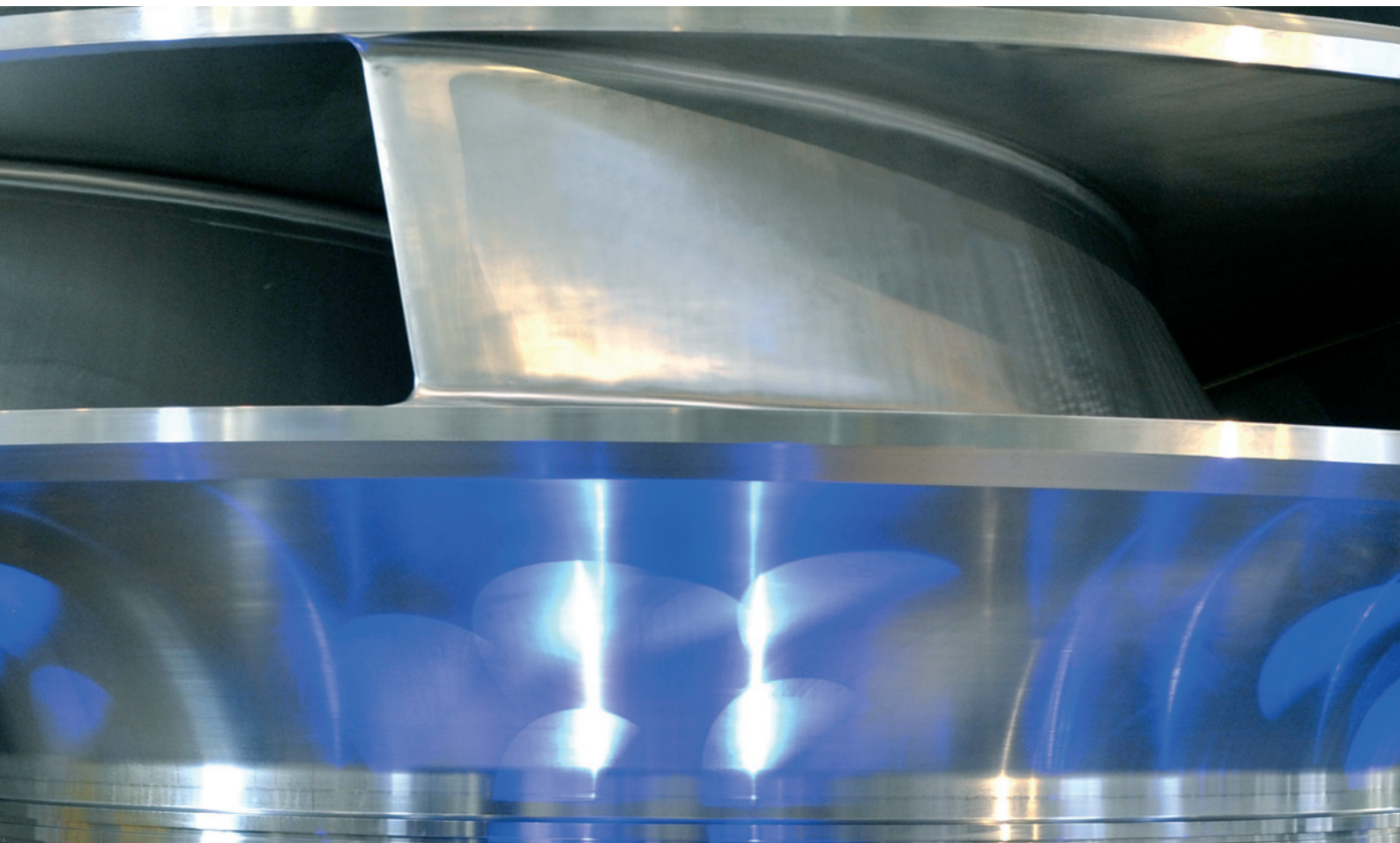


Pumps

Tailormade solutions for water applications





1



2

1 Waterfall
2 Workshop assembly cooling water pump

Expertise in hydro with engineered reliability

Voith

is offering the overall responsibility, from planning to start of commercial operation for new pumping stations as well as the modernization of existing plants. As your reliable partner in hydropower, Voith also covers long-term service needs through its After Market Business Division.

