

VOITH

Voith Hydro S.r.l., Italy
The electrifying power of water.





Cover picture Telessio, Italy



Santa Giustina, Italy

Innovation and experience

Voith acts as reliable partner for key industries. Providing innovative solutions and high-end technology within the hydropower industry, Voith Hydro makes a significant contribution to the further development of global markets and improving living standards for millions of people around the world.

Voith set standards in the markets energy, oil and gas, paper, raw materials, transportation and automotive. Founded in 1867, Voith employs more than 42,000 people, generates €5.7 billion in sales, operates in about 50 countries and is one of the biggest family-owned companies in Europe. Over a period of more than 145 years, the company has written engineering history.

Voith Hydro is one of the four divisions of Voith and produced its first hydropower turbine in 1870. Today a quarter of all electricity generated by hydropower is produced with Voith products. The company provides a full-line service and manufactures at its own locations in Asia, Europe, North and South America. At four research and development centers worldwide, Voith engineers work today to create the electricity generation of tomorrow.

From Riva to Voith Hydro As a part of further expansion in 1992, Voith acquired the Italian hydropower equipment manufacturer Riva, in order to consolidate its position as leading supplier in the hydropower market. Riva itself embodies over 150 years of experience constructing and building hydroelectric power plants and, therefore, supplemented and strengthened Voith's expertise in the Italian market. Thus, Voith has acquired know-how and the usage of the complete technical

record office consisting of drawings for more than 1,000 installed hydropower plants. Due to the diverse and specialized product portfolio reaching from large hydro to pumped storage plants, the company is able to offer feasible and innovative solutions. More than 50 percent of the hydropower capacity installed in Italy have been provided by Voith Hydro. Additionally, we offer cutting-edge solutions for automation and modernization of hydropower plants.

Our philosophy Back in 1927, Voith codified his conduct as follows: "In the business world people must be ethical, decent and honest. If a contracting party or a competitor behaves unfairly, this does not give us the right to deviate from this principle." These words have constituted the very core of our value system over the past decades and is still valid within Voith today. Our conviction is based on experience from more than 145 years in mechanical engineering and construction. Having been a family-owned company since its inception, Voith is now an internationally operating group truly understanding how to combine tradition with innovation.

Our values define the character of the relations to our partners, customers and suppliers. We pursue sustainable and long-term business alliances. Our reputation in the business world is based on 'Engineered Reliability', standing for our high quality products, excellent service and professional consultancy. It is the spirit of our actions and motivation for flawless performances. Voith is the partner for your future success.



1+2 Center of Excellence, Brunnenmühle, Heidenheim (Germany)

Expertise in hydropower

Everything from a single source

To ensure maximum efficiency, we offer innovative, standardized concepts for each customer according to the specific focus and requirements of hydro electric power stations. By using modern technologies, operating costs can be reduced and performances optimized.

This offers additional advantages:

- High availability
- Clearly defined scope of delivery
- Good amortization
- Long life and adaptability
- Environmentally friendly solutions

Competences and capabilities

- Consulting, engineering, erection and commissioning
- System, plant assessment
- Solutions for Large and Small Hydro Power Plants
- Complete equipment installation services for hydro electric power plants
- Francis, Pelton, Kaplan, Bulb turbines, pump turbines, standardized and customized solutions
- Storage pumps, radial, semi-axial and axial-flow
- Generators and motor-generators for constant and adjustable speed, excitation systems
- Powerplant automation, control centers for hydropower plants and cascades, including plant management and diagnostic systems
- HyService - global, fast and effective for modernization and rehabilitation of existing hydropower plants

Research and development

In order to maintain a leading position in the hydropower industry, we constantly work on innovations and improvements. In our center of excellence, the Brunnenmühle in Heidenheim, Germany, our experts design outstanding innovations.

Engineering at its best. By the increasing complexity of the hydropower business, demands are becoming more challenging. At Voith, we take on this challenge and rely on innovation and improvement. Due to our worldwide network of experts we benefit from collaborative processes and a mutual product know-how. Supported by Voith Hydro's further R&D facilities, such as our units in York (US), São Paulo (Brazil) or Västerås (Sweden), Voith is able to design improved products gathered from our global knowledge. The use of competence as well as close association with business partners is a fundamental operating principle of Voith Hydro.

