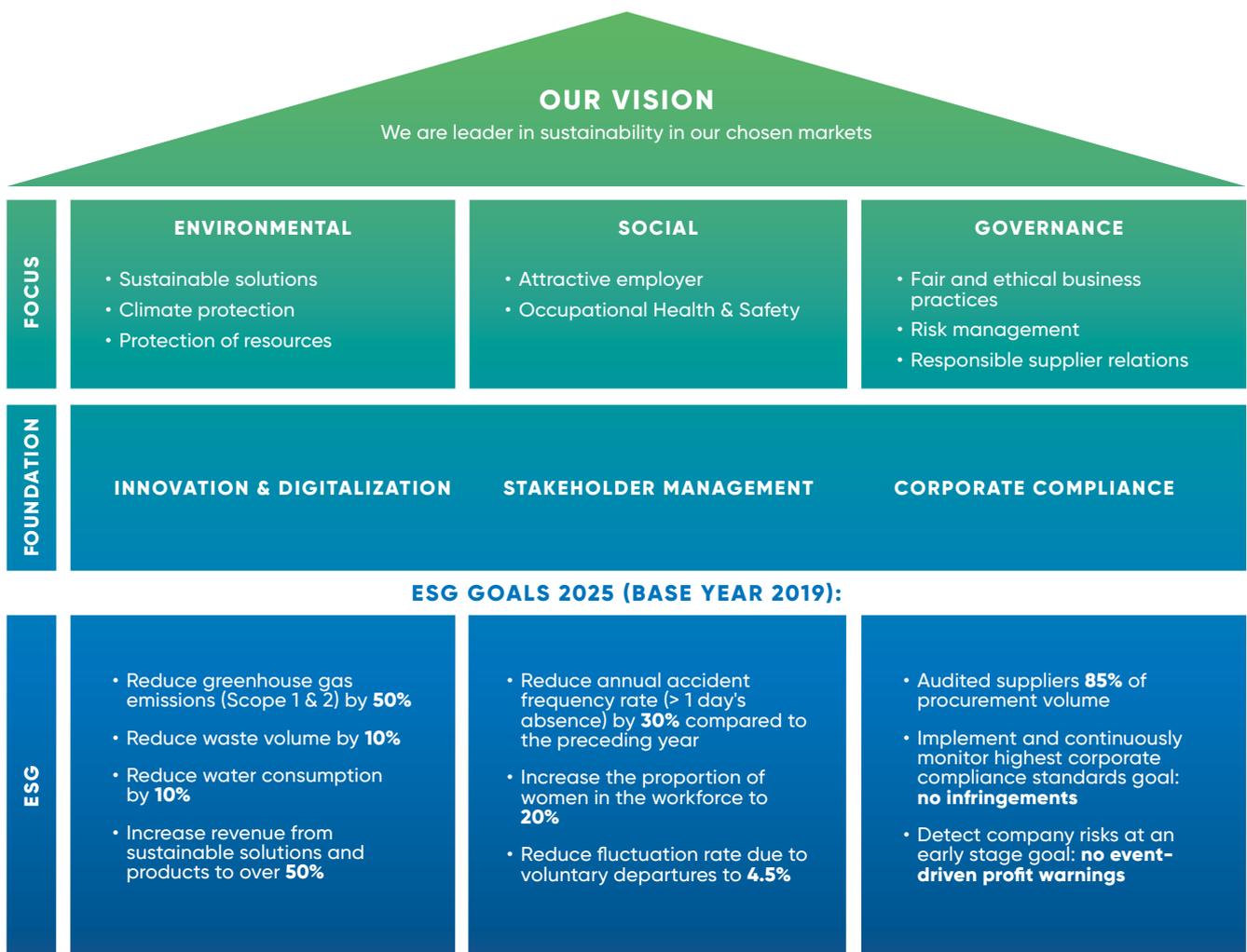
At the beginning of 2023, ANDRITZ committed to the Science Based Targets initiative (SBTi), as part of its determination to contribute to the 1.5° C goal established in the Paris Agreement.

“Our commitment to SBTi offers a way to have our greenhouse gas reduction targets assessed and validated by an independent organization based on science. It will help us make our contribution to containing global warming,” says Schönbeck,

adding: “This initiative also helps to strengthen our stakeholders’ confidence in us.”

Under the SBTi commitment, ANDRITZ will develop comprehensive greenhouse gas emission reduction targets. Data on Scope 1 emissions (from sources controlled by the company) and Scope 2 emissions (related to the purchase of electricity, steam, heat, or cooling) is already being collected and reported. The next step will be to identify Scope 3 emissions that arise upstream and downstream in the supply chain as the basis for the SBTi targets. Typically, Scope 3 emissions account for the largest share of a manufacturer's total emissions.

Sustainability is key to our collective future and the ANDRITZ environmental, social and governance program is just part of that tangible commitment. We Care.



AUTHOR

Caroline Hofer
hydronews@andritz.com



TECHNOLOGY IS JUST A WOMAN'S JOB

Women in Engineering at ANDRITZ Hydro

At ANDRITZ Hydro, we recognize the importance of gender diversity and inclusion in the workplace. As a leading provider of innovative solutions for the hydro industry we understand that our success depends on talent, creativity, equality, and the unique perspectives of all our employees. One of the key areas where we have been successful in promoting gender diversity is in our R&D departments. HydroNews talked with Sigrun Fugger, Hydraulic Project Engineer at ANDRITZ Hydro Austria, about her passion for hydropower and what it is like to forge a successful career in a 'man's' world.

