VOITH

hypower

by Voith Hydro — N° 34

Modernized!

Editorial
hypower N° 34

From Porto Colombia and Paulo Afonso in South America, to Fort Randall and Norfork in the U.S., to Foyers and Tinfos in Europe, many major hydropower plants are undergoing impressive upgrades. Modernization projects are particularly important in the context of a sustainable and secure energy supply, as they enable the plants to operate reliably. They also make hydropower capacity fit for the new requirements of a renewable electricity supply. The plants improve grid stability and increase security of supply. Environmental aspects also play an important role. Innovations such as our Sediment Care solution, retrofitting for fish protection, and the revolution in horizontal Pelton turbines are addressing this need. You can read more about these projects and the remarkable people involved in the modernization of hydropower plants in this issue. We hope you enjoy discovering some of our most exciting modernization projects!

Dr. Tobias Keitel
Chairman of the Board of Management
Voith Hydro

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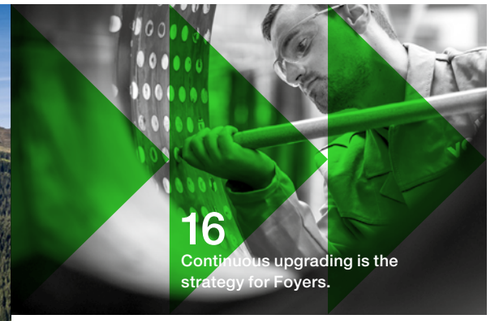
This picturesque landscape is the scene of a groundbreaking innovation in hydropower.



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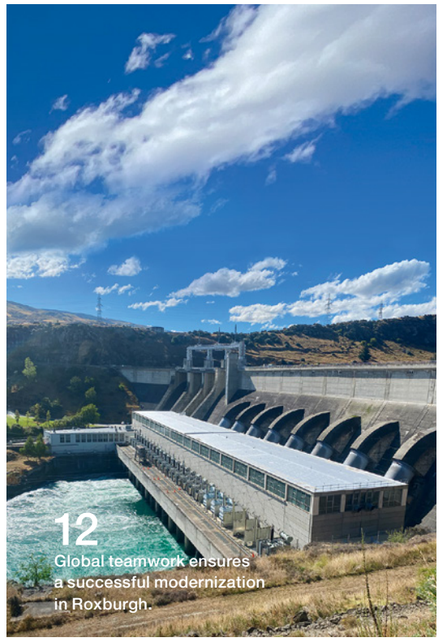

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Massive Millimeter Work

Whether a turbine, generator or butterfly valve – when every millimeter counts and the schedule is tight, Voith's logistics team manages the seemingly impossible.

Heidenheim → Herdecke

Transportation of a butterfly valve to the pumped storage power plant.

Route length	Duration	Team
550 km	10 days	40

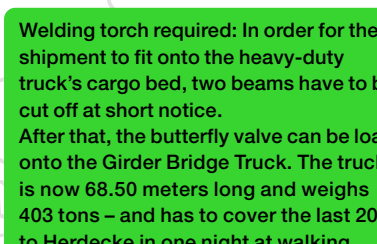
Heidenheim → Töging

One-piece delivery of a stator to the Töging hydropower station.

Route length	Total weight	Team
250 km	173 tons	10

Heidenheim

1



With a width of 8.20 meters, the stator leaves the factory premises. Stopovers aren't an option; since the load is too wide, the trip has to be completed in one night.
Due to its sheer size, signs need to be dismantled and traffic lights rotated along the route.

Stator width
8.2 m

2 Ampfing

On Highway A94, a tunnel had to be measured with lasers in advance to ensure that the truck could pass through it. The highway was first completely closed in this area to allow for the passage of the truck. Only then does it pass through at walking speed.

Töging

3

The customer had to enlarge the entrance gate for the one-piece delivery.
The last meters went over unpaved roads, with a second truck braking from behind.

Total truck weight
403 t

Dortmund

3

The butterfly valve is unloaded from the vessel with the help of two mobile cranes.
In order to have space for the cranes, a restricted unloading area needed to be rented in advance.

Welding torch required: In order for the shipment to fit onto the heavy-duty truck's cargo bed, two beams have to be cut off at short notice.
After that, the butterfly valve can be loaded onto the Girder Bridge Truck. The truck is now 68.50 meters long and weighs 403 tons – and has to cover the last 20 km to Herdecke in one night at walking speed.

Herdecke

4

Only 500 meters to go to the final destination in the power plant.
The cargo bed is too long, so the shipment has to be transferred to another vehicle yet again.
The last 500 meters are covered by what's known as a self-propelled modular transporter (SPMT).

2 Heilbronn

The transport moves to the Neckar. The butterfly valve is loaded into the inland vessel by mobile cranes. After that, the journey continues via water on the Neckar, Rhine, Rhine-Herne Canal, and finally Dortmund-Ems Canal to Dortmund.

Heidenheim

Heavy truck transport via the route from Heidenheim to Heilbronn to the port on the Neckar River.

1

Route length: **150 km**
Duration: **2 nights**
Total truck weight: **300 tons**

News

News from the World of Voith Hydro

Voith Hydro Board of Management Newly Formed

Dr. Tobias Keitel has been appointed Chairman of the Board of Voith Hydro effective 1 November 2022. He took over from Uwe Wehnhardt. This also means a change in the structure and responsibilities of Voith Hydro's Board of Management.

Dr. Tobias Keitel

Chief Executive Officer

After holding positions at the Boston Consulting Group and MAN AG, Dr. Tobias Keitel joined Voith Hydro in 2010 as a project manager. Since then, he has held various management positions, most recently as a member of the Management Board and Chief Operating Officer.

Markus Mader

Chief Financial Officer

Markus Mader joined Voith Hydro as a Member of the Management Board in 2018. As CFO, he is responsible for Finance, Controlling and Human Resources. He is also in charge of Quality and IT. Previously, he held various management positions at Voith Turbo and Voith Paper.

Dr. Norbert Riedel

Chief Technology Officer

Dr. Norbert Riedel joined Voith Hydro in 1998 as a development engineer. In 2011, he was appointed President and Managing Director of the international Voith Hydro Engineering Center (VHEC). As a Member of the Board of Management, he has been responsible for Central Technology since 2013.

Michael Rendsburg

Chief Operating Officer

The new Chief Operating Officer is Michael Rendsburg. He joined Voith in 2014 and has held various positions in the Voith Paper Group Division. Since 2022, he has been in charge of Operations, Project Management, Service and Small Hydro.

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New Systems and Services

transform

"In modernization projects, we are not only focused on extending the lifespan of the hydropower plants but also on the local people. It is important for us to contribute to the economic transformation of entire regions through our work."

Yolanda Odette Sebolao
Offer Project Manager

An Update for Brazil's Hydropower

Voith is modernizing two of Brazil's most important power plants, Paulo Afonso and Porto Colombia.

New heating systems, new electrical equipment or new smart home features – homeowners know that extensive modernization measures need to be carried out after two generations at the latest. Hydropower is subject to similar cycles. After 40 to 50 years, it's time to start thinking about extensive upgrades. In this context, various factors play a role from extending service life and increasing efficiency and performance to adapting to changes in environmental protection requirements or grid integration.

In the hydropower nation of Brazil, which ranks only behind China and the United States in terms of installed capacity, some important plants were built in the 1970s and are therefore candidates for comprehensive modernization measures. These include the Paulo Afonso and Porto Colombia power plants, which are operated by CHESF and Furnas and owned by the Eletrobras electric utility company. Voith Hydro has been working successfully with Brazil's energy companies for many years and has now been contracted to carry out the modernizations that are now due.

A Large-Scale Project

The hydropower plant in Porto Colombia was connected to the grid in 1974 and is located on the Rio Grande on the border between the states of São Paulo and Minas Gerais.

This project's comprehensive measures include:

- Refurbishment of the plant's four 80 MW Kaplan turbines, the associated generators and the overhead crane
- Modernization of the mechanical and electrical auxiliary systems
- Monitoring, protection and control systems
- Inspection of the actuator systems as well as refurbishment of the hydro steel structure as headwater trash rack, stop log and spillways gates

The modernization project ensures the performance and production of the hydroelectric power plant using advanced technologies while extending its useful life. Dino Lima, the project manager at Voith in charge of the modernization, explains: "The modernization of this plant also includes changing the analog plant's components to digital instruments and components." The digitalization will make it easier to control the systems and contribute to greater operational reliability. This, in turn, increases the reliability of the national power grid and avoids downtime for repairs. Lima emphasizes: "Ensuring the output and range of the machines means more power is available to the grid, even during the dry season." →

Brazil and Hydropower

- Brazil currently has more than 2,000 hydropower plants in operation
- The most important hydropower plants were built in the 1970s
- The country's total installed capacity is roughly 100 GW
- In terms of installed capacity, Brazil ranks third in the world (behind China and the U.S.)
- Today, renewable energy sources already account for 80% of the country's electricity
- Hydropower accounts for 65% of the renewable energy mix

1 The Porto Colombia hydropower plant dams the Rio Grande, which at this point forms the border between the states of Minas Gerais and São Paulo.

2 Dino Lima is the project manager responsible for the modernization of the Porto Colombia plant.

4 x 80 MW

Station: Porto Colombia
River: Rio Grande
Federal State: São Paulo / Minas Gerais

You Never Know What to Expect
The partners signed the contract for the modernization in late August 2022, and now the project is in its executive design stage. One of the challenges at the beginning is to accurately calculate the costs without knowing the machinery from the inside. “When refurbishing such an aged unit, you never know what to expect when you open it up,” explains Lima. “To conduct a more detailed analysis, the unit must be stopped and disassembled. That’s when the hard work begins.” The customer can rely on Voith Hydro’s expertise; its employees have years of experience with turbines and generators as well as with all the auxiliary systems, including the control systems that surround the core components. And their modernization is one of Voith Hydro’s greatest strengths.

The Voith Hydro team has one year to modernize each machine unit. This means that the entire project is scheduled to run for five to six years. During the process, only the unit that is being modernized will be switched off. The other turbines and generators will continue to run to ensure a continuous power supply.

A Successful Partnership
Modernization work also recently began on the Paulo Afonso complex, one of the largest plants in Brazil. The complex consists of three dams and five hydropower plants. It is located on the São Francisco River near the city of Paulo Afonso in the state of Bahia, Brazil.

