

hypower

by Voith Hydro — N° 36

NextGen Energy

Wind power in action:

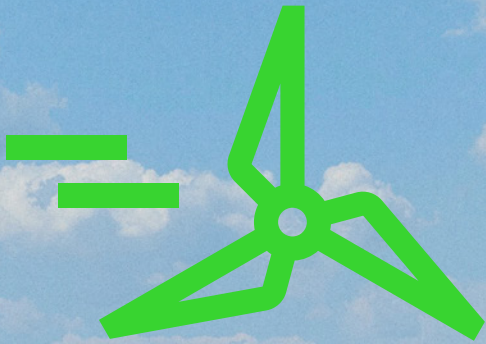
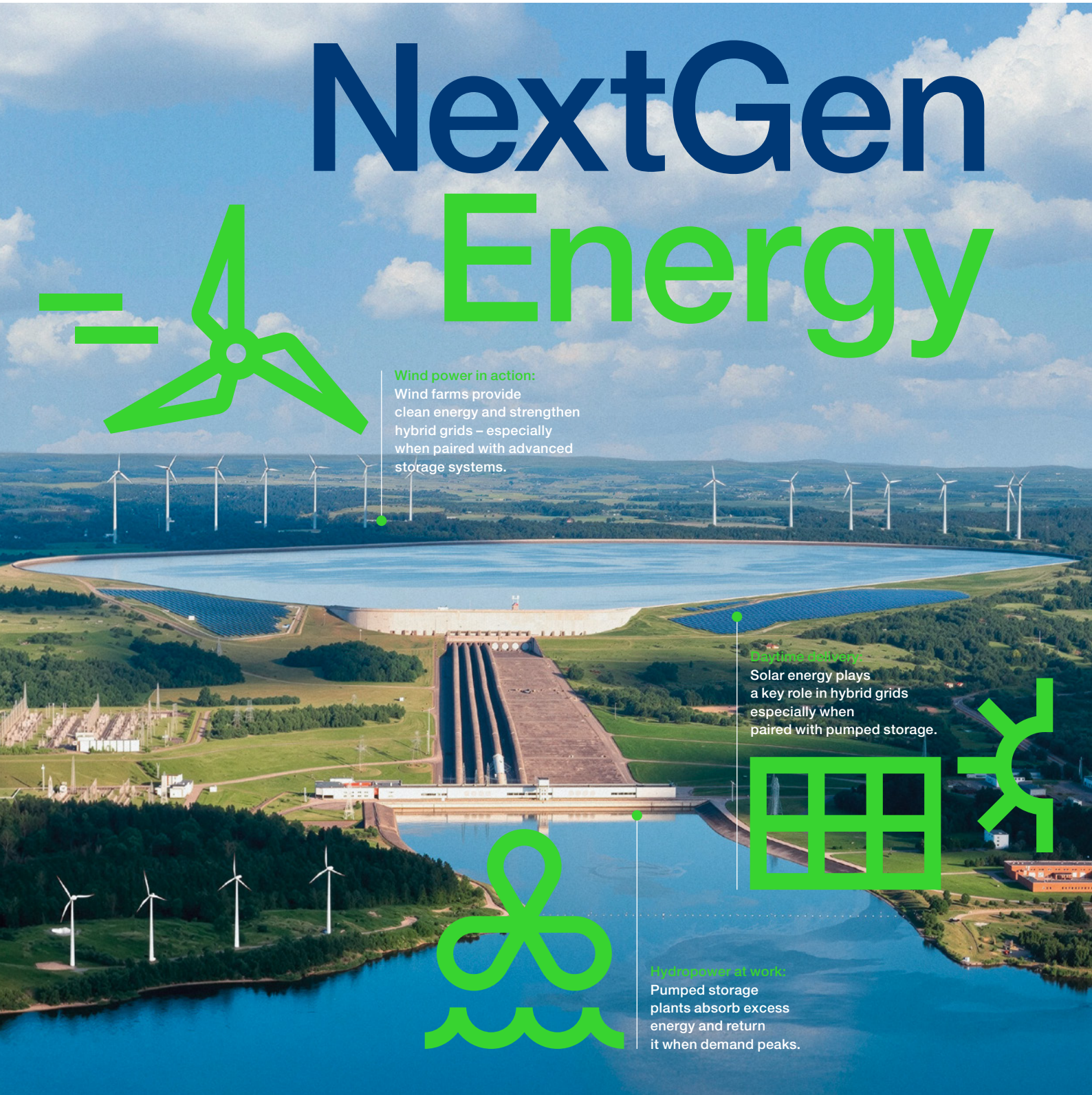
Wind farms provide clean energy and strengthen hybrid grids – especially when paired with advanced storage systems.

Daytime delivery

Solar energy plays a key role in hybrid grids especially when paired with pumped storage.

Hydropower at work:

Pumped storage plants absorb excess energy and return it when demand peaks.





The global energy transition is gaining momentum – but as more wind and solar power feed into the grid, one question becomes increasingly urgent: How do we ensure reliability?

True stability requires storage capacity, controllability, and proactive service. This is where hydropower shows its full strength: it is more than a generator – it forms the backbone of a dependable energy system.

Our cover story explores why hybrid systems combining water, wind, and solar are essential. Pumped storage plants are becoming the key to large-scale energy storage, as demonstrated by current projects in China.

Additional articles show how modern services enhance efficiency, availability, and cost performance – including the modernization of Inga II and an interview with Chief Service Officer Sunil Pandiri.

I hope you enjoy this inspiring read.

Jan Lüder
President and CEO
Voith Hydro



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Hybrid systems for a reliable energy transition.

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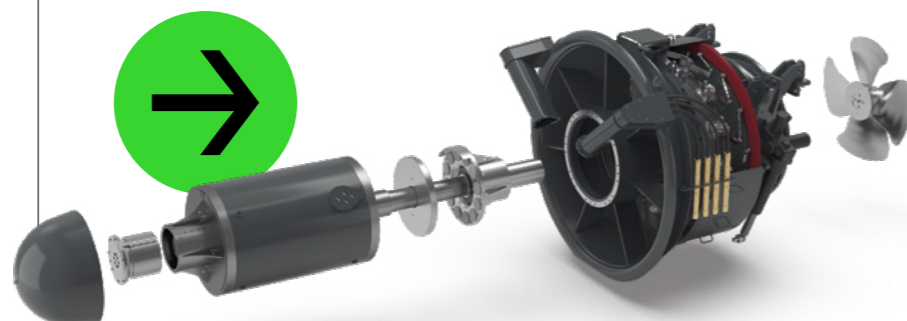
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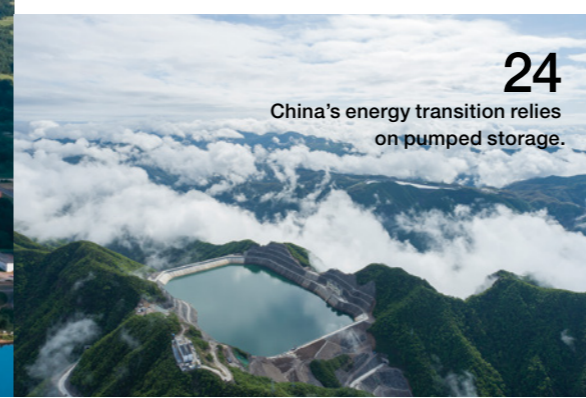
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You can find more information on the calculation methodology, offsetting and the selected gold standard climate protection project at klima-druck.de/ID.

Diving into

As part of the full refurbishment of a turbine unit at the Inga II hydropower plant (see detailed article on page 38), the entire trash rack – made up of 100 individual panels – must be replaced. Each panel weighs around 700 kg. The work takes place at depths of up to 30 meters, under unpredictable vortex (chaotic, unidirectional current) conditions and near-zero visibility. At this depth, divers' working time is inherently limited, after which a decompression phase is required. To carry out this task, Voith brought in specialist divers from ULIS, based in Morocco.

Darkness

The Challenge

The main challenge is completing complex tasks in total darkness and under strict time pressure. At 27 meters depth, divers breathe compressed air – limiting their work time to 60 minutes, followed by a 45-minute decompression ascent. Enriched gas mixtures, which could extend bottom time by 50 percent, aren't an option due to the lack of necessary technical equipment in the DRC.

The Divers

After screening their experience and certifications, each candidate is interviewed personally by the ULIS supervisor. All divers must be medically fit and able to stay calm in high-pressure situations. Experience on dams and in murky waters is essential.

The Risks

The greatest danger is the vortex current from the neighboring turbine units, which run in parallel. If active, they would be fatal to divers. Voith ensures they are fully shut down before any descent. Another major risk is decompression sickness, mitigated by the presence of an on-site hyperbaric treatment chamber (OHB) – a crucial safety measure given the remoteness of the location. And finally, there is total darkness underwater – no workaround, just training and composure.

The Success

Thanks to the professional work of the specialist divers and the minute-by-minute, precise coordination between teams, the operation was completed successfully. The turbine unit is now equipped with a new trash rack.

News

News from the world of Voith Hydro

A new service project in Scotland and AI-enhanced turbine design: two examples of how modern solutions boost hydropower's efficiency and future readiness.

Long-term partnership:

Green Highland takes over operation and modernization of the Kinlochleven hydropower plant

Green Highland has recently been commissioned by client Equitix to provide comprehensive operations and maintenance services for the Kinlochleven hydropower plant in Scotland. As a subsidiary of Voith, the company now assumes full responsibility for the plant's daily operations. In addition, the facility is set to undergo modernization to meet and maintain high standards in performance, longevity, health and safety, environmental protection, and quality.

The long-term service agreement, which is part of Voith's global HyService portfolio, reflects the operators' clear commitment to a forward-looking, sustainable collaboration.

Kinlochleven is expected to benefit from both Voith's extensive expertise as a trusted service provider and Green Highland's local operational know-how. With this partnership, the plant will continue to deliver renewable energy reliably and efficiently.

Operating since 1909, Kinlochleven is one of the oldest hydropower plants in the United Kingdom. Originally built to supply electricity to a large aluminum smelter, the plant now feeds clean, renewable power into the national grid.

The service agreement provides a comprehensive support package tailored to the site's specific requirements. It ensures long-term planning certainty, high plant availability, and reliable energy production – well into the future.

AI meets hydropower: AutoOpti boosts turbine design efficiency

In a joint research initiative, Voith and the German Aerospace Center (DLR) are advancing digital innovation in hydropower technology. The focus: AutoOpti, an AI-supported optimization tool developed by DLR. In early project phases, the tool already shows strong results enhancing turbine performance and accelerating the design process.

Hydropower faces rising demands for efficiency, robustness, and cost control. Components like runners and guide vanes must deliver top performance under complex physical conditions. At the same time, development cycles are becoming shorter and more data-driven. AutoOpti addresses these challenges through a fully automated, multidisciplinary design process that integrates fluid dynamics, structural mechanics, and intelligent optimization strategies.

By using surrogate models, AutoOpti reduces the number of computational fluid dynamics (CFD) simulations required, enabling faster and more efficient design iterations. In a recent use case with a Francis turbine, the tool produced new runner geometries that delivered clear efficiency gains across several operating points – while keeping flow rates constant.

As the next step, the tool will be applied to additional components and design challenges. Voith and DLR aim to further expand this collaboration and integrate AutoOpti into broader product development workflows.

“Technology is essential – but so are people. At Voith, both matter: quick thinking, real teamwork, and the sense of doing something meaningful for the future every single day.”

Hannah Scheu,
Commissioning Engineer
at Voith Hydro

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A Look at
Key Trends

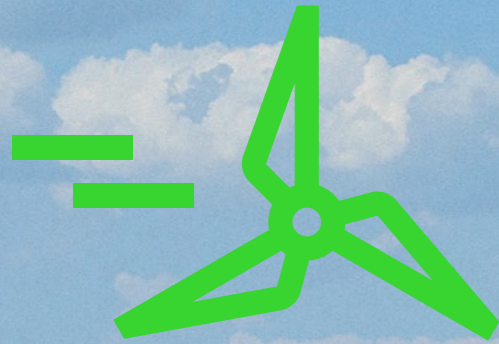


innovate.

NextGen Energy

The Key Technology

How the global energy transition can be sustainably and reliably managed using hybrid systems combining hydropower, wind, and solar energy.



