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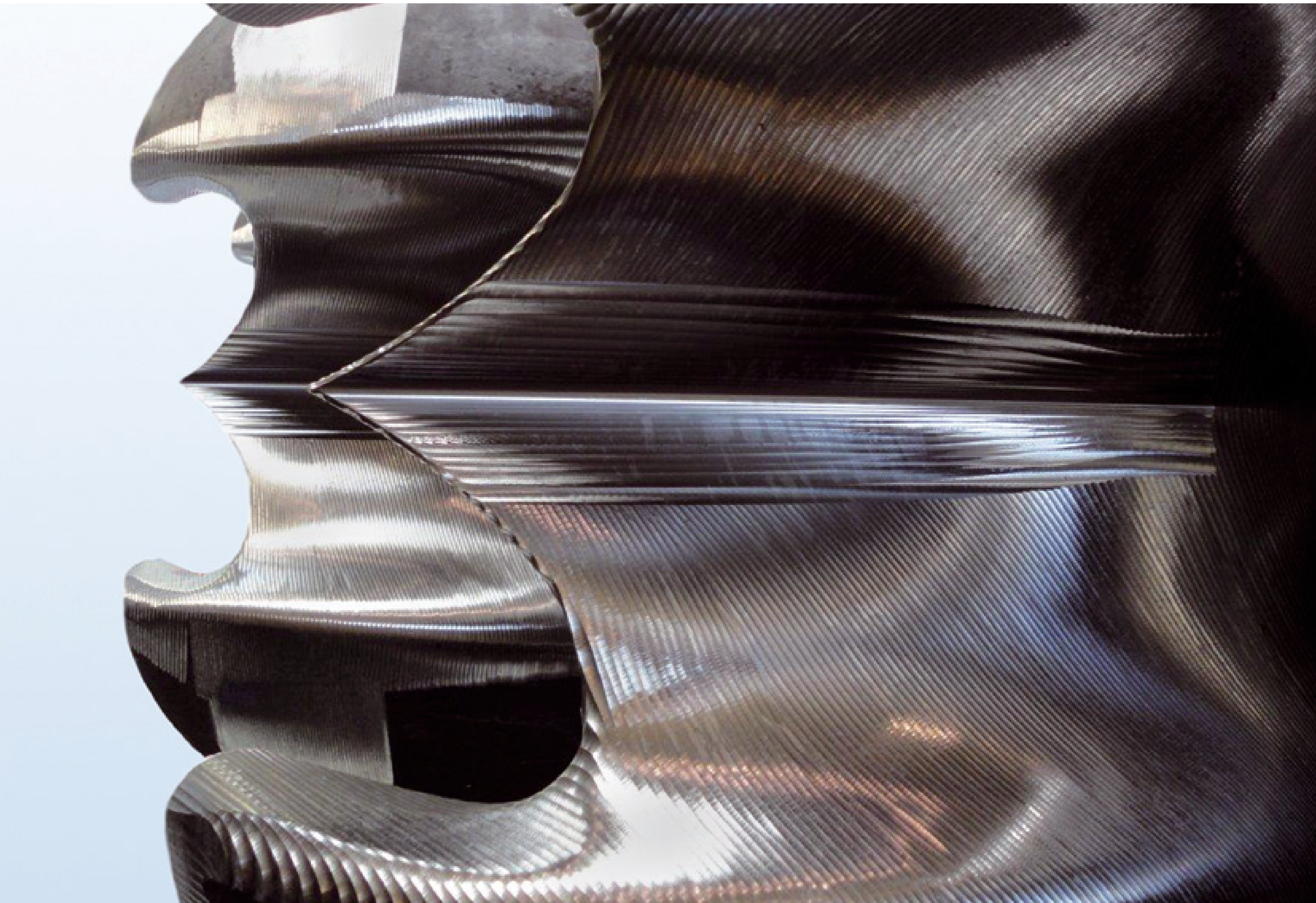
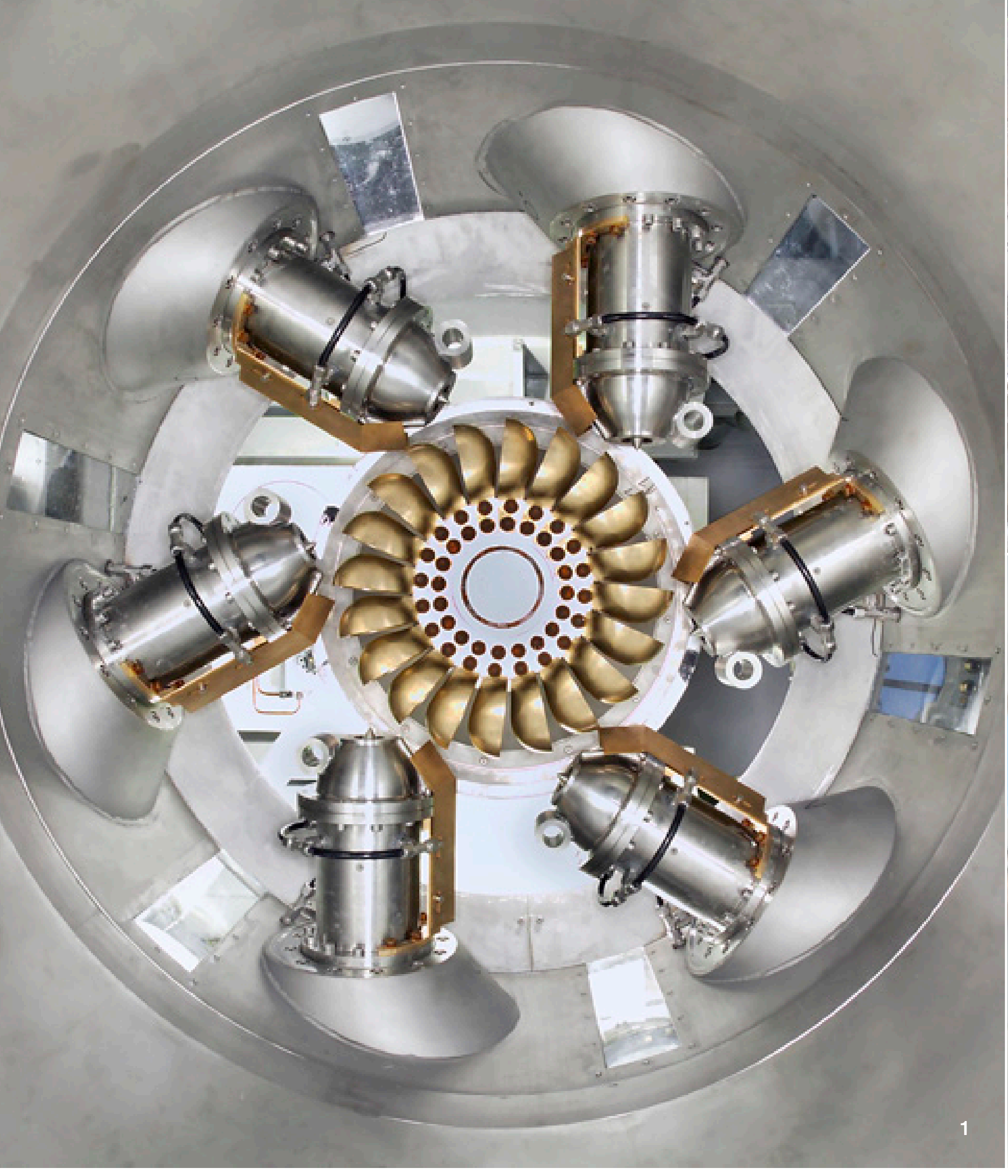
VOITH

