

Small Hydro solutions by local experts with global expertise



We are pioneers of sustainable energy for generations

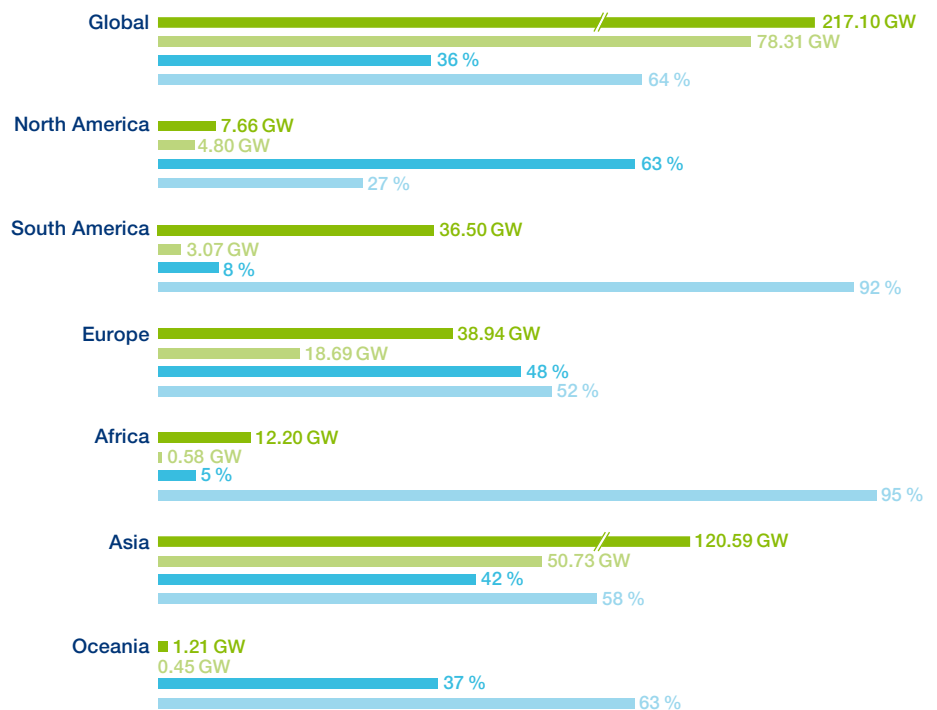
Small hydropower plants are an important component of the energy mix worldwide. They have the potential to ensure a stable local power supply. The development of renewable energies can

also be boosted with hydropower. Around 64 % of the worldwide hydro-power resources remain unused – the majority of which would be ideal for small hydropower solutions.

64 %

of the worldwide small hydropower resources remain unused

- Potential capacity
- Installed capacity
- Developed SHP potential
- Remained unused potential



Source: World Small Hydropower Development Report. UNIDO, 2016
 Note: Only plants < 10 MW are considered

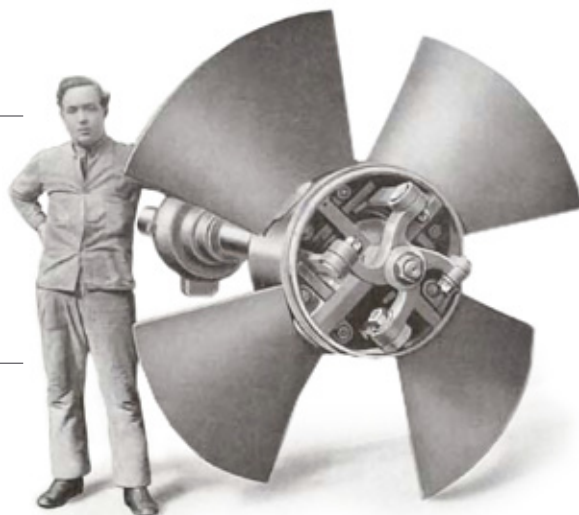
From water wheels to turbines


150 years in hydropower

Voith began building water turbines in 1870 with a 100 HP Henschel-Jonval turbine. The first Voith Francis turbine was delivered in 1873. In 1903, Voith supported Viktor Kaplan in the developing and testing of turbines in the Brunnenmühle. Regarding the development of the Kaplan turbine, Viktor Kaplan once called Walther Voith the “discoverer of my invention”.