Moreover, the core of this network is the Brunnenmühle at the Voith Hydro headquarters in Heidenheim, Germany. Here, we drive forward and coordinate the development of hydraulic fluid machinery.

The R&D center embraces an incredible range of services: product development, improvement in model and field testing, advances for governors, control and monitoring, material property investigations and delivery of mechanical and electrical designs.

Our best engineers work on optimal and most effective solutions to ensure the best possible result for our customer's requirements, products and processes.

Range of products at Voith Hydro

Voith Hydro is a Group Division of Voith and belongs - with a workforce of more than 5,100 employees - to the world-wide leading companies for hydropower equipment. Globally, hydropower is the largest source of renewable energy generation and storage, with 930 GW of globally installed capacity - and 80 percent share of all installed renewable energy sources.

Hydropower has been in use for over 100 years. Its contribution to a low-emission, reliable and safe energy generation will remain indispensable all around the world. It provides clean, safe, reliable, and highly efficient energy in large quantities. In both Large and Small hydropower plants, this proven technology is central to the world's economic and social development.

We are leading in the development of hydropower technologies and well-known as one of the largest turbine manufacturers world-wide.

In 2000, Voith Hydro founded a joint venture with Siemens and consequently extended its product portfolio. Since that time, design, production and installation of generators is done in-house.

Today, Voith Hydro's business activities cover the whole life cycle of a hydropower project:

- Development of the power unit (turbine and generator)
- Design of the power plant according to customer-specific requirements
- Automation and control systems
- Services during the plant's complete life cycle
- Modernization of existing plants

Voith provides Large hydropower plants as well as Small hydropower plants with a unit size of < 30 MW.

The company is also leading in the development of "new renewables" in the field of Ocean Energies (wave and tidal current technology).

Quality, reliability, financial solidity as well as long-lasting customer relationships (often more than 100 years) are cornerstones of our corporate philosophy.





Francis turbines

The classic turbine for medium heads and large flow applications.

Francis turbines are primarily used in Run-of-River plants and storage power stations with large flow volume. They are characterized by their optimal degree of efficiency and high speed ranges. Their special hydraulic characteristics result in comparatively high-speed compact units, right up to the largest capacities. Voith Hydro develops and produces Francis turbines as spiral turbines, which can be used in horizontal as well as in vertical design. The runner is often directly coupled to

the generator shaft which ensures ideal compactness and little maintenance requirements.

Voith Hydro S.r.l., Italy: Technical details

Types	Spiral turbine for medium and large heads. Usage in horizontal or vertical shaft spiral case turbines.
Power	up to 120 MW in Italy up to 264 MW abroad
Head	up to 540 m
Runner size	up to 7.950 mm



Pelton turbines

The ideal turbine for high heads and smaller flows.

Pelton turbines are mainly designed for applications with large heads and small water volumes. Even with fluctuating water supply these turbines achieve an optimal efficiency, since the number of used nozzles can be individually adapted. By load changes the Pelton turbine buckets are exposed to high forces. In order to achieve high resistance of the buckets, we rely on specially milled Pelton-buckets and advanced manufacturing. Whether horizontal or vertical

design, one jet or up to six jets, internal or external regulation: Voith Hydro engineers, designs and produces Pelton runners tailored to the field of application to meet the need of your unit.

Voith Hydro S.r.l., Italy: Technical details

Types	Horizontal and vertical design with one to six nozzles.
Power	up to 280 MW in Italy
Head	up to 1.300 m
Runner size	up to 4.400 mm





Kaplan turbines

The optimal turbine for low head and large flows.

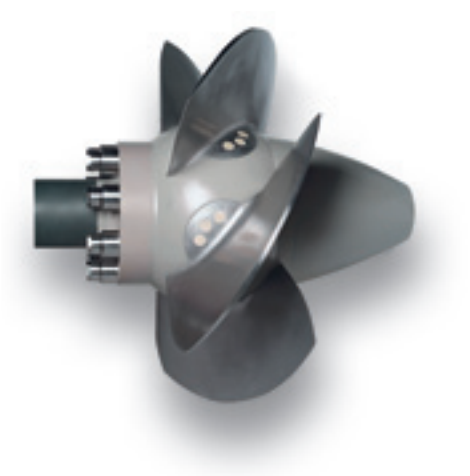
Based on the Francis turbine, Victor Kaplan designed the Kaplan turbine between 1910 and 1913, with Voith using it for the first time in 1922. Today, it is mainly used in small head applications and large volumes of water, such as in run-of-river plants.