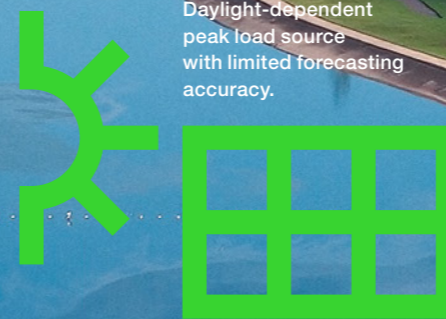
Wind power
Volatile generation with significant contribution to nocturnal load coverage.



Hydropower
Key storage technology with high grid support and control performance.



Solar power
Daylight-dependent peak load source with limited forecasting accuracy.



As of 2024, renewable sources accounted for 32% of global electricity generation, an increase from 30% in 2023, according to the Ember Global Electricity Review 2025. However, the rising reliance on renewable energies introduces new challenges for energy suppliers: the output of wind and solar facilities depends on weather conditions, which often do not align with actual energy demand. This situation poses the critical question: How can we ensure a stable and reliable electricity supply despite this volatility?

The challenge: variable generation

Weather-driven fluctuations can cause solar and wind energy generation to significantly exceed or fall below actual electricity demands. Many countries face four common scenarios: prolonged periods of excess energy supply, extreme load fluctuations in short intervals, extended periods of low production (“dark doldrums”), and forecasting inaccuracies due to unpredictable weather.

A clear example occurred in December 2024 when Germany experienced such a “dark doldrums” period. During this time, wind farms delivered only 7% of their normal capacity, prompting increased reliance on coal and gas power plants. Consequently, electricity prices surged dramatically, peaking at €936 per megawatt-hour – 12 times the average rate.

Ensuring long-term grid stability

These dynamics place stringent demands on grid stability, requiring flexible balancing mechanisms capable of rapidly responding to these fluctuations. Possible solutions include modern, flexible gas power plants and energy storage systems (such as pumped storage and battery storage). Although gas power plants can quickly ramp up or down to compensate for peaks or troughs, they emit CO₂.

For example, in South Australia, all coal-fired power plants have been shut down. However, to maintain grid stability, new gas-fired power plants had to be constructed and operated concurrently. Often, these gas plants remain operational even when wind and solar energy alone could fully meet electricity demand – purely to provide enough rotating inertia to maintain grid frequency stability. In situations where wind and solar production is minimal, these gas plants become indispensable.

Yet, relying on natural gas, a fossil fuel, directly conflicts with long-term climate objectives. Battery systems can respond to grid fluctuations within milliseconds, effectively stabilizing voltage and frequency. However, their potential is limited: globally, all installed battery storage systems combined can cover only a fraction of a single day's electricity demand in an industrialized country like Germany.

Wind power strengthens grids and complements flexible storage systems.

The only technically proven solution currently available for large-scale, cost-efficient energy storage: pumped storage power plants.”

Dr. Klaus Krüger
Senior Expert Plant Safety and Energy Storage Solutions at Voith

32%

In 2024, 32% of global electricity generation already came from renewable sources, up from 30% in 2023.

The solution: harnessing the power of water

It's high time we paid greater attention to an essential renewable energy source, especially given the challenge of grid stability: hydropower. Already providing around 14% of global electricity demand, hydropower generates more electricity than nuclear power and all other renewable energy sources combined. Furthermore, it offers unmatched storage capabilities.

“Hydropower currently provides the only technically proven, large-scale, cost-effective solution for energy storage: pumped storage power plants,” explains Dr. Klaus Krüger, Senior Expert in Plant Safety and Energy Storage Solutions at Voith. “These systems boast storage capacities that are 13 times greater than all the battery storage systems worldwide combined. They not only facilitate energy storage on a scale ranging from tens to hundreds of gigawatt-hours but also play a crucial role in maintaining grid stability – especially as the share of intermittent sources like wind and solar continues to grow.”

Hybrid energy systems

Renewable energy can only fully deliver complete and reliable power when wind, solar, and hydropower are combined. Hybrid energy systems integrate multiple renewable sources, such as photovoltaic solar, wind, and hydropower, into a cohesive overall system. By carefully coordinating these technologies, weather-induced variability from individual sources can be balanced, providing a more stable energy supply. For instance, while solar installations predominantly produce high outputs during the day, wind turbines offer complementary power, especially during nighttime or seasons characterized by strong winds.

Pumped-storage systems play a central role as dynamic energy-storage components in these hybrid setups. When there's an excess of electricity, water is pumped to reservoirs situated at higher elevations and then released through turbines when demand increases – this is a proven and highly efficient method for storing energy.

Hybrid systems like these are applied both in remote, off-grid areas for autonomous energy supply and in grid-connected contexts to stabilize grids or manage peak loads. When paired with weather-dependent sources, pumped-storage facilities enable flexible load shifting, thereby significantly enhancing reliability of supply. The technological cornerstone of these systems is intelligent control combined with optimal balancing of generation, storage, and consumption.

1.2 GW

1.2 GW pumped storage plant combined with a 2 GW solar park and a 400 MW wind farm – that's what defines the Pinnapuram project.

Flagship projects in India and Lithuania

Some countries have already recognized the potential of hybrid systems. A stand-out example is the Pinnapuram project in the southern Indian state of Andhra Pradesh. This model initiative combines a 1.2 GW pumped-storage power plant with a 2 GW solar park and a 400 MW wind farm. Most of the energy used for pumping is supplied by the neighboring wind and solar installations, enabling the system to operate with near-zero carbon emissions. Only occasionally is grid electricity needed – to power the pumps during startup. The hybrid plant is integrated into a shared substation, allowing for streamlined control and efficient power delivery.

A particularly innovative feature of the Pinnapuram project is its tariff structure. To ensure reliable peak load supply – such as during morning and evening demand surges – a variable tariff of up to 8.5 US cents per kWh has been set for a period of 25 years. This not only guarantees energy security during peak periods but also provides long-term investment stability.

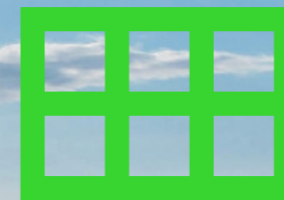
Another forward-thinking example of successful hybrid system integration is the expansion of the Kruonis pumped-storage power plant in Lithuania. The existing facility, which currently operates four units delivering a combined 900 MW, is being upgraded with a fifth, cutting-edge machine. Voith's expertise is playing a central role in installing this highly flexible pump-turbine unit, setting a new global benchmark: it will be the most powerful variable-speed system of its kind in the world.

Unlike the existing fixed-speed turbines, the new unit will operate using a variable-speed concept – featuring the world's largest full-size frequency converter ever integrated into a hydropower plant, rated at 130 MVA. This high-performance setup enables direct pump starts while submerged, as well as exceptionally fast load changes in both pump and turbine modes. In practice, this means the system will be far more responsive to fluctuating supply and demand, offering an adjustable pumping range from 50 to 110 MW. It also supports grid frequency stabilization and reactive power compensation.

"This project is a prime example of how traditional hydropower technology can be combined with state-of-the-art converter systems to meet the evolving demands of power grids with a high share of renewable energy," says Dr. Klaus Krüger. With its modular multilevel converter architecture, high energy efficiency, and grid-supportive controllability, the new Kruonis Unit 5 stands out as a remarkable benchmark for the next generation of pumped-storage plants.



Solar power underpins the hybrid system, providing predictable output.



Global expansion of pumped-storage power plants

Other countries are also embracing this approach – China and Australia among them. Both are strategically expanding pumped-storage solutions to stabilize their increasingly renewable energy systems. In China, plans are underway to quadruple pumped-storage capacity from 30 GW to 120 GW by 2030. This expansion is a key enabler for integrating variable wind and solar power while simultaneously reducing reliance on fossil-fuel-based peaking plants.

Australia provides a clear illustration of the strategic value of this technology: the Snowy 2.0 project is set to become one of the world's largest pumped-storage power plants, featuring Voith technology. The underground powerhouse will house six reversible Francis pump turbines. With a generating capacity of 2.2 GW and 350 GWh of storage, the facility is designed to bridge supply gaps during periods of low wind and solar generation, while also reducing curtailment of renewable energy.

Thanks to its flexibility and the rotating masses from up to six pump-turbine sets, the plant will make it possible to shut down many gas-fired power stations in the region – lowering electricity costs for consumers and cutting CO₂ emissions.

A look at Germany reveals the costly consequences of insufficient access to these technologies – both for grid stability and climate targets. Despite high shares of renewables, significant volumes are still being curtailed due to stagnation in grid and pumped-storage expansion. In 2022, 8,071 GWh of renewable energy were curtailed, rising to 10.47 GWh in 2023.

To put this in perspective: the 2022 curtailment alone equals the annual output of 800 onshore wind turbines, each rated at 5 MW and operating 2,000 full-load hours per year. At approximately €1 million per megawatt, the cost of building those 800 turbines would amount to €4 billion – invested in infrastructure that ultimately stands idle.

A solution for decentralized systems too

Hybrid energy systems that combine wind, solar, battery storage, and hydropower aren't just suited for large-scale infrastructure – they're also ideal for smaller, decentralized applications. Their flexibility allows them to be tailored to local conditions and specific needs, which is especially valuable for users who require on-site energy generation and storage. One key example is hydrogen production via electrolysis, which can serve as a sustainable fuel or play a vital role in green steel production. For more details, see our article "Clean Energy for Green Steel" on page 18.

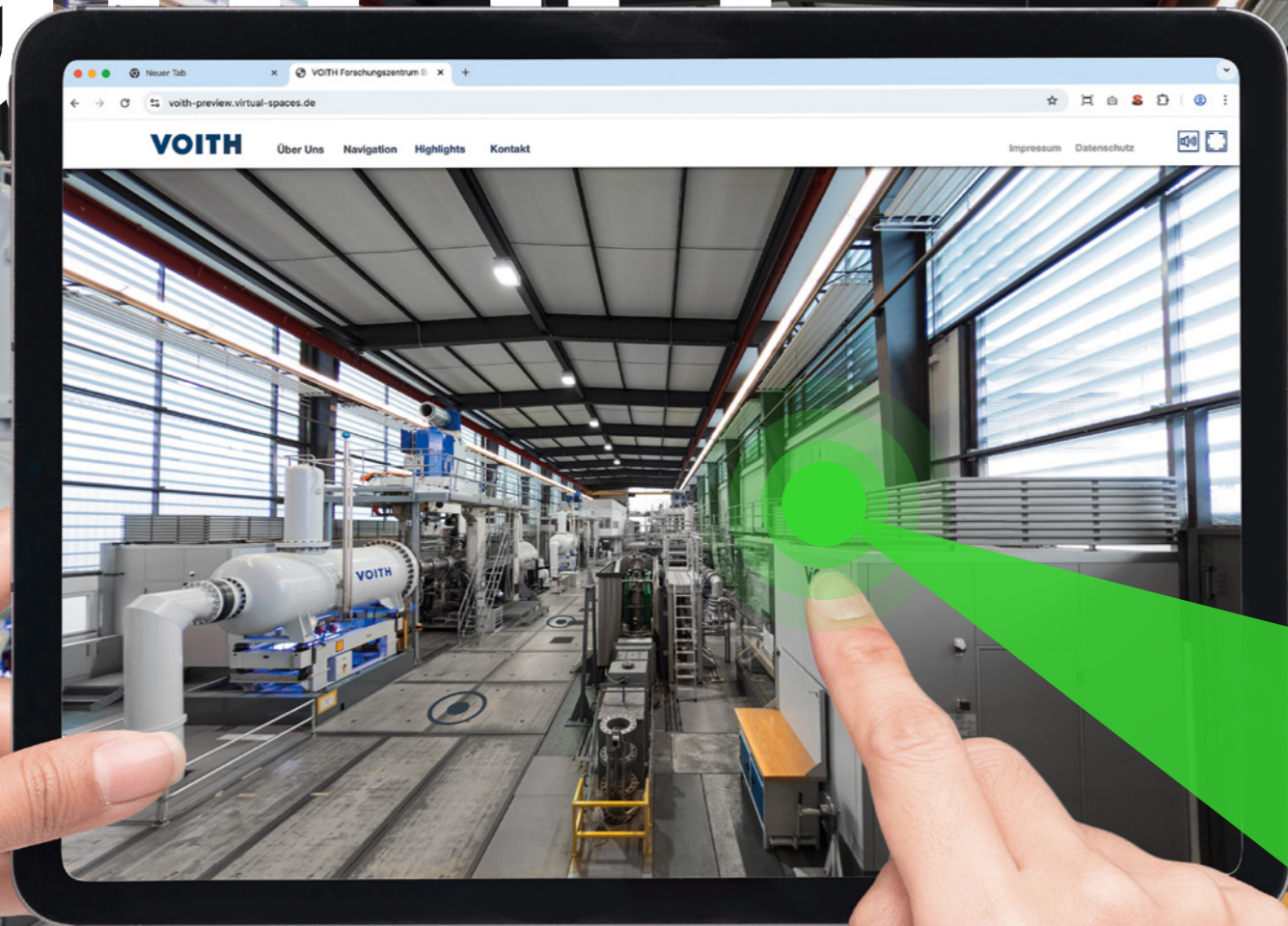
Hybrid systems also offer promising solutions for securing smaller local energy communities. Even highly energy-intensive industries – such as data centers – can be supplied in a way that's both sustainable and reliable through these integrated setups.