Alexandre Bueno has been a project manager since 2021 and explains: “We started with the modernization of Paulo Afonso 4. It has a total of six units, each of which has a capacity of 400 MW. This means we still have three to four years of work ahead of us. Our long-term partnership, which goes back some 60 years, was one of the factors that led to us being contracted to carry out the modernization.”

The age of the plant is one of the main reasons for the upgrade. A large part of the components still date from the 1970s. This means that Voith will have to completely replace all of the mechanical components, such as the valves, pipes and pumps, as well as all of the electrical parts. The team of experts from Voith Hydro only recently got started and opened up the first unit in January. “We’re upgrading the hydraulic equipment and replacing the old runner, the heart of the turbine, with a new one. This will increase efficiency and performance,” notes Bueno.

Engineering in 3D
Voith Hydro is already using the latest technology ahead of the actual upgrade itself, in the form of the building information modeling (BIM) digital planning method. BIM is a digital representation of the physical and functional characteristics of a building and typically includes information about building materials, equipment and systems, as well as energy performance and sustainability data. These models help during building planning, design, construction and maintenance. “BIM is included in our scope of services,” explains Alexandre Bueno. “We have a highly qualified and committed team that takes care of this. Their scans are then used to create a 3D model.”

The customer uses BIM primarily for its asset management activities. “The idea is that all the components are interconnected, and the customer can use a computer to control, monitor and, if necessary, replace parts of the system. BIM offers the customer maximum flexibility. This was science fiction until recently, but now it’s a reality.”

Gaining access to the power unit is quite difficult, as it is in an enclosed area. The team has to go down almost 100 meters by crane to get the turbine out of the shaft. Once it has been lifted out, another challenge lies ahead: the space available in the powerhouse to disassemble the unit is extremely limited. On top of that is the tight schedule, as disassembly and the delivery of new parts have to be precisely timed and coordinated.

Why The Upgrade is so Important
Reliable plant operation is crucial for the customer, as it is responsible for the national power supply and must avoid power outages. “This modernization project is intended to give the customer greater flexibility and security,” explains Bueno. “In Brazil, hydropower is the largest source of electricity. Brazil is currently investing heavily in solar and wind power, although their yields fluctuate. But the national power grid needs a stable base in order to handle this transformation – and hydropower provides that.”

3 The team around Alexandre Bueno together with the customer during the acceptance of a runner.

4 The historic photograph from the 1970s shows the transport of a Francis turbine for Paulo Afonso.

5 The Paulo Afonso hydropower plant in Bahia, Brazil.

6 x
400 MW

Station Paulo Afonso
River São Francisco
Federal State Bahia

The modernization of the Roxburgh hydropower plant in New Zealand is an impressive example of international cooperation.

Global Team Supports Sustainable Trailblazer

1

Impressive: The Roxburgh Dam backs up the Clutha River over a length of 28.5 kilometers to a width of 667 meters.

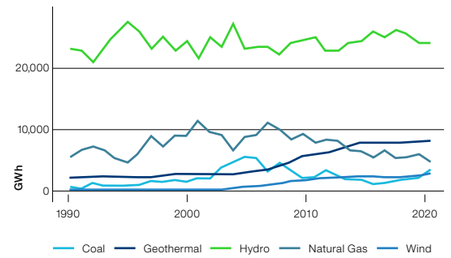
New Zealand is a country that is extremely advanced when it comes to the use of renewable energy sources such as hydropower, geothermal and wind power. In 2021, their share of New Zealand's total electricity consumption stood at an impressive 82.1 percent.

In this context, hydropower is the most important resource, responsible for nearly 60 percent of the nation's total electricity generation. But in order to be able to produce completely carbon-neutral electricity by 2030, the existing plants must now be modernized and brought up to the current state of the art.

One such facility is the Roxburgh hydropower plant, which is owned and operated by New Zealand's second-largest electricity provider, Contact Energy. The power plant was brought into operation between 1956 and 1962. It still generates its power using the eight original turbines, the first four of which were installed in 1956/57 and the remaining four in 1960/61.

Contact Energy's plan is to upgrade four of the turbines by 2026 and extend the life of critical components by up to 40 years. The goal is for a more efficient and modern design to increase the plant's output in order to ensure that the region has a reliable supply of electricity – especially during the dry season, when water is scarce. To this end, the upgrade will allow the plant to use existing water volumes more efficiently, generating an additional 44 GWh in an average year.

New Zealand's Sustainable Energy Mix



2

Eight turbines are at the heart of the Roxburgh power station.

3

A team with Voith employees from India and New Zealand shared the work.

"The teamwork between Voith Hydro's international sites is impressive."

Gaurav Saxena
Deputy General Manager at Voith Hydro

Perfect Global Teamwork

Voith Hydro was contracted to upgrade the critical turbine components of these four units (40 MW each). Voith's services include designing the new runner, model testing, as well as production, installation and initial startup.

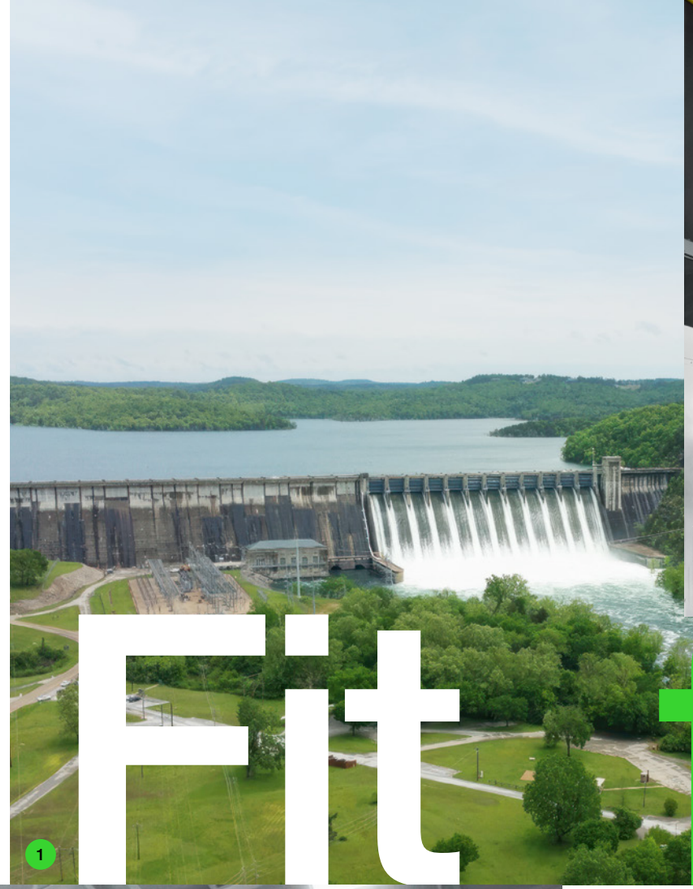
To take full advantage of Voith Hydro's strengths that are spread across the globe, an international team is dividing up the work. On the one hand, model testing of the new runner was successfully carried out at Voith Hydro's hydraulic laboratory in the U.S. state of Pennsylvania. On the other hand, detailed planning, manufacturing and project management will be carried out by Voith Hydro in India, with support from Voith Hydro in Germany. During the bidding phase, additional support was even provided by the teams from Spain and Italy. The challenge of reconciling and coordinating the different time zones was mastered with aplomb thanks to the team's many years of experience.

Founding a subsidiary in New Zealand and appointing Nikhil Kumar as the new Country Manager were important steps in making this project a success. This means Voith Hydro is closer to the customer and can effectively manage the tasks on site. The collaboration between New Zealand, project management and Voith Hydro's project team in India and globally has been exceptional.

"It's an awesome experience for Voith Hydro employees to be involved in this project and thereby help New Zealand achieve its ambitious goal of generating 100% of its electricity from renewable energy sources," said Kumar, commenting on the project. And project manager Gaurav Saxena added: "The teamwork between Voith Hydro's international sites is impressive."

Fit for Change

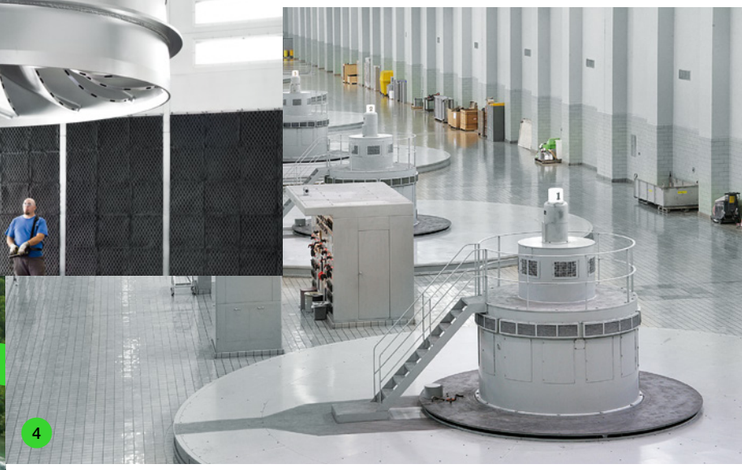
Voith Hydro in the United States plays a key role in the modernization of large hydroelectric power plants – as current projects for the U.S. Army Corps of Engineers (USACE) at Fort Randall and Norfork show.



1 The Norfork Dam in Baxter County, Arkansas, was built in 1944.

2 Francis turbines at the Voith plant in York, Pennsylvania.

3 A Francis turbine is transported with the overhead crane.



4 Interior view of the Fort Randall powerhouse.

The United States has a long tradition of hydropower generation and has a large installed fleet of facilities. According to the U.S. Department of Energy, hydropower currently accounts for 31.5% of the renewable energy capacity. The U.S. Energy Information Administration (EIA) estimates that 2,270 hydropower plants were in operation in the United States in 2019 – with an average age of roughly 60 years. This means that many of the hydropower plants in the U.S. are operating beyond their expected life and may need to be upgraded or overhauled to improve their performance and efficiency. Environmental performance improvements are also possible during these major modernization activities.

This is true for the Norfork power plant in Arkansas and the Fort Randall power plant in South Dakota. Both are operated by the USACE, a federal agency that is the largest owner-operator of hydropower generation in the United States. To modernize these two plants, the USACE engaged Voith Hydro, with whom it has already successfully completed many hydropower modernization projects. Both projects involve upgrading the generator and turbine equipment.

2

Work on the Fort Randall project began in January 2022 with hydraulic design and model testing. “Once the first runner is manufactured and delivered to the site in Pickstown, South Dakota, installation work will begin on site. We expect the project to be finished in roughly 2031,” says project manager Abraham Camacho. By then, Voith Hydro will have manufactured and installed a total of eight new Francis turbine runners and generator stator rewinds.