Due to the flexible adjustability of the distributor and the hard coated blades Kaplan turbines enable an ideal management of heavily fluctuating water supplies. This control technology ensures efficiency and high output ranges.

Voith supplies vertical Kaplan turbines as well as horizontal bulb turbines in various types with three to seven blades. The drive to the generator is effected preferably via direct connection. In certain cases, flat belts or gearboxes propel the drive.

Voith Hydro S.r.l., Italy: Technical details

Types	Pipe turbines, vertical Kaplan turbines and Kaplan spiral turbines
Power	up to 100 MW
Head	up to 45 m
Runner size	up to 8.400 mm



Voith Hydro's workshop in Italy

Investing in leading-edge technology and durable solutions is a core principle of Voith Hydro. We offer our partners the best service and maintenance to ensure optimal facility operation during the whole life span of a hydropower plant. Voith Hydro's new workshop close by Milan is a decisive progress. Through this, we offer higher flexibility and availability of services. Thus, it is possible to perform complex maintenance work, such as overhaul and repair work.

The workshop offers proper facilities for testing and repair work. It is specially designed for this purpose only and offers latest technological know-how. On a surface of 1300 m², Voith Hydro offers the whole range of services such as complete turbine revisions as well as inspections and maintenance of components such as main Inlet Valves, Servomotors or injec-

tors of Pelton turbines. Our factory is equipped with two lifting cranes. They have a maximum load capacity of 20 and 5 tons, respectively. The facility represents an important development for our existing and future business.

Generators

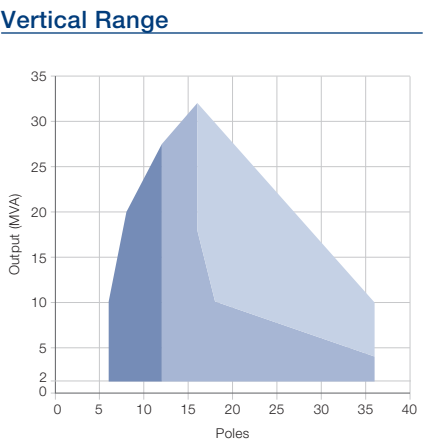
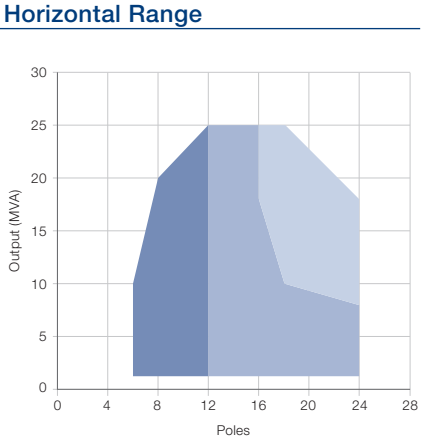
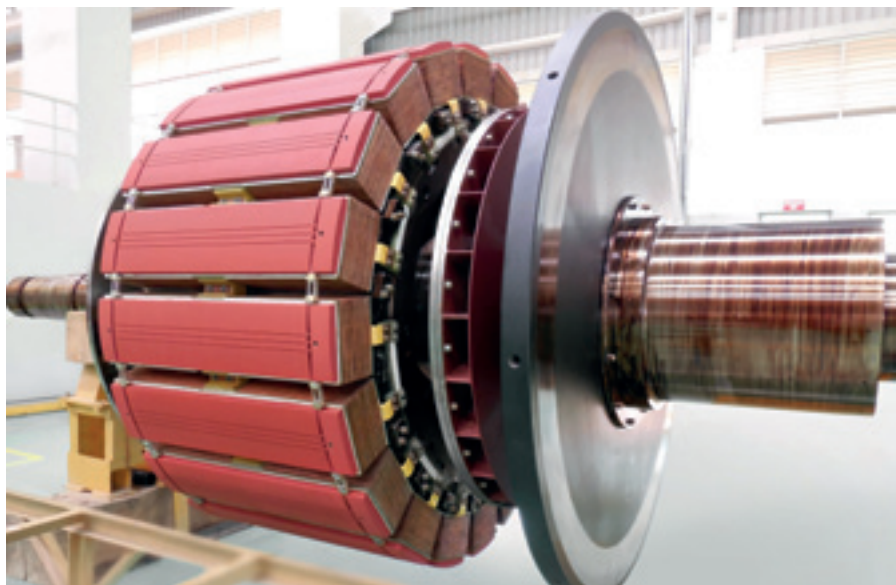
Voith gained mastery in building generators with extraordinary longevity. We perfectly integrate the generator into your powerhouse concept. And we give closest attention to water-to-wire solutions. Our aim: maximizing the power output and raise the generator's efficiency.

