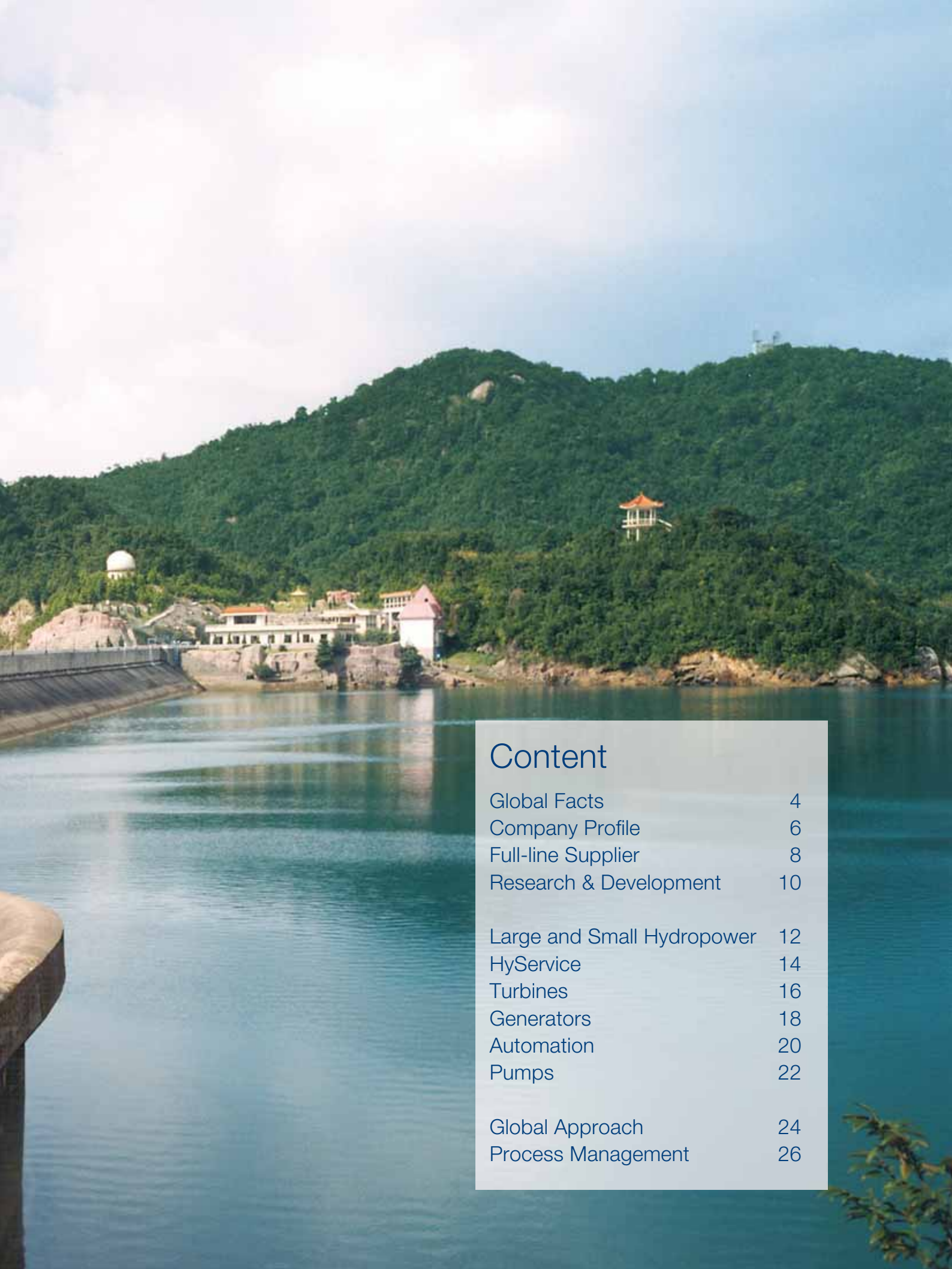
VOITH

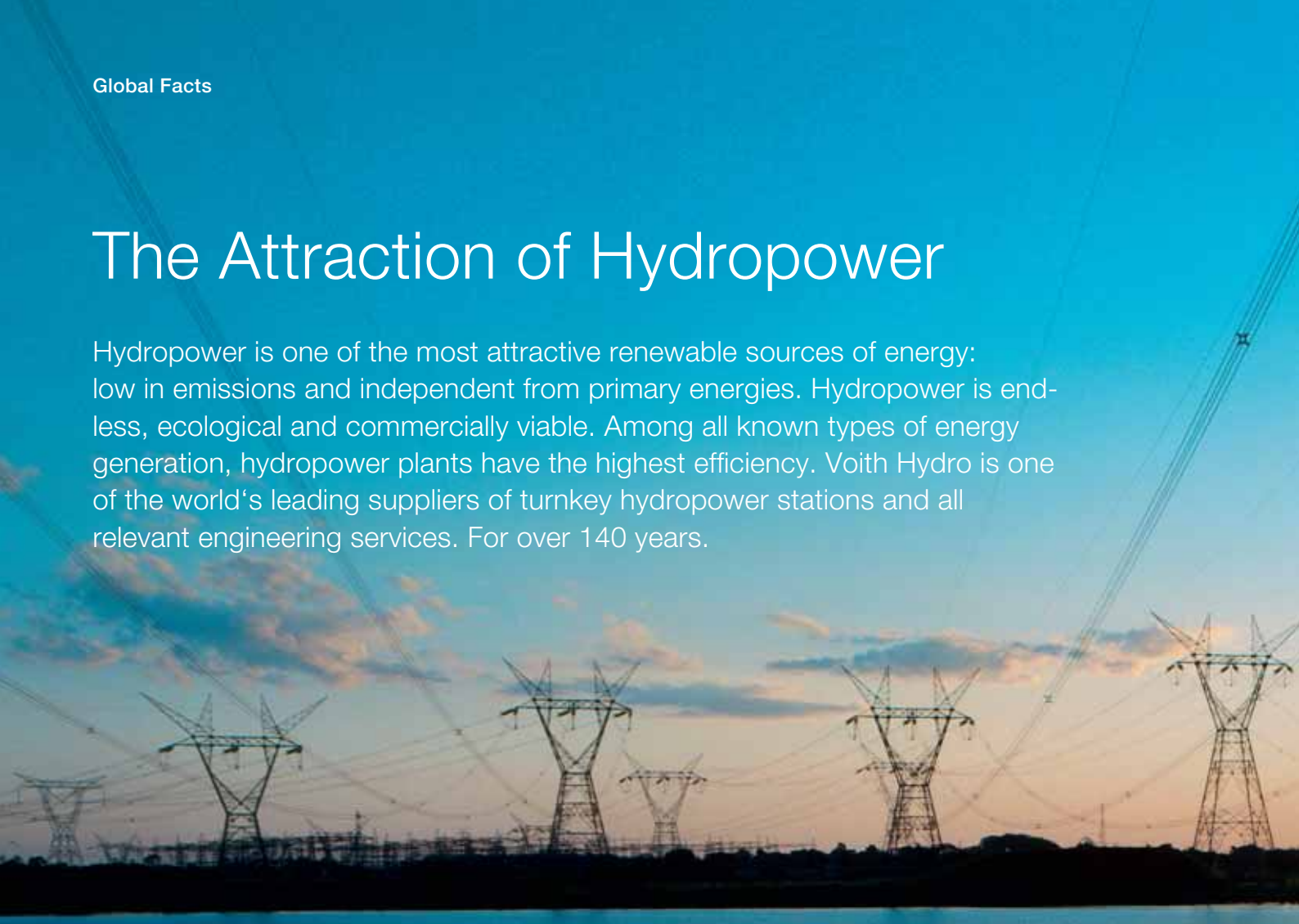
Shaping the Future of Hydropower



Content

The Attraction of Hydropower

Hydropower is one of the most attractive renewable sources of energy: low in emissions and independent from primary energies. Hydropower is endless, ecological and commercially viable. Among all known types of energy generation, hydropower plants have the highest efficiency. Voith Hydro is one of the world's leading suppliers of turnkey hydropower stations and all relevant engineering services. For over 140 years.



up to 115 %

Between 98 % and 115 % of **Norway's annual electricity demand** is covered by hydropower (depending on rainfall).

200,000,000 t

Using hydropower avoids nearly 200 million metric tons of carbon pollution in the United States each year – equal to the output of over 38 million passenger cars.