Interview with **Sigrun Fugger,**

*Caroline Marchand,
Maria Collins and
Magdalena Neuhauser*



Sigrun Fugger: Hydraulic Project Engineer
ANDRITZ Hydro Austria

After earning a degree in mechatronics from the Johannes Kepler University in Linz, Austria, Sigrun Fugger started working directly at ANDRITZ Hydro in the R&D department in Linz. She is now working as a hydraulic project engineer while expanding her knowledge working on a MBA degree at the University of Applied Sciences in Steyr, Austria. She lives in Oberföhring, is in a partnership and has three children.

Caroline Marchand: Group Leader Hydraulic Project Management/Development, ANDRITZ Hydro Austria

Maria Collins: Lead Engineer - Hydraulic Project Engineering, ANDRITZ Hydro Austria

Magdalena Neuhauser: Head of Hydraulic Laboratory, ANDRITZ Hydro Switzerland

Sigrun, please tell us about how you joined the hydro business and why hydropower and especially R&D work is your passion.

Sigrun – When I first visited the hydraulic test stand in Linz 15 years ago, I had no idea that this would be the beginning of my passion for hydropower. The model turbines fascinated me immediately and I was excited about the possibilities that arose from this technical field.

Right after graduating from university, I was lucky to get a job with ANDRITZ Hydro and to take part in important projects. It is particularly important to stay focused, constantly push limits, and accept every challenge. It takes a lot of dedication and

“It is particularly important to stay focused and accept every challenge.”

perseverance, but it's incredibly rewarding seeing the results of your work at the end of a project. In

contractual projects, having a satisfied customer is of paramount importance.

I was fully accepted and respected from day one in the R&D department. Overall, the decision to work in a technical profession was the best decision of my life. It is inspiring to see how everyone contributes towards a common goal.

This strong bond between colleagues is beautiful to see. Therefore, I took the opportunity to interview some of my female colleagues and share their insights too.

Can you describe a project that you're particularly proud of in your hydropower career?

Maria – There are many projects and accomplishments that I am proud of. Each time you manage to finish a model testing campaign together with your team – starting with a design phase and closing with an acceptance test – makes me proud. The happy expressions on the faces of the clients is especially rewarding.

Caroline – I have had the opportunity to work on many challenging projects during my career. The project I am particularly proud of is one which required a lot of development in the laboratory over two years. It gave me the chance to engage with the customer and explore challenging questions, deal with unexpected results and prepare

contingency plans. These were all fundamental skills I have used many times since in my work!

What message would you like to share with other women considering a career in hydropower?

Maria – Stay confident in yourself and keep on going with enthusiasm. Hydro is such an amazing and incredible business!

Caroline – From a R&D point of view, the work is challenging, creative and requires a rigorous approach to solving problems. Women in hydro are treated equally and are successful!

What inspired you to pursue a career in hydropower, and how did you get your start in the industry?

Magdalena – I studied technical mathematics in Vienna and during my master's degree I had the opportunity to do an internship at the hydraulic lab of ANDRITZ Hydro in Linz. I was fascinated by the variety of topics that are linked to design, manufacturing, and installation of turbines. At that time, I already appreciated that hydropower is an international enterprise. Working in hydropower allows us to get to know people with different languages and different cultural backgrounds.

2022 Women of Waterpower Award

Christine Monette, Team Leader & Principal Engineer, ANDRITZ Hydro Canada

We are proud to highlight that our colleague Christine Monette received the 2022 Woman for Waterpower award from the Women in Renewable Energy (WiRE) network. This award was given in recognition of Christine's exceptional contribution to technology development in the hydroelectric field.

How did you feel about being awarded the Woman of Waterpower for 2022?

I was very honored and surprised that this award was presented for a technical role. The fact that I received it is recognition of all the people working on the technical solutions for our hydroelectric equipment. It recognizes that we need talent in technical positions, not only in management.



A DIVERSE WORKFORCE DRIVING SUCCESS

Living inclusion at ANDRITZ Hydro

Women are making a significant impact in the field of engineering, and the hydro industry is no exception. With advancements in technology and the need for sustainable energy solutions, the demand for engineers in this field is only growing. However, despite the increasing need for engineering professionals, women remain underrepresented in this field.

At ANDRITZ Hydro, we recognize the importance of diversity and inclusion in the workplace, and we are committed to promoting gender equality in engineering. We believe that women have a valuable contribution to make to the field of engineering, and their involvement is essential for driving innovation and progress.

Studies have shown that gender-diverse teams tend to be more innovative, creative,

and efficient in problem-solving. Women bring unique perspectives and approaches to engineering, which can lead to more comprehensive solutions to complex challenges. Furthermore, we believe that a

"ANDRITZ is committed to promoting gender diversity and inclusion."

more diverse workforce results in higher employee satisfaction rates and is better equipped to adapt to changing market conditions.

There are many talented women in engineering, and we are committed to attracting, developing, and retaining these professionals at ANDRITZ Hydro.

We actively seek out and hire women for a range of roles in engineering, from entry-level positions to leadership roles. We also provide training and professional development opportunities to support the growth and advancement of our female employees.

At ANDRITZ Hydro, we understand that diversity goes beyond gender, encompassing nationalities, religions, and different cultural backgrounds. Embracing diversity is not only the right thing to do, but it is also a smart business decision. By promoting gender equality in engineering and supporting teamwork across age, genders, and cultural boundaries, we are unlocking the true potential of our workforce opening the doors to new ideas and innovative solutions, and true progress, paving the way for a brighter, more inclusive future.