Quality and adherence to schedules are top priorities in modernization projects, especially on this scale. Voith Hydro has one of the world’s largest hydropower manufacturing facilities in York, Pennsylvania, which is dedicated specifically to the North American market. This not only shortens distances and speeds up coordination; it also creates American jobs and economic development opportunities. Runner design and critical overhaul work for Fort Randall will be performed in York.

“The Norfork hydropower plant was completed in 1944 and currently consists of two turbine-generator units with a capacity of 31.3 MW each,” says Voith Hydro’s Norfork project manager Eric Chronister. “Once the upgrade is completed, which we expect to happen in 2028, each unit will be capable of delivering up to 46.5 megawatts while also improving the environmental impacts of the original station.” As such, this overhaul will increase the plant’s capacity by just under 50%.

The Norfork project is not only about increasing output; it is also about improving water quality downstream of the dams. Yadu Banjara, Voith Hydro VP of Account Management for USACE Projects explains: “In the southeastern United States, the level of dissolved oxygen in streams and rivers can fall to extremely low levels. This affects vegetation and the wildlife habitat in the water. Voith has developed aerating runner technology that specifically tackles this challenge by allowing air to be drawn into the water passage to increase dissolved oxygen downstream.” This technology is now being used in Norfork.

Modernization also plays an important role for non-federally held hydropower stations. With the support of tax incentives and grants, the hydropower industry is investing in infrastructure upgrades, the expansion of existing facilities, as well as the construction of new hydropower projects. When coupled with Voith’s ability to source and manufacture within the United States, these investments create job opportunities and stimulate economic growth while enhancing the overall stability and health of the U.S. energy grid.

Proactive Asset Management in Action

SSE Renewables relies on continuous, regularly scheduled upgrades for Foyers to maximize the availability of the pumped storage plant.

SSE Renewables is part of SSE plc and owns a significant fleet of renewable energy assets. The company currently generates 1955 MW with onshore and 579 MW with offshore wind turbines. In addition, SSE Renewables' hydro portfolio has a total installed capacity of 1460 MW, including 300MW of pumped storage and 750MW of flexible hydro. In this context, the Foyers pumped storage power plant (PSW) in operation since 1974, plays an important role in the fleet. With a capacity of 300 MW and two machine units, it provides vital flexibility for the electricity grid, allowing energy to be stored for when it is needed most. Voith Hydro has been a key partner in the modernization of SSE Renewables' plants for more than 20 years.

Continuous Modernization Strategy

In contrast to a full-scale overhaul at a fixed point in time, SSE Renewables pursues an Asset Management strategy of continuous life cycle-based upgrades of components and systems in order to continuously maximize availability. "The secret to this approach is proactively investing in the right assets at the right time to minimize periods of downtime. Our expertise lies in providing our customers with the best possible support in deciding which components need to be upgraded and when," says Markus Wirth, Head of Sales Western Europe at Voith Hydro.

In this context, Voith Hydro's goal is always to work in partnership with its customers and help them achieve their business goals in the best possible way. This was also the case here – after the rebuild, SSE Renewables' Hydro business recorded the best year in its history.

"We are proud to work with Voith Hydro as a key partner for our Hydro business. The team's technical expertise has helped us meet, and exceed, our goals as we modernize our existing fleet to maximize its flexibility and energy security. Hydropower is Scotland's original source of renewable energy and one that has an increasingly vital role supporting the country's path to achieving net zero carbon emissions. Therefore, we will advance its future together with further landmark projects," says Finlay McCutcheon, Director of Onshore Renewables, Europe at SSE Renewables.

2004

Voith Hydro completely upgrades the plant's control technology and parts of the electrical auxiliary systems.

2006

The partners sign a maintenance contract for the components that Voith Hydro upgraded, which is still in place today.

2012

The spherical valves, each weighing almost 100 tons and with an inside diameter of nearly three meters, are replaced. They can now close under full flow, which was not possible before. This considerably increases plant safety.

2014

Voith Hydro launches its Asset Live Assessment solution at Foyers. This analysis enables recommendations to be made in order to plan appropriate measures. This can prevent unplanned operational downtime while optimizing plant performance.

2018/19

Asset Live Assessment is updated, discovering vulnerabilities in highly stressed components that could impact the Foyers plant's availability. One of these concerned the rotor-pole connections, which had already resulted in damage at another operator's power plant. SSE Renewables was shown solutions to prevent damage and minimize plant downtime during the rebuild.

During implementation, Voith Hydro was able to shorten the schedule further by cleverly optimizing the assembly sequences.

"The rotor rims consist of thousands of metal sheets that are stacked up to a height of two meters using a device that is accurate to hundredths of a millimeter. Assembly was so precisely executed that none of the usual adjustments and balancing of the machine were required when bringing the unit into service. The team on site did a fantastic job," says project manager Laura Merkl.

2019/20

A major rebuild began in 2019, and in March 2020 – during the height of the coronavirus pandemic – the upgraded plant was successfully brought on line remotely. This was carried out by SSE Renewables' highly qualified on-site staff and Voith Hydro experts from the Brunnenmuehle site in Heidenheim, Germany, using Voith Hydro OnCall.Video.

2021

On Voith Hydro's recommendation, SSE Renewables uses digital health assessments to analyze the plant's operating data and identify problems or even potential damage at an early stage. The analyses prove to be very useful for the continuous operation of the plant because three decisive factors converge here to provide a reliable diagnostic solution: data sets covering a long operating period, the extensive library of algorithms, and Voith Hydro's expert knowledge. As a result, SSE Renewables decides to extend the contract for Voith Hydro's digital health assessments after an initial trial period.

Renewable energy, new roads, jobs – entire regions can benefit from hydropower, as the modernization of the Wanjii small hydropower plant in Kenya shows.

A Boost to the Region

The Wanjii hydropower plant in Kenya is close to 70 years old since its commissioning in 1952. Over time, the power units became technologically obsolete and expensive to maintain. The operator, Kenya Electricity Generating Company Ltd. (KenGen) contracted Voith Hydro to modernize the plant and simultaneously increase its existing capacity of 7.4 MW by more than 10%. In addition, KenGen's tender specifications required Voith to take steps to reduce the time and effort required to maintain and replace the turbines, generators and control technology for modern components. Upgrading the hydropower plant's technology also included automating the plant and equipping it with a remote-control system.

The two companies have a long-standing and fruitful partnership since the time of the successful Gitaru and Kiambere projects, where the Voith Hydro team displayed unique expertise in hydro technology. KenGen was happy when Voith Hydro successfully won the bid to upgrade and refurbish the power plant.

The small hydro plant's machines were originally supplied by S. Morgan Smith, a company later acquired by Voith. As a result, Voith Hydro's engineers had all the plans at their disposal, which made it much easier to develop the modernization concept. This played a key role during the design of the new equipment, reducing the time required for site work and installation.

1 The hydropower plant has been supplying the region with energy for over 70 years.

2 The construction of new transport routes eases the logistical challenges.

Modernization of the Wanjii small hydropower plant improves energy supply:

→ 10% increase in capacity

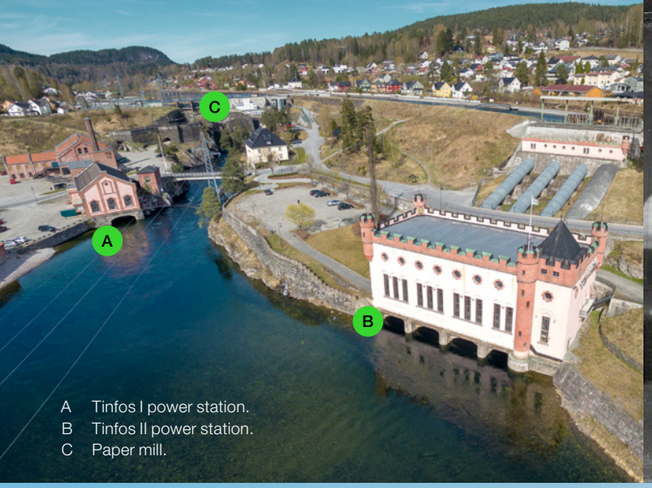
A New Road for the Region

The COVID-19 pandemic, which set all of the plans back by a year, was not the only challenge facing the project. Up until that point, only a narrow trail led to the hydropower plant, meaning that a road had to be built first. Also, the old and inclined winch and trolley system at the site proved not to be safe enough for transporting the turbines to their final destination and was replaced by a new access via the road by KenGen.

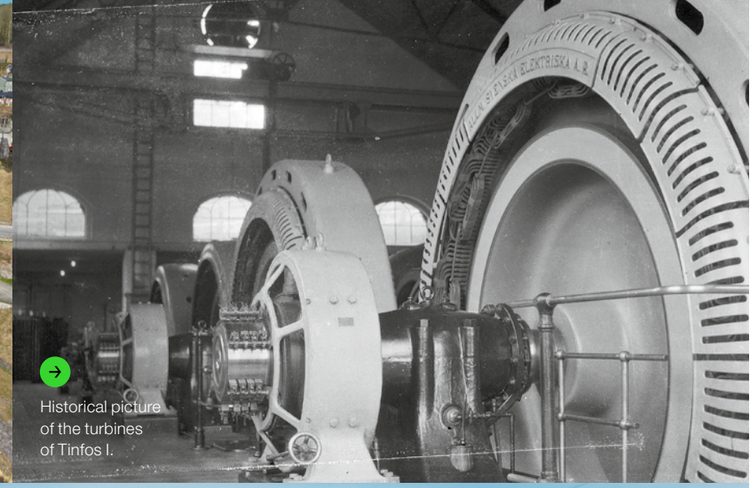
The modernization of the power plant not only improved the region's power supply but also added value by expanding the local infrastructure and creating new opportunities. "During the five years we were on site, you could really feel the boost to the region," recalls Voith Hydro project manager Edilmar Filho. "The people were extremely grateful."

3 The Voith and KenGen team is happy about the modernization.

> "During the five years we were on site, you could really feel the boost to the region."
>
> **Edilmar Filho**
> Voith Hydro Project Manager



A Tinfos I power station.
B Tinfos II power station.
C Paper mill.



Historical picture of the turbines of Tinfos I.

The lightning ornaments on the front of Tinfos represent the generation of electricity.