As the world's largest affordable renewable energy source, hydropower currently accounts for over **16% of the total world electricity supply.**

85%

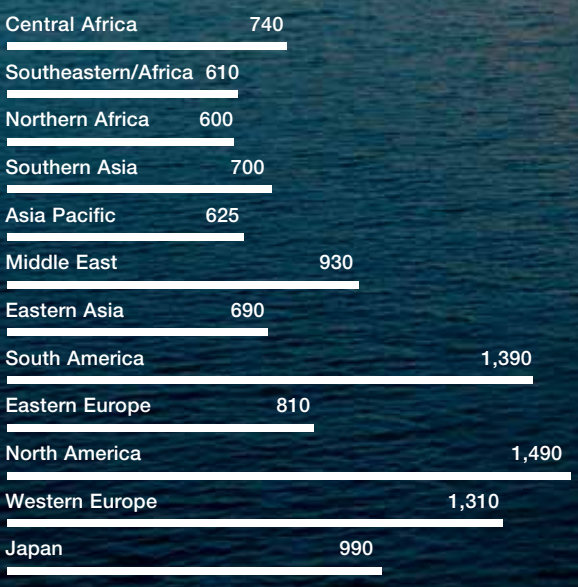
Over 85% of all dams in the world **remain unused** for hydropower generation.

More than **80% of the world's renewable energy** is generated from hydropower.

*1870

The first hydraulic turbine from Voith was manufactured in 1870.

Hydroelectric power generation kWh per person p.a.



More than 35 countries obtained more than half of their total electricity from hydropower.

99%

Pumped storage represents 99% of energy storage capacities worldwide.

A Partner to Industry for Generations

Highest quality past and present:
a Francis turbine runner from 1920
and today.