"In the coming years, the key question won't just be how much renewable energy we can generate, but how we can ensure it's reliably available – anytime, anywhere. The answer lies in hybrid systems, formed by combining the right technologies to meet the specific demands of each location," concludes Dr. Klaus Krüger.

“
How do we
make renewable
energy
reliably available?”

Dr. Klaus Krüger
Senior Expert Plant Safety and Energy
Storage Solutions at Voith

Innovation



on the Test Bench

The Brunnenmühle facility in Heidenheim is more than just a technical laboratory – it's a hub where the future of hydropower is actively shaped. Those interested in the development of turbines and generators can take part in an interactive virtual tour through this historic site and explore key areas of hydropower technology. From the state-of-the-art hydraulic testing laboratory and advanced simulation and development methods to the high-voltage lab, visitors gain in-depth insights into essential technologies.

The hydraulic test laboratory – the heart of turbine development

At the core of the Brunnenmühle lies the hydraulic test laboratory – one of the most advanced facilities worldwide for testing model turbines. This is where all customer-specific turbine concepts are physically validated. The process adheres to a rigorous development sequence: following design and computational fluid dynamics simulations, the model geometry is constructed, manufactured, and installed on a closed-loop test bench. Water circulates in a continuous cycle – pumped into the headwater tank, through the model turbine, and back into the tailwater tank.

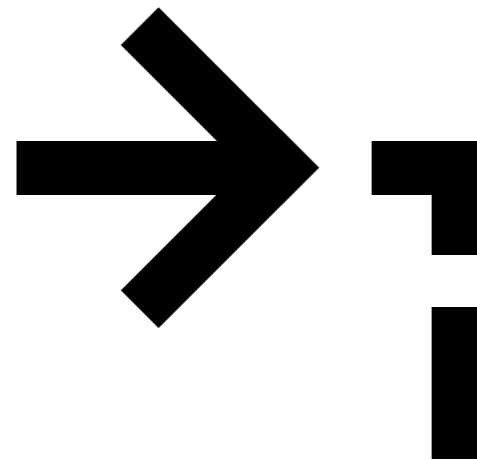
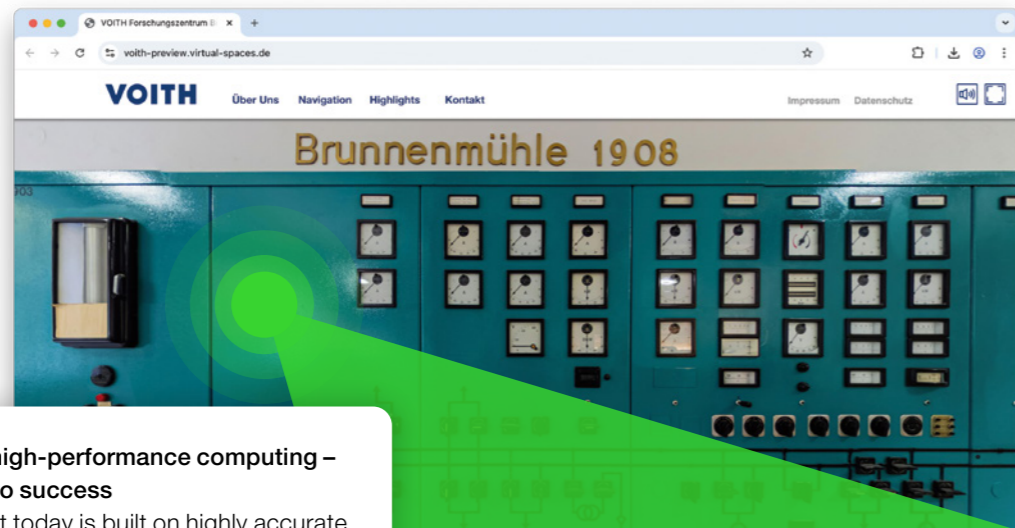
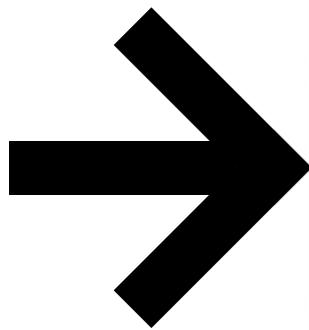
The model turbines are scaled-down replicas of the final full-size systems – typically with runner diameters between 400 and 500 mm – and, through geometric and kinematic similarity, enable highly accurate predictions of prototype performance.

The laboratory plays a key role in hydraulic development, testing parameters such as efficiency, cavitation, pressure fluctuations, and runaway speed – often beyond the required operating range. A successful model test can be the deciding factor in securing a contract, which places the highest demands on precision. Feedback from commissioning is also systematically fed back into development, ensuring continuous knowledge retention. —>



The hydraulic test laboratory

Flow dynamics tests on scale models are carried out in the Brunnenmühle's hydraulic laboratory to thoroughly assess the performance characteristics of turbines and pumps.



Simulation methods and high-performance computing – digital precision as a key to success

Every successful model test today is built on highly accurate fluid dynamics and structural mechanics predictions. This is ensured by the “Tools and Methods” team, which has developed proprietary simulation methods fully integrated into the development process. At the core is a dedicated high-performance computing cluster, enabling complex flow and efficiency calculations in a matter of moments.

What makes the difference is that the tools are so tightly integrated into the development process that product engineers can use them directly – even without advanced numerical expertise, explains Roland Jester-Zürker, Vice President Science & Methods at Voith. He adds, “We selectively enhance commercial software and adapt it to Voith’s specific needs.” But it’s about far more than just efficiency: “A tenth of a percent in efficiency can be worth millions – so the accuracy of our predictions has to be spot on.”

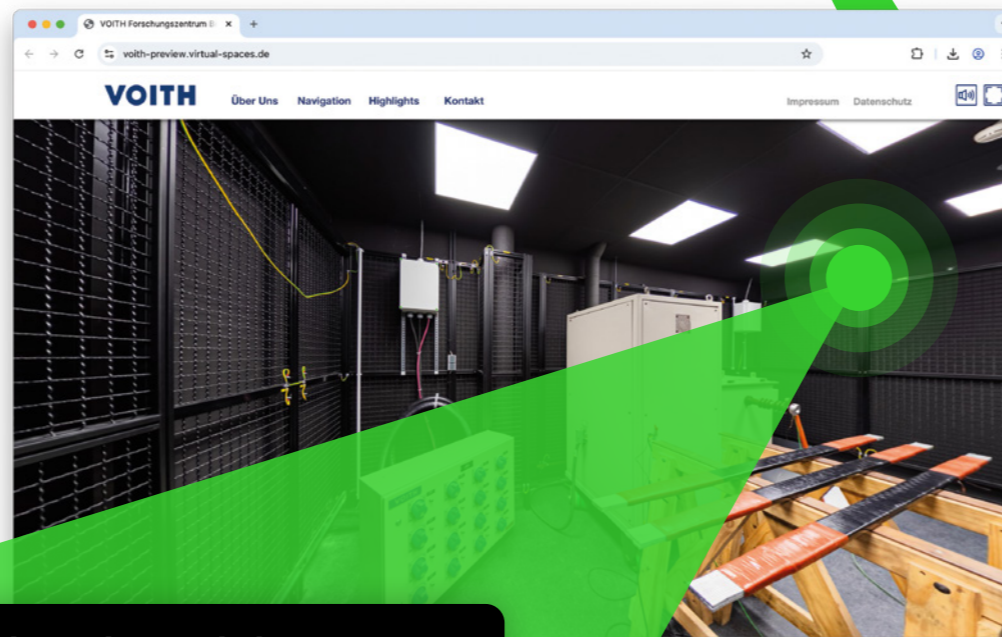
A clear advantage: development and testing are closely co-located. Product engineers work side by side with the test laboratory – a physical proximity that enables rapid insights and ensures continuous model feedback. “This allows us not only to calibrate simulation models efficiently, but to keep improving them over time,” says Roland Jester-Zürker.

New technologies such as GPU computing, cloud platforms, and machine learning are already being trialled – for example, to evaluate designs at an early stage. The goal is clear: “To combine the accuracy of classical methods with the efficiency of data-driven approaches,” Jester-Zürker explains. The path to that goal lies in experience, data, and interdisciplinary collaboration – all of which the Brunnenmühle brings together.



Historical origin

The “Brunnenmühle” has housed Voith’s global hydropower R&D hub since 1908.



High-voltage lab for simulations

In the “dark room,” potential partial discharges are monitored – phenomena that could lead to damage within insulation systems.

High-voltage laboratory – quality assurance in electrical energy conversion

While physical models are tested in the hydraulic laboratory, generator development remains largely simulation-driven. The reason: electromagnetic processes, cooling, and mechanical stresses can only be evaluated in their entirety using a full-scale prototype. This makes Voith Hydro’s high-voltage laboratory all the more essential, as it subjects critical components like windings to extensive testing.

In several test zones – including Building 613 of the Brunnenmühle – samples undergo a three-stage procedure. “First, a high-current test (thermal cycling) is conducted, in which components such as winding bars are exposed to thermal stress over multiple cycles,” explains Dr. Gunar Klaus, Vice President Generator Development at Voith. “Next comes a high-voltage test (voltage endurance test), which simulates dielectric strength after ageing.” Finally, in the so-called “dark room,” any partial discharges that could potentially damage the insulation system are observed.

“The high-voltage laboratory is complemented by an in-house production line for development components, as well as mechanical and chemical laboratories for material analysis,” says Dr. Gunar Klaus. “Particular attention is paid to the interaction between materials, processes, and design – the keyword here is ‘insulation system.’ This includes precisely matched materials and manufacturing methods that are considered standard across Voith facilities worldwide.”

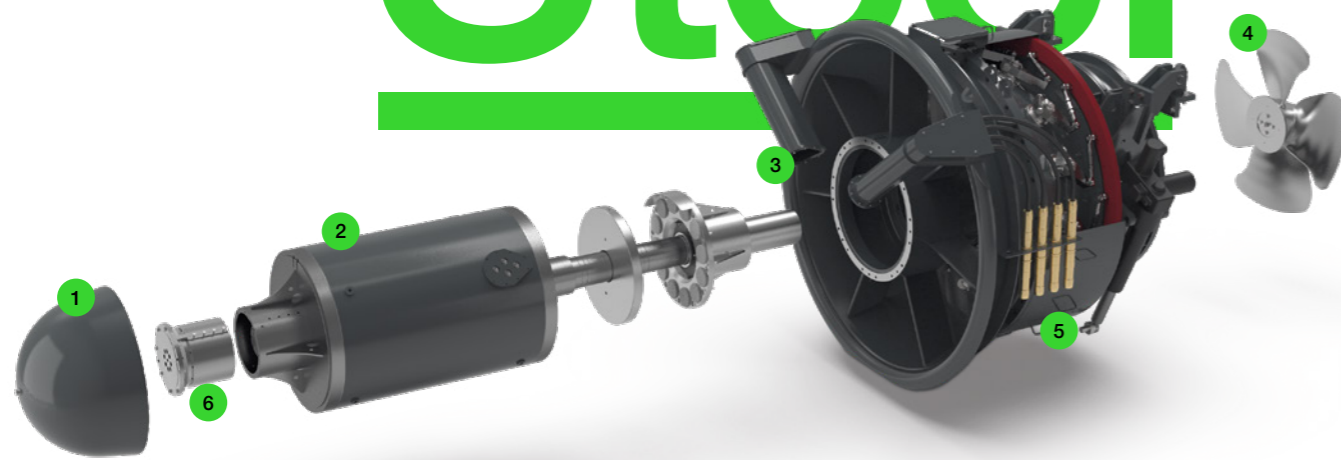
In addition to testing and material development, internal and external training sessions are offered – for example, through the HydroSchool program. There’s also the Genolab at the University of Hannover, a collaborative project that focuses on examining the interaction between generator and converter under real operating conditions. Through these efforts, Voith ensures the highest quality in generator technology – backed by experimental validation and robust methodology.