From Paper to Hydropower

Norway's industrial history goes hand in hand with the use of hydropower – as the upgrades to the Tinfos plant show.

Even from a distance, the picturesquely located Tinfos power plant's past is clearly visible. In the background, the Tinfossen waterfall pours down, and old millstones surround the plant's brick buildings. They are a reminder of the paper mill that was the first to use the waterpower of the Tinnelva River here in 1877 to provide lighting by means of a small generator. The Tinfos power plant's historic buildings, which date back to the time of Norway's industrialization, have been a UNESCO cultural heritage site since 2015.

An Historic Connection

The Tinfos power plant is also a historic site for Voith. The plaques on the turbines in the former Tinfos I plant testify to the fact that Voith turbines have been generating electricity here since the beginning of the 20th century. In addition, the practical combination of paper production and hydropower is also part of Voith's early company history. Indeed, after the metalworking shop's specialization in paper machines, the construction of hydropower turbines became the company's second main line of business from the 1870s onward.

But back to Norway. In 1901, Tinfos I was built with horizontal Francis twin turbines from Voith with a total output of about 6 MW. This powerhouse initially supplied an artificial fertilizer factory. In 1910, the second powerhouse, Tinfos II, was added to produce energy for the Tinfos Jernverk AS melting plant being built there at Lake Heddalsvatn. After Tinfos II was fully operational with three turbines in 1912, a fourth unit with a vertical Francis turbine was added to the powerhouse in 1925. In the mid-1970s, units 1, 2 and 3 of Tinfos II were decommissioned. Unit No. 4 is still in operation and provides a 10-year average production of about 22 GWh with the original runner.

Voith – Before Hydropower, There Was Paper:

Paper manufacturing has a long tradition at Voith. Johann Matthäus Voith designed the first wood grinder to produce paper from wood fibers back in 1859. Voith Paper is a division of the Voith Group. As a full-line supplier to the paper industry, it delivers the broadest range of technologies, services and products on the market. Today, a large part of total global paper production is carried out on Voith paper machines. In this context, Voith Paper places a special focus on sustainability and an efficient, resource-friendly manufacturing process.

An anecdote from Steinar Maalen, the Voith Hydro employee responsible for business development in the Nordics, shows just how long-lasting Voith turbines are: "A turbine and a generator from the old Tinfos I from 1901 were purchased by the city of Harstad in northern Norway for another power plant. Previously, the machines were inspected by an expert from the local technical university who certified that they had an expected service life of another 15 years. It turned out, however, that they still ran for more than 30 years."

Historical plaques show that the partnership with Voith goes back over 100 years.

The machine room in the Tinfos II power plant. The three generators from 1912 are no longer in operation today.

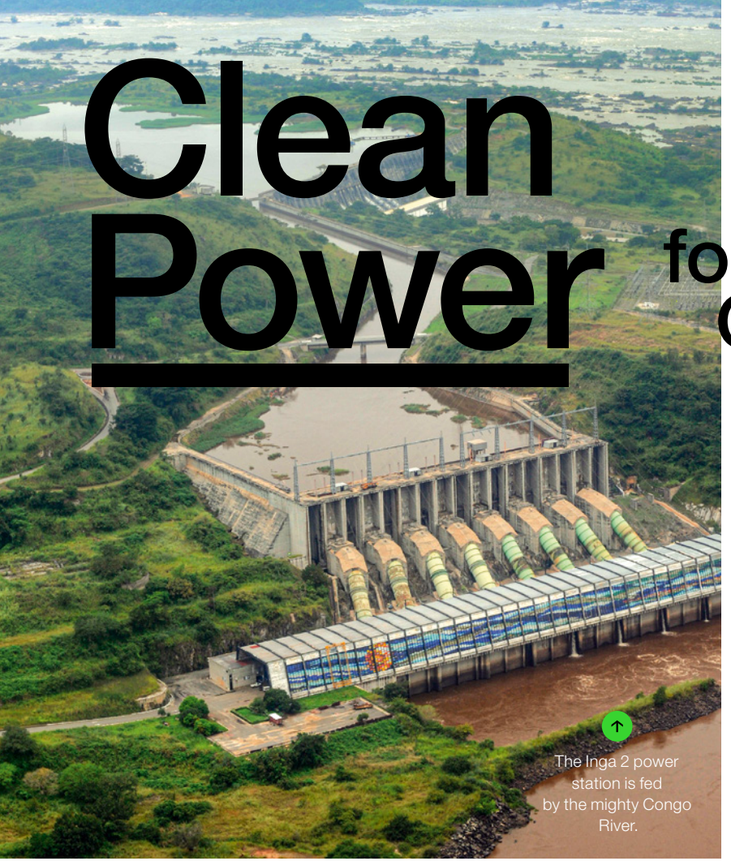
Tinfos I/II

Voith Hydro also contributed to the plants' long service life by carrying out extensive upgrades:

1901/06	The old Tinfos I was brought into service with the first machine unit in 1901 and the second in 1906. Both turbines were from Voith Hydro and supplied approx. 4 to 5 MW of electricity.
1910/11/12 1925	The original turbines for Tinfos II in 1910 also came from Voith Hydro, with others added in 1911 and 1912 and later turbine No. 4 in 1925, delivering 6 MW.
1955	In 1955, the Tinfos I power plant was rebuilt at a different location and its predecessor was taken off the grid. In the new power plant, a Kaplan unit with a Voith turbine 26,000 hp and a Siemens generator produced about 21 MW of energy.
1975	In 1975, the three old Tinfos II units were taken out of service and replaced with a large 27,400 hp Kaplan turbine installed in the new Tinfos I, which greatly improved efficiency.
1990–92	In 1990 to 1992, the automation equipment was replaced in the new Tinfos I power plant.
1997	Tinfos I unit No. 1 was upgraded in 1997 with a new runner from Voith.

"Tinfos is one of the oldest hydropower plants in the world. Thanks to a wide range of upgrades, it continues to supply green electricity to this day. We are delighted that we've been able to contribute to this historic hydropower success story through our expertise over all these decades," says Maalen.

Clean Power for Copper and Communities



The Inga 2 power station is fed by the mighty Congo River.

Through a comprehensive modernization of the existing station by decommissioning one of the old power units and the complete installation and commissioning of a new group in its place, Voith is increasing the capacity of Inga 2 to 178 MW.

The Inga Falls in the Democratic Republic of Congo is one of the largest waterfalls in the world. The Congolese energy company SNEL SA operates the Inga 2 run-of-river power plant there. Along with the project, SNEL SA is represented by the engineering company GRUNER STUCKY. The main customer for the green electricity produced there is the Canadian copper mining company Ivanhoe Mines. This not only benefits the mining company but also the local population, and it tackles the local energy shortage.

Having been in operation for 40 years, Voith Hydro was engaged to comprehensively modernize one of the plant's operating groups. The goal is to increase the installed capacity by 10 percent while maintaining the same flow rate and water level. As a result, the upgraded plant is expected to generate roughly 16 MW more power.

The modernization project includes a new turbine, a new generator and a complete overhaul of the mechanical and electrical systems, such as the transformers, compressed air system, firefighting system and cooling water system. In addition, several hydraulic systems will be replaced and upgraded.

Furthermore, Inga 2 is going to become more digital. Working closely with the customer, Voith Hydro has developed solutions that allow the monitoring of several components, such as the water gap, and the control of the power unit production at any time. This enhances the protection of the mechanical parts and also allows better control of the generator output.

The logistics are challenging because the material has to be delivered via two different ports, and unloading the more than 5,000 individual parts is a time-consuming and complex task. What's more, some of the components are more than 12 meters long and therefore cannot be shipped in standard containers, requiring special sea logistics and even more complex overland transport to the construction site.

"The turbine components are heavy and extra-long, and the roads also have length limits that we have to adhere to," says Voith Hydro project manager Joao dos Santos Ferreira.

His personal conclusion: "The tight schedule and the demanding technical and organizational requirements make the modernization of Inga 2 a special project that gives me the opportunity to apply all my experience as a manager and mechanical engineer."

Green electricity for copper mines:

10 % more installed capacity

178 MW installed capacity

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A Look at Key Trends

innovate

"We are driven by the ambition to continuously advance our customers' businesses with new solutions. Creative problem-solving is of great importance for this purpose. My experience has shown that diversity and close international collaboration contribute greatly to fostering this innovative thinking – and that's exactly what we do at Voith."

Junji Kasagi
Managing Director Voith Hydro in Kawasaki

Horizontally Revolutionary

Voith Hydro is setting new standards with the first horizontal, six-nozzle Pelton turbine.

1 Two-part distribution channel.

2 Jet protection roof.

3 Cone for water discharge.

One particular challenge has kept Voith Hydro's development engineers busy for more than 10 years: What if we could arrange Pelton turbines with three or more nozzles horizontally without sacrificing performance, instead of vertically, as is the norm today?

Wouldn't this make maintenance work and repairs much easier and safer? In addition, it would be possible to replace turbines without major structural works in the event of a plant modernization. Furthermore, new plants would require less excavation work and a smaller footprint.

The first Pelton turbines were positioned horizontally and equipped with one or two nozzles. If they were built with more nozzles, however, the backsplashing water slowed down the runner and thus reduced the turbine's efficiency. In order to be able to use more nozzles and thereby increase output, turbines with vertical shafts were therefore installed from the 1950s onwards. In this arrangement, the water discharged by the buckets can be drained upwards and downwards without much effort.

"We asked ourselves how we could combine the advantages of a horizontal shaft with those of a six-nozzle arrangement," explains Reiner Mack, a development engineer at Voith Hydro. It quickly became clear to him that the only way to install more nozzles in a horizontal turbine was to improve the water management.

Using Existing Space More Effectively

But how could this challenge be solved horizontally? Mack describes Voith Hydro's approach like this: "We effectively utilize the available space by using a cone that acts both as a baffle plate for the outflowing water and as a drain for the water that would fall back onto the runner without the cone." This prevents the runner from being slowed down by water splashing back onto it.

The implementation of this concept in the real world was preceded by complex simulations and model tests. "The interaction between the water jet and the buckets of the Pelton wheel is extremely short, often just a few milliseconds," explains Peter Mössinger, responsible for the Pelton turbines' numerical flow simulation.

This is why numerical forecasting of the bucket flow is extremely complex and requires a great deal of effort. "In addition, we refined the methods in recent years so that we can now also analyze the housing flow or the water flow downstream of the turbine. This progress played a significant role in the successful development of the new concept."