**“Walther Voith –
the discoverer of
my invention”**

Viktor Kaplan, Turbine pioneer



Global footprint  Small Hydro Center of Competences • Workshops and local offices



Water-to-Wire solutions

By perfectly aligning electric, hydraulic and control components, and developing them in an integrated manner, we are able to optimize the energy production and life cycle of your plant. For us, efficient power supply means reconciling economic efficiency with environmental friendliness: We consciously and sparingly use natural resources for high capacity utilization to increase earnings.

We provide complete solutions and are close to our customers



1 Turbines

Our portfolio of turbines offers an economical solution for all requirements. For smaller hydropower plants, Voith delivers attractively priced systems in a standardized design – and individually adjusts them to accommodate their environment.

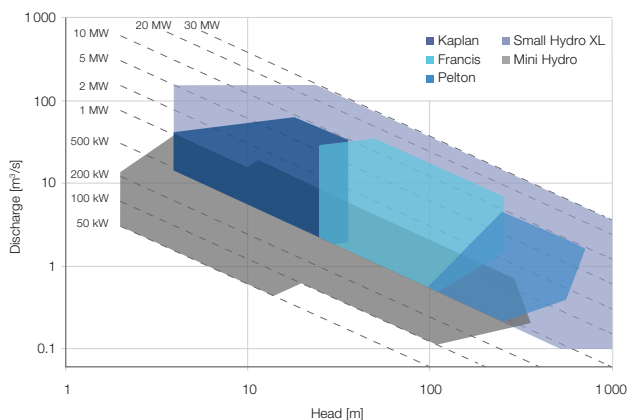
- Pelton turbines for heads up to 1 000 meter
- Francis turbines for heads up to 750 meter
- Kaplan turbines for heads up to 50 meter
- HyComplete products for heads from 2 up to 350 meter



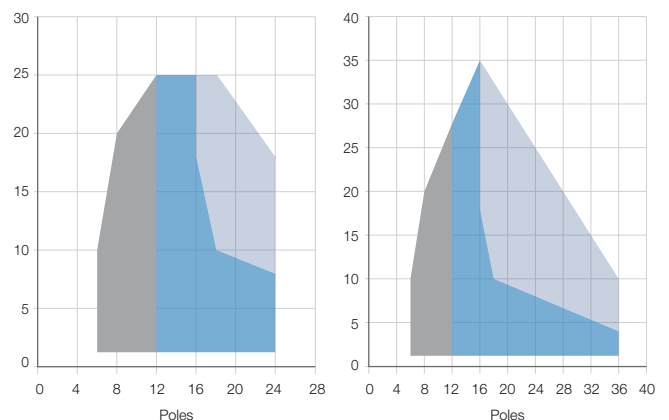
2 Generators

Thanks to our long-standing experience in the development and production of generators, we are able to perfectly integrate them in your power plant – and optimize the energy yield accordingly. The electric, mechanical and thermal stresses are extraordinarily high in the field of hydropower compared to other industries. This is why we have developed a robust hydropower generator line coping these special requirements and the longer expected lifetimes in the hydropower industry.

Range of turbine application



Range of generator application





3 BoP-E – Electrical systems

From design to integration to set-up and adjustment, Voith is also your small hydropower partner for electrical power plant equipment. Amongst other things, our systems include HV switchyard AIS/GIS, power transformers, generator circuit breaker, earthing and lightning protection.



4 BoP-M – Mechanical systems

Our mechanical systems for the power plant equipment are also planned in an integrated manner within the Hy2Grid product line for SH plants. This includes cooling water, dewatering and drainage systems, compressed air supply, crane equipment, fire protection as well as heating, ventilation and air conditioning.



5 Automation

Hy2Grid offers plant operators a perfectly configured plug-and-play system for control, monitoring and automation of the plant. Your plant is IIoT-ready with optional cloud connection, plant operational data is transferred into optimized operation and maintenance. You can benefit from the large hydro world – even for small-scale hydropower plants. Automation is an integral part of the entire power plant.