Take a virtual tour of the Brunnenmühle, available from March 2026. Scan the QR code to start exploring.



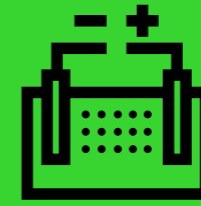
How StreamDiver technology supports hydrogen production at Cogne Acciai Speciali

Clean Energy for Green Steel



StreamDiver regulated
Less components – higher reliability

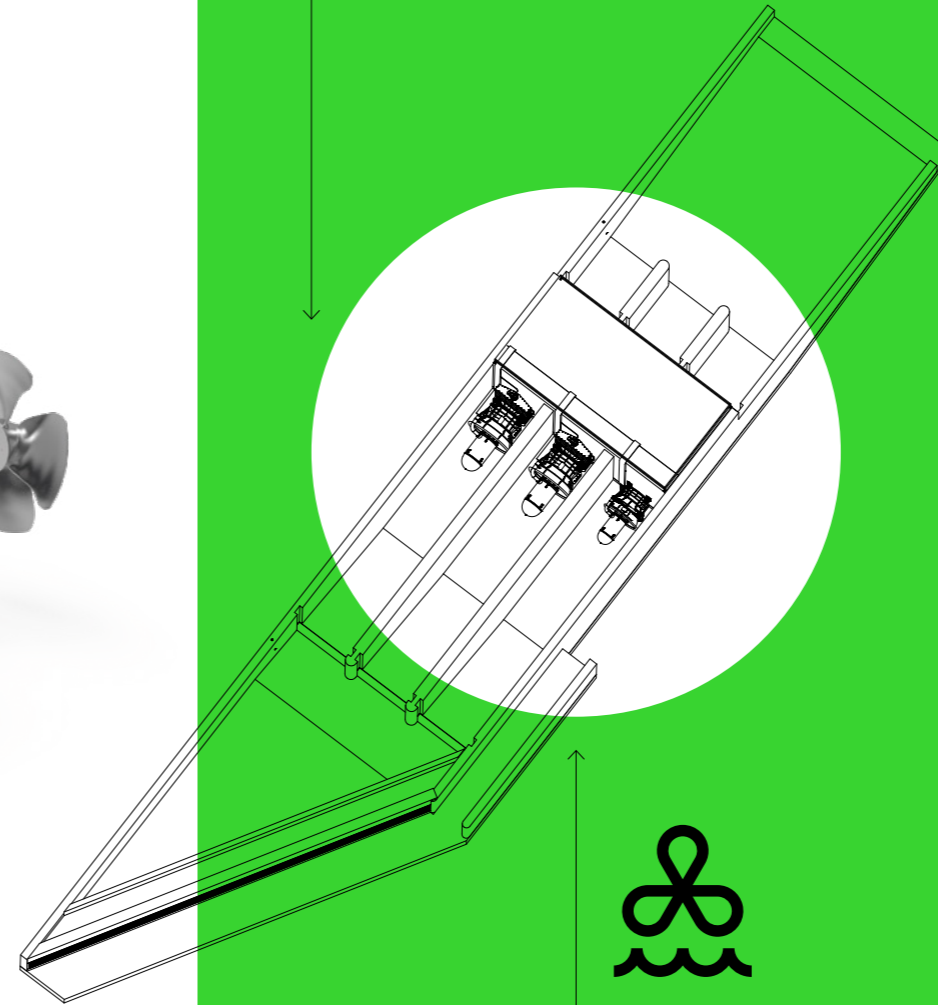
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| <p>1 Glass-reinforced plastic bulb nose</p> <ul style="list-style-type: none"> ● Lightweight – easy to handle ● No corrosion possible <p>2 Permanent magnet or synchronous generator</p> <ul style="list-style-type: none"> ● Water-flooded generator ● Stainless shaft and shields <p>3 Turbine housing</p> <ul style="list-style-type: none"> ● All in one | <p>4 Runner, fixed blades</p> <ul style="list-style-type: none"> ● High quality stainless steel ● No moveable components <p>5 Electrical plugs</p> <ul style="list-style-type: none"> ● Special underwater plugs/marine bronze ● Perfectly flexible <p>6 Water-lubricated bearing</p> <ul style="list-style-type: none"> ● No oil or grease ● No maintenance during lifetime |
|--|---|



Efficient hydrogen production with renewable electricity.



The photovoltaic system provides the volatile share of energy for electrolysis.



Hydropower provides a continuous energy supply for hydrogen electrolysis.

Nestled in the picturesque Aosta Valley in the heart of the Alps, a flagship project for sustainable industrial production is underway. Cogne Acciai Speciali, a leading steel manufacturer, will soon begin producing its own green hydrogen for steelmaking. A crucial element of this EU-funded initiative is the use of renewable energy sources for the electrolysis process. That's where hydropower comes in.

A key to sustainable steel production

The steel industry faces a major global challenge: dramatically cutting its CO₂ emissions. One vital solution is replacing coke with hydrogen as a reducing agent during the steel-making process (see info box). But this only becomes truly climate-neutral when the hydrogen is generated using renewable electricity.

To meet this requirement, a state-of-the-art hydropower plant is being built along an industrial channel that branches off from the Dora Baltea river and was previously used for power generation. Combined with a solar power system, this plant will generate the electricity required for hydrogen electrolysis. The project team opted for Voith's StreamDiver technology to power the hybrid system of solar and hydropower. Why? Its compact design, fast installation, and ability to reliably supply renewable energy regardless of weather conditions made it the ideal choice (see also: "hybrid systems as the backbone of the energy transition").

Maximizing energy efficiency with StreamDiver

There were several additional reasons to choose StreamDiver turbines. This specialized Kaplan turbine is low-maintenance and built for longevity. Unlike conventional Kaplan powerhouses, the StreamDiver system has a distinct advantage: its infrastructure can be discreetly integrated into the landscape.

"The construction effort is minimal, and the cost savings can be as high as 25% compared to traditional hydropower plants. Plus, the modular design means each turbine can typically be installed within a single day," explains Johannes Daxelmüller, Senior Sales Manager at Voith, Division Small Hydro.

Another significant advantage is that the turbine operates entirely without oil or grease. Its bearings are water-lubricated, which is environmentally friendly, prevents contamination, and significantly reduces maintenance requirements.

Cogne Acciai Speciali uses three StreamDiver units: two larger turbines rated at 372 kW each and a smaller one at 218 kW. All turbines are directly connected to water-cooled permanent magnet generators. Together, they generate nearly 1 MW – enough reliable power to support the hydrogen electrolysis process in combination with the solar system.

25% Cost savings

Lower costs through smart turbine technology
StreamDiver units cut investment and operating costs significantly.



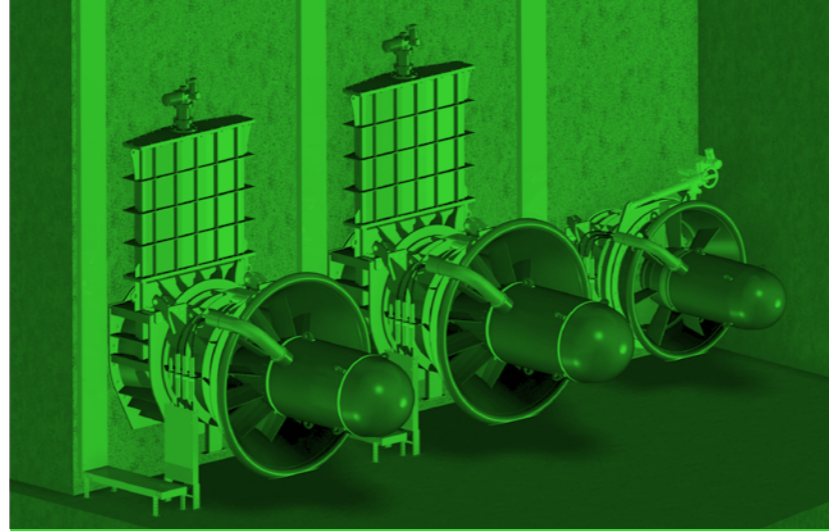
StreamDiver in the sustainable energy mix

The green hydrogen project at Cogne Acciai Speciali includes several elements that are relevant for other renewable energy applications. "StreamDiver technology is designed to deliver a continuous supply of renewable energy – without the need for complex structures or lengthy installation times," says Johannes Daxelmüller. "That's what makes it such a great fit for projects like this one."

Scalability is another key advantage. Traditional Kaplan turbines are often large and heavy. In contrast, multiple StreamDiver units can be flexibly combined to meet the desired output. This makes them especially attractive for decentralized energy projects – not just in industrial settings but also for municipalities and local power grids.

With more than 70 StreamDiver units installed worldwide, Voith has demonstrated that this technology is not only sustainable but also economically viable. And with rising energy demands driven by new technologies like data centers and hydrogen production, the combination of hydropower and efficient turbine technology shows strong potential. According to analyst firm Gartner, for example, energy consumption by data centers – driven by additional AI-optimized servers – is projected to reach 500 TWh per year by 2027. That's 2.6 times the 2023 level.

Cogne Acciai Speciali's project may well serve as a model – not just for the steel industry but for any sector that relies on stable, local sources of renewable energy.



Hydrogen for steel reduction

- In steelmaking, oxygen is removed from iron ore in a process called reduction.
- Traditionally, this is done using coke, which emits large amounts of CO₂.
- Hydrogen is a more climate-friendly alternative: it produces water instead of CO₂.
- In 2022, 2.1 billion metric tons of steel were produced globally – causing roughly 3.6 billion metric tons of CO₂ emissions (World Steel Association).

"Contributing to the dream of sustainable energy for all – that's what drives me. Hydropower and renewables go hand in hand. As a team and part of society, we're actively shaping the future. That's exactly why I chose Voith."

Lorenz Lenhart,
Head of HSS Engineering Team
at Voith Hydro

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transform.

Sustainable

Two pilot projects are demonstrating new ways to tackle the challenges that sediments can create in storage and run-of-river hydropower plants.

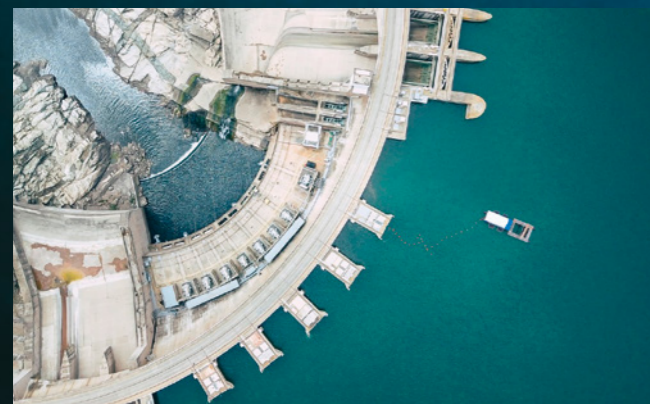
Mobilization

Fine, ever-present, and demanding to handle – sediments are made up of sand, silt, and clay carried down from the mountains by rivers. In nature, this transport is essential. In technical systems, though, it can become a burden. In hydropower plants these particles settle in reservoirs, reducing storage volume, and when they enter water passages their abrasive effect can damage sensitive equipment. The result is high maintenance and repair costs.

The SedimentCareProgram offers innovative solutions to prevent these issues and keep plants running smoothly. Pilot projects in Austria and Brazil highlight the practical value of these sustainable technologies for both storage and run-of-river facilities.



Targeted sediment management protects assets and reduces operating costs.



Desilting the Tassenbach reservoir in Tyrol

The Tassenbach reservoir, part of TIWAG's Amlach hydropower plant, suffers from sediment deposits carried in by the River Drau. These accumulations significantly reduce the reservoir's capacity. Traditionally, addressing such build-up meant major intervention: shutting down the plant, draining the water, bringing in heavy equipment and coordinating extensive logistics – all of which demanded time and incurred considerable cost.

The new approach is far more efficient. A mobile dredger dislodges the sediments and feeds them directly into the plant's water flow during operation. The device can loosen sediment layers several meters deep and guide them back into the current. This allows the annual sediment load brought in naturally to be passed on gently and without interrupting operations. It also helps restore the natural sediment balance in the river.

"This method enables near-natural sediment transfer in line with the objectives of the EU Water Framework Directive and ensures that the plant can remain in continuous operation," says Peter Weiskopf, head of power plant maintenance and project lead at TIWAG. "It not only reduces downtime compared with conventional reservoir desilting but also saves us substantial costs associated with excavation, disposal, and transport."