But the model testing technology also faced new challenges. "The greatest difficulty our model machine designers faced was certainly ensuring that we had the flexibility to make advancements to the housing," explains Mössinger. "Not all numerically developed versions prove themselves right away, which means that flexibility in the model machine is extremely important."

> "We asked ourselves how we could combine the advantages of a horizontal shaft with those of a six-nozzle arrangement."
>
> Reiner Mack
> Development Engineer, Voith Hydro

HP3+

The flow simulation virtually displays, among other things, the turbulence of the backsplashing water.

HP3+, which stands for a horizontal Pelton turbine with three or more nozzles, is the name given to this innovation by Voith Hydro. An increase in the number of nozzles results in an increase in power density and thus also in speed. As a result, both the generator and the turbine can be made smaller.

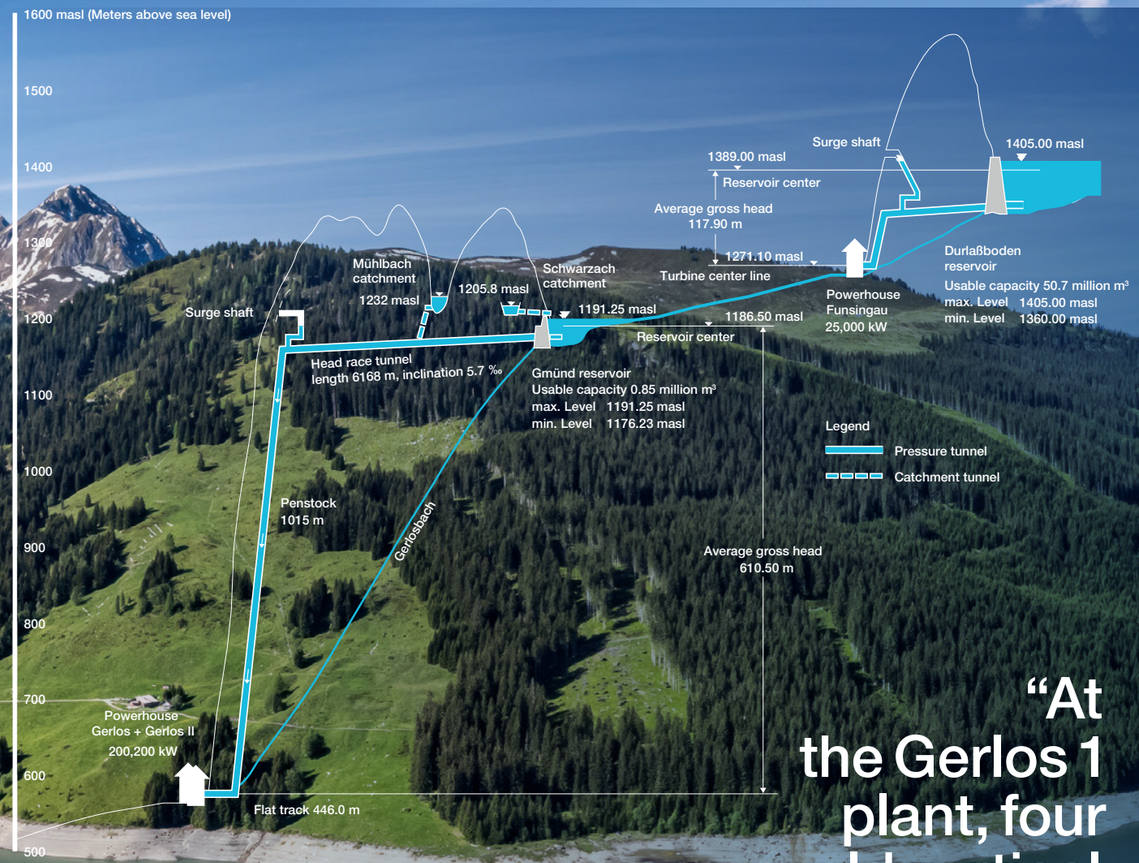
Everything at the Same Height Makes Maintenance Easier

Ultimately, the many years of research paid off, and the new concept has been able to meet expectations. Voith Hydro calls the innovation HP3+, which stands for horizontal Pelton turbines with three or more nozzles. Increasing the number of nozzles increases the power density and thus also the rotational speed. As a result, both the generator and turbine can be built smaller.

Mack sees another major advantage: "Servicing a horizontal machine is much easier than a vertical shaft because everything is on one level in a horizontal arrangement." The maintenance team can stay on one floor and in the powerhouse environment when servicing the turbine and has a direct view of the overhead crane. When installing vertical arrangements, the installation team often has to work across several floors under makeshift lighting conditions using chain hoists. Accordingly, this requires much more effort to create a safe working environment. "Our colleagues from St. Pölten came up with a lot of ideas during the mechanical design work for the HP3+ in order to be able to service the turbine quickly and safely," says Mössinger. "The result has likewise been innovative solutions that didn't exist before."

In addition, about 20 years ago, companies started to completely gut old powerhouses that were equipped with horizontal machines in order to then use vertical machines. This required dismantling the underwater channels and the entire infrastructure on site. Because the powerhouse is too low to properly perform maintenance on a vertical machine, however, this solution always remained a compromise. "When performing general maintenance, it is often necessary to tilt the entire generator and then dismantle the rotor in a horizontal position. This obviously involves a considerable amount of work," explains Mack. When utilizing horizontal units, this effort is, of course, no longer required. Construction measures are also much more modest, as the new horizontal machines can, ideally, be placed on top of the existing foundations.

The new turbine was presented to the public for the first time at a leading international hydropower conference in Vienna. The concept generated a great deal of interest there from hydropower operators. The exciting question was then how the new turbine would prove itself in practice. The corresponding pilot project was already underway. This was because Voith Hydro had already found a suitable company that had the necessary pioneering spirit, courage and technical understanding required for the new solution.



Gerlos hydropower plants, waterway longitudinal section

The candidate that met these requirements is none other than Austria's leading energy transition company Verbund. It operates the Gerlos 1 storage power plant in the Zillertal valley in Tyrol. This plant was brought into operation in 1949 and now has an annual capacity of 326 GWh. As a result, the power plant supplies over 70,000 four-person households with renewable energy, as the first six-nozzle horizontal Pelton turbine has been successfully in operation here since October 2022. It replaced the four two-nozzle vertical machines previously installed.

Although the equipment itself is more expensive with the horizontal solution, customers save that much more when it comes to construction costs. This is because the turbine can be replaced without major construction work, which saves a massive amount of time and money. And the fact that fewer machines are in operation also reduces maintenance costs in the future.

“At the Gerlos 1 plant, four very old vertical turbines were replaced with one horizontal unit because the powerhouse ceiling was too low and the powerhouse area was too small for a vertical one.”

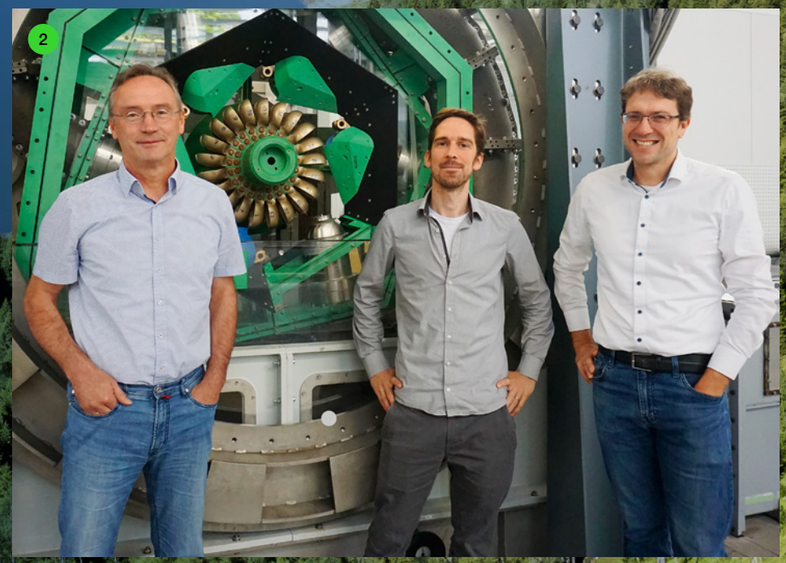
Reiner Mack
Development Engineer, Voith Hydro

326 GWh

Commissioned in 1949, Gerlos 1 now generates 326 GWh per year. This is enough to supply more than 70,000 four-person households with renewable energy. The plant's first six-duct horizontal Pelton turbine has been operating successfully since October 2022.

1 The two powerhouses Gerlos I (right) and Gerlos II in the Zillertal.

2 Innovative turbine developers at Voith: Reiner Mack, Dr. Peter Mössinger and Dr. Jörg Necker.



Perfect for Modernization Projects

The pilot project also clearly shows why the horizontal arrangement of the Pelton turbines particularly benefits modernization projects: “At the Gerlos 1 plant, four very old vertical turbines were replaced with one horizontal unit because the powerhouse ceiling was too low and the powerhouse area was too small for a vertical one,” Mack explains. The specification originally envisaged a conventional twin unit with one generator and two two-nozzle turbines each. There simply wasn't enough installation space for this solution, however. “For our HP3+ solution, we were able to gain valuable space by developing the inlet numerically,” Mössinger adds. “This ensured that the unit would be well positioned in the powerhouse for all maintenance operations.”

These advantages are also proving their merits in a second pilot project at the Vermuntwerk plant in Vorarlberg, which is operated by Illwerke. Here, five two-nozzle units are being replaced by two turbines with six nozzles – while total plant capacity will remain the same. “Two turbines means you only have to maintain two runners and two generators and also only two transformers, instead of five like before. This will significantly reduce maintenance costs.”

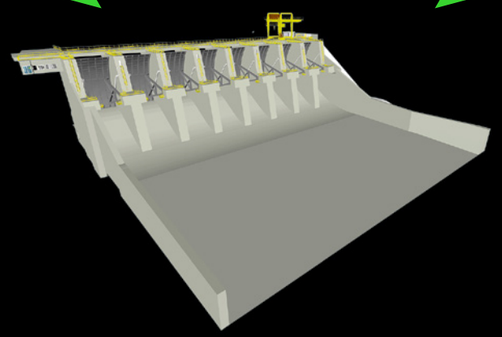
Mack has been involved in the development of this innovative solution from the very beginning. “It was great seeing the first prototype of an HP3+ installed and then in operation.” To him, one thing is abundantly clear: “On the one hand, developing a solution like this requires members of management at Voith who have the necessary vision to see that such an idea will be successful. On the other hand, confidence in our solution on the part of customers, which has grown over many years of continuous collaboration, is also necessary. At the end of the day, we want our customers to be satisfied with our turbines, that's the main thing.”

