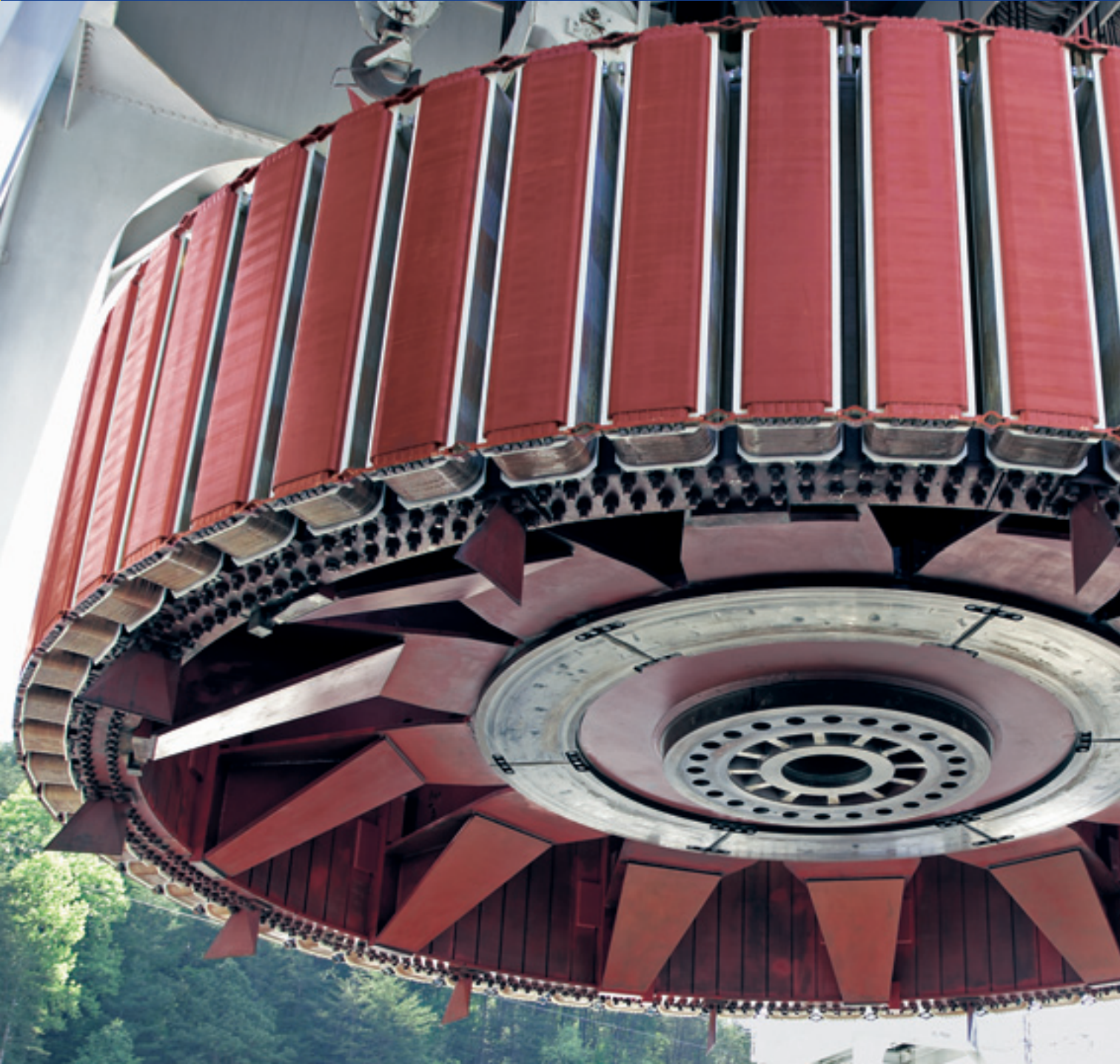


Voith Hydro

VOITH

Generators



Harnessing the power of water

with engineered reliability

Generating energy from the power of water represents large amounts of clean, renewable energy. 71 percent of the earth's surface is covered by water. The world's hydro power potential amounts to 20 billion Mega Watt hours per year and only 30 percent of this has been developed so far.