Using dredgers to remove or relocate sediment, sand, and gravel within water bodies is not new and is widely practiced. Actively routing sediment into a hydropower plant's waterways, however, has only been tested in isolated cases and demands extensive knowledge and technical expertise to protect hydraulic equipment and maintain smooth operation. This requires reliable methods for estimating erosion rates, robust measuring technology, and an expanded portfolio of products designed to mitigate potential risks to customer assets.

Turbine protection for a run-of-river plant in Brazil

The second pilot project of the SedimentCareProgram leads to the Amazon region, specifically western Brazil.

Unlike the situation in Tyrol, where sediment accumulates in a reservoir and must be mobilized, sediments in this project travel directly with the water, reaching concentrations of up to 50 grams per liter as they pass through the machinery. These fine particles hit turbine surfaces without any reduction in force.

Over time, their abrasive action causes erosion on turbine blades. The hydraulic profile deteriorates, efficiency drops, and maintenance demands increase. In extreme cases, localized destruction of the hydraulic contour can lead to abrasion-induced cavitation, where material is torn from the surface.

To address this, Voith has equipped the pilot plant with its new Softurb LS coating. Laboratory tests show that this protective layer is five times more resistant than common soft coatings currently in use. It is designed to prevent direct material loss, extend necessary maintenance and service intervals, reduce overall service effort, and enhance machine availability.



5x longer service life thanks to advanced coating technology.

As part of the energy transition and to achieve national climate goals, China is increasingly focusing on the expansion of renewable energies. To further advance this and ensure grid stability, the superpower is investing in pumped storage power plants. With over 50 GW, China already has the largest share of installed pumped storage capacity worldwide.

Voith is supporting China's energy providers through this monumental transformation – with innovation, technological expertise, and a unique team spirit. The following three projects offer a glimpse into how this is being put into practice.



Pumped Storage Innovations in China

– High-Capacity, High-Speed, High Impact

Changlongshan – high speed, large capacity

Changlongshan plays a vital role in stabilizing China's power grid by balancing fluctuations from wind and solar through peak shaving and load regulation. As part of the country's drive toward carbon neutrality, the plant contributes to the national "carbon peak and neutrality" goals. Leveraging its global expertise, Voith led iterative design reviews to resolve complex electromagnetic and material challenges – playing a key role in achieving the plant's outstanding performance. Today, the units meet the "Excellent Unit" standards of China Three Gorges Corporation – delivering performance that sets a new benchmark in pumped storage.

Commissioning date:

- The final unit (Unit 6) was officially commissioned on June 30, 2022

Technical specifications:

- Capacity per unit: 350 MW
- Total installed capacity: 2,100 MW (6 units)
- Rated speed: 600 r/min (Units 5 and 6)
- Rated head: 710 m (maximum generating head: 756 m)
- Type: reversible pump-turbine motor-generator units

Key features:

- 350 MW capacity at 600 r/min
- Unusual combination of high speed (600 r/min) and large capacity (350 MW)
- Rotor center forging required material breakthroughs (yield strength increased by 100 MPa, weight over 150 tons)

Voith technologies used:

- Pump-turbines, motor-generators, inlet spherical valves, and auxiliary systems
- Three-shafts integrated machining: ensured precision alignment of rotor components
- New magnetic pole welding: dual-weld process with custom tooling for copper joints
- Monolithic spiral case stay ring: replaced split design to reduce on-site welding risks

375 r/min



Rated speed

Tianchi – tailored for special conditions

Tianchi plays a key role in securing the safe and stable operation of the Central China power grid while enabling the integration of clean energy sources. Contributing to the development of a modern energy system, it supports China's drive toward carbon peak and carbon neutrality. Voith leveraged more than 155 years of hydropower expertise and applied strict quality control across design, manufacturing, and installation. On-site project teams closely supervised installation to ensure first-time acceptance. One of the standout moments was the early commissioning of the final unit – completed three months ahead of schedule. With performance indicators described as "outstanding" and quality deemed "industry-leading" by the chairman of Tianchi Company, the project stands as a benchmark in excellence for China's hydropower sector.

Commissioning date:

- The four units were officially commissioned in January, April, June, and August 2023

Technical specifications:

- Total installed capacity: 1,200 MW (4 units of 300 MW each)
- Planned annual electricity generation: 962 million kWh
- Annual electricity consumption for pumping: 1.283 billion kWh
- Grid connection: 500 kV Central China power grid
- Head: 510 m

Key features:

- Development of hydraulic models for pump-turbines tailored to the project's hydraulic conditions
- Adoption of a "single-shaft structure" for generator-wmotor rotors
- High technical demands in design and manufacturing

Voith technologies used:

- Four 300 MW reversible Francis pump-turbine generator units and auxiliary equipment
- Customized solutions including hydraulic model development, precision design, and the single-shaft rotor structure

Qingyuan – gigawatt-level pilot project

Qingyuan strengthens China's energy system by increasing peak shaving capacity and enhancing grid stability in the northeastern province. It enables greater integration of renewable sources such as wind and solar. Annually, the project saves 158,000 tons of standard coal and cuts CO₂ emissions by 375,000 tons – marking a significant step toward a greener energy future. Voith controlled the entire process of unit design, procurement, manufacturing, and installation. Its R&D center completed the hydraulic development and successfully passed the model tests. Key milestones during implementation included the successful runner model test and the first acceptance of a spherical valve.

Commissioning date:

- The final unit (Unit 6) was officially commissioned on January 16, 2025

Technical specifications:

- Capacity per unit: 300 MW
- Total capacity: 1.8 million kW (6 units)
- Rated head: 390 meters
- Rated speed: 375 r/min

Key features:

- Inlet spherical valves with a nominal diameter of 2,500 mm and a design height of 714 meters, classified as high-pressure large-diameter valves
- Development of 375 r/min pump-turbines that passed runner model tests and acceptance at the first attempt

Voith technologies used:

- 6 vertical-shaft, single-stage, reversible Francis pumped storage units and auxiliary equipment (e.g., spherical valves)
- Optimized spherical valve design, integrating global and local expertise to enhance materials and sealing performance
- Successful hydraulic development and model testing of high-speed pump-turbine

710 m

Rated head



hypower N°36

4x

reversible Francis pump-turbine generator units



Voith's new Vertical Turning Lathe boosts precision, speed, and sustainability in York.

Machining the Future



Inauguration of the new Vertical Turning Lathe at Voith's York facility.



“

This machine helps us deliver faster, safer, and smarter.”

Carl Atkinson

Vice President of Sales and Marketing at Voith Hydro North America



In the heart of Voith's York facility, a powerful new presence is reshaping the way hydroelectric components are made. Towering over the factory floor, the Pietro Carnaghi AP 120 TM Vertical Turning Lathe (VTL) is more than just a machine – it's a symbol of the company's ongoing evolution. With its massive size and advanced capabilities, it represents a new era of precision manufacturing, sustainability, and strategic investment.

Installed in Voith's 250,000-square-foot manufacturing facility in York, Pennsylvania, the Carnaghi VTL is already redefining how large-scale hydroelectric components are produced. It replaces a decades-old predecessor with cutting-edge technology designed to meet the demands of a modern energy economy – quickly, precisely, and safely.

Designed for impact

The Carnaghi VTL can handle workpieces up to 12 meters in diameter, 6 meters in height, and weighing up to 300 tons. More importantly, it performs multiple operations – turning, milling, drilling, threading, grinding, and finishing – within one streamlined setup. This greatly reduces downtime and rework while enhancing precision.

“This machine helps us deliver faster, safer, and smarter,” explains Carl Atkinson, Vice President of Sales and Marketing at Voith Hydro North America. “It allows our team to work more efficiently while also supporting the highest standards of quality and environmental performance.”

Equipped with digital controls, automated measurement tools, and hydrostatic pockets that eliminate vibration, the VTL ensures long-term geometrical accuracy and better surface finishes. Its integrated operator cabin includes built-in safety interlocks and barriers, keeping people safe while optimizing production flow.

Pietro Carnaghi AP 120 TM Vertical Turning Lathe (VTL)

The Pietro Carnaghi AP 120 TM is a CNC-controlled vertical turning lathe with integrated milling and drilling capabilities. It machines rotationally symmetric large parts up to 12 m in diameter and 150 t – ideal for turbine runners and casings.



The Pietro Carnaghi VTL marks a new era in hydro component machining.





Precision and sustainability: manufacturing large hydro components at Voith's York facility.

Built for a greener future

But the Carnaghi VTL is more than just a marvel of engineering. It's part of Voith's larger vision to build a sustainable future. By reducing the need for repeated machining due to quality issues, lowering material waste, and improving energy efficiency, the VTL contributes directly to Voith's environmental goals.

The ability to complete more operations in a single setup means fewer machine hours and less energy consumed. Combined with reduced tool changes, setup times, and manual measurements, the lathe supports Voith's mission to offer cleaner, faster, and more responsible production.

"With the Carnaghi VTL, we're raising the bar on what's possible in terms of productivity and precision," Atkinson adds. "And we're doing it in a way that aligns with our long-term sustainability objectives."

A strategic investment in US, infrastructure

The Carnaghi VTL is one of several strategic investments made by Voith Hydro in its York facility. Together with the recently added PAMA Speedram 3000 Horizontal Boring Mill, these upgrades are supported by Section 48C tax credits from the Inflation Reduction Act of 2022 and underscore Voith's commitment to revitalizing American manufacturing.

With over 2,500 hydropower sites operating in the US, many of which require refurbishment or modernization, this investment comes at a critical time. Voith's local manufacturing capability plays a key role in strengthening US energy independence and advancing toward net-zero targets.

"The last three administrations have placed a priority on infrastructure and domestic manufacturing, and Voith has invested in our factory to meet the rapidly growing demand," says Atkinson. "We're proud to manufacture here in York, using union labor, and to deliver sustainable, high-performance solutions for American hydropower."

With the Carnaghi VTL, Voith Hydro is equipping itself – and the entire US hydropower industry – for a more resilient, efficient, and sustainable future.



With the Carnaghi VTL, we're raising the bar on what's possible in terms of productivity and precision and we're doing it in a way that aligns with our long-term sustainability objectives."

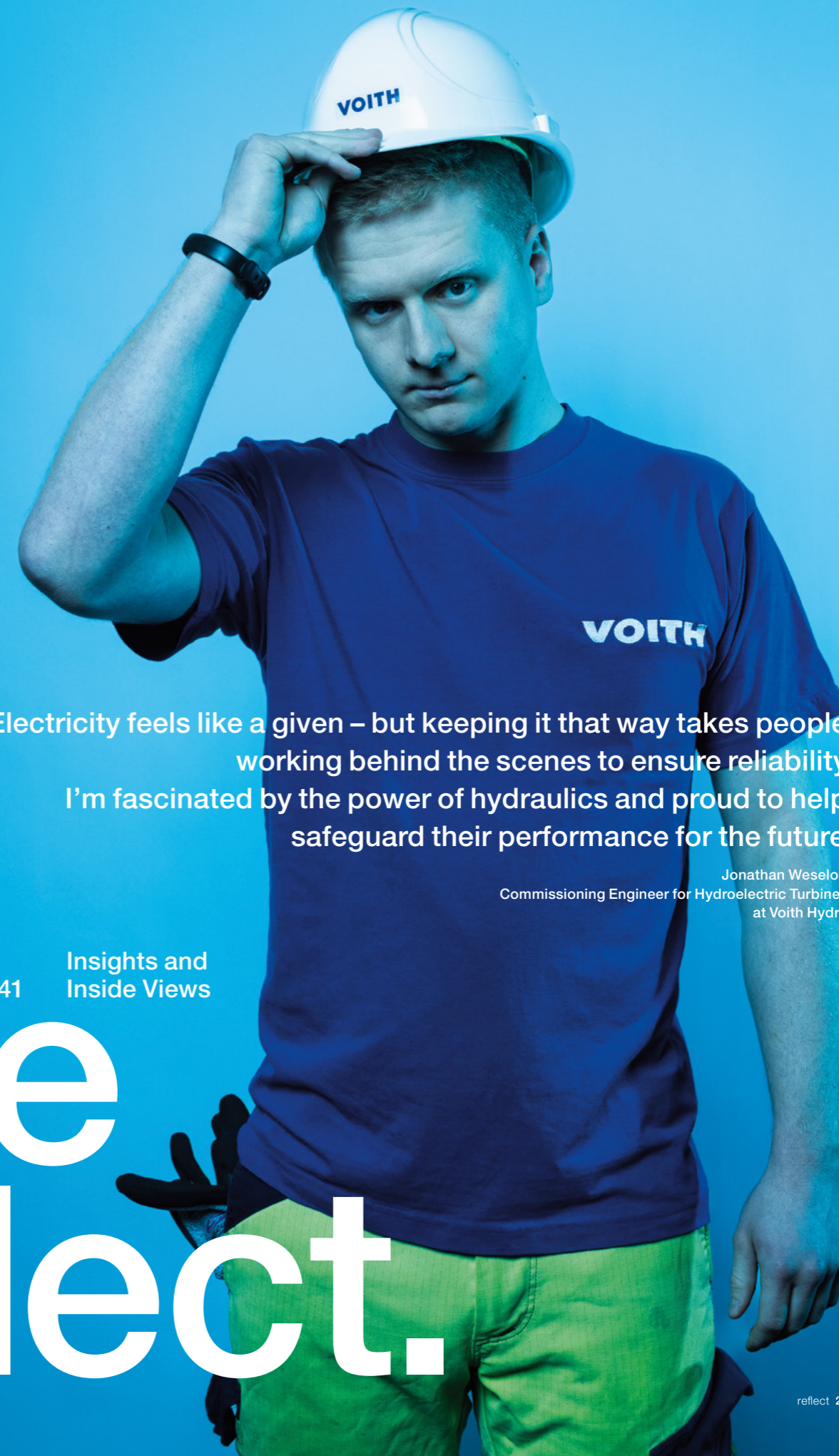
Carl Atkinson

Vice President of Sales and Marketing at Voith Hydro North America



PAMA Speedram 3000 Horizontal Boring Mill

The PAMA Speedram 3000 is a CNC-controlled horizontal boring and milling machine with a movable column. It machines large components up to 60 t with high precision – ideal for spiral casings and turbine parts.