For more than 140 years, hydropower plants all over the world have been fitted with components from Voith Hydro. Our reputation for excellence in products, technology and services is based on reliability, trust and commitment in long-lasting, partnering relationships with owners and operators around the globe.

Today Voith Hydro belongs to the world's leading companies for hydropower equipment and services for both new and modernization projects. In more than 30 locations in 24 countries, we are leading in the development of hydropower technologies and wellknown as one of the largest turbine manufacturers world-wide. That's what 5,300 employees are working for. Design, production and installation of our components is done in-house.

With its product and service portfolio, Voith Hydro covers the entire life cycle and all components of large and small hydropower plants: from generators, turbines, pumps, electrical and mechanical power plant equipment, and automation systems to services, including spare parts deliveries and maintenance work.

Entrepreneurial foresight was, and still is, one of the key elements of Voith Hydro's success. A perfect example of this was shown by Friedrich Voith who launched his first turbine in 1870. The successful entering into mechanical engineering was awarded with the "Progress Medal" at the world exhibition in Vienna in 1873. When they built the largest and most powerful turbines of the time for Ontario Power at Niagara Falls (1903), Voith became a synonym for technological competence in the hydropower sector. For over 100 years the Brunnenmühle at the company's headquarters in Heidenheim has been an internationally recognized research institution.

Full-line Supplier

Everything from one single source:

- Complete electromechanical equipment, installation and services for hydropower plants
- Francis, Pelton, Kaplan, bulb turbines, pump-turbines, both standardized and customized
- Pumped storage, radial, semi-axial and axial-flow pumps
- Generators and motor generators
- Complete automation systems and excitation systems for governors
- Computer supervisory and monitoring system
- Shut-off valves


2


3

Recent Projects highlight Voith Hydro's expertise as a turnkey supplier of a comprehensive range of services:

1 Furnas hydropower plant in Brazil
2 Power plant Bonneville in the USA
3 Pumped storage power plant Reisseck II in Austria

Reliable Partner for Complete Hydropower Solutions

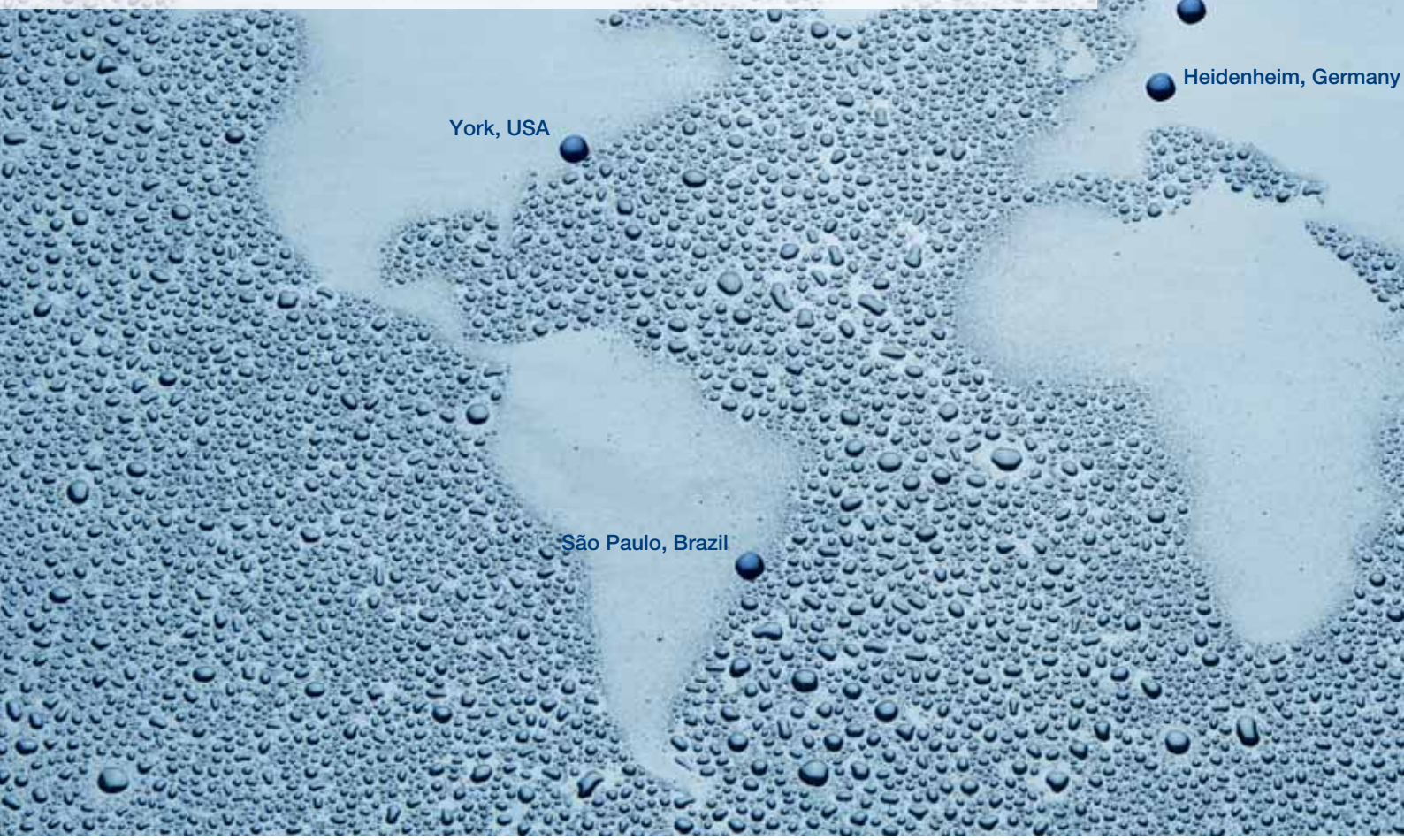
A successful project requires more than first-class technical equipment. Voith Hydro – as a world leader in full-line hydropower solutions – offers not only high-quality manufacturing, but also the complete engineering of power plants.