2022

The year in which the first horizontal Pelton turbine with six nozzles was commissioned.

Virtual First

Digital models support modernization – like this 3D graphic of the spillway in Paulo Afonso.



The hydropower plant in Paulo Afonso, Brazil, as a virtual BIM model.

3D scans and Building Information Modeling – BIM for short – are the buzzwords for the new approach to construction, planning and asset management. They also deliver significant benefits in hydropower projects.

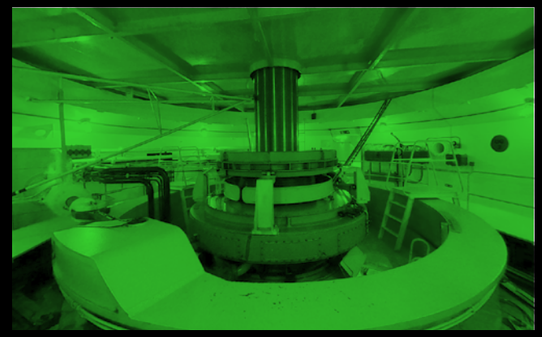
So what is BIM exactly, and how does it differ from other digital planning methods such as 3D scans? BIM refers to a digital representation of the physical and functional characteristics of a building. It is used for building planning, design, construction and maintenance. Building information models typically contain information about building materials, equipment and systems, as well as data on energy performance and sustainability.

Not New, but with New Possibilities

BIM is nothing new – it was first introduced in the construction industry about 20 years ago. But now this software-based methodology is increasingly becoming the new standard above and beyond traditional projects in the construction industry. The market and academia agree that harnessing the power of digital tools such as BIM is the key to successfully completing complex projects.

Complex construction projects also include hydropower plants. In this case, digital models also help improve planning and design and optimize collaboration between the many partners involved.

In fact, Voith is already working with the new possibilities offered by BIM and with 3D scans when modeling plants. In South America, for example, the company already offers virtual tours of power plants here, as well as models of existing plants (known as “BIM as is”) or those of plants as they are going to be built (“BIM as built”). It is also possible to create 3D models of entire hydropower plants or just parts of them.



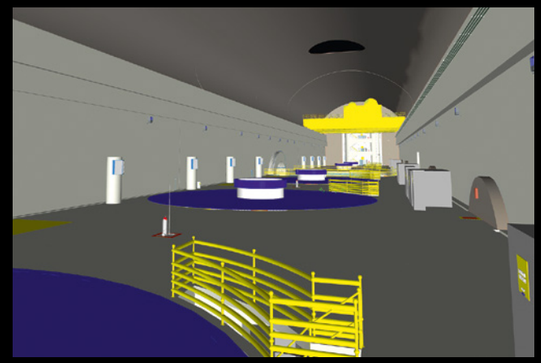
While BIM is a step into the metaverse, 3D scans of the equipment or powerhouse are particularly helpful in modernization projects. The difference is that BIM is a process and a set of tools that primarily help with planning and management. 3D scans, on the other hand, are used to capture and create a digital representation of the real-world situation in the powerhouse.

As a result, 3D scans offer extremely valuable support, especially in engineering. This is because the resulting models can very precisely indicate what shape, dimension or connection a component has. A part that needs to be replaced can then be designed exactly according to these specifications. It is also possible to virtually test whether components fit the conditions on site. In the case of piping, for example, a veritable jungle often develops over the course of many years of operation, which is no longer adequately reflected in the paper plans. With a 3D scan, on the other hand, the engineer sees not only all the pipelines but also the dimensions and connection types, and can prepare the modernization process accordingly.

Leading the Way Thanks to Digital Expertise

While BIM and 3D scans will soon be standard in other construction industries, the hydropower sector is still in the early-adopter phase in this regard. Numerous potential areas of applications are emerging for customers. In addition to more accurate and therefore more efficient modernization planning thanks to 3D scans, there are also advantages in asset management and document organization.

As the technology becomes more widespread, other use cases will emerge. In any event, hydropower plant operators are expressing considerable interest in the possibilities. And with its experience and digital expertise, Voith is leading the way here.



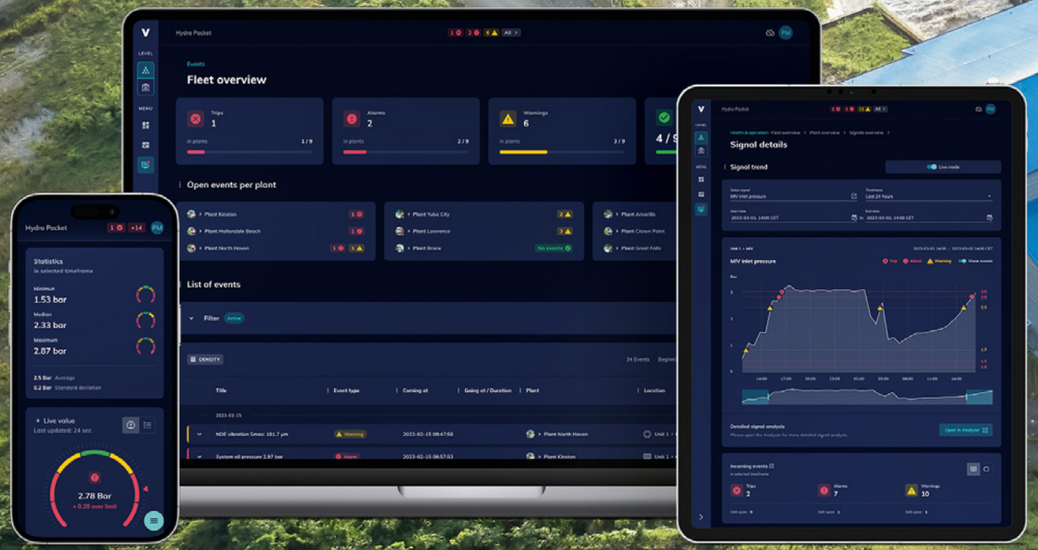
One of the four turbines in Paulo Afonso.

The 3D model of the powerhouse helps to visualize the specific spatial conditions in the power plant.

Mobile Management for Hydropower

The smart app Hydro Pocket helps to monitor processes and optimize plants.

With the Hydro Pocket app, optimizations are possible via tablet.



Digital technologies to monitor technical systems via mobile devices are pushing their way into an increasing number of industry segments. The same is true for generating energy via hydropower plants. Together with the digital company Ray Sono, Voith has launched the intelligent app Hydro Pocket that operators of small hydropower plants can use to keep an eye on important parameters related to their plant's operational status. Specifically, the digital product that Voith has rolled out internationally makes it possible to monitor and optimize all of a plant's processes from anywhere in the world at the touch of a button via desktop, tablet and smartphone. This means that the engineer doesn't have to be on site, use a VPN connection or even speak with anyone directly.

Help When Making Decisions About Production Targets

"Not only can Hydro Pocket be used to monitor energy production and therefore revenue. Collecting real-time data from different areas of the plant and its intelligent analysis also allows better decisions to be made," explains Gustavo Arantes, Product Manager Hydro Pocket at Voith Hydro. Using the information displayed in the app in graphical form, operators or investors in hydropower plants are able to, for example, set individual production targets on the basis of current and historical data. Similarly, Hydro Pocket makes it possible to check the status of grid connections or continuously monitor the health of hydropower plants. A dashboard that can display individual machine units, complete plants and even entire fleets at the touch of a button provides a comprehensive overview. Hydro Pocket can reduce long downtimes.

Users are notified of problems such as low water or overheating through error messages and can respond in real time. They also automatically receive predefined reports and can share them with all relevant stakeholders.

Comprehensive Security Mechanisms

Security is a top priority for Voith when it comes to Hydro Pocket. In this context, Voith relies on a cybersecurity strategy known as defense in depth. This involves layering a series of defense mechanisms to protect valuable data and information.

At the power plant, every step of development is regularly documented and reviewed. The power plant hardware supplied by Voith was developed according to a certified secure development process in compliance with the IEC 62443-4-1 security standard. Voith has developed a secure system architecture, including products such as Hydro Pocket, based on threat analysis and risk assessment according to IEC 62443.

Voith and third-party companies regularly perform audits of various parts of the systems in order to evaluate and mitigate risks. Furthermore, Voith is responsible for continuously and rapidly providing new security updates. Data is only sent to the cloud in one direction via a protocol, so there is no way to access PLCs and SCADAs via edge devices.

Up and Running in Just 10 Weeks

The effort required to set up the app is minimal – from receiving the equipment to installation, configuration and activation takes a maximum of 10 weeks. Furthermore, setup does not require any major changes to the power plant or additional sensors or controllers – Hydro Pocket "plugs in" to existing, standardized technologies such as SCADA (supervisory control and data acquisition) or condition monitoring and can be adapted to individual needs and user groups.

To configure the system, the user receives a starter kit that must be connected to the power plant. This contains a gateway that serves to securely transmit the data via an encrypted connection to the Voith Cloud. Voith handles the configuration of the system. The user can then access the information directly from the cloud via an equally secure and encrypted connection. As Arantes explains, "We're continuously updating and enhancing the app – we bring out a major release about every two months and a small update about every two weeks."

Pilot Project in Indonesia, Other Plants in Trial Operation

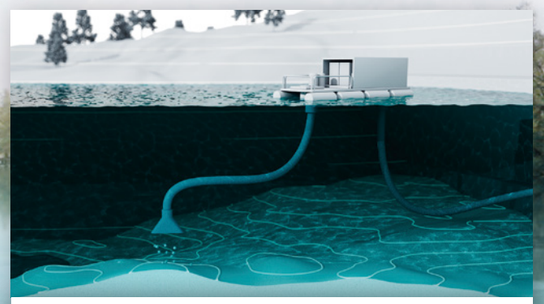
Hydro Pocket has now been in operation within the scope of an Indonesian pilot project for over a year. The findings from this deployment contributed significantly to the enhancement and design of the app and its features. After its implementation at the plant in Southeast Asia, Voith optimized the user experience and the technical stability of the application, among other things, together with Ray Sono and incorporated feedback from the customer. "In addition to the 12-MW plant in Indonesia, more than 10 other plants in Europe and Southeast Asia are now using Hydro Pocket in trial operation. And a number of other customers have also already purchased Hydro Pocket and will soon have it up and running."