"Electricity feels like a given – but keeping it that way takes people working behind the scenes to ensure reliability. I'm fascinated by the power of hydraulics and proud to help safeguard their performance for the future."

Jonathan Weseloh,
Commissioning Engineer for Hydroelectric Turbines
at Voith Hydro

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Insights and
Inside Views

reflect.

Rethinking Hydropower Maintenance
for a New Era

A Service Partner



with
Vision

Hydropower operators are under growing pressure: aging infrastructure, skilled labor shortages, rising costs, and the push for digital transformation are all challenging traditional ways of working. So how can operators respond – optimizing performance while future-proofing their operations? In this interview, Sunil Pandiri, Chief Service Officer at Voith Hydro, explains how service is evolving from reactive repair to a strategic lever – and reveals that his team is not just modernizing machinery, but mindsets.

Mr. Pandiri, where do you currently see the greatest challenges facing your customers?

The cost pressure is immense – existential, even, in some regions. On top of that, new regulatory demands are coming into play, such as stricter CO₂ reporting and heightened safety requirements. Many plants around the world are 40 or 50 years old, some even older. That means components are wearing out, expertise is being lost, and spare parts are getting harder to source. At the same time, expectations around availability, efficiency, and sustainability are rising. One key issue is that many operators still assume hydropower plants don't really need maintenance. As a result, either no budget or far too little is set aside for it. And when something does fail, they often find themselves without the reserves needed for repairs or refurbishment. Additionally, other renewable energy sources such as wind and solar do not supply sufficient reactive power and inertia required for transmission system stability. Therefore, continuous operation of hydropower plants has become necessary in many countries today.

What does that actually mean for service needs?

We're seeing that many operators need to take a more strategic approach to maintenance – meaning holistic and forward-looking. That's where monitoring and data analytics come in, though both are still underutilized. Yet their impact is huge: they help prevent unplanned downtime, enable more efficient use of resources, and generally allow operators to get more out of their assets.

What role does digitalization play in all this?

A central one. But it shouldn't be an end in itself. It's not about installing sensors everywhere – it's about targeting the areas where data can deliver real value. That means vibration analysis, thermal condition monitoring, predictive models for wear parts, and much more. What customers want to know is: which specific tool will actually help me reduce downtime, avoid unplanned outages, and make better use of my resources? We don't just provide the technology – we also help interpret the data and integrate it into a broader strategic framework.

“For us, service is strategy.”

How is Voith responding to these challenges?

By bringing our service technologies, engineering expertise, and 155 years of experience directly to our customers – working side by side to craft a strategy tailored to their specific needs. We see service as a key part of our customers' long-term strategic development, and we support our partners along a clearly defined transformation journey that helps their plants perform better year after year. In other words, we meet each customer where they are – and together, we chart a path toward greater efficiency and long-term viability that's both realistic and achievable. →



We meet each customer where they are – and together, we chart a path toward greater efficiency and long-term viability that's both realistic and achievable.”

Sunil Pandiri
Chief Service Officer at Voith Hydro

What exactly do you offer within this model?

Our offering centers around four key areas: OPEX (day-to-day operations, regular overhauls, proactive repairs, support, and long-term service agreements with station engineers), SPARES (parts management ensuring immediate availability whenever needed), AUTOMATION & DIGITAL (replacement of control, protection, and governor systems, along with expertise in OEM operational software and data-driven services), and CAPEX (refurbishment and replacement projects). Right now, long-term service agreements – or LTSAs – are a major focus. With these, we take on long-term responsibility for plant availability, often over several years. We also offer specialized solutions like our Sediment Care Program, which is one-of-a-kind globally and delivers strong results in regions with high sediment loads. And through our HydroSchool, we provide training opportunities to help customers deepen their understanding of both hydropower fundamentals and emerging technologies.

What does collaboration with the service teams look like?

First and foremost, it's about really understanding where the customer stands. So we start with a comprehensive assessment – working closely together to map out all the relevant factors using a structured process and a range of diagnostic tools. That includes things like operational data, technical and performance issues – such as wear on components like turbines or generators – irregularities in how the plant runs, outdated control systems, or inefficient maintenance routines. From there, we build a customized solution that fits their exact needs. That might be a one-off service, a modular package, or a fully integrated approach. What matters most is that it's practical and doable. And usually, customers can expect a clear, actionable proposal within a week.

“We want to be a true partner.”

How do you bring that philosophy to life globally?

We do it with a clear structure. Our service teams are based locally in what we call Service Hubs. That means they're close by, quick to respond, and always available when needed. At the same time, our Key Account Managers work with customers on a more strategic level – helping them reach their mid- and long-term goals. It's that combination of day-to-day support and big-picture thinking that really sets our approach apart. And because our teams speak the local language, understand the culture, and know the local business environment, they can build real, lasting relationships on the ground.

How do you measure the success of your approach?

We look at the hard numbers – less downtime, higher availability, and a more efficient cost structure. But just as important is how the relationship with the customer evolves. When a customer starts viewing us as a strategic partner, that's when we know we're making a real impact.

What does the future of service look like to you?

It's connected, proactive, and far more digital. Think digital twins, AI-powered analytics, predictive resource planning, and deep integration into our customers' day-to-day operations. But above all, it's still human – because service starts with trust.

And on a personal note – what draws you to service?

What excites me most is how quickly you can make a difference. When you do the job right, you see results almost immediately – results that save the customer money and drive real value. You're innovating, staying close to the customer, solving real-world problems, and seeing the impact of your work firsthand. That's what makes service not just exciting, but genuinely rewarding.



What matters most is that it's practical and doable. And usually, customers can expect a clear, actionable proposal within a week.”

Sunil Pandiri

Chief Service Officer at Voith Hydro



Service in Action

Whether it's long-term service agreements (LTSAs), digital diagnostics, or rapid emergency support – Voith Hydro's business cases show how service delivers real value across a wide range of scenarios around the world.

CAPEX – extending asset life

Cathaleen's Fall, Ireland – Electricity Supply Board (ESB)
Voith developed a customized refurbishment concept for this aging plant – featuring a flexible pricing structure, close collaboration, and technical upgrades to boost operational efficiency.

Automation – control with precision

AGUS 7&4, Philippines – National Power Corporation
In AGUS7, the excitation system suffered for losing precision on reactive power control, after it was running smoothly for over ten years. By implementing a precise upgrade with the HyCon Thyricon 500, Voith upgraded power stability model into PSS2C and improved the grid performance and consequently the turnover.

Digital – driving decisions with data

Lysebotn, Norway – Lyse Produksjon AS
Using a structured analysis framework, Voith's experts advanced digital condition monitoring at the site. The project led to a comprehensive assessment of the entire facility.

OPEX & Spares – fast-track emergency support

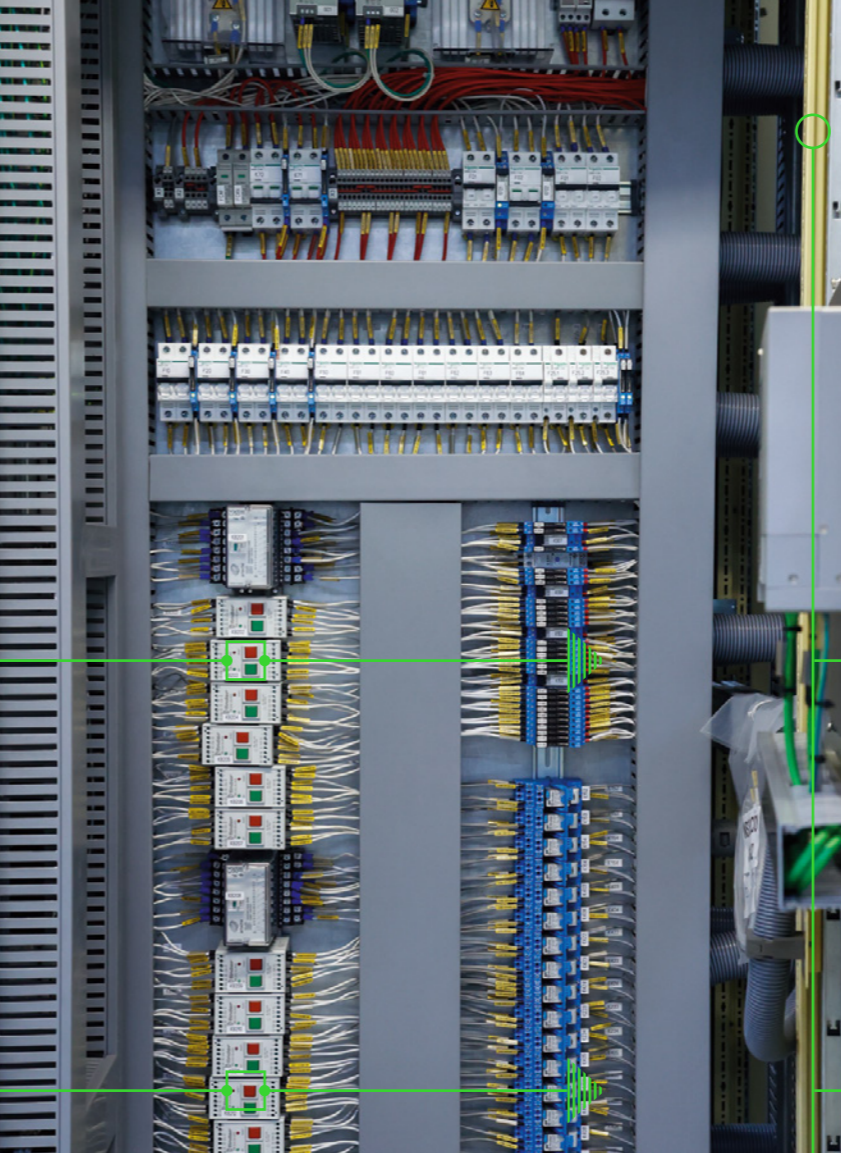
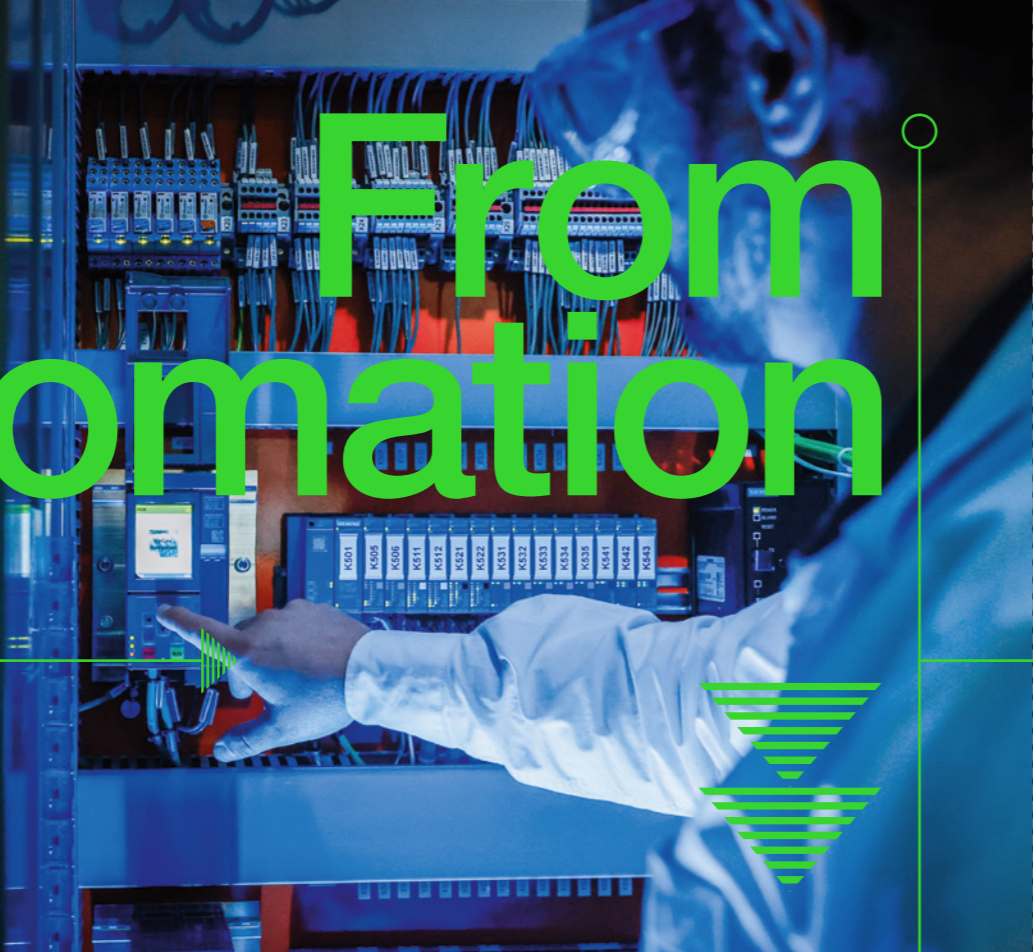
Aishihik, Canada – Yukon Energy Corporation
After a generator failure, Voith quickly provided on-site support, coordinated a rewind with new spare coils, and optimized the timeline. Impressed by the rapid, professional service, the customer also asked Voith to manage commissioning.