AUTHORS

Sigrun Fugger and
Marie-Antoinette Sailer
hydronews@andritz.com



One of us

Interview with Florian Brungraber

Florian Brungraber is a hydraulic development engineer and project manager at ANDRITZ Hydro based in Linz, Austria. He is also an elite para-triathlete (elected Para Triathlete of Europe 2022). The next step in his athletics career is the Olympic Games in Paris 2024. HydroNews took an opportunity to talk to him about the balancing act between work and professional sport.



FLORIAN BRUNGRABER'S ACHIEVEMENTS:

- Bronze medalist at the 2019 European Triathlon Championships.
- Silver medalist at the 2021 Paralympic Games
- Vice World Champion 2022
- Three-time Austrian national champion 2020, 2021, 2022
- World ranking (World Triathlon Para Rankings, PTWC Men) second place



How was the last season and what parallels are there between your job and your athletic success?

I consider it crucial that I master both work and sport to the highest level possible. Last year was intense and due to the demands of both I could only achieve my full performance by increasing my efficiency. Most of the world's top competitors are not employed and can dedicate themselves to their sport, but I also have a demanding job. I believe that makes my fellow competitors admire my athletic performance even more.

How often do you train?

I train almost every day but every 10 days there is a rest day. In addition to strength training, all the disciplines of the triathlon have to be mastered. On weekends I use the extra time and do two training sessions per day. I get a lot of support from my girlfriend, but also support from the company helps me to be flexible in my second job as a professional athlete.

Can awards become a habit?

You always must give your best effort. Never underestimate a competition. Of course, the demands you place on yourself increase constantly. It's always a matter of trying to achieve one's personal best and I am always happy when I succeed in doing so during a competition. The variety and the requirement to master

"Always give your best!"

all the disciplines are the greatest charm of the triathlon and it's the same with a job working as a hydraulic engineer.

CHECK OUT FLORIAN'S WEBSITE:

www.flobrungraber.at



The The

SPECIAL TOPIC — INTERVIEW GLOBAL WOMEN'S NETWORK

**Barbara Fischer-Aupperle and Christine Lins
tell HydroNews about the Global Women's Network**

Dedicated and highly qualified employees are our greatest asset and gender balance is an important part of our philosophy. The Global Women's Network for the Energy Transition (GWNET) empowers women in energy through interdisciplinary networking, advocacy, training, and mentoring and ANDRITZ Hydro became a Corporate Member of GWNET in early 2023. HydroNews spoke with GWNET's Barbara Fischer-Aupperle and Christine Lins about their work and the importance of women in the energy transition.

Power of Women. Power of Change.

Christine and Barbara, you are engaged in the Global Women's Network for the energy transition. Could you please give us a brief overview of this network and its activities?

Barbara – GWNET aims to advance the global energy transition by empowering women in energy. We seek to address the current gender imbalance in the energy sector and to promote gender-sensitive action.

Our activities and mission focus on networking by connecting women worldwide to advance the energy transition through advocacy, generating and sharing information on the role of women in the energy transition, including mentoring for advancing the role of women as agents of change in society through regional and global programs.

Christine – Since GWNET was created in 2017, we have forged a variety of partnerships with international organizations and the private sector. Furthermore, we partner with national and regional women in energy networks, delivering advice and guidance for their work and development. All these networks are connected with us but act regionally and nationally in their own capacity and also independently. Our advice creates value and progress in all these networks, for example through a concise guide on "how to build a women's network" that is publicly available on our website.

You obviously have a broad mission. Why did GWNET decide to do that, instead of focusing on a particular sector or region?

Christine – We deliberately chose to work on the energy transition, welcoming women in energy in all different sectors as long as they are ready to embrace the change needed to make our energy



Interview with Barbara Fischer-Aupperle & Christine Lins

Christine Lins is Executive Director of GWNET, responsible for network, strategy and work plan development, fundraising, and overseeing implementation of various projects. Lins is also a member of the Board of Directors of the International Solar Energy Society. Over a career of more than 25 years in renewable energy and energy efficiency, she also acted as Executive Secretary of the Renewable Energy Policy Network of the 21st Century (REN21) and served as Secretary General of the European Renewable Energy Council.

Barbara Fischer-Aupperle worked in the hydropower industry for more than 33 years in international sales and as Head of Communications and Head of Sustainability. She was actively involved in the development and application of the Hydropower Sustainability Standard, including trial assessments and stakeholder relations management. Today she works as coach, mentor and as a speaker across a variety of gender and energy transition issues. With an Executive Master of Business Engineering and Change Management from the St. Gallen University in Switzerland, she is a co-founder and Board Member of GWNET.

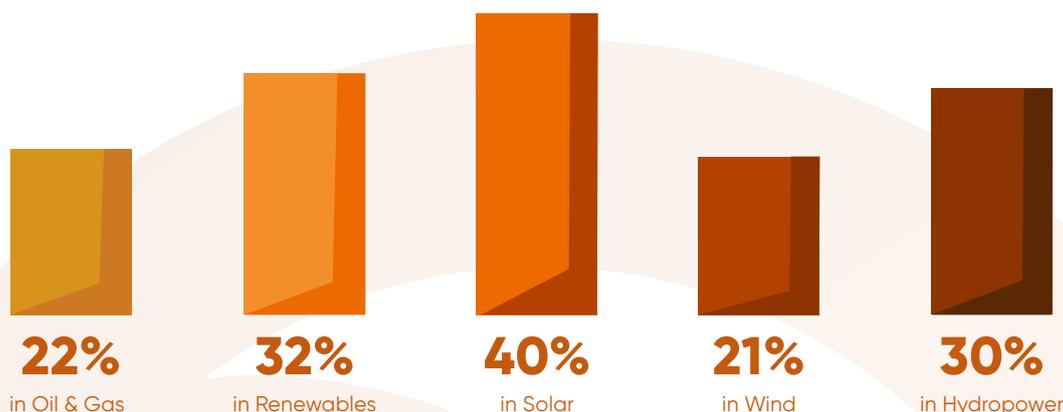


[Barbara Fischer-Aupperle](#)



[Christine Lins](#)

Share of female workforce in the energy sector:



Source: IRENA; GWNET 2023

→ system more sustainable. We are convinced that the energy transition will be fairer and progress faster when more women get involved. We created GWNET as a global platform to bring the voice of women in energy to the global debate.