About Ray Sono

As a full-service agency, Ray Sono designs companies' and organizations' digital worlds. Its customers include brands such as Audi, BMW, Linde and McDonald's. In addition to its headquarters in Munich, Ray Sono maintains a design lab in Berlin and another office in Frankfurt am Main. Voith holds a majority stake in the company.

New Sustainable Solution

Sedimentation:
Voith's SedimentCareProgram offers a customized and environmentally friendly solution to sedimentation issues.



At the heart of Voith's SedimentCareProgram is a fully automatic boat. Sediments are sucked from the bottom through a pipe and transported in low concentrations via a pipeline to the hydropower plant.

A

The stirred-up sediment particles pass through the pipe into the penstock and can simply pass through the turbine with the flow of the water.

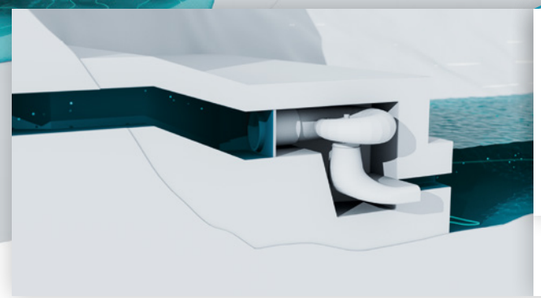
B

Each fully automated boat has a user interface. This allows experts to constantly monitor the efficiency, productivity and location of the boat and other process parameter.

D

Controlled sediment transport: Continuous transfer ensures that the power plant operates in a sustainable manner.

Uncontrolled sediment transport: Turbines or other parts may be damaged.



The amount of solids carried by the turbines is carefully adapted to the particular hydropower plant and its environment. This prevents damage to the turbines and unnecessary interruptions to operation. Each project lasts around one to three years and is carried out in close coordination with local environmental authorities.

C

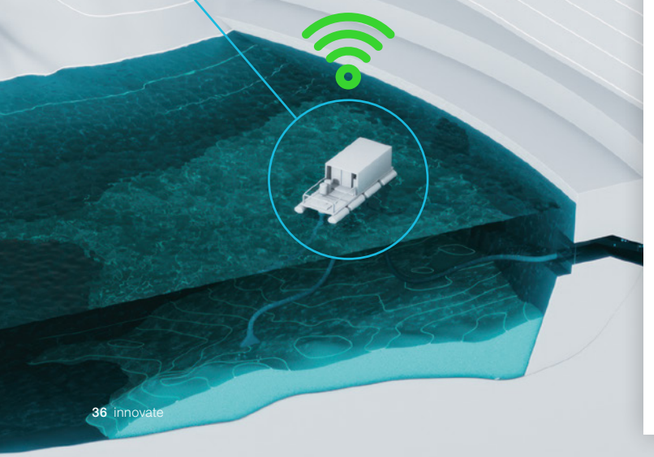
The problem of sedimentation in reservoirs has been known for a long time. A recent UN study[1] once again confirms that sediment deposits in reservoirs around the world reduce the capacity to store water. This has implications for the drinking water supply, flood management and electricity production. According to the study, the worldwide storage capacity will decline by one-quarter of the original storage capacity by 2050. The loss of capacity at the roughly 50,000 sites analyzed in the study would add up to 1.65 trillion cubic meters, or roughly the annual water consumption of India, China, Indonesia, France and Canada combined.

For this reason, Voith Hydro now provides a service that gently removes accumulated sediments from reservoirs via the turbines. This isn't only beneficial to the environment – the SedimentCareProgram is also highly competitive financially.

Undesirable Minerals

"Hydropower is the backbone of renewable and sustainable power generation," says Lorenz Lenhart, Product Manager for the SedimentCareProgram at Voith Hydro. Ensuring that hydropower plants will still be used on a large global scale to generate electricity and stabilize grids in the future not only requires rivers, dams and the respective equipment. Sediments, i.e., loose mineral materials or organic particles that are stirred up from the bottom of the waterway or enter the rivers through precipitation, also play a decisive role "and can therefore lead to malfunctions or even failures of the complex plants." Lenhart knows. These sediments reduce the storage volume of reservoirs, thereby impairing power generation as well as storage and discharge capacity, and in the worst case, can even block the bottom outlets – an important safety feature of a dam.

1 Present and Future Losses of Storage in Large Reservoirs Due to Sedimentation: A Country-Wise Global Assessment. 2022.



Active Environmental Protection

"Scientific research on this topic in artificial dams and reservoirs dates back to the 1950s; however, people have known about this challenge for as long as water has been used for energy generation," explains Lenhart. As the sedimentation of the reservoirs becomes increasingly visible, this issue is now once again coming to societies and the industries' attention. According to the Voith expert, "If the sediment deposits extend into the reservoir depths used for power generation, energy production is no longer guaranteed." But that's not all. Flood control and drinking water production could also be affected by sediment deposition. "You simply lose usable water volume."

Ecological, Economical, Sustainable

Conventional methods of de-sedimentation, such as dredging or flushing, are comparatively expensive, inefficient and time-consuming. Important nutrients for flora and fauna are also lost in the process and the natural sediment balance in the river is disrupted. Voith Hydro has come up with a special procedure: "Our SedimentCareProgram is a service we've developed to transport the sediment through the hydropower plants, just as if there wasn't a plant there at all." The process mobilizes the sediment at the bottom of the respective water reservoir, transports it to the hydropower plant, and injects the sediment continuously and in a controlled manner into the power plant's penstock. As a result, it is routed through the power plant with the moving water.

By offering the SedimentCareProgram, Voith Hydro is expanding its range of services in line with the company's DNA of developing sustainable technologies for future generations. Due to its many years of experience with sediment loads in hydropower plants and technological leadership in turbine layout, simulation and design, Voith Hydro is best positioned to offer a global solution for this issue and support its customers to produce energy economically and sustainably into the future.

"We wanted to develop a financially and environmentally sustainable product and solve the sediment problem for all stakeholders – our customers, the environment and society at large," explains Lenhart. Financially sustainable, because the solution maintains the efficiency and recovers the productive capacity of the hydropower plants during de-sedimentation process, without creating unnecessary downtime. Environmentally sustainable, because the natural sediment balance in the rivers and reservoirs is re-instated. "The world is looking to Europe when it comes to environmental protection and respective solutions. We are subject to strict regulations and work closely together with the environmental authorities."

The SedimentCareProgram is "particularly exciting" – and not only for use in domestic waters. North America, Asia, and especially countries suffering from water shortages such as nations in Southern Europe, North Africa and island states could re-instate their water storage capacities without creating unnecessary water loss using conventional methods. "Water is a valuable resource", Lenhart puts it succinctly.

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Insights and Inside Views

reflect

"With our decades of experience, we find the best solution for every modernization of a hydropower plant and thus keep this traditional energy source eternally young. That's very important, because as the largest renewable energy, it also plays a supporting role for future generations."

Harald Haiduk
Coordinator Assembly

Short Distances

1 In Bosnia and Herzegovina, generator components are produced for the markets in Africa, Europe and America.

2 Production has been running at full speed since the end of 2022.

3 Robots help with production in the state-of-the-art plant.

1

2

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At the competence center in Lukavac, in the northeast of Bosnia and Herzegovina, Voith produces bars, coils and poles for hydropower generators.

1.5 h

is all it takes from an airport near the Voith headquarters in Heidenheim to Tuzla.

At the end of last year, Voith Hydro opened its new center of competence for generator components in Lukavac (Tuzla Canton), Bosnia and Herzegovina. The state-of-the-art facility supplies products for the markets in Africa, Europe and America. Its range includes bars, coils and poles for hydropower generators.

The new center of competence is strategically located in the heart of Europe and only 1.5 hours by plane from Voith Hydro's German headquarters in Heidenheim. The site was set up in close collaboration with experts from the company's Central Technology Department in Germany, where key research and development functions for generator components are located.

Short Distances, Fast Responses

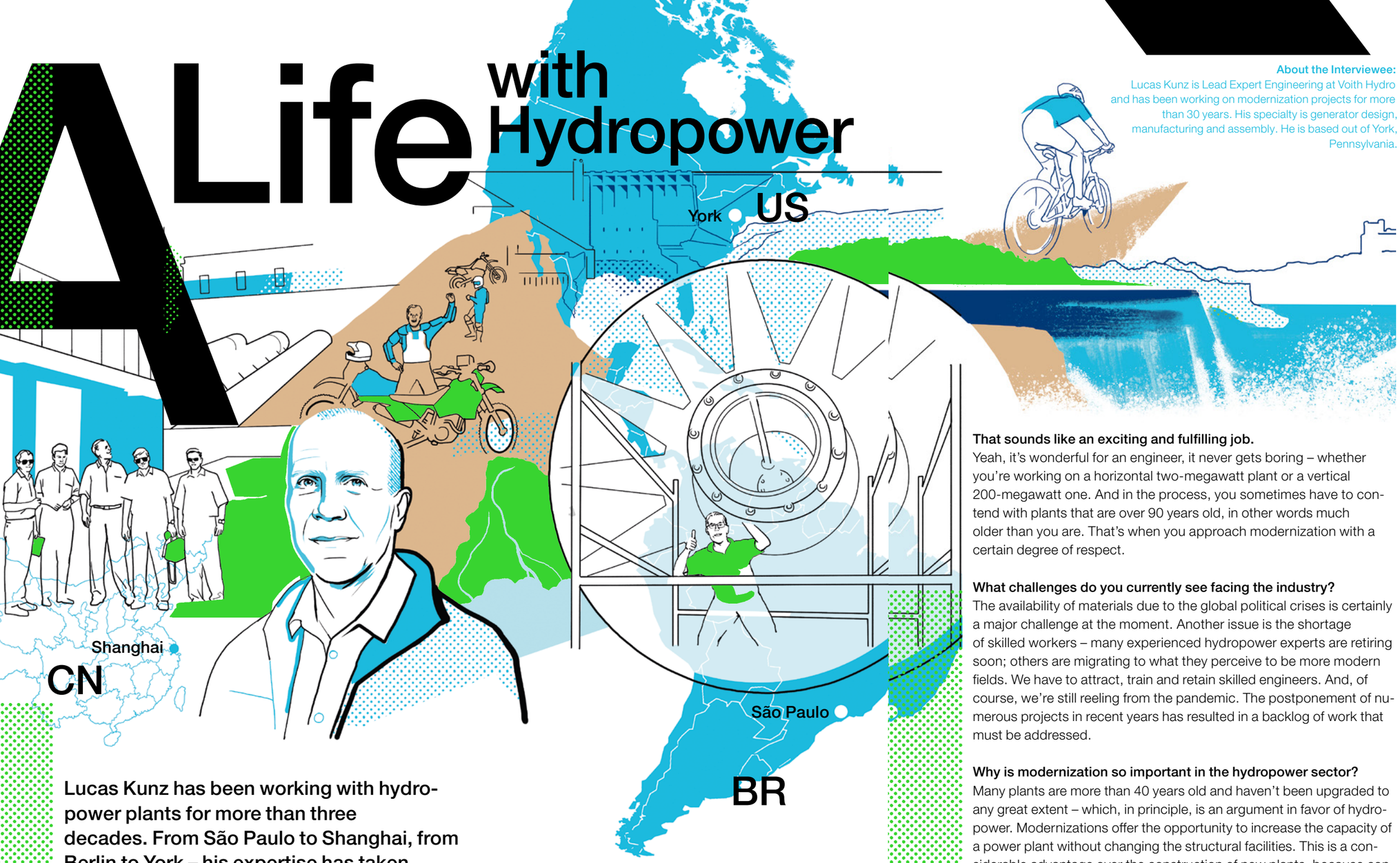
Due to its proximity to company headquarters, customers benefit from short distances and fast response times. In addition, ELIN Motoren – a Voith company that has been successfully producing motor and generator coils as well as wind generator components for several years – has its Bosnian factory located in the immediate neighborhood.