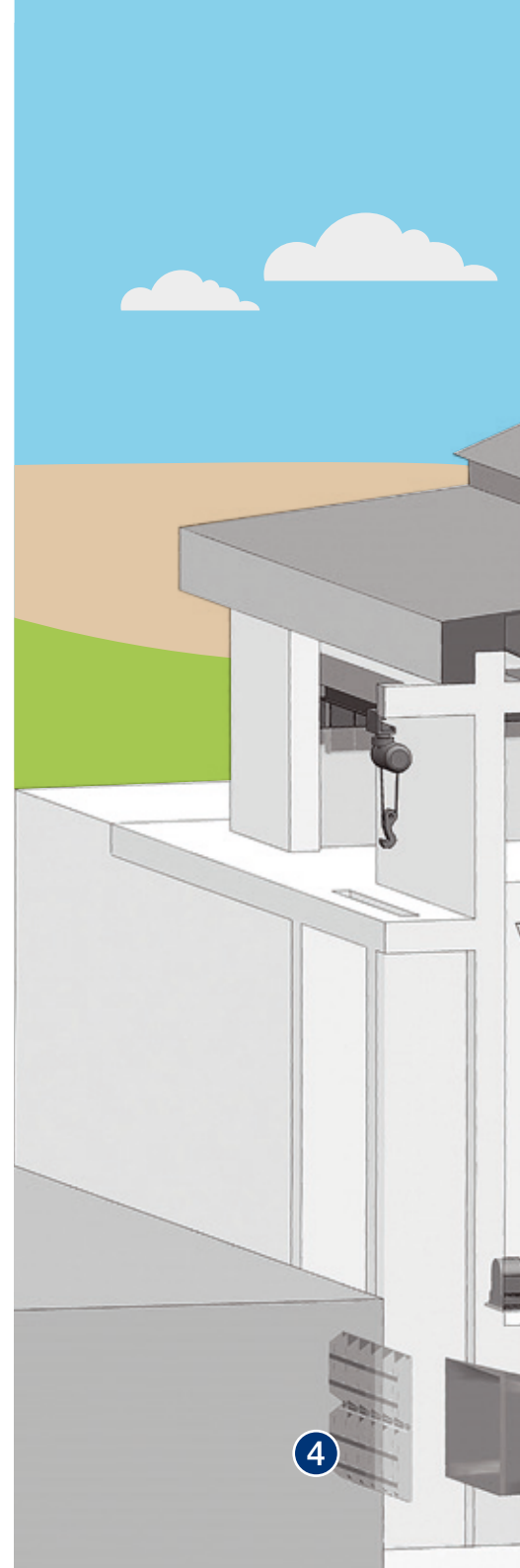
6 Shut-off valves

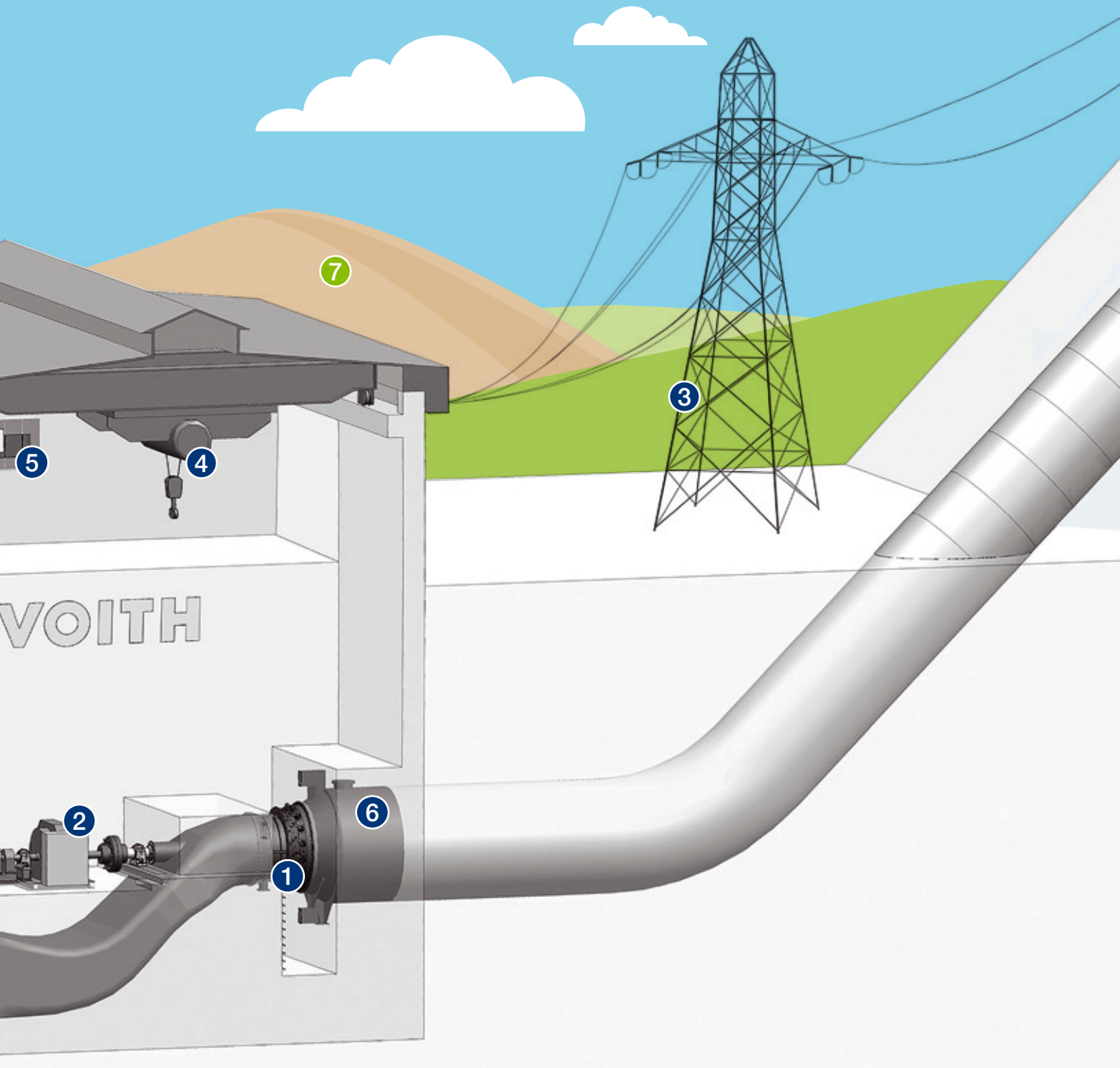
Voith started designing shut-off valves as mechanical-hydraulic control equipment for water turbines over a century ago. This way, even small hydropower plants can cope with extreme adjusting forces and short closing times.