Pelton turbines





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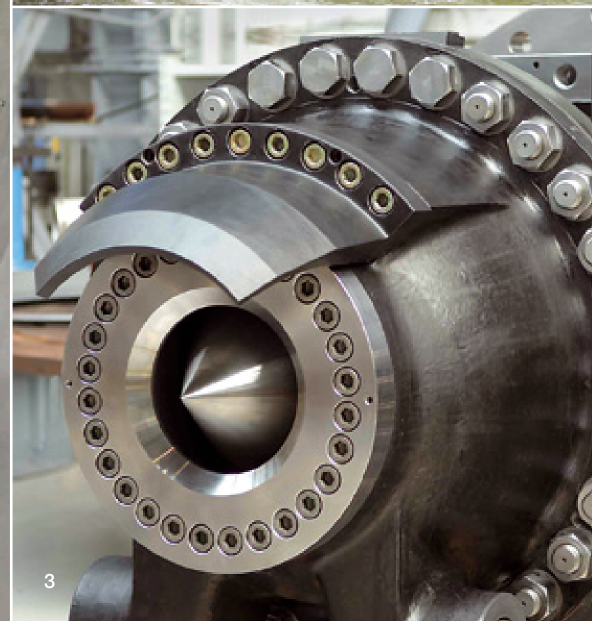

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Harnessing the power of water

Generating electricity from the power of water represents large amounts of clean, renewable energy. Seventy-one percent of the earth's surface is covered by water. So far, the installed world´s hydropower potential is 4 million GWh/year. There remains a huge hydropower potential of 16 million GWh/year.

1 Model test set up for dynamic measurements

2 Akköy, Turkey

3 Pelton nozzle

Hydropower is a clean, renewable and environmentally friendly energy source – with low carbon dioxide emissions. Hydropower plants have the highest operating efficiency of all renewable energy generation systems. They are largely automated, and operating costs are relatively low. Hydroelectric power plants also play an important role in water resource management, flood control, navigation, irrigation and in creating recreational areas.

Customer focused and innovative

Voith is a leading full-line supplier as well as trusted partner for equipping hydropower plants all over the world. Our portfolio of products and services covers the entire life cycle and all major components of hydropower plants:

- Generators
- Turbines
- Pumps
- Automation systems
- Spare parts
- Steel structural components
- Maintenance and training services
- Digital solutions for intelligent hydropower

A world-class laboratory

Using state-of-the-art technologies and innovative digital solutions, we are committed to developing customized long-term solutions in hydropower in the years to come. At the Voith Hydro Engineering Center, scientists, engineers and measurement technicians access more than 100 years of know-how and can make use of one of the most modern hydraulic laboratories in the world. Combined with the deep domain knowledge that evolved over decades from more than 40 000 units delivered to customers, this environment paves the way to innovations of the existing product portfolio as well as new technologies.

Global experts

As part of our international network, each Voith 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, North and South America, we are close to our customers and active in all major hydropower markets worldwide.

Technical reliability with highest quality standards

Voith has been known for quality right from the start. We strive to continuously meet our own high aspirations in terms of quality: Our global certification is based on well-known international standards (ISO) for quality management environmental protection as well as occupational health and safety. Moreover, we have developed our own methods for quality assurance and work according to them. In this way, future generations will continue to benefit from the quality of our work.

Characteristics and latest technology

From the beginning, the development of Pelton turbine technology has been synonymous with Voith. Since the turn of the 19th century, Voith has supplied thousands of Pelton turbines, including large and powerful machines. These turbines are in service around the globe in many hydropower plants.

The flow simulation of Pelton turbines is by far the most complex and difficult of all hydraulic turbo-machinery simulations.

Pelton turbines involve a number of special flow characteristics which are extremely difficult to simulate. The jet-to-bucket interaction is fully transient and depends on the geometry of the moving buckets. Even more challenging is the multiphase system of air and water that governs the formation of the free jet and the flow through the buckets. In the past, developing a flow simulation that would allow a realistic analysis of these phenomena seemed to be an impossible task.

The Voith numerical development group has overcome the major problems of simulating typical free water jet and bucket flow for Pelton turbines. Simulation results and experimental data have shown a remarkable congruence.