On-time and cost-efficient project implementation can only work through the best cooperation of all stakeholders. This is why Voith offers turnkey solutions for its customers. Right from the start, we provide supply with concepts, customized design, production, quality control and project management through to maintenance work. Thanks to decades of experience and the know-how of our project managers, we always find the appropriate complete solution, even for specialized demands. This means that customers benefit from fully integrated single source solutions – worldwide.

Voith's innovative concepts ensure the highest possible degree of efficiency – especially as a result of plant modernization. Our optimum price-performance ratio results from applying state-of-the-art technologies. Our aftermarket business covers the full service of everyday operation, annual maintenance, supply of genuine spare parts and fast assistance.

Strong Global R&D

As part of our international network, each Voith Hydro facility operates under the same cutting-edge platform and is equipped with consistent best-in-class processes and tools.



São Paulo, Brazil

The engineers in São Paulo specialize in the development of insulation systems for the global market, as well as the redesign and modernization of generators in America.

York, USA

In York, USA, research and development focuses on turbines and the modernization of older power plants. The first fish-friendly turbines were developed here.

Västerås, Sweden

In Västerås, the competence center for generator research and development focuses on the modernization of generators for the European market.

With a global **R&D network,** Voith Hydro is always close to the customers' needs and familiar with local conditions, and all local customers benefit from our global know-how network and our experience from projects around the world. This worldwide network is also a reason for implementing projects with multinational involvement.

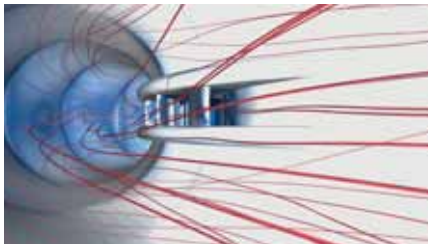
It also ensures that we can meet special customized requirements: from individual components to project planning, through project management to plant maintenance. More than 300 engineers work in research and development at its six locations worldwide. Generators, turbines, shut-off valves, control and regulation technology are all developed here.

Selection of Voith Hydro's scope of international projects:

- Three Gorges, China
- Itaipu, Brazil
- Niagara, Canada
- Goldistal, Germany
- Eastmain, Canada
- Estreito, Brazil
- Gilgel Gibe, Ethiopia
- Omkareshwar, India
- Eglisau, Switzerland
- Bath County, USA
- Uglich, Russia
- Guangzhou, China,
- Tai'An, China

Brunnenmühle Heidenheim, Germany

Voith Hydro's central technology location for hydropower. In the R&D center for generator and turbine technology, extensive model tests are carried out. Today, as 100 years ago, only the latest technologies are applied – making it one of the world's high-performance laboratories.



Noida, India

In Noida, near Delhi, work is being done on topics from the area of basic system development, as well as on modern solutions for automation systems and innovative methods for system planning and integration.

Shanghai, China

Our competence center in Shanghai performs the system engineering of main inlet valves for both the markets of Voith Hydro Shanghai as well as for international markets of other operating units.

Large and Small Hydropower – Always Reliable and Efficient

Capabilities:

- Consulting, engineering, erection and commissioning
- System and plant assessments
- HyService – global, fast and effective for modernization and rehabilitation of existing hydroelectric power plants
- Complete equipment, installation and services for hydroelectric power plants