7 Eco-friendly products

We set new standards in terms of nature conservation: our small hydro solutions are based on technological innovations with the objective of keeping the environment healthy and clean. Oil-free turbines and fish-friendly rotor blade concepts help to adapt the small hydropower plants to their natural local environment.





8 Financing support

Voith can also support owners who have a profitable project but are interested in further optimization. We have the resources to support our customers in finding equity and other financing options.



9 HyService

With our proactive services and a customized service agreements, your hydropower plant will run at maximum profitability. Our experts provide support all over the world and around the clock, so you can get the best from your hydropower plant: smooth interaction of all components, maximum service life, and optimum productivity.

Hydropower plants are systems that last for generations. That's why modernisation is one of our key business areas. Equipped with state-of-the-art technology, performance and energy yield can be significantly increased. Which also benefits the environment.

Modernization: an advantage for operators and the environment

Modernizing an existing plant can be challenging. Our objective is to develop and implement the best solution for you. The same level of commitment is shown on individual component upgrades or complete plant rehabilitations.

Rehabilitation is complex since the change of a single component can affect the operation of the whole plant. Each component is inter-related in a hydropower plant. Voith is your reliable and experienced partner for all modernization projects. Our broad range of references and our successful long-term partnerships with our customers are a proof of our excellence in rehabilitation.

“The advantages for both people and the environment”

- + **Eco-friendly:** renewable energy production with a high degree of efficiency
 - + **Economical:** low investment costs, shorter gestation periods
 - + **Rapidly implemented:** simple construction and start of operation
 - + **Reliable:** long performance time, low maintenance requirements
 - + **Competent:** experienced contact persons, highest quality
-

By the modernization of the hydropower plant Eglisau (Switzerland) the annual performance could be increased by almost one third from 254 GWh to

**314.5
GWh**

Success stories



Tulila, Tanzania



2x2.6MW
Saxo-type
turbines

“Our constructing engineers have enabled isolated operation by using enormous mechanical centrifugal masses, a complex control system and an electronic load controller.”

Karl Henninger,
Project Manager Voith Hydro

The power to change lives

Tulila, Tanzania

A stable power supply is not a matter of course in the Ruvuma region in south-western Tanzania. The small hydroelectric plant Tulila on the Ruvuma River is powered by two Kaplan turbines by Voith and is very efficient. It has significantly improved the lives of the people in the area.

This success story would have been unthinkable without the Benedictine Sisters of St. Agnes. The 370 nuns of the Chipole Convent have dedicated their lives to the people in the region. They give orphans a home, enhance the education of children and young people, and ensure basic health care for the population in rural areas.