Why is it important to work toward gender equality in energy, and what does that equality look like?

Christine – Gender diversity drives innovation, opens new pathways for technology deployment, brings valuable perspectives to social and economic development, and provides a richer pool of talent. There is also evidence that companies with diverse leadership show better financial results. Few areas are as critical as the transition to a sustainable energy system and, clearly, if more women join the workforce, everybody benefits!

What progress has been made since the foundation of GWNET?

“We are convinced that the energy transition will be fairer and progress faster when more women get involved.”

Christine – We founded the NGO in 2017 at a side event of the Vienna Energy Forum and had a membership of 60 right away. Then we began to develop concrete products and services, such

as mentoring offers for women. In 2018, we launched our first mentoring program with just 10 mentees. Four years later, GWNET is running 20+ mentoring programs with various partners, such as the World Bank, SEforALL, GIZ, and the German government, for over 600 women from more than 90 countries and can rely on a mentor pool of 600+ experts. We also managed to significantly grow membership to over 3,500 members from 150+ countries.

Barbara – And we have started a women's energy expert database as a platform for members, mentors, and mentees to showcase themselves there. So, when you need to find a capable or expert woman, we offer to search our database and find one for sure!

What was your initial motivation for this network and to what extent did your expectations come true?

Christine – I witnessed how women were underrepresented in the energy sector and that younger women often lack role models. That led me to co-founding GWNET in 2017 and it has developed at an incredible pace. We are very well connected, considered a preferred and competent partner, and get several requests each year to work on gender programs worldwide.

Currently, the global renewable energy industry employs 12.7 million people. Forecasts indicate that it will reach 42 million by 2050. To thrive, the renewable energy industry will clearly require the talents of both women and men. So, the competition for qualified staff will

get more intense, and that requires all organizations to put much more effort into recruiting across the genders.

Barbara – My perceptions were very similar to Christine’s, but I also note that hydropower is the renewables sub-sector that has a pretty low share of women, although it is higher than in fossil energy. But if you look at levels of work, the share quickly decreases to 20% or below in managerial positions. So, it is clear there is an urgent need to pace up and close the gender gap.

My personal expectations since our foundation were met far beyond my imagination. Yet,

“Provide a vibrant work environment for your staff. Motivated employees are the most important asset of any business!”

there is still a lot left to do. Nonetheless, I also observe that gender and diversity requirements are being brought forward through policy and regulation. For example, if you cannot offer enough gender diversity within an application for EU programs, you will not be eligible! That naturally helps.

How can companies support or engage with GWNET?

Christine – Very easily, just become a corporate member and evaluate the opportunities for developing gender-related themes with our support for your business. Apart from the financial aspects, this will make your efforts much more visible and credible. Sustainability today is not a “nice to have” but a “must” and

ENERGY MENTORING PROGRAM

From October 31 until November 4, 2022, 17 women from five Central Asian countries visited Vienna, Austria, for a study tour as part of the Empowering Central Asian Women in Renewable Energy Mentoring Program. This program was organized by the Organization for Security and Co-operation in Europe (OSCE), together with GWNET. The group also visited ANDRITZ Hydro’s headquarters.

gender diversity is a crucial aspect of sustainability, also in the Sustainability Development Goals of the United Nations.

How can others get involved in GWNET’s work?

Christine – Any woman in energy can easily join the network, becoming an individual member and creating a profile on our website, applying for a mentorship program, and/or becoming a mentor right away!

What advice would you give to women interested in the sector and to corporates looking to promote diversity?

Barbara – To any woman I would say choose your career path wisely and find a meaningful job. You will spend lots of your time there! Working on the energy transition and being part of the solution to this critical issue is personally rewarding.

Christine – And to any industry player I would say provide a vibrant work environment for your staff and make sure you manage to retain talent, male AND female. Motivated employees are the most important asset of any business!

AUTHOR

Interview conducted by Peter Stettner, Head of Market Strategy, ANDRITZ Hydro



GWNET
Global Women's Network
for the Energy Transition



FIND OUT MORE:
www.globalwomennet.org



PROJECT

RAMU 1, PAPUA NEW GUINEA

Two new Francis runners

ANDRITZ has manufactured two spare Francis runners for units 4 and 5 of the Ramu 1 hydropower plant located in the Eastern Highlands of Papua New Guinea. The contract was awarded by the state-owned utility Papua Power Ltd. (PPL) in February 2022 and the two spare runners were delivered in August 2023.

The runners are rated at 17 MW output each, have a diameter of 1,200 mm, and an operating speed of 750 rpm.

Ramu 1 is an underground power plant and consists of five machine sets with a total plant capacity of 77 MW. Three units with 15 MW each were put into operation in 1975/76 and two more units with 17 MW each were added subsequently and put into service in 1989. Immediately thereafter, the three original units were extensively modernized by ANDRITZ. Since 2011, some of the auxiliary systems were modernized. As Ramu-1 plays an important role for the local population to gain independence from expensive diesel and oil as a source of energy, PPL is planning to conduct a major overhaul of the plant.