Considering growing world population and therewith significant increasing demand for drinking water, process water and agricultural products, the adequate sustainable management of water resources seems to be indispensable. Also taking into account today's adverse climatic conditions, like frequent floods or long-lasting droughts due to observable climate change, proper water handling solutions gain even more importance.

Sustainable use, appropriate allocation, conservation and reuse of water is a must. Building pumps is taking part in the science and art of water conveyance, irrigation, drainage as well as flood control. Therewith high pump efficiency levels should be guaranteed to ensure low cost during operation and to counter the worldwide increasing demand in electricity.

Due to our comprehensive 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.

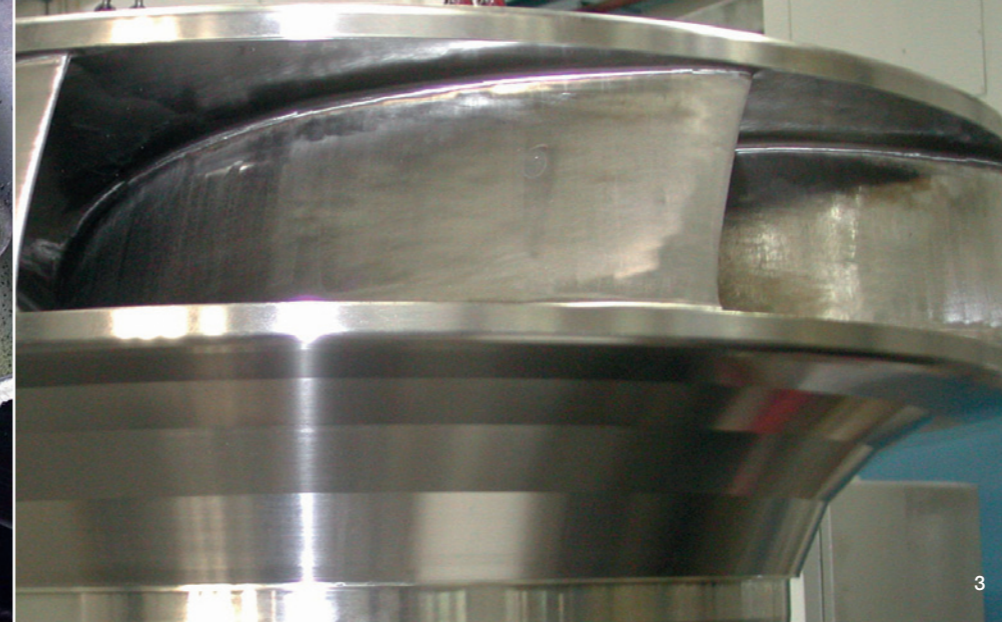
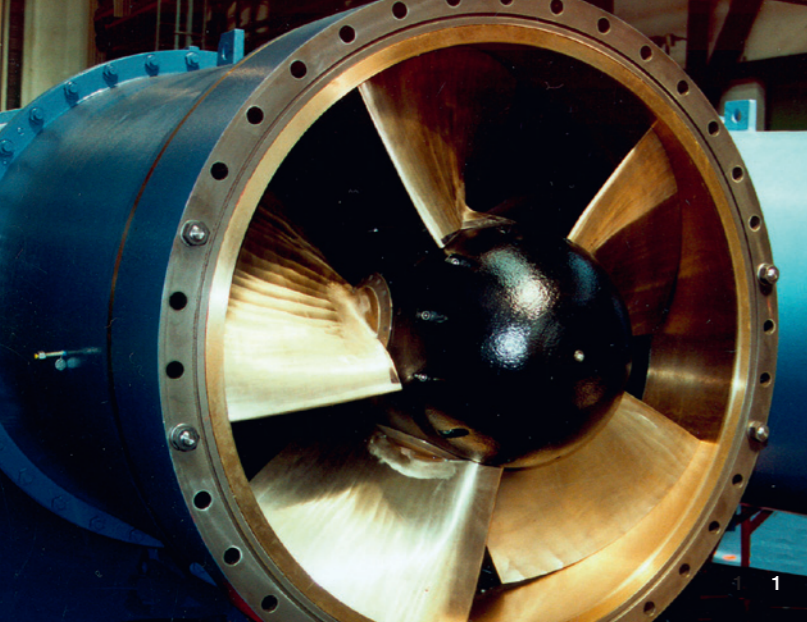
Pumps – our competences and capabilities