A small hydroelectric plant as a driving force for change

Hydropower expert and investor Albert Koch was extremely impressed by the selflessness of the nuns and their unequivocal will to change. Having travelled to Tanzania to determine whether the 400 kW hydroelectric plant, which had been used by the nuns to supply electricity to the convent for around 15 years, could be expanded, he started thinking on a larger scale together with the Benedictine nun Yoela Luambano: a more powerful hydroelectric plant would not only improve the financial situation of the nuns, but also the lives of the people in the region.

Sister Luambano devoted herself to their mutual vision: it soon became clear that water rights could be obtained from the government, a potential customer was found as the state-owned electricity supplier planned to purchase elec-

tricity externally to feed into the local grid, and the financing was secured with loans and a multi-million investment by Albert Koch himself. A suitable location was also soon identified: the Ruvuma River flows into the region of Tulila just a few hours away from the convent.

From the installation to the commissioning

Two Kaplan turbines by Voith with a total output of 5 MW have been installed and meanwhile produce around 36 GWh – as soon as the demand for electricity increases, the plant can be expanded with a third turbine. The successful installation was a true team effort: the nuns supported the project team with administrative and logistical support, food and accommodation. They even supervised the blasting works – one of the nuns is a trained explosives engineer.

Particularly challenging: the isolated operation of the power plant must be guaranteed. Normally, the energy is fed into the local grid that supplies the rural region with electricity. However, the grid often breaks down here. When this happens, the turbines must be able to continue running at minimum performance. Project Manager Karl Henninger is pleased with the solution that they have developed.



“Before the plant was built, the power was unreliable. Life is so much easier for everyone now.”

Sister Yoela Luambano, Benedictine Sisters of St. Agnes, Chipole Convent, Tanzania

The nuns of St. Agnes are also pleased. Sister Yoela is confident that the sales of the surplus energy will soon allow them to pay themselves a wage for their efforts. Together with the investor Albert Koch, she wants to ensure that this model sets an example – other convents in Tanzania should also benefit from the potential of small hydroelectric power plant solutions.

Øvre Forsland, Norway



2x5 MW



Vertical Francis turbines

The small hydropower plant is in operation since August 2015 and produces around 33 GWh annually.

Beauty and power – energy generation in harmony with nature

Øvre Forsland, Norway

Norway is known for its spectacular nature. The abundance of rivers and streams also forms the basis for sustainable energy generation from hydropower. The Øvre Forsland hydropower station, which is impressive both architecturally and technologically, aims to raise awareness of the harmony between nature and technology.

It is considered Norway's most beautiful hydropower station and its location alone is breath-taking: Øvre Forsland lies on a riverbed in a clearing on the edge of a spruce forest. The façade is made of wood, reflecting the irregular shapes of the spruce. The lighting of the building was inspired by the mysterious northern lights of the Aurora Borealis. As beautiful as the small hydropower station looks from the outside, as first-class is the technical equipment inside.

Water-to-Wire – efficient complete solutions from one source

The power plant operator Helgeland Kraft relied on Voith's Small Hydro products and services for the technical design and implementation. In total, Voith supplied two Francis turbines, generators, automation as well as balance of plant electrical and mechanical. A special feature of the "Water-to-Wire" solutions: All electrical, hydraulic and control components are ideally matched to each other and perfectly adapted to local conditions. This means that even small quantities of water and heads can

be optimally used for energy generation. The medium-sized Øvre Forsland hydropower plant produces around 33 gigawatt hours (GWh) of energy annually. This corresponds to the annual energy requirements of 1 700 households.

HyService – for lasting optimum performance and service life

Helgeland Kraft also relies on Voith's know-how when it comes to maintenance and service and has concluded a tailor-made service level agreement for Øvre Forsland with services in the areas of maintenance and operation, spare parts and repair. Comprehensive diagnostic procedures and service tools as well as flexible service teams that are always ready for action guarantee permanent plant availability with minimum downtimes.



“The transparency of the building’s architecture makes it possible to take a close look at these cutting-edge technologies: the turbines and generators at the heart of the power plant.”

Torkil Nersund, Production Manager,
Helgeland Kraft



Semangka, Indonesia



2x 28.3 MW



Vertical Francis
turbines

The run-of-river power plant
is located in the Tanggamus
Regency on Sumatra.