AUTHORS

Gerhard Enzenhofer,
Edo Ronaldo
hydronews@andritz.com

TECHNICAL DETAILS

Year of manufacture: 1976 (1989)
Nominal power of unit 4 & 5: 17 MW
Nominal speed: 750 rpm
Runaway Speed: 1,435 rpm
Rated head: 185 m
Draft tube outlet: 2,100 mm



UPDATES

ENERGYCONNECT, AUSTRALIA

Grid stability in progress

In August 2021, ANDRITZ received an order related to the EnergyConnect project from SecureEnergy Joint Venture (SEJV). The order comprises the supply of four synchronous condenser units, including all required Electrical Power Systems (EPS) for two substations, Buronga and Dinawan, in New South Wales, Australia.

Vital to the country's transition to a future powered by renewable energy, the EnergyConnect project will be a new interconnector between New South Wales and South Australia along with an added connection to north-west Victoria. Two synchronous condenser plants will be installed on the new interconnector to provide system resilience services, such as inertia, short circuit contribution and reactive power compensation. These services are required to maintain grid stability and will enable the National Energy Network to connect additional large-scale renewable energy resources.

The engineering and manufacturing of the synchronous condensers was successfully executed by ANDRITZ Hydro Weiz, Austria, and the electrical elements, including control, protection, and excitation system by ANDRITZ Hydro Vienna, Austria.



A highlight and an important milestone was the suite of Factory Acceptance Tests (FAT) in the workshop in Weiz of the different components, especially of the final pre-assembled and tested stator.

With the arrival of the synchronous condensers at the Buronga substation in May 2023, installation and precommissioning is ongoing.

AUTHOR

Josef Friesz
hydronews@andritz.com

TECHNICAL DETAILS

Buronga and Dinawan (330 kV substations)

Units: 4 × 120 MVA

Speed: 750 rpm (8-pole salient)

Overload: 200% of rated MVA for 10s

Inertia time const.: 7 s (natural)

Transportation weights: ~110 tons stator halves, main transformer



IALY EXPANSION HYDROPOWER PLANT, VIETNAM

All requirements met

In December 2022, Vietnam Electricity (EVN) and ANDRITZ conducted the turbine model test for the Ialy Hydropower Plant Extension Project. The results prove the turbines fully meet the contract technical requirements. The testing process was carried out at ANDRITZ' top tier hydraulic technology laboratory in Linz, Austria and was witnessed by EVN project engineers. Testing of the hydraulic model plays a very important role in evaluating the basic parameters and determining the cost-effectiveness of the project investment.

The contract scope for ANDRITZ includes the complete electromechanical equipment for two 180 MW Francis units and additional auxiliary equipment. Project construction started in June 2021 and Unit 1 is expected to begin generating electricity in the fourth quarter of 2024.

Once completed, the project will increase the capacity of the Ialy Dam Hydropower Project to meet grid loads, especially during peak hours. This will contribute to stabilize the National Power System. The expanded Ialy hydropower plant will also increase the average annual power generation output by 233.2 GWh, thus

contributing to EVN's efforts to reduce fossil fuel costs and CO₂ emissions.

Due to the impact of the COVID-19 pandemic and the global political situation, material prices have increased

“Testing of the hydraulic model plays a very important role in evaluating the basic parameters and determining the cost-effectiveness of the project investment.”

significantly, affecting the progress of the project. However, ANDRITZ made every effort to conduct the turbine hydraulic model tests ahead of the contractual schedule in order to commence manufacturing as soon as possible and to ensure the timely supply of equipment to the project site.

AUTHOR

Neelav De Samrat
hydronews@andritz.com

**TECHNICAL DETAILS**

Total output: 1,080 MW
Scope output: 360 MW
Head: 185 m
Voltage: 15.75 kV
Runner diameter: 3,700 mm



BRESSANONE, ITALY

As good as completed

Only 22 months since construction work began, the fourth machine set of the Bressanone hydropower station was successfully commissioned in November 2022 – an important goal for the customer and the entire project team.

ANDRITZ signed the Bressanone contract with Alperia Green Power in December 2019. The scope of the contract saw the complete modernization of the plant, including the supply of three 38 MW Francis vertical turbines, one 18 MW turbine, five valves, four new generators, as well as supply and installation of balance of plant, electrical systems, and automation.

The project proved very challenging due to the tight schedule, which called for the parallel installation of two machine sets per year. In addition, the limited space in the cavern required special attention during installation. The project also included supply of four 3,000 mm diameter butterfly valves, which had to be installed within just six months.

For both companies this project was the first “public contract above the EU Community Threshold” where many restrictions and regulations demanded compliance. For example, more than 20 subcontractors had to be accredited, which presented a major documentation management challenge.

In early 2023, the customer conducted performance tests on all four machine sets. The results were all in line with the contractually agreed values. This leaves only modernization of the fifth machine set, the twin of the fourth. The scope of this project includes the supply of the turbine, machine valve and balance of plant, and the refurbishment of the generator. Completion is scheduled for October 2023.

The contract reaffirms a decade of solid cooperation with Alperia and provides a strong basis for subsequent contracts we received for the San Floriano and Lana projects.