Hydro power is not only environmentally friendly, but also cost-effective. Hydro power plants have the highest operating efficiency of all known generation systems. They are largely automated, and their operating costs are relatively low. Hydroelectric power plants also play an important role in water resource management, flood control, navigation, irrigation and in creating recreation areas.

Voith Hydro is an industry leader in the production of generators, turbines and the associated control systems to put the power of water to work. A range of services, from engineering through manufacturing and project management to commissioning, completes our portfolio as a leading product and service provider.

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. This network also ensures that we can meet special customized requirements: from individual components to project planning, through project management and plant maintenance. With branches and production facilities for electrical and hydraulic machines and components in Europe, Asia and North and South America we are close to our customers and all major hydro power markets.

Voith Hydro is also a trend-setter in the field of "new renewables". Wave and ocean current power technology from Voith Hydro are amongst the pioneering initiatives for the commercial development of the power of the oceans in the foreseeable future.



Guri, Venezuela



Competence and capabilities

- Consulting, engineering, erection and commissioning
- System/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
- Francis, Pelton, Kaplan, bulb turbines, pump-turbines, standard and custom
- Storage pumps, radial, semi-axial and axial-flow pumps
- 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 hydro power plants and cascades, including plant management and diagnostic systems
- Shut-off valves
- Integrated Management System to safeguard excellence and quality

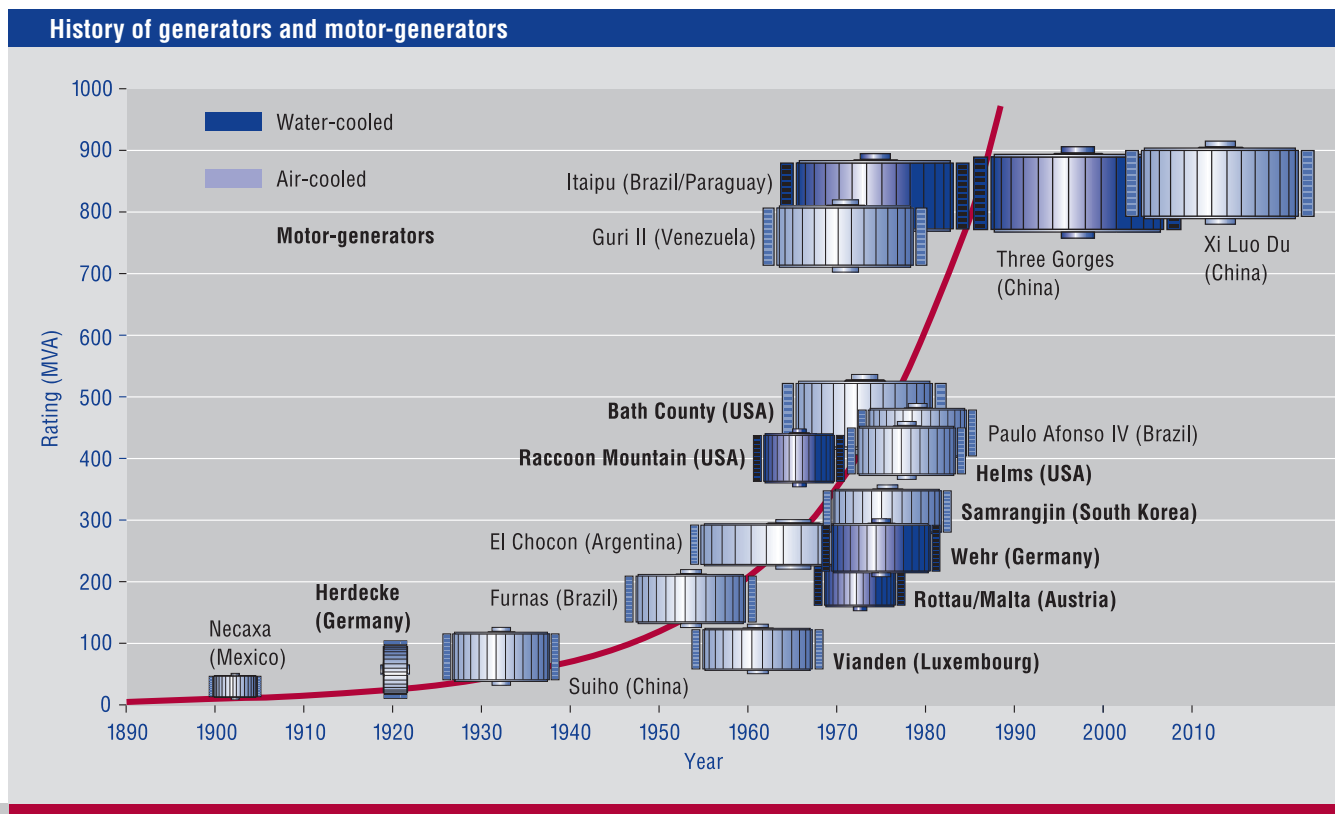
Engineered reliability.