Nogueira, Brazil



7x 715 kW



StreamDiver

Minimal constructional effort,
submerged units and oil-free
operation makes the StreamDiver
the ideal solution for environ-
mentally sensitive areas.

Supporting the renewable development

Semangka, Indonesia

Indonesia has enormous renewable potential. With its innovative hydropower solutions, Voith Hydro is supporting Indonesia's renewable development. One of Voith's Small Hydro projects is the run-of-river Semangka hydropower plant. The plant has been in operation since the end of 2018 and partially replaces electricity in the Sumatra grid, which was previously fed from fossil-fueled power plants.

An ambitious renewable-energy target

Located in South Sumatra Region of Indonesia, the power plant utilizes discharge from the Semangka river. Voith delivered the complete Water-to-Wire scope. The scope of supply included two vertical Francis turbines, each with a rated output of 28.3 megawatt as well as two generators and two generator transformers. Semangka is thus making an important contribution to increasing the share of renewable energies in the power generation mix. The government's ambitious target is to increase its share in the country's total energy consumption to 23 percent by 2025.

“Indonesia is blessed with lots of rivers that can provide renewable energy; hydropower will play a very big role in the country.”

Eka Satira, CEO of energy supplier
PT Medco Power

Minimal intervention – maximum effect

Nogueira, Brazil

In order to keep the ecological impact of the new Nogueira hydropower plant as low as possible, the Brazilian hydropower plant operator Usina Hidrelétrica Paranhos decided to use the compact StreamDiver units from Voith and against conventional vertical Kaplan turbines. Thanks to its standardized and modular design, the new turbine type also convinces as an economically attractive solution. Compared to the costs of civil works incurred for conventional power plants, the StreamDiver costs are 40 percent lower.

Premiere for Brazil

At the small hydropower station in the Chopim river – a tributary of the Iguazú river – a natural waterfall already provides the necessary gradient for the seven underwater turbines to produce more than 31 gigawatt hours of electricity annually. Usina Hidrelétrica Paranhos hopes that the plant will be copied and that the StreamDivers installed in Nogueira will not remain the only ones in Brazil.

“We want to keep the ecological impact of our power plants to a minimum, so the StreamDiver is really the best solution.”

Jairo Bandeiro, CEO of Usina
Hidrelétrica Paranhos

We prepare the future

The use of hydropower has a long tradition. These days, it plays an important role and is one of the most intensively used renewable energy sources in the world. Due to climate change, the share of climate- and CO₂-neutral energy sources in global electricity and energy generation will continue to increase in the future. This development holds great potential for hydropower resources – especially for small-scale hydropower. After all, more than 64 percent of all hydropower resources in the world have not yet been used to generate electricity.

Research and development – shaping the future of hydropower

Since the founding days of Voith, our engineers write with their inventions History of Technology. Knowing that we can only secure the future of hydropower through continuous innovation, Voith continually invests in research and development of its technologies – from turbines, generators and pumps, through automation and services, to the growing portfolio of digital solutions for intelligent hydropower.

A worldwide research network

The Hydro Division bundles its research & development activities in the Voith Hydro Engineering Center, which is located in the “Brunnenmühle” in Heidenheim. In addition, Hydro operates three further engineering centers with different focus areas in Brazil, Sweden and the USA. In this way, we are always able to develop our innovations in the areas of Large Hydro, Small Hydro and Service in close cooperation with our customers and partners.

Joint research

To facilitate seamless, multinational cooperation, we collaborate with leading universities and research institutions around the globe, e.g. in Germany, France, Switzerland, Brazil and Canada. For instance, Voith Hydro endows a junior professorship for research into hydro-power generators at Leibniz University of Hannover. Part of the research is the Generator Converter Laboratory, a universal generator test bench.

Our global research and development portfolio:

- **Hydraulic laboratory**
 - **Hydraulic development and application**
 - **Generator application**
 - **High voltage laboratory**
 - **System engineering**
 - **OnPerformance.Lab**
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Next level – intelligent hydropower



Automation technologies have been standard in the energy industry for decades. Hydropower plants are highly automated, e.g., they are networked within the power supply grid as well as controlled or operated remotely as a power plant tool.