AUTHOR

Francesco Dalla Vecchia
hydronews@andritz.com

TECHNICAL DETAILS

Total output: 150 MW

Scope Output: 3 × 38 MW / 1 × 18 MW

Head: 143 m / 155 m

Speed: 375 rpm / 500 rpm

Runner diameter: 2,220 mm / 1,530 mm

Av annual production: 520 GWh





LIKHU-A AND LIKHU 2, NEPAL

Successful commissioning

A contract for the complete electromechanical elements of the Likhu cluster of Nepalese projects, consisting of Likhu-A, Likhu 1 and Likhu 2, was awarded to ANDRITZ by Nepal's leading private sector hydro developer, namely the Dugar Group of Companies. The contract, awarded in December 2018, involved the design, manufacture, supply, installation, and commissioning of electro-mechanical and hydromechanical works of the three projects.

Despite various challenges faced during execution due to COVID-19 and a volatile raw material market, the ANDRITZ team worked tirelessly to ensure the successful execution of this contract. With a focus on safety, quality, and sustainability, they drove a timely commissioning. As a result, ANDRITZ successfully completed the Likhu-A hydro power project (2904 MW) in February 2023.

The success of the Likhu-A project was a result of the team's expertise in project management, engineering, construction, and commissioning. They worked closely with the customer and stakeholders to ensure that the project met their needs, while also prioritizing the safety of all workers and the environment.

The Likhu 2 project (55 MW) is almost complete and is set to be commissioned soon. ANDRITZ is proud of the team's commitment to quality and safety in the execution of this project.

Also in execution is the last and third project namely Likhu 1 HPP (77 MW), which is expected to be commissioned in 2024.

These projects are a testament to the excellence of ANDRITZ in delivering state-of-the-art technology for hydropower projects that meet the technical requirements of our clients and stakeholders.

ANDRITZ remains committed to the development of Nepal's hydropower sector. We firmly believe that hydropower has the potential to play a critical role in Nepal's economic growth and development, and we are excited about the opportunities that lie ahead. We look forward to continuing to work with our clients, partners, and stakeholders to deliver more successful projects that benefit the people of Nepal.

TECHNICAL DETAILS

Likhu-A:

Total output: 29.04 MW

Scope output: 2 × 12 MW / 1 × 5.04 MW

Turbine: horizontal Francis

Rated net head: 138.55 m

Rated speed: 600 rpm / 750 rpm

Likhu 2:

Total output: 55 MW

Scope output: 1 × 44 MW / 1 × 11 MW

Turbine: vertical Francis

Rated net head: 229.53 m

Rated speed: 600 rpm / 750 rpm



Likhu A and Likhu 2

AUTHOR

Neelav de Samrat
hydronews@andritz.com

MARCKOLSHEIM, FRANCE

New discharge ring assembly

In December 2020, ANDRITZ Hydro Switzerland signed a contract with EDF (Electricité de France) for the supply of one embedded discharge ring, intermediate ring and bottom ring for the largest Kaplan unit in France with a runner diameter of 7,250 mm, and an assembly weight of more than 70 tons.

The scope of supply included the erection of the discharge ring assembly including the dismantling of the old ring, which was fully embedded in concrete.

After intense work, including heavy civil engineering activities over several months, the discharge ring assembly was positioned by the tenth of mm, welded, embedded and then re-machined on-site. This work was successfully completed mid-March 2023.

Our specialist teams were able to meet this technical and human challenge and make it a success for ANDRITZ Hydro Switzerland.

We would like to thank our customer EDF for their valuable collaboration and for their trust.

AUTHOR

Damien Bonjan
hydronews@andritz.com

TECHNICAL DETAILS

Total output: 40 MW
Net head: 13.2 m
Flow: 350 m³/s
Nominal speed: 75 rpm
Diameter: 7,250 mm



OUR INDONESIA

TECHNICAL DETAILS

Peusangan 1

Output: $2 \times 23.1 \text{ MW} / 2 \times 26.5 \text{ MVA}$

Head: 205.3 m

Voltage: 11 kV

Speed: 600 rpm

Runner diameter: 1,200 mm

Peusangan 2

Output: $2 \times 22 \text{ MW} / 2 \times 25.3 \text{ MVA}$

Head: 187.7 m

Voltage: 11 kV

Speed: 600 rpm

Runner diameter: 1,200 mm

Peusangan 1 & 2

Installation works completed

Peusangan 1 and 2, Indonesia - The installation of the electromechanical (E&M) equipment at Indonesia's Peusangan Powerhouse No. 1 (PH 1) has been completed.

Peusangan PH 1 has an underground powerhouse, whereas a second plant, Peusangan PH 2 has a surface powerhouse. Both are run-of-river power plants located on the Peusangan River and adjacent to Lake Laut Tawar in the central region of Aceh Province in the northwest of Sumatera, also known as Sumatra.

ANDRITZ' scope of supply for the HPP Peusangan 1 and 2 comprises vertical Francis turbines, generators, transformer, 150 kV switchyard, cranes and comprehensive mechanical and electrical auxiliaries.

With an expected annual output of 327 GWh of electric energy, Peusangan 1 and 2 will be the first large hydropower plants in the region. The commercial operation of Peusangan PH 1 is scheduled to begin in early 2024.



Stator lowering of Unit 1 of Peusangan 1

IAN PROJECTS

Successful Installation and Testing

Asahan 3, Indonesia - In May 2023, the Penstock Isolation Valve (PIV) has been successfully installed and tested at Asahan 3. The valve was manufactured at ANDRITZ workshop located in Hungary. The Factory Acceptance Testing (FAT) of the PIV was completed in November 2021.

The project is located downstream of Lake Toba on the Asahan River and southeast of the city of Medan, North Sumatera, Sumatera Island.