Our promise to the customer. Precise and creative. Our products and services are designed specifically for our customers' needs. Always efficient and economical, and, above all, following our values and visions for a sustainable solution.



Characteristics

For well over a century, Voith Hydro has supplied the world's largest and most powerful units with respect to both performance and size, continually setting new world records.



Power demand increases with the expansion of the economy and improved living standards. Following this trend, the capacity of generating units has also increased, growing from 6.25 MVA at Necaxa in 1903 up to 840 MVA at Three Gorges in 1997 and soon to more than 855 MVA at the Xi Luo Du power station.

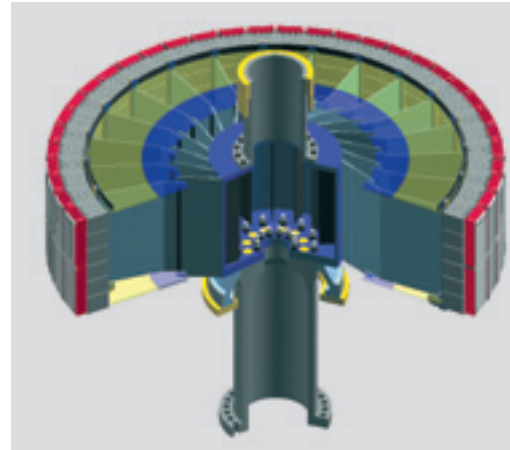
To improve optimum project economics, higher unit capacity machines are often used in order to reduce the number of units at each plant. For compact machines, direct water cooling is very effective.

The following design criteria influence the generator's main dimensions:

- The specified output can be produced by the dimensions within the allowable limit of the temperature rise of stator and rotor windings and stator core.
- The required moment of inertia must be provided within the given stator bore dimensions.
- The mechanical stress incurred by the rotating parts at runaway speed can be designed within the maximum allowable stresses of the specific material.
- A safe margin is provided between the first critical speed and the unit's runaway speed. Shorter lengths and lighter rotor weights help to achieve this margin.
- For air-cooled machines, a shorter core length and a larger diameter are better for uniform cooling along the entire core length.