L TSA – securing long-term performance

Kinlochleven, Scotland – Equitix
Through a full-scope long-term service agreement built on a dynamic asset management system, Voith enables stable planning, fast incident response, and continuous performance improvement.



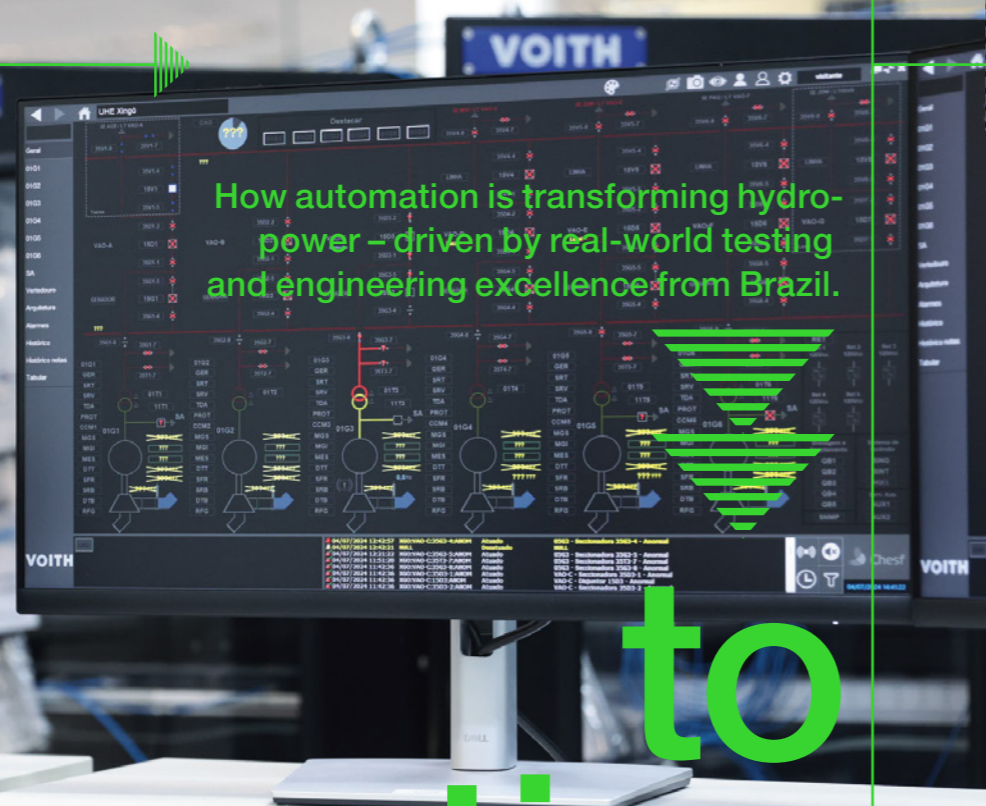
From Automation



Engineering excellence from Brazil:
developing smart control solutions in the lab.

Precisely wired:
the electrical core of modern hydropower control systems.

How automation is transforming hydropower – driven by real-world testing and engineering excellence from Brazil.



to Innovation

The room hums with quiet intensity as operators monitor thousands of megawatts flowing through turbines. For those who run hydropower plants, every second of uptime matters. Every unit start and stop, every warning, every grid disturbance demanding a rapid response tells a story – and every bit of automation helps write a better ending.

In today's energy landscape, as renewables scale up and power systems become increasingly dynamic and complex, hydropower plays an even more vital role in ensuring overall grid stability due to its rotational inertia. As a result, the availability and reliability of hydropower plants have become more vital than ever. In this context, predictive maintenance is no longer a luxury – it's a requirement. To meet these demands, hydropower facilities must integrate advanced automation systems capable of monitoring and managing every part of the plant in real time, adjusting to grid dynamics and environmental variables – all without compromising safety or uptime.

Tested before it matters: LATAM's Automation Lab

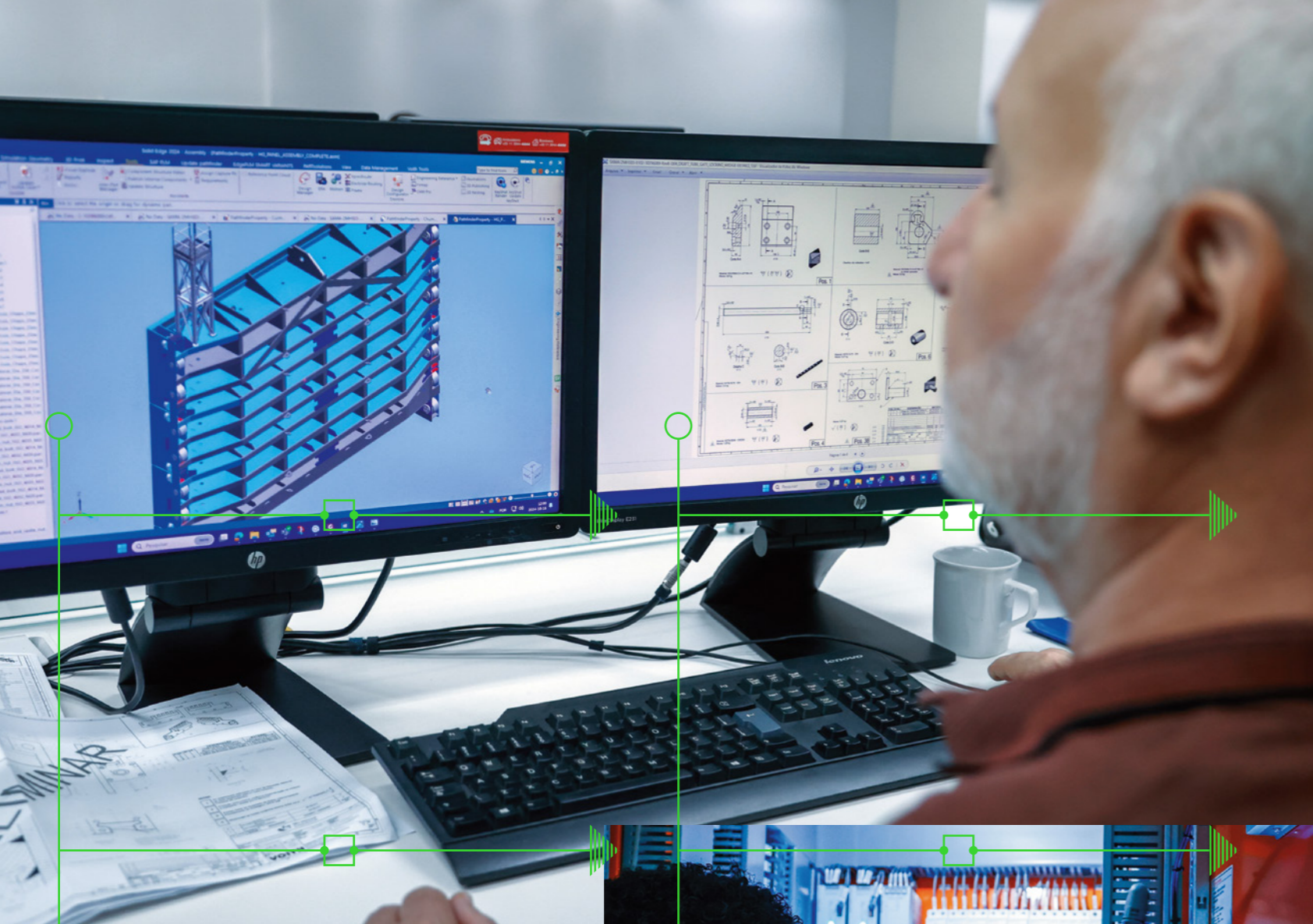
"Operators don't just run a plant anymore – they orchestrate a symphony of systems," says Dr. Manuel Goncalves, Director of Engineering at Voith Hydro in Brazil. "Automation is how they stay in control."

To help solve these challenges, Voith established a dedicated Automation Lab in Brazil in the late 2000s. The goal was clear: provide a space to rigorously test automation systems before site deployment and attract top engineering talent to develop and refine those systems.

"When we test a control system in the lab, we're replicating the exact conditions of the real plant," says Dr. Manuel Goncalves. "We can troubleshoot, improve, and customize everything – long before it reaches the site."

Spanning 600 square meters, the lab can handle up to three full-scale systems at once. It includes infrastructure for testing digital governors, excitation systems, PLC logic, HMI interfaces, alarm handling routines, and more. In a recent project for the massive Xingó Powerplant from Eletrobrás, the lab handled over 50 control panels in parallel.

Crucially, the lab is also a collaboration space. Operators from utility companies often spend weeks or even months on-site, working with engineers to tailor the systems' logic and interfaces to their specific operational needs. Instead of just receiving drawings, customers shape the software together with the Voith team. This saves time later and gives both sides confidence in the final solution.



In recent years, customers have also increasingly used the lab to codevelop custom logic, test digital interfaces, and integrate new technologies – adding flexibility and long-term value to their automation investments.

Real-world projects: scale and complexity

Brazil is home to some of the largest and most complex hydropower plants in the world – many of which rely on automation systems tested and fine-tuned in the lab. These projects illustrate not only the scale of modern hydropower, but also the diversity of technical requirements automation systems must address.

- **Belo Monte** (18 units, 11,233 MW): Complete automation system developed and tested for one of Brazil’s most powerful plants.
- **Paulo Afonso IV** (6 units, 2,462 MW): Full modernization for Eletrobras, with the automation system tested and accepted in the lab.
- **Xingó** (6 units, 3,162 MW): Recently modernized using the lab’s simulation and testing environment.
- **Tucuruí** (23 units, 8,370 MW): One of the largest automation modernizations in Brazil. Final acceptance tests are scheduled later this year.

Real-time knowledge transfer:
customer trainings and live demos in the Automation Lab.

Building reliability into the system

Instead of relying on trial and error in small-scale setups, Voith has invested early and extensively in a comprehensive Automation Lab to support customers not only during individual projects, but across the entire life cycle of their assets – and to maximize value as a trusted partner. This long-term commitment, embedded in Voith’s Service approach, helps ensure reliable performance, seamless modernization, and future readiness.