In September 2019, ANDRITZ signed a contract with the state-owned utility PT. Perusahaan Listrik Negara (Persero) (PLN) for the hydromechanical equipment and metal works at the Asahan 3 hydropower plant. The scope of supply comprises 12 roller gates, six intake trash racks, one

intake trash rack cleaning machine, steel penstock with bifurcation, two draft tube roller gates, all with hoists and stop logs, as well as a butterfly valve with a diameter of 5.3 m. An international ANDRITZ team from Austria and Indonesia executes the project together. Completion and commissioning are scheduled for April 2024.

This contract award is another outstanding achievement, and contributes to ANDRITZ' more than century-long success story in Indonesia. With this project, ANDRITZ continues its dedication and excellence in supplying electromechanical equipment and full life cycle services "from water-to-wire" for hydropower projects to all its customers for the benefit of the people of Indonesia.



Beginning of 2023, the pressure test for the bifurcator of Asahan 3 was successfully executed.



Installation team of Penstock Isolation Valve (PIV)



PIV during FAT (Factory Acceptance Test) at ANDRITZ' workshop in Hungary

TECHNICAL SPECIFICATION OF PENSTOCK ISOLATING VALVE (PIV):

- Valve type: Butterfly with biplane disc
- Hydraulic-2 cylinder hoist with a hydraulic oil unit
- Number of units: 1
- Nominal diameter: 5,300 mm
- Design water head in closed position: 33.35 mWC
- Design water head in open position: 57.81 mWC
- Max. static water head: 33.35 mWC
- Test pressure: 86.71 (1.5 × 57.81) mWC



Asahan 3



Excitation cubicles

Excitation retrofit for Indonesian power supply

PT. Indonesia Power Mrica PGU (UP-Mrica), Indonesia - ANDRITZ was awarded multiple contracts by PT Indonesia Power, a subsidiary of PT PLN (Persero), operating hydropower plants across the archipelago. The contracts are for the upgrading and retrofit of excitation systems for hydropower plants located in Central Java, namely Panglima Besar Jenderal Soedirman Unit-2 (with

redundant automatic voltage regulation - AVR), Timo Unit-3 (brushless excitation), Wadaslintang Unit-1, and Wonogiri Unit-1.

The scope of supply includes state-of-the-art HIPASE-E automatic voltage regulators, including thyristor bridges, installation, and commissioning for all four units within six months.

ANDRITZ has proven to be successful in a highly competitive market, delivering quality products and services in a very challenging time frame.

AUTHORS

Gerhard Enzenhofer
Edo Ronaldo
hydronews@andritz.com

TECHNICAL DETAILS

Panglima Besar Jenderal Soedirman

Total output: 180.9 MW
Scope: 1 × 60.3 MW / 67 MVA
Excitation Current / Voltage: 1170 A / 160 V

Wadaslintang

Total output: 18.4 MW
Scope: 1 × 9.2 MW / 10.22 MVA
Excitation Current / Voltage: 674 A / 85 V

Wonogiri

Total output: 12.4 MW
Scope: 1 × 6.2 MW / 7.75 MVA
Excitation Current / Voltage: 256 A / 220 V

Timo

Total output: 12 MW
Scope: 1 × 4 MW / 5 MVA
Excitation Current / Voltage: 6 A / 110 V



PT. Indonesia Power UP Mrica

ANDRITZ HYDRO IN INDONESIA, JAKARTA

For more than a century, ANDRITZ Hydro has made significant contributions to Indonesia's hydropower development with its first deliveries taking place in 1912.

As of now, ANDRITZ Hydro has supplied or rehabilitated more than 220 units with a total capacity of 3,220 MW, representing a market share of more than 60%. Responding to the positive hydro market outlook and in readiness to provide client support, ANDRITZ established a local entity, PT ANDRITZ HYDRO, back in 1996.

With its vast experience in the execution of hydropower projects in Indonesia, ANDRITZ Hydro is constantly looking for ways to improve. PT ANDRITZ Hydro has successfully built a dedicated engineering team for the design and supervision of the installation and commissioning of automation products, electrical power systems, and penstocks and gates. ANDRITZ Hydro's Indonesian team also offers services for projects both locally and in more than 50 other countries.

POWERING SUSTAINABLE GROWTH

Join us in Bali for the 2023 World Hydropower Congress

The World Hydropower Congress will take place at the Nusa Dua Convention Centre on the Indonesian island of Bali, between October 31st and November 2nd 2023. Under the leadership of H.E. the Indonesian President Joko Widodo, the Government of the Republic of Indonesia has set out an ambitious path for growth through renewable energy development, including hydropower.

Over 200 high level speakers from governments, industry, finance, research, and civil society are expected to participate in over 30 sessions. The event will cover key issues such as clean energy security and flexibility, climate mitigation, resilience and adaptation, water use, the water-energy-food nexus, sustainability, policy, finance, and many more.

ANDRITZ is not only a proud member of the International Hydropower Association, but also a supporting partner of the 2023 World Hydropower Congress.

As electricity grids become more dependent on variable sources of generation such as solar photovoltaic and wind, the need for long-term storage and flexibility

will increase in line with decarbonization. ANDRITZ is pleased to host a session on how hydropower can contribute to flexible, stable, and low-carbon grids. This session will explore hydropower's critical role in enabling the energy transition and how it supports keeping the lights on.

Participants are also offered a tour of the Cirata hydropower project, located on the Ciratum River in West Java. With its 1,008MW of installed capacity and an annual electricity production of 1,428 GWh, Cirata is the largest hydropower power plant in Indonesia and at the same time one of ANDRITZ' best showcases.