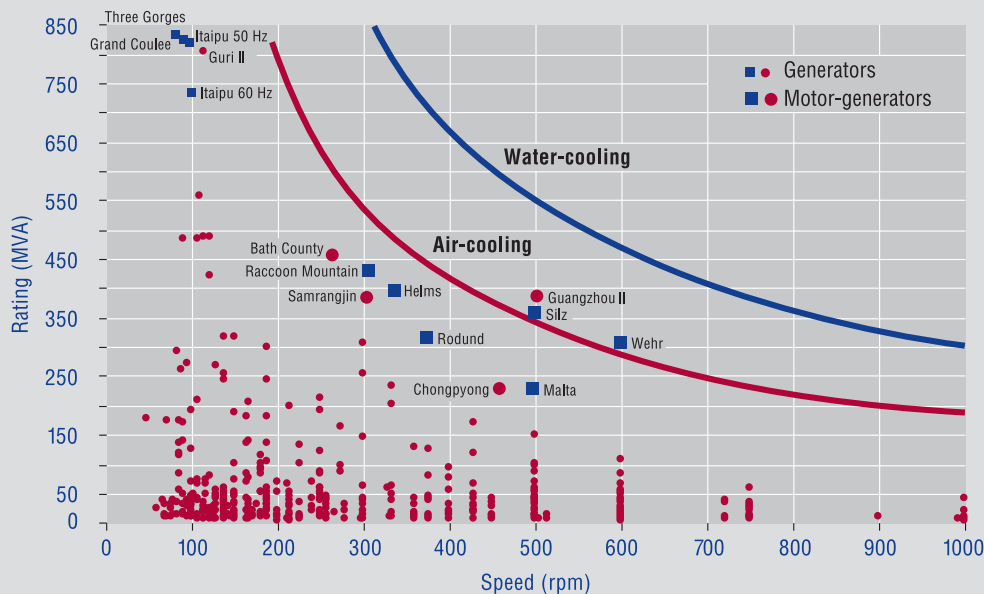
Voith Hydro has vast references in water-cooled machines and has designed the world's largest and most powerful air-cooled hydro generators, including Guri II (Venezuela) rated at 805 MVA and the 672 MVA units at Grand Coulee II (USA) as well as the world's largest and most powerful directly water-cooled units at Itaipu (Brazil/Paraguay) rated at 823.6 MVA and the 840 MVA units at Three Gorges (China). Soon these records will be broken with the totally air-cooled generators for the Xi Luo Du power station (China) with a rated output of 855.6 MVA.

All Voith Hydro 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.



3D generator model

Generators and motor-generators



References and milestones



Three Gorges, China



Itaipu, Brazil

- 1866** Werner von Siemens invents the direct current dynamo.
- 1881** Start of design and manufacturing of direct current dynamos at Siemens factory in Berlin.
- 1895** Kurås fossen, Norway:
First alternating current machine for a hydro power station.
- 1903** Necaxa, Mexico:
World record: 6.25 MVA machine.
- 1938** Fengman, China:
The world's first 100 MVA generators.
- 1941** Grand Coulee I, USA:
The world's first 108 MVA generators.
- 1964** Roenkhausen, Germany:
First reversible motor-generator unit in a German pumped storage station.
- 1969** El Chocon, Argentina:
First generator with a stator bore diameter of 16 m.
- 1970** Raccoon Mountain, USA:
Most powerful pumped storage machines in the world at the time, with four 425 MVA units and directly water-cooled stator and rotor.
- 1974** Grand Coulee II, USA:
Most powerful air-cooled generators at the time with 672 MVA.
- 1976** Bath County, USA:
Largest pumped storage machines in the world at the time, with six 447 MVA air-cooled units.
- 1976** Guri II, Venezuela:
Most powerful air-cooled generators with 805 MVA.



Furnas, Brazil



Waldeck, Germany

1978 Itaipu, Brazil/Paraguay:
Complete mechanical design for the world's most powerful hydroelectric plant (13,300 MW). Maximum output of each unit: 823 MW.

1992 Grand Coulee III, USA:
New water-cooled stators for the largest hydroelectric generators in the world to date, rated 826 MVA per unit with an outside diameter of 23 m.

1997 Three Gorges, China:
Design and supply of generators and electrical equipment for the largest hydroelectric power plant in the world with an ultimate total capacity of more than 18,000 MW.

2000 Guangzhou II, China:
Commissioning of the world's largest pumped storage plant with 2,400 MW total capacity. Four motor-generator units from Voith Hydro.

2008 Xi Luo Du, China:
Design and supply of totally air-cooled 855.6 MVA generators.

2008 Santo Antonio, Brazil:
Design and supply of the world's most powerful bulb generators with a rated output of 82.25 MVA.

2008 Ohio River, USA:
Complete mechanical design for three projects with eight bulb machines. Expected total capacity: 208 MW.

2008 Akköy II, Turkey:
Design and supply of the world's largest air-cooled generators with rated speed of 750 rpm and a rated output of 135 MVA.

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VOITH
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