Generators in hydropower applications are an integrated part of the power unit with interfaces to various power house components – the understanding of the complete power house system is hence essential in developing such products.

With 140 years of experience, we know how to adjust each component in relation to the generator. Our engineers think twice in order to design vertical or horizontal generators with increased lifetime by having moderate costs of operation. Over the years, Voith demonstrated repeatedly optimized arrangement concepts for small and large hydropower plants to the benefit of our customers.

Moreover, generators for hydropower plants with different capacities have also different requirements. As global player with many production facilities worldwide, Voith can satisfy a great variety of generator sizes. Voith Hydro particularly specialized in developing generators for applications with a range from 2 to 30 MVA.

Customers in Europe, America and Asia decided for sophisticated solutions with no hidden expenses throughout the generator's lifetime.



15 MVA and 20 pole rotor



Automation

A tailor-made product to meet individual demands.

Automation systems and products play a key role in enhancing plant productivity and lowering energy costs. Specifically adapted modules improve not only the plants functionality, but also the quality of processes. With the support of these modules, we are able to quickly and cost-effectively put together customized concepts for every type of hydroelectric power plant. Voith's innovative automation solutions are always efficient and above all we follow our

values and visions for sustainable hydropower solutions.

The Voith Hydro Automation family includes different control systems, such as the digital and hydraulic turbine governor. Optimally aligned hydraulic mechanical governor components help the digital turbine governor to play its strength.

To add matching actuators to the digital governor we design and deliver:

- electro-hydraulic amplifiers
- control valves
- precisely positioning servomotors

Our mission does not end with the commissioning of the plant. We strive to be your partner during the entire life cycle of the plant.



San Giacomo Fraele, Italy



Turnkey hydropower plants

Turnkey solutions for the electromechanical equipment: Voith develops, designs and manufactures the entire product and equipment series for hydropower plants.

A successful project requires more than first-class technical equipment. On-time and cost-efficient project implementation can only work through optimum cooperation of all parties concerned. And this applies to every single interface of the project.

This is why Voith offers turn-key solutions for its customers. We supply you right from the start with concepts, developments, design, production, quality control and project management up to assembly and commissioning - everything from one single source.

Thanks to decades of experience, we always find the appropriate solution even for specialized demands, and we implement this solution professionally up to the handover of the turn-key plant. And afterwards we accompany you all the way with our dedicated services.

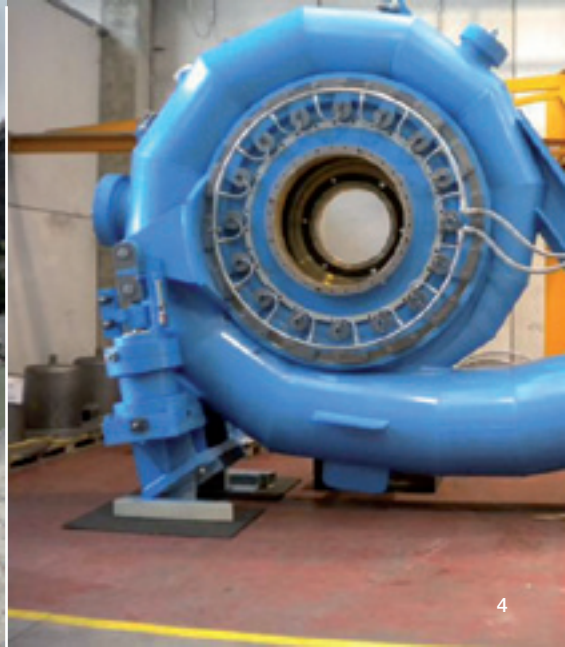
Service, maintenance and upgrade

To Voith the customer service does not end with the handover of the plant. We support you with our service specialists - across the entire life circle of your hydropower plant.