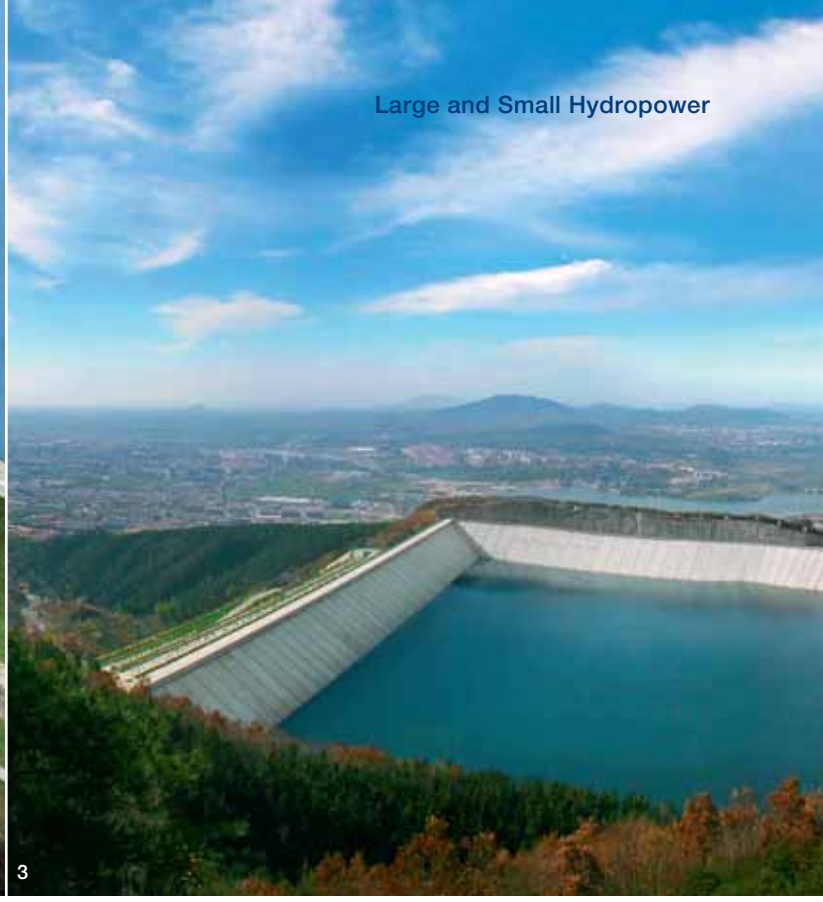
Small hydropower plants guarantee a local, stable power supply. Often, they are the only way to create environment-friendly power. Moreover, it is one of the most reliable and cost-efficient renewable energy sources.

Voith Hydro has a history of business experience in the field of small hydropower since 1870. Additionally, Voith built or equipped 25% of all small hydropower plants worldwide with an output up to 30 MW per unit. Small hydropower plants are a precursor for economic growth and social development.

In developing countries, they are a good substitute for diesel-powered generators. Even in industrialized nations, small hydropower plants are in demand, as they provide a useful contribution on the whole and effectively support energy change.

The planet's largest power plants

Large hydropower plants are the most efficient generators of electricity in the world. They are located on all major rivers and provide a reliable source of power for growth regions as well as industrial nations. Traditionally, Voith supplies the technology for



1 River power plant (small hydro) Blaichach, Germany
2 Red Rock Dam on the Des Moines River, USA
3 Pumped storage plant Tai'An, China

the largest and most powerful hydroelectric power stations in the world. As a partner to the industry and a full-line supplier, the company develops and produces all of the components for power plants of this kind.

Effectiveness for pumped storage units

The individual components of large hydropower weigh hundreds of tons and run like clockwork. For decades, they have been converting the power of water into electricity. Their capacity can be many times greater than that of coal or nuclear power stations. Large projects with components from Voith have demonstrated their effectiveness in the field as indefatigable suppliers of renewable energy.

Hydropower pumped storage is already helping to meet the need for cost-effective grid-scale energy storage all over the world. Our developments, such as variable speed systems, ternary systems and multi-stage pumps, make this technology even more effective.

Competencies:

- Francis, Pelton, Kaplan, Bulb/Pit/S-turbines, pump turbines, standard and customized products
- Storage pumps, radial, semi-axial and axial-flow pumps
- Torque converters
- Generators and motor-generators for constant and adjustable speed, excitation systems
- Frequency converters, protection systems, switchyards for all voltages, transformers
- Power plant automation, control centers for hydropower plants and cascades, including plant management and diagnostic systems
- Shut-off valves
- Integrated Management System to safeguard excellence and quality

1

2

Hydro Service Expertise – HyService Increased System Availability

Offerings of HyService:

We offer a reliable service for all generator types and hydraulic machines, as well as for automation and auxiliary equipment:

- Preventative and regular maintenance
- System and component inspections
- Delivery and fitting of spare parts
- From simple repairs to general overhauls to the original state
- Emergency Support

We are the premier specialist in field machining, cavitation repair and outage services for the hydropower generation industry. As a service partner for reliable power generation from hydroelectric power plants, we ensure the performance and efficient operation of the system throughout its entire life cycle. It's the first-class service to extend service life and to increase system availability

Effective and customer-oriented

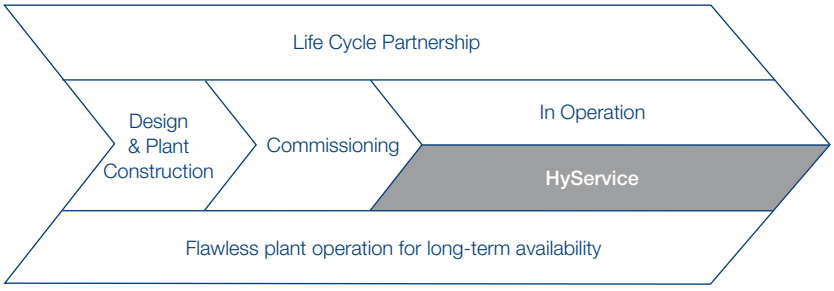
Whether it's a turnkey replace-in-kind, or optimized repair, full rehabilitation, or part replacement, we are a full-service provider for turbine and generator parts and repair. We work to ensure your system is up and running by developing custom solutions, minimizing costs, and reducing outage times.