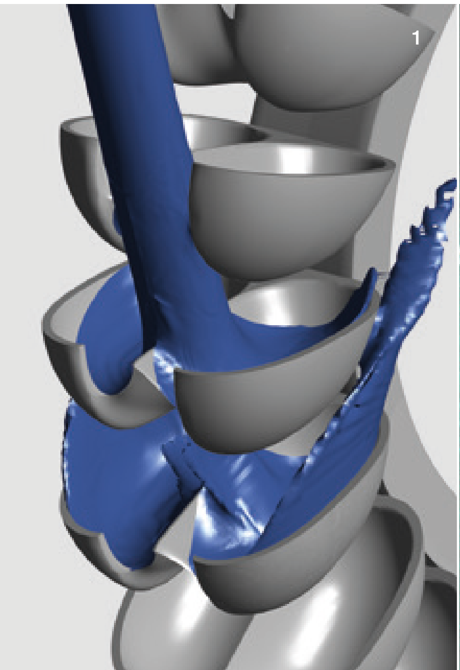
Today, designers have new insights into complex jet, bucket and casing flow phenomena providing a solid basis for the development of new bucket profiles that result in improved performance.

1 Simulated flow through Pelton runner

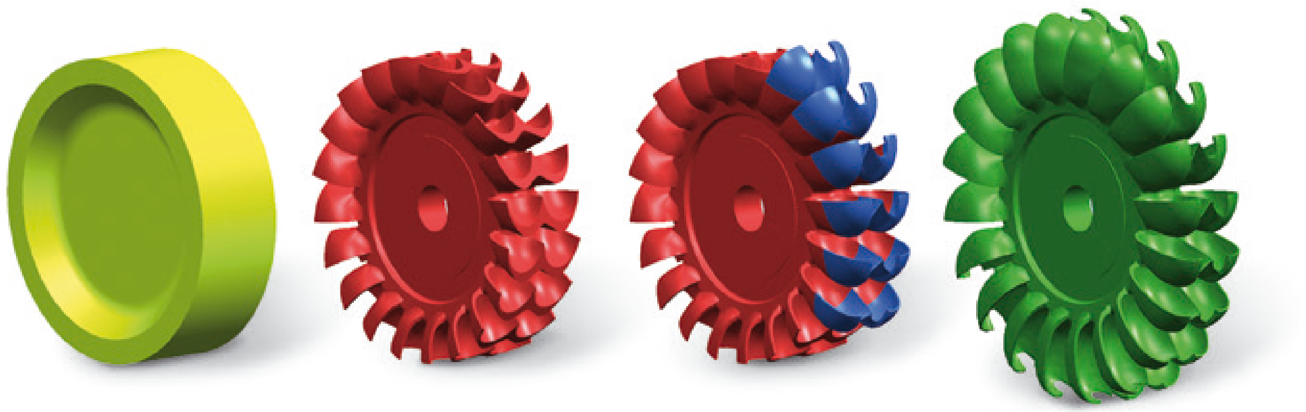
2 Actual flow through model

3 Disc for welded manufacturing strategy, Workshop, São Paulo, Brazil

4 Disc for fully milled manufacturing strategy, Workshop, St. Poelten, Austria



Pelton runner made of forged disc/welded-on bucket heads, manufacturing steps



Step 1:
forged disc machined

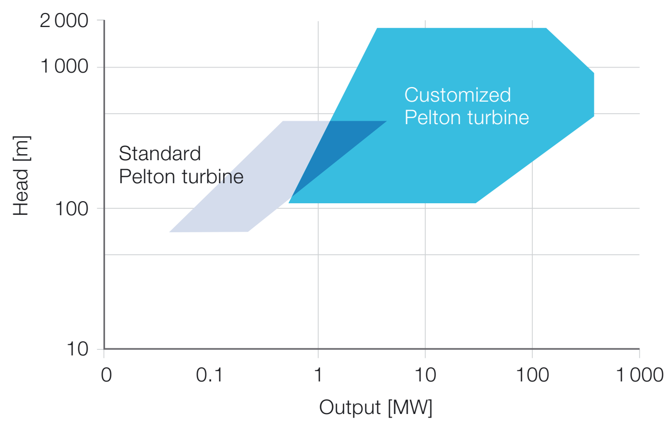
Step 2:
milled root area

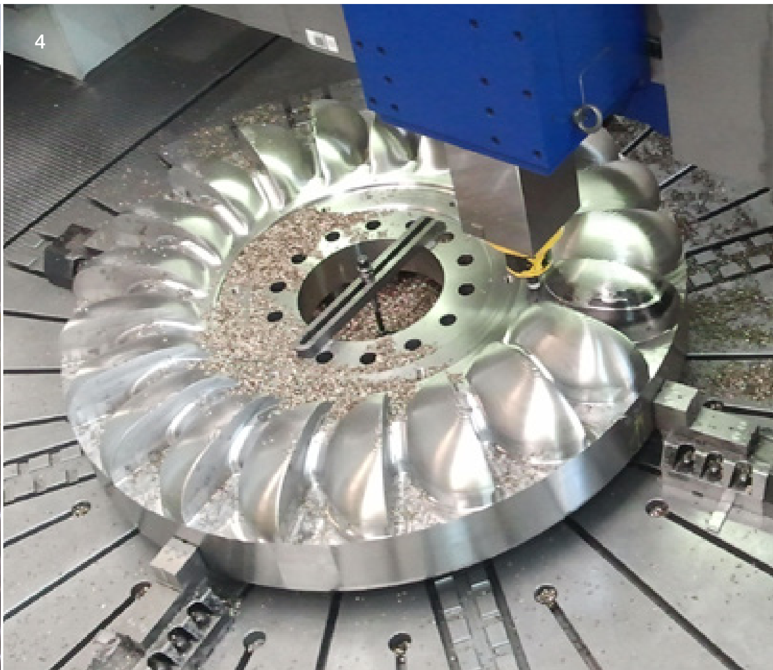
Step 3:
bucket head welded

Step 4:
finished mashined runner

A broad manufacturing program offers an economical solution for any requirement. Large, custom-built Pelton turbines for high output ranges are our speciality, but we also offer a full line of cost-effective standard machines for small hydropower plants.

Application range





1870 **Beginning of the hydropower turbine manufacturing.**

1903 **First Pelton turbine.**

1924 **Walchensee power plant, Germany:**
First high-head power plant in the country with 18 MW Francis double-spiral turbines and twin 15 MW Pelton turbines.

1960 **Naturns, Italy:**
Pelton turbine at a head of 1 129 m.

1964 **New Colgate, USA:**
Largest Pelton turbines at that time with 5.44 m outside runner and 1.1 m bucket width.

1977 **Chivor, Colombia:**
Largest Pelton power plant in the country at that time with eight 151 MW units.

1985 **Carona, Italy:**
Three horizontal Pelton turbines were replaced by one 48 MW vertical machine while preserving historical structures.

1998 **San Giacomo sul Vomano, Italy:**
One of the most powerful Pelton turbines at that time with an output of 282 MW, a runner diameter of 4.4 m, a jet diameter of 315 mm and a bucket width of 1.1 m.