After Market Business (AMB) covers the full service of everyday operation, annual maintenance, provision of original spare parts and fast assistance in the event of failures. We know that standstill of a hydropower station can mean significant financial losses.

Therefore, we react promptly, flexibly and efficiently whenever required in order to keep downtimes to a minimum. Depending on the construction and operating conditions, power stations have life cycles spanning decades. For that reason, Voith offers individual services for general overhauls of long-in-

service plants. A conversion to oil-free bearings, the restoration of the original hydraulic profile and special coatings can, for example, significantly increase life cycles and efficiencies. A performance and efficiency analysis by Voith will point out existing potentials and improvement possibilities.



1 + 2 Bardonetto, Italy

3 San Giacomo Fraele, Italy

4 Sarentino, Italy

1938 Bressanone, Italy:
3 Francis turbines,
30 MW each, 2.200 mm

1939 Hone, Italy:
1 Kaplan turbine,
18.5 MW, 2.900 mm

1949 Avise, Italy:
2 Pelton turbines,
45 MW each, 3.200 mm, Generators

1950 Ala Mori, Italy:
2 Kaplan turbines,
24.3 MW each, 4.000 mm

1955 Somplago, Italy:
3 Francis turbines,
57 MW, 2350 mm

1957 Isola Serafini, Italy:
2 Kaplan turbines,
12.5 MW each, 7.600 mm

1962 Venaus, Italy:
2 Pelton turbines,
122 MW each, 4.200 mm, Generators

1967 Fadalto, Italy:
2 Francis turbines,
120 MW each, 4.000 mm

1968 Roncovalgrande, Italy:
4 Pelton turbines,
127 MW each, 2.740 mm

1989 S. Giacomo Vomano, Italy:
1 Pelton turbine,
282 MW, 4.400 mm

1999 Pont Ventoux, Italy:
2 Francis turbines,
78 MW, each 1800 mm
splitter 15 +15, 1 Pump, 82 MW

2003 Chievo, Italy:
3 Francis turbines,
10.7 MW each, 3.000 mm

2005 Mese, Italy:
5 Pelton turbines
33.5 MW, 2.830 mm

2005 Premadio, Italy:
5 Pelton runners,
84 MW each, 4.200 mm

2006 Bagisli, Turkey:
3 Francis turbines,
10 MW each, 1.420 mm, Generators

2008 Telessio, Italy:
1 Francis turbine, splitter 13+13,
39 MW, 1.360 mm,
1 Pump, , Refurbishment

2008 Torrent, Italy:
2 Pelton turbines,
7.3 MW each, 1.600 mm, Generators

2008 La Siagne / Saut de Vesoles, France:
2 Pelton runner,
5.1 MW each, 2.000 mm
1 Pelton runner,
6.7 MW, 1670 mm

2010 Roncovalgrande, Italy:
Hydro-governors,
8 units, 44 injector revisions

2010 Santa Giustina, Italy:
1 Francis turbine,
3.7 MW, 900 mm, Generator, BoP E

2011 Sarentino, Italy:
2 Francis turbines,
12.2 MW each, 1.340 mm, Generators,
BoP M/E

2011 Rénovièze, Switzerland:
1 Pelton turbine,
13 MW, 1.750 mm, Generator, BoP M/E

2011 Tanagro, Italy:
1 Francis turbine,
20 MW, 1.470 mm, BoP M

2011 Tolentino Italy:
2 Kaplan turbines,
2.8 MW each, 1.260 mm, Generators, BoP E

2011 Chiavenna, Italy:
3 Francis turbines,
22 MW each, BoP M/E

2012 Pouzin, France:
1 Kaplan PIT turbine,
6.6 MW, 3.120 mm, BoP M/E

2013 Perucica, Montenegro:
2 Pelton runners,
30 MW each, 3.100 mm

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