We know every repair is important, and every repair is unique. Therefore, Voith Hydro offers a unique, customized approach to your hydropower repair needs. Our innovative equipment, technology, and capabilities are unparalleled in the industry. We specialize in on-site work, delivering custom solutions to you quickly, safely and efficiently.

3

1 Rewinding of a stator, Chilhowee, United States.
2 Manual rewinding of a 70 years old stator in a Generator Workshop of Voith Hydro, Norway.
3 Service project in Erzhausen, Germany.

Integrated technical and economic approach



Voith Hydro's HyService is an important part of our Life Cycle Partnership Concept to ensure flawless plant operation for long-term availability.

With HyService, you obtain:

+ Efficient customized solutions
+ Experienced welders and machinists
+ Reduced outage time and longer-running machines

With HyService, you will:

+ Significantly reduce outage downtime
+ Prolong the life of turbine and generator components
+ Restore components to meet OEM standards
+ Ensure environment-friendly repairs

Voith Turbines – Not Just For the World's Largest Hydropower Plants

Voith Hydro is developing, building and installing hydraulic machines for hydropower plants and has contributed significantly to the advancement of many types of hydro turbines. Thousands of installed hydropower plants worldwide are equipped with Voith Hydro turbines.

Francis turbines – for wide head ranges and large flow applications
Francis turbines are primarily used in run-of-river power stations and water storage power plants with large flow volumes. Voith develops and produces Francis turbines as spiral turbines, which can be used in horizontal as well as in vertical constructions.

Power: up to 1,000 MW
Head: up to 800 meters
Runner size: up to 11 meters

Francis turbine

Pelton turbines – for high heads
This turbine type can achieve optimum efficiencies, even with fluctuating water supplies since the number of nozzles can be individually adapted. Voith develops, designs and produces the Pelton turbine that is most suited to individual requirements.

Power: up to 500 MW
Head: up to 2,000 meters
Runner size: up to 6.5 meters

Pelton turbine

Kaplan turbines – for low pressure applications with high water volumes
Victor Kaplan designed the Kaplan turbine between 1910 and 1913, and Voith built it for the first time in 1922. This turbine type can also be applied as a run-of-river power plant. Voith supplies Kaplan turbines in vertical design with concrete or steel spiral, as well as horizontal bulb turbines in a wide variety of shapes with three, four, five or six blades.

Power: up to 350 MW
Head: up to 90 meters
Runner size: up to 12 meters

Kaplan turbine

Turbine for the Cambambe Power Station. The hydroelectric power plant on the Kwanza River is located in Angola, Africa.

Bulb/Pit/S-Turbines – for economic solutions

Higher full-load efficiency and higher flow capacities of bulb and pit turbines can offer many advantages over vertical Kaplan turbines. The application of bulb/pit turbines results in higher annual energy generation and lower relative construction costs.

Power: up to 100 MW
Head: up to 30 meters
Runner size: up to 10 meters

Bulb turbine

Alden/Aerating turbines – our environment-friendly turbine design

Voih has been working to minimize the impact of hydropower on the environment. Specifically, ensuring safe fish passage has been one of Voith's industry goals for the last 50 years. Voith has developed state-of-the-art aerating turbine technologies to improve dissolved oxygen levels with minimal impact on energy generation.

Power: up to 100 MW
Head: up to 40 meters
Runner size: up to 5 meters

Alden turbine

The most powerful generator-turbine unit ever built by Voith entered into service in the Chinese hydropower plant Xiloudu on the Jinsha River. With 855 MVA, the output of the generator is higher than that of the world's largest hydropower plants and consequently sets new standards.

The Tremendous Power of Voith Generators

Power demand increases with the expansion of the economy and improved living standards. Following this trend, the capacity of generating units has also increased. For well over a century, Voith Hydro has been supplying the world's largest and most powerful hydroelectric units. We offer own generator solutions for all ranges of speed, for horizontal and vertical designs, with air-cooled as well as water-cooled windings.