2002 **Breakthrough in 3D-simulations for Pelton turbines.**

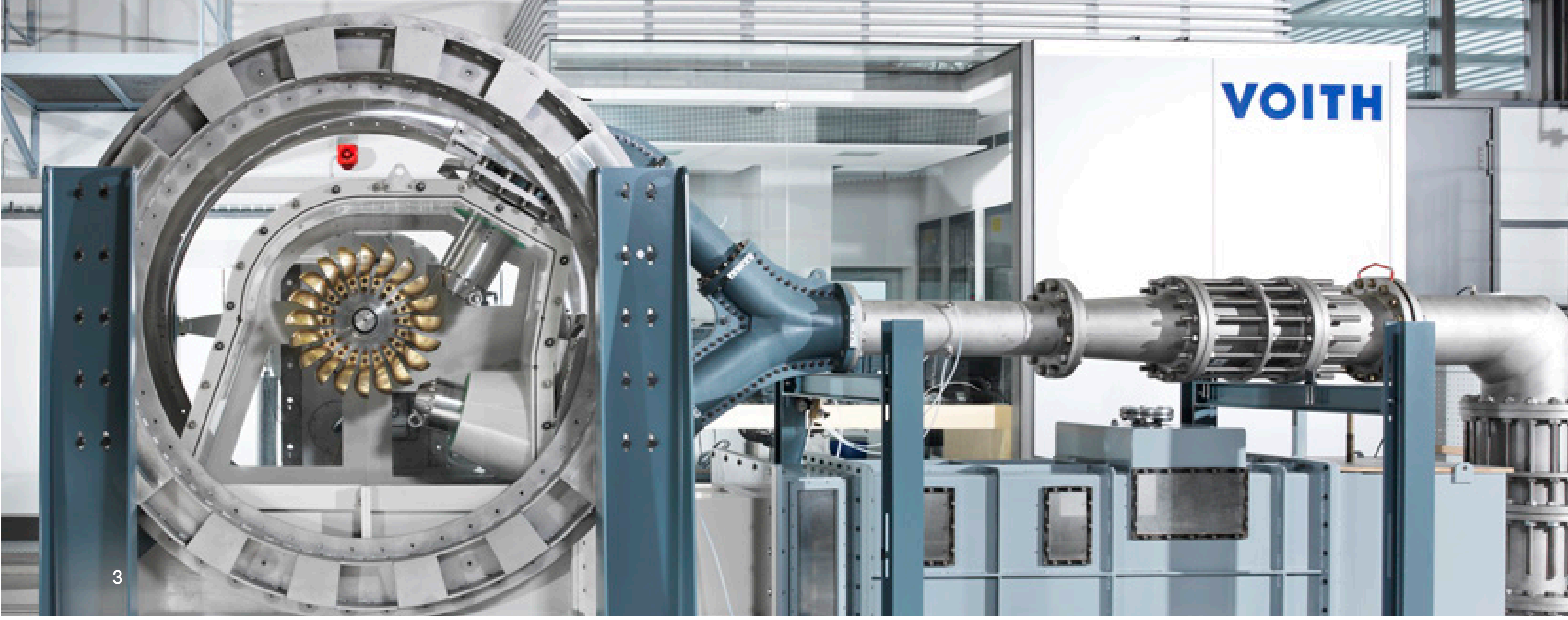
2003 **Gilgel Gibe II, Ethiopia:**
Four vertical, six-jet Pelton turbines, each with a rated output of 105 MW at a net head of 487 m.

2007 **Sedrun, Switzerland:**
Large rehabilitation project with seven runners and 12 nozzles.

2008 **Extensive modernization of Pelton test facility at Corporate Technology Center in Heidenheim, Germany.**

2008 **Akköy II, Turkey:**
One of the highest head Pelton applications worldwide with two 117 MW Pelton turbines at a head of 1 220 m.

2008 **Zaramag 1, Russia:**
Two 176.5 MW Pelton turbines with runner diameters of 4.2 m at a head of 635 m.



1 Gilgel Gibe Powerhouse, Ethiopia

2 Sedrun, Switzerland

3 Modernized Pelton model test rig, Germany

2012 Kops I, Austria:
Modernization and uprating of three horizontal twin Pelton turbines to 96 MW at a head of 776 m.

2012 Alfalfal II, Chile:
Two 135.6 MW Pelton turbines at a head of 1 122.6 m.

2012 Las Lajas, Chile:
Two 135.2 MW Pelton turbines at a head of 465 m.

2015 Los Condores, Chile:
Two six-jet units with a rated output of 89.6 MW operated at a head of 699 m.

2017 Nikachu, Bhutan:
Two four-jet units with a rated output of 66.2 MW operated at a head of 520 m.

2019 Ritom, Switzerland:
Two new units, one running at 500 rpm (16,7 Hz) and 750 rpm (50 Hz) each with a rated output of 62.66 MW operated at a head of 809 m.

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