At the heart of this approach lies a powerful combination: automation and digitalization working in harmony. Automation solutions enable safe, reliable, and efficient operations. Voith’s digital portfolio builds on this foundation to deliver superior intelligence – empowering highly efficient operation and maintenance. It’s this interplay that defines the future of hydropower.

And it’s the people who make it possible. “Automation is crucial throughout all stages of a plant’s life cycle – making it both a service and a people business,” says Dirk Fuchs, Head of HyService Digital & Automation. Every successful project reflects close collaboration between our customer’s team and the Voith Hydro team – including engineers, developers, and service experts. We are proud to have such a great facility, but even more so of the dedicated team behind it – especially in such an important market as Latin America.

Lab testing:
ensures reliability in both operations and modernization projects.

Automation as a service: when customers turn to the lab

The services offered by the Automation Lab are part of a broader life cycle support strategy within the Service portfolio. Customers typically engage with these services in two key scenarios: when planning the modernization of existing plants or commissioning new ones. In both cases, the lab serves as a critical staging environment.

“During commissioning, everything must work right the first time – especially in modernization projects, where implementation timelines are particularly tight,” explains André Cunha, Automation Manager at VHLA. “By completing the software development and thoroughly validating the control logic in a laboratory environment – including communication tests and integrated system simulations – we help our customers reduce unit downtime, accelerate commissioning, and improve system reliability during on-site implementation.”



Innovation that solves real problems:
How the Automation Lab turns challenges into practical solutions

Behind every innovation at the Automation Lab lies a real-world challenge. Here’s how recent developments are helping operators boost reliability, reduce costs, and prepare for a digital future:

- **Challenge:** Diverse hardware requirements and standards
- **Innovation:** Development of PLC-based automation solutions beyond Siemens platforms
- **Customer benefit:** Greater flexibility to meet local or project-specific requirements

- **Challenge:** Early detection of mechanical wear
- **Innovation:** Vibration monitoring systems developed with Hydonne, using real-time sensor data
- **Customer benefit:** Predictive maintenance becomes possible – avoiding costly unplanned downtime

- **Challenge:** Maintaining grid stability under dynamic load conditions
- **Innovation:** Enhanced excitation system functionality, enabling synchronous condenser mode
- **Customer benefit:** Improved voltage control and plant adaptability during grid fluctuations

- **Challenge:** Complex operations and knowledge transfer
- **Innovation:** Integration of Building Information Modeling (BIM) and live automation data into a digital twin
- **Customer benefit:** Interactive plant control, realistic operator training, and remote monitoring


Optimized Geometry

The modernized Unit 5 at the Inga II hydropower plant in the Congo now delivers over 12 additional megawatts of output.


Powers Upgrades

 **12** MW

more output through
flow-optimized design

 Essential energy source for the region: Inga II harnesses the power of the Congo.

 Diving team replaced 100 segments of the old screen.

 Inga II: Powering the region and the Kamao copper mine since the 1980s.



In the heart of the Democratic Republic of the Congo, about 300 kilometers west of the capital Kinshasa, lies one of the country's most significant infrastructure projects: the Inga II hydropower plant. Since the 1980s, it has supplied energy to the region, especially to the Kamao copper mine. But after decades of operation, part of the facility had deteriorated to a state that made continued use impossible.

The focus is on Unit 5, one of eight turbine-generator sets housed in Inga II's powerhouse. The turbine was no longer operational, the equipment outdated, and the control systems obsolete. The national utility SNEL (Société nationale d'électricité de la RDC) faced the challenge of not only reactivating the unit, but also brought up to modern performance standards.

Voith Hydro was commissioned to carry out this comprehensive overhaul, with project financing provided by Ivanhoe. Extensive modernization work has been underway since 2022. Now, nearly three years later, Unit 5 is on the brink of full reactivation. The new rotor has been installed, and the final critical phase of commissioning has begun.

Specialist divers in action

The modernization involved far more than just replacing the turbine and generator. The entire peripheral infrastructure was also brought up to date. One of the most demanding tasks was replacing the so-called trash rack – the intake screen that prevents large debris such as wood or waste from entering the turbine.

What made this particularly complex: the replacement had to be carried out underwater, in heavily sedimented water with near-zero visibility. A specialist diving team removed and replaced 100 individual segments of the old screen. The work was performed while the power plant remained operational, creating strong currents and whirlpools in the upper reservoir – necessitating strict safety protocols and precise coordination with the power utility.

The work was carried out by a Moroccan specialist company renowned for underwater installations in challenging environments. The task was formidable: divers operated in shifts under extremely limited visibility, using heavy equipment, underwater communication systems, and coordinating their movements with millimeter precision. A second diving team was deployed to make the most of the narrow operational windows, ensuring the project stayed on schedule.

The newly engineered trash rack is designed to accommodate higher flow volumes – a critical prerequisite for the safe operation of Unit 5 following its performance upgrade. This approach is now also being considered for neighboring machine units.

Over 12 megawatts of additional output

The modernized Unit 5 is set to go online later this year. The increase in output is remarkable: instead of 178, the upgraded unit now delivers 190.7 megawatts. This gain of over 12 megawatts is primarily the result of increased water flow and a new, flow-optimized design. From the intake screen to the turbine itself, Unit 5 has been reengineered to generate more energy with less loss. In purely mathematical terms, the additional energy could supply electricity to around 100,000 Congolese households.

Yet as impressive as the technical figures are, the implementation was equally challenging. The project team had to overcome significant logistical hurdles: long transport routes, complex import approval procedures, and the constant need to adapt workflows to the availability of components. Months often passed between placing an order and receiving the materials, further delayed by protracted customs processes. This demanded exceptional flexibility in project coordination and execution.

Björn Reeg, Head of Project Management at Voith Hydro and responsible for executing the Inga 25 project, remarked: "The Inga II project demonstrates what's possible when technical expertise, the right partners, and personal commitment come together. We repeatedly had to adapt to changing conditions – and could always count on the skill and dedication of our team."

In addition to the mechanical components, all control and automation systems were completely renewed. The new control system is designed to ensure greater availability, enhanced safety, and improved data exchange with the operator SNEL. The digital turbine governor, protection and excitation systems, as well as the hydraulic controller, were also entirely modernized.

The Voith project team maintained a strong on-site presence throughout the entire implementation, ensuring the necessary expertise was available and avoiding any communication bottlenecks. Their commitment spanned from technical specialists to regular visits by the international project management team and executive leadership – a clear indication of the high priority Inga II holds within the company. Collaboration with SNEL, the engineering firm Gruner, and financial partners was constructive and conducted on an equal footing.

A representative from Gruner puts it in a nutshell: "This project is in the spotlight of all economic players in the country due to its strategic importance for the stability of the power grid and the development of mining activities in southern DRC. Close cooperation between the project teams was essential to tackle the many challenges of this project together, without compromising on the technical quality of the equipment and works carried out by Voith."

The modernization of additional units is already in the pipeline. For Inga is destined to remain what it has always been: the powerhouse of an entire region.

HydroSchool

– Where Learning Generates Power



Well-trained staff are essential to the safe and efficient operation of hydropower plants. Voith has responded to this need by launching the HydroSchool, a regular training program for employees across the company. In this interview, Business Development Manager Jennifer Schilk explains how the idea came about – and what kind of knowledge the courses aim to deliver.

What's the idea behind HydroSchool?

In the hydropower industry, continuous training is key – the technology is complex and constantly evolving. Our inspiration came from Canada, where Voith has long hosted a well-established customer event that includes mandatory training for engineers. We were impressed by that model and wanted to adapt something similar for our own market. That's how the idea for HydroSchool was born around nine years ago. Today, the program is geared toward industry professionals who want to deepen or refresh their knowledge in a targeted way.



It creates close exchange."

Who are the courses designed for?

Our training programs are tailored for professionals working in the field – primarily plant personnel. And they're not limited to engineers. We also receive requests for sessions aimed at technicians and apprentices. The content is customized to suit the audience, ranging from entry-level to expert. Participants can choose from a variety of formats. Our open courses are particularly popular: these cross-plant training sessions are accessible to anyone and cover fundamental topics such as turbines or hydraulic governors.

What kind of feedback do you get from participants?

The feedback has been overwhelmingly positive. One participant recently told me, "The way the content is delivered is outstanding – truly impressive. The trainers are subject-matter experts and present the material in a clear, hands-on way."

And that's exactly the case: our trainers come straight from the technical departments. They share their knowledge and skills directly – many of them do it with real passion alongside their regular jobs. And that enthusiasm comes through in every session.

How important are maintenance and repair topics?

Many operators still wait until something breaks before taking action. But with preventive maintenance, it's possible to cut costs and avoid downtime. That's why our training sessions focus on practical ways to implement these strategies – for example, through the targeted use of sensors and monitoring technologies. One key example is our Condition Monitoring Training course, where we demonstrate how to prevent failures and optimize operations.

So the trainings also help make hydropower plants more reliable?

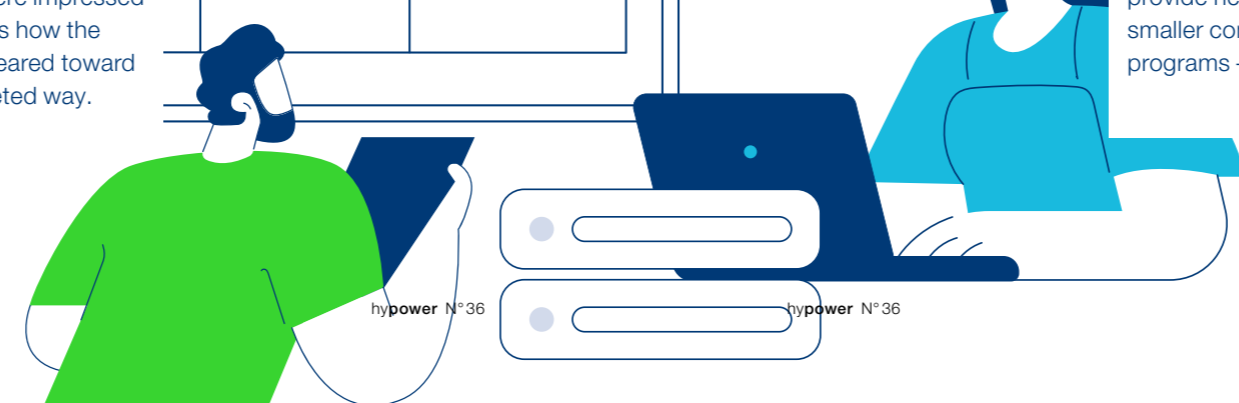
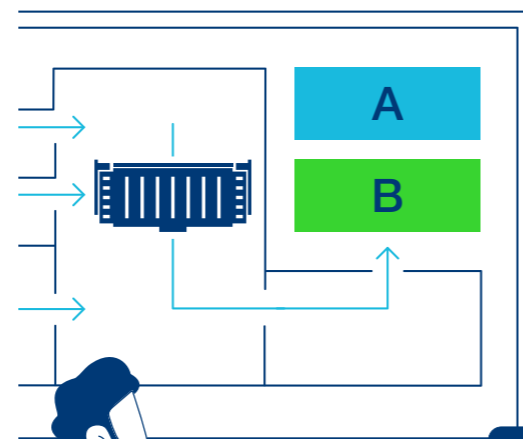
Absolutely. Spare parts management plays a role here, too. Instead of keeping large stocks, operators can plan ahead and order more strategically – which helps reduce inventory costs.


And what's in it for Voith?

For us, the real value lies in strengthening our customer relationships. In customized training sessions especially, we often engage in close dialogue – which can lead to deeper conversations and new ideas. One example: we're currently involved in a large-scale project that has grown over the past three years. We're delivering both basic and advanced training – partly on-site, partly at our facilities. That kind of collaboration builds trust and long-term partnerships.

What message would you like to share with potential participants?

Learning never stops. Even if you already have a solid grasp of a topic, our courses often provide new perspectives and fresh insights. Our trainings are particularly valuable for smaller companies and operators of small hydropower plants. We offer practical, customized programs – ideal for anyone looking to run their operations more efficiently and reliably.



A portrait of Raphael Bäuerlen, a man with short dark hair and glasses, wearing a dark sweater over a collared shirt. He is smiling and has his arms crossed. The background is a solid blue color.

“What excites me about Service is the technical complexity of each plant – and the responsibility to keep it running efficiently for decades to come. Together as a team, we directly contribute to the success of renewable energy.”

Raphael Bäuerlen,
Global Head of HyService CAPEX
(Refurbishments & Upgrades)



Learn more about HyService:
from diagnostics and maintenance to modernization – for reliable
operation and optimal performance of your hydropower plant.

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