Most up-to-date technology

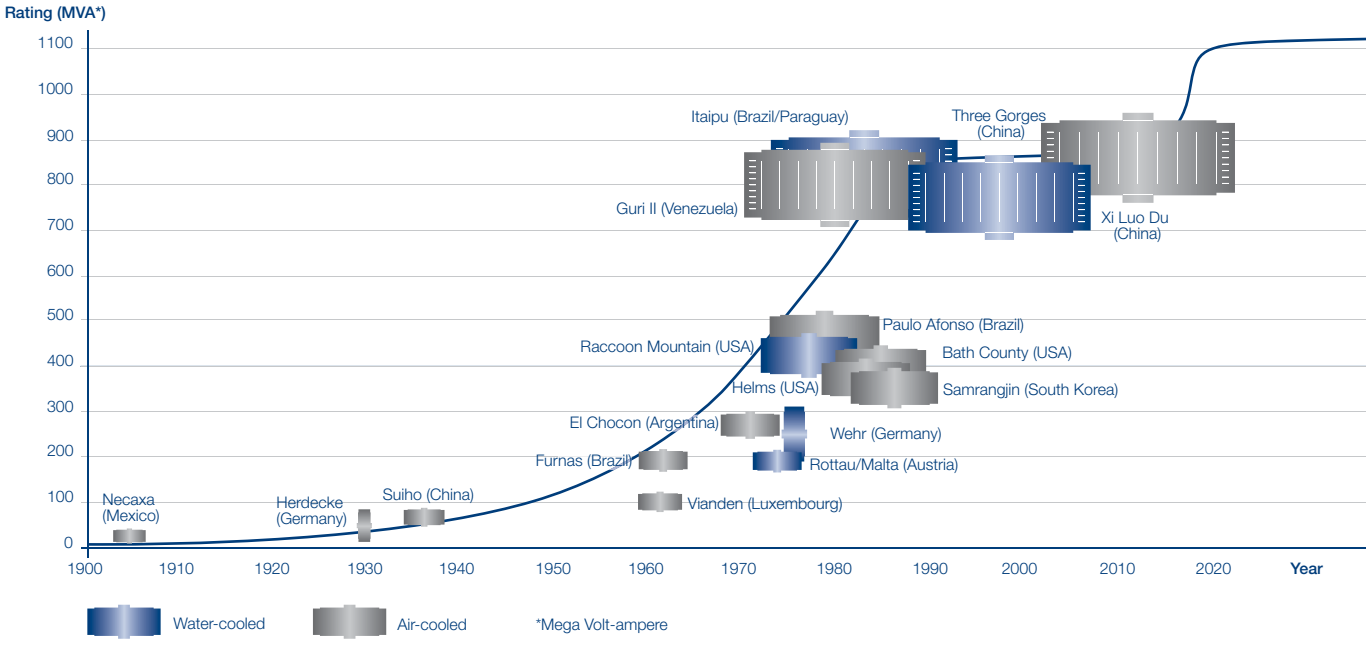
As an industry leader in the production of generators and motor-generators for constant and adjustable speed, Voith has vast references in water-cooled machines and designed the world's largest and most powerful air-cooled hydro generators.

All Voith generators are designed and manufactured with the latest state-of-the-art technology, including the use of Vacuum Pressure Impregnation (VPI) for the stator bars and coils. Rated voltages up to 25 kV are part of our standard production. These generators are designed to fit new or existing hydro facilities. The range of services includes maintenance support, full refurbishment and upgrade services for hydro generators, bulb generators, motor-generators, synchronous condensers, as well as rotating and static excitation systems.

Picture: Caio Coronel / Itaipu Binacional

For the hydropower plants Itaipu (Brazil/Paraguay), photo, and Three Gorges (China) we have installed the world's largest and most powerful water-cooled units.

History of generators or motor-generators and their (apparent) power performance



Plant Automation – Key to Maximum Efficiency

Our automation solutions:

- Automation equipment
- Thyricon excitation systems
- HyCon control systems
- HyCon MD monitoring, analysis, diagnosis
- HyCon optimization modules
- Protection systems
- Telecommunication and access security
- Turbine governors

Voith Hydro has installed more than 40,000 generators and turbines worldwide, providing a strong basis for its automation approach. Our hydro plant control systems include all components for safe, reliable and cost-effective operation, even if multiple plants with different types and sizes of machines have to be equipped with a uniform control technology.

Tailor-made systems for individual demands

Hydro automation is not an off-the-shelf product. It is tailor-made system based on customer requirements to meet individual demands. We offer hydro automation from a single source to ensure complete service and seamless availability for your hydropower plant and all its components and systems. Therefore, we manage solutions which detect damage by monitoring, analysis and diagnostics at an early stage so that inspection and repair measures can be reduced to a minimum.

These solutions are based on a variety of subsystems that ensure a safe, reliable and cost-effective operation owing to our long-term process know-how and control system expertise in hydropower applications.

For best-in-class automation system design, it is crucial to have comprehensive knowledge of all plant equipment and processes, excellent engineering expertise and experience, and seamless integration of all plant systems and plant-related functions.

Economically and eco-friendly

HyCon, the automation concept of Voith Hydro, is an integrated overall system which makes hydropower stations safer, more economical and more environmentally compatible. The ability to control a hydropower unit and the quality of the electric power it provides largely depends upon the performance of the turbine governing system. The HyCon Plant Optimization for hydropower stations includes all components for operating hydropower stations with even greater economy and eco-friendliness.

Voith has supplemented the fundamental monitoring and control functions of the HyCon by intelligent optimization modules. In the short term, we optimize the overall system to achieve high availability and efficiency at the best possible cost.

Advantages:

+ Safety and availability
+ Longevity and adaptability
+ Proven solutions and cutting-edge technology
+ Standard and flexibility

Voith Pumps – High Efficiency Solutions

Medium to large scale customized pumps for the following applications:

- Drinking water
- Wastewater
- Irrigation and drainage
- Flood control
- Desalination
- Cooling water for thermal power plants
- Storage

Pump construction is part of the science and technology of water conveyance, irrigation, drainage as well as flood control. It is therefore essential to guarantee high pump efficiency levels to ensure low operating costs and to counter the worldwide increasing demand in electricity. Worldwide, Voith has earned a reputation as a major pump manufacturer, evidenced by far more than 200 pumping stations equipped with our products.