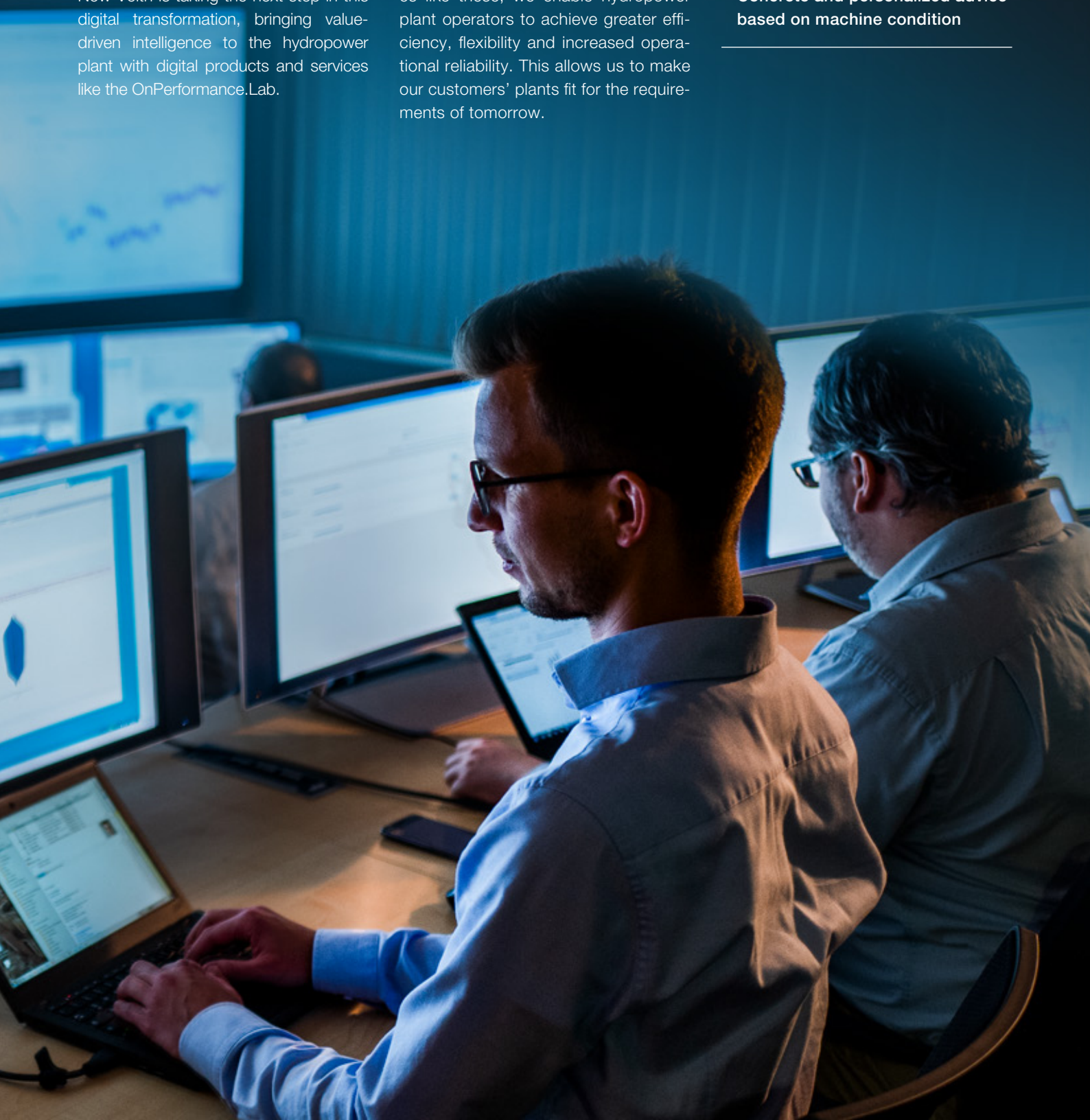
Now Voith is taking the next step in this digital transformation, bringing value-driven intelligence to the hydropower plant with digital products and services like the OnPerformance.Lab.

Detection, diagnosis & optimization

Our OnPerformance.Lab located in the Brunnenmühle combines deep hydropower domain knowledge with state-of-the-art data analytics. For instance, we offer remote health assessments, acoustic diagnostics and online monitoring. With smart products and services like these, we enable hydropower plant operators to achieve greater efficiency, flexibility and increased operational reliability. This allows us to make our customers' plants fit for the requirements of tomorrow.

Customer benefits when working together with the OnPerformance.Lab:

- **Reduced unplanned downtime**
 - **Optimized maintenance planning and plant operation**
 - **Reduced maintenance costs**
 - **Fast, remote expert support**
 - **Concrete and personalized advice based on machine condition**
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