ANDRITZ is an important partner for hydropower development in the region with a strong base in Indonesia for many decades.

We are looking forward to meeting you at the world's most important congress for sustainable hydropower!

"Selamat Datang / A warm welcome !"



world hydropower congress



FIND OUT MORE AND REGISTER HERE:

www.worldhydropowercongress.org

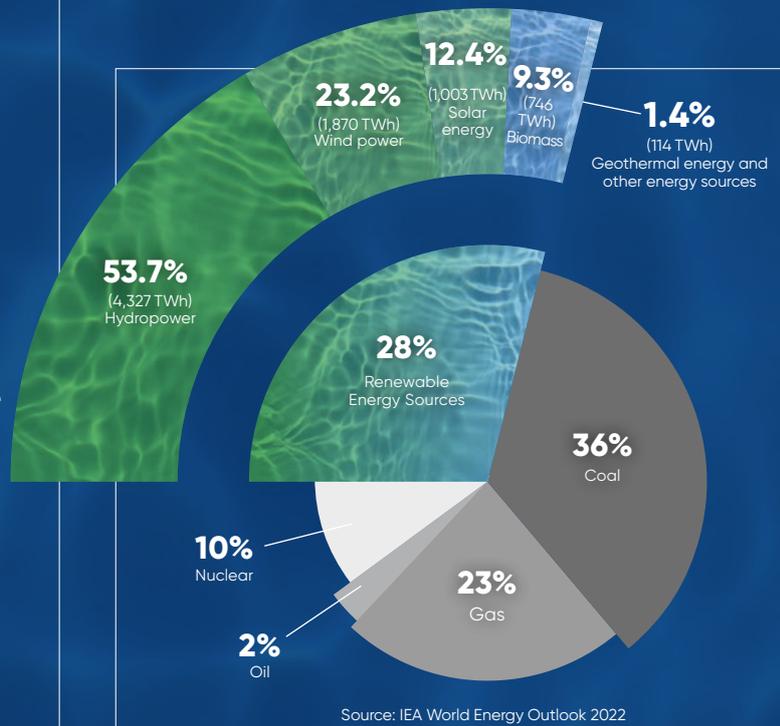
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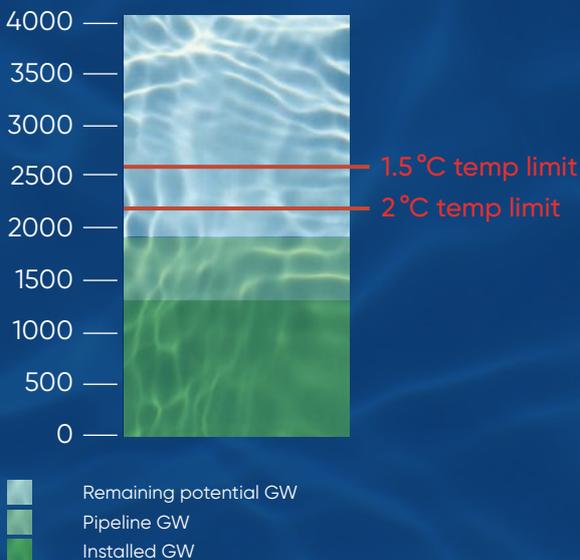
Renewable hydropower is a reliable, adaptable and cost-effective source of clean power generation and responsible water management.

Modern hydropower plants help accelerate the transition to a clean energy supply by providing important services in the areas of power generation, energy storage, flexibility, and climate protection.

Hydropower is also an important resource for building secure, clean power systems and achieving global net-zero targets.



Hydropower 2050 - Towards NetZero



*Excluding pumped storage hydropower

HYDROPOWER FACTS & FIGURES



+ 85%
of installed global energy storage capacity

... CHARGING UP VARIABLE RENEWABLES

Hydropower is an optimal balance to variable renewables like wind and solar, thanks to its flexibility and energy storage services.

Pumped storage is the world's largest energy storage technology accounting for over 85% of installed global energy storage capacity, far ahead of lithium-ion and other battery types.

ER IS ...

... THE SINGLE LARGEST RENEWABLE ENERGY SOURCE

Around 54% of all renewable electricity is generated from hydropower. The sector produces about 15% of total electricity generation from all sources. No country has come close to achieving 100% renewables without hydropower in the energy mix. Hydropower installed capacity reached 1,397 gigawatts (GW) in 2022 as generation hit a record of 4,408 terawatt hours (TWh).



1,397 GW
installed



4,408 TWh
of generation



15%
of total electricity generation

... AMONG THE CHEAPEST SOURCES OF ELECTRICITY

The global weighted average cost of electricity from hydropower projects was US\$ 0.061 per kWh in 2022, making it one of the cheapest sources of electricity in many markets.

US\$ 0.061 per kWh



+ 2 million jobs

... AND MORE

Hydropower does not end with electricity generation. It provides socioeconomic benefits, creates local jobs, supports regional economies, ensures water supply and flood control, and can be used for irrigation and navigation. The hydropower industry employs more than 2 million people worldwide directly and many more in related supply chains.

... POLLUTION FREE

According to independent research, using hydropower instead of fossil fuels to generate electricity has helped avoid more than 100 billion tons of carbon dioxide in the last 50 years alone.

The IEA estimated that 1,300 GW of additional hydropower capacity is needed by 2050 to limit the temperature increase to 1.5 degrees Celsius.

- 100 billion tons

+ 1,300 GW to keep < 1.5°





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