From medium to large-scale pumps

Pumps have been part of Voith‘s product portfolio for decades. The diversity of pump sizes and types manufactured in the course of these years defines our efficiency and cost effectiveness in the field of pump construction. Due to our experience in engineering, manufacturing and project management for electro-mechanical equipment for hydropower plants and pumping stations, we are able to offer technical solutions, customized from medium to large-scale pumps.

1 Large-scale pump impeller
2 Kops II Pumped Storage plant in Austria, equipped with three vertical three-stage radial pumps.

We offer large capacity pumps to meet any need in pumped storage, waste water, cooling water, drinking water, irrigation and drainage. Our own research laboratories are developing competitive hydraulic and electrical application layouts for new and existing pumps. We therefore produce high-quality pumps by using the right materials and applying the appropriate technologies.

Optimum integration into buildings

Voith pumps feature compact arrangement and robust design. Due to their complex hydraulic shapes, our pumps achieve high efficiency levels. As we have different ways to design pumps, they can be optimally integrated in both new and existing buildings.

Advantages:

+ Long-term proven state-of-the-art technology and constant manufacturing process check-ups lead to excellent quality
+ Optimum technical solutions for any kind of pump type in the medium and large size application range
+ Flexible, customized, efficient and economic solutions
+ High reliability as a sound basis for long-lasting business relationships
+ Fast reaction times ensure optimized customer support

Itaipu Iguazu waterfalls: A horseshoe-shaped row of 275 waterfalls that spring from the Iguazu River on the Brazil-Argentina border. Itaipu hydropower plant, located on the Paraná River at the Brazil-Paraguay border, began operation on May 5, 1984. The last two of the 20 units meanwhile installed, started operation in September 2006 and March 2007, raising capacity to 14,000 MW. Voith supplied more than 50 percent of the equipment.

Sustainability – A Key Part of Our Mentality

The concept of sustainability embodies the tradition and business style of Voith.

Hydropower is one of the most attractive renewable energy carriers: low in emissions and independent from primary energies. Hydropower is endless, ecological and commercially viable: among all known types of energy generation, hydropower plants have the highest efficiency.

Voith Hydro is fully aware of its responsibility to develop hydropower projects in an environmentally and socially sustainable way: With innovation, reliability, safety and technological excellence. We aim to give equal importance to economic, ecological and social aspects in our management, products and processes. We are concerned with an intense consideration and promotion of sustainability issues within the hydropower industry, including the continuous education of our staff worldwide. Our HyEco product portfolio offers forward-looking solutions to improve energy efficiency, water consumption and environmental compatibility.

We are a global leader in environmentally-friendly turbine design. Minimum gap runner, oil free hubs or the newly developed Alden Turbine are just examples of our innovations. Specifically, ensuring safe fish passage has been one of Voith's industry goals for the last 50 years, leading the company to conduct analytical and physical modeling in its laboratories. Greaseless technologies have been commonly used to maintain water quality for more than twenty years.

Global integration

The International Hydropower Association IHA is a nonprofit organization, working with a network of members and partners like Voith to advance sustainable hydropower. The Hydropower Sustainability Assessment Protocol covers more than 20 sustainability topics and is regarded as an engine for operating with “sustainability” as a strictly defined term across the sector. External stakeholders are now recognizing the protocol, including the OECD and the World Bank. Assessments by independent bodies are currently in progress in several countries in Europe, Asia, and North and South America.

Surface processing of modern turbines at the Austrian location of Voith Hydro in St. Pölten.

Our Excellence in Process Management

With more than 20 engineering and manufacturing units, Voith Hydro is always close to its customers in the major hydro markets of the world.

These units work together through the Blue Book, a unique process management tool to achieve a seamless intermeshed understanding of complex component design, manufacturing, commissioning and operation. The company's unique and unified global process and project management is second to none in the industry.

All of our principles are implemented in the management system in each Voith company. Independent certification by an authorized body provides our customers with the assurance that our organization is managed systematically and that projects are handled with care and professionalism according to a proven system.

Our global certification is based on well-known international standards for quality management (ISO 9001), environmental protection (ISO 14001), as well as occupational health and safety (OHSAS 18001). All Voith Hydro locations are in complete compliance with these three standards. They handle all processes identically and are formally certified by a single certification. This certification is an important driver and safeguards constant, reciprocal conditions over defined periods of time in order to guarantee a stable quality level in all phases and fields of our activities.

Voith Hydro's Blue Book

In accordance with the applicable international standards and laws in force, the Integrated Management System within the Blue Book comprises all risk and quality issues, as well as environmental protection and occupational health and safety within the working arena of Voith Hydro's operating units and project sites. It is of major concern to Voith Hydro to ensure the safety of its own employees as well as that of employees of companies that are involved in our processes.

t3397e

Voith Hydro Holding GmbH & Co. KG
Alexanderstr. 11
89522 Heidenheim/Germany
Phone +49 7321 37 0
Fax +49 7321 37 7828
www.voith.com

A Voith and Siemens Company

VOITH
Engineered Reliability