Pole manufacturing is already in full swing, and bar and coil production has also begun. Beforehand, all products underwent extensive life cycle simulations and high-voltage tests. These were completed to management's full satisfaction and not only meet international standards but also Voith Hydro's own high internal standards of quality. The site is currently executing or has already partially completed its first projects for customers from Belgium, Luxembourg, Sweden and Switzerland.

"With this facility, we bundle our competence for bars, coils and poles. The location in central Europe is ideal to serve not only the European market but also Africa, the Americas and beyond," says Dr. Tobias Keitel, President & CEO of Voith Hydro.

The feedback received from the facility's first customers has been very positive and confirms that the new center of competence is a significant milestone for Voith Hydro and its customers.

A Life with Hydropower



Lucas Kunz has been working with hydropower plants for more than three decades. From São Paulo to Shanghai, from Berlin to York – his expertise has taken the engineer all over the world. In this interview, he tells us what matters most in successful modernization projects.

How long have you been working in the field of hydropower?
I've been working with hydropower for more than 36 years. My profession has taken me around the world over the course of my career – from São Paulo to Berlin to Shanghai and finally to York, Pennsylvania, where I have now been working for 18 years. That sounds like a long time, but all I can say is I'm still learning and having a lot of fun with hydropower.

What is it about hydropower that fascinates you personally?
What has always fascinated me the most throughout my professional career is the fact that no two rivers are the same. The run of the river, regional and seasonal conditions, pump storage – there is always a new challenge, and we have to adapt our technologies to achieve the required performance.

About the Interviewee:
Lucas Kunz is Lead Expert Engineering at Voith Hydro and has been working on modernization projects for more than 30 years. His specialty is generator design, manufacturing and assembly. He is based out of York, Pennsylvania.

That sounds like an exciting and fulfilling job.
Yeah, it's wonderful for an engineer, it never gets boring – whether you're working on a horizontal two-megawatt plant or a vertical 200-megawatt one. And in the process, you sometimes have to contend with plants that are over 90 years old, in other words much older than you are. That's when you approach modernization with a certain degree of respect.

What challenges do you currently see facing the industry?
The availability of materials due to the global political crises is certainly a major challenge at the moment. Another issue is the shortage of skilled workers – many experienced hydropower experts are retiring soon; others are migrating to what they perceive to be more modern fields. We have to attract, train and retain skilled engineers. And, of course, we're still reeling from the pandemic. The postponement of numerous projects in recent years has resulted in a backlog of work that must be addressed.

Why is modernization so important in the hydropower sector?
Many plants are more than 40 years old and haven't been upgraded to any great extent – which, in principle, is an argument in favor of hydropower. Modernizations offer the opportunity to increase the capacity of a power plant without changing the structural facilities. This is a considerable advantage over the construction of new plants, because construction accounts for 80 percent of the costs in a new plant project, while the electromechanical components only account for 20 percent. This means that if you only have to invest in the latter, because the structure is already there, the financial return is much higher than building a new one.

You are part of a new interdisciplinary modernization team – why was this team established and what are its duties?
We always strive to find the ideal solution for our customers. The best way to do that is to combine the expertise that is spread across the regions into one team. This team gathers and organizes Voith's vast knowledge and wealth of experience, working together to develop and implement best practices that will benefit our organization.

What are the particular challenges facing modernization projects?
We're dealing with complex projects here – on the one hand, there are very different local regulatory processes, and you have to understand these and know what the consequences of these requirements are for the customers. On the other hand, hydropower plants and dams are complex systems. Their maintenance and modernization require special knowledge and expertise. This is Voith's greatest strength. You always have to decide and determine which components need to be replaced and which can stay. This can often only be decided after taking a close look at the real-world conditions on site.

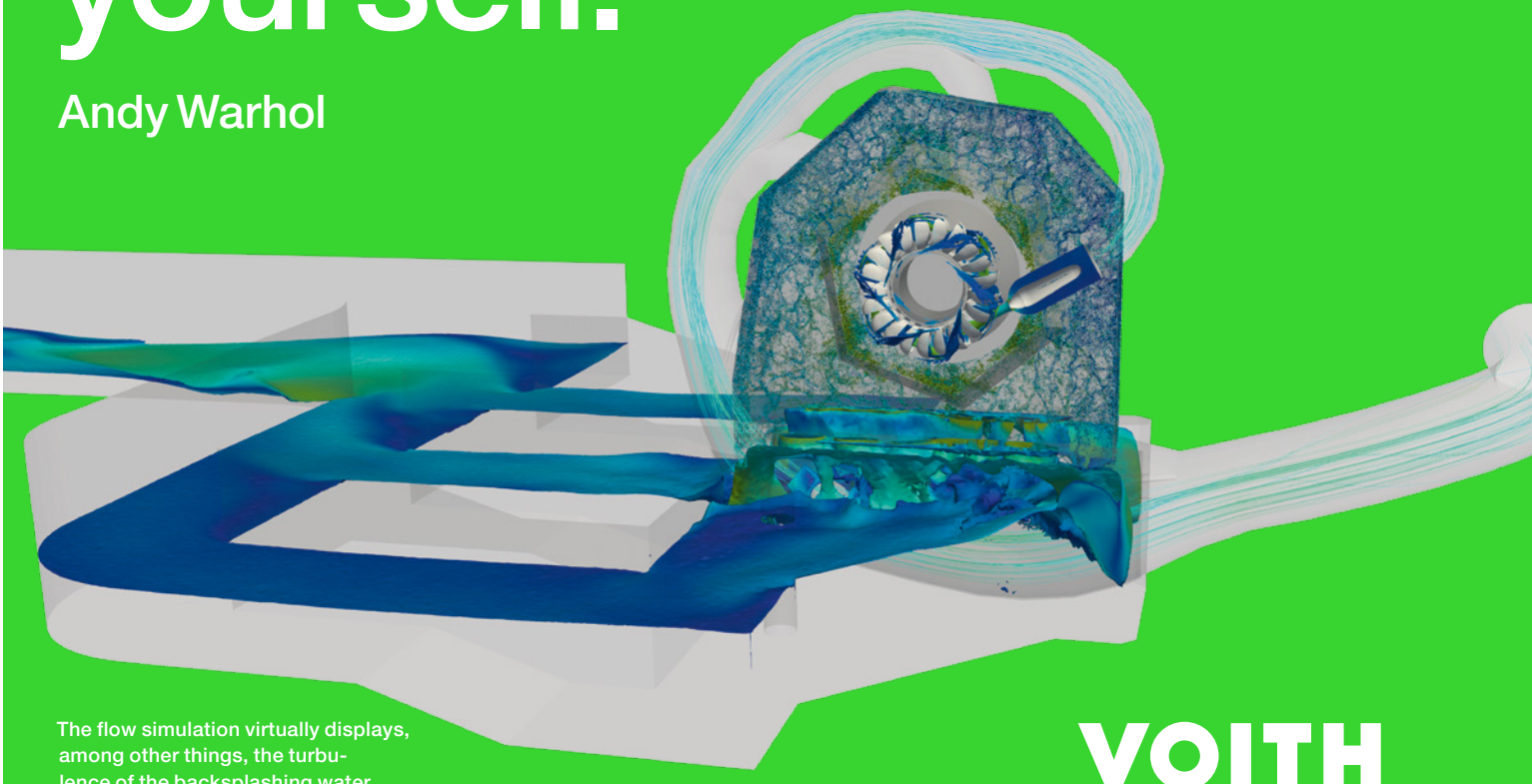
Why is Voith Hydro the right partner for these projects?
Voith has special expertise in the fields of design, engineering and construction. That is our major strength, as it enables us to complete modernization projects safely, efficiently and on schedule. And our mission doesn't end there, because we can also provide maintenance and service. Our HyService helps customers ensure that the new systems and components will operate efficiently and perform reliably for many years to come.

What was the most exciting modernization project you personally worked on?
One that comes to mind off the top of my head is from the beginning of my career in the United States. We were working on the modernization of the Conowingo power plant in Chesapeake Bay. During the project, a sudden short circuit caused major damage to a machine unit that wasn't scheduled to be upgraded. We then had to move that schedule forward, of course, to keep the power plant running. Design, manufacturing, installation – it all had to be completed on short notice to keep the power flowing. And we succeeded – after only eight months, the customer was able to bring the machine into operation. A great teamwork with multiple operation units involved that shows how successful we can be when we join forces.

What are the future plans for the team?
We will increasingly support selected, complex projects in all four corners of the globe. To this end, we will expand our team to include important key members in all areas of commercial, field service and engineering. Training the next generation of hydropower engineers is very important for the future – we've a lot of work ahead of us and I'm looking forward to passing on my knowledge and experience.

“They always say time changes things, but you actually have to change them yourself.”

Andy Warhol



The flow simulation virtually displays, among other things, the turbulence of the backsplashing water.

VOITH