We offer 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
- details on pumped storage application see brochure Pumped storage machines: Reversible pump turbines, Ternary sets and Motor-generators

Voith Hydro provides electro-mechanical turnkey solutions:

- Consulting, engineering, erection, supervision and commissioning
- Radial, mixed-flow, axial-flow pumps
- Motors
- Valves
- Electrical and mechanical balance of plant equipment



1 Altenheim, axial impeller Kaplan type
 2 Niederaußem, mixed-flow impeller
 3 Alamos, radial impeller

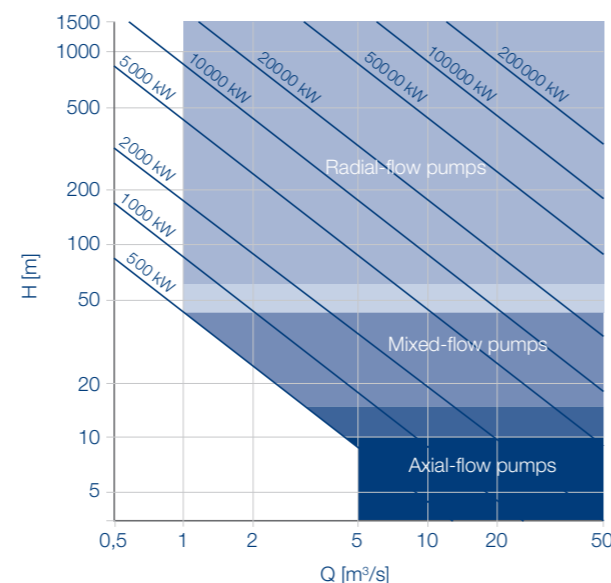
Our technology

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, in combination with high demands in our hydropower business, defines our efficiency and cost effectiveness in the field of pump construction.

Voith
 Voith Hydro has earned a worldwide reputation as reliable pump manufacturer, evidenced by about 380 pump applications equipped with our products, with a total power consumption of around 45,000 MW, reversible pump turbines included.

With great commitment and dedication we seek to offer best fit solutions leading to high effectiveness and reliability of entire pumping stations.

Voith pump application range



Axial-flow pumps

Discharge:
 From about 5 m³/s

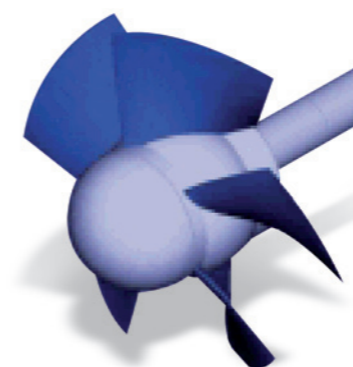
Pump total head:
 Up to about 15 m

Type of construction:

Propeller pumps with fixed impeller blades and fixed guide vanes. Kaplan pumps with adjustable impeller blades and fixed guide vanes.

Application:

Pumps for drainage and irrigation plants, flood control, storm water, (drinking) water supply, waste water pumps, storage pumps, cooling water pumps.



Axial-flow pumps

Mixed-flow pumps

Discharge:
 from about 5 m³/s

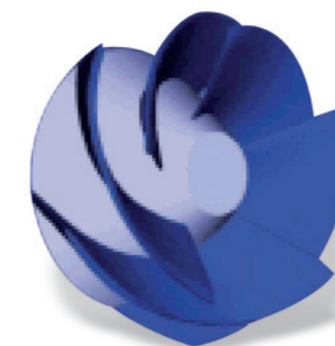
Pump total head:
 Up to about 60 m

Type of construction:

Fixed and adjustable impeller blades, fixed guide vanes, single-flow, single-stage and multi-stage, discharge bend or volute casing.

Application:

Pumps for drainage and irrigation, (drinking) water supply, storm water pumps, waste water pumps, storage pumps, cooling water pumps, pumps for desalination plants.



Mixed-flow pumps

Radial-flow pumps

Discharge:
 from about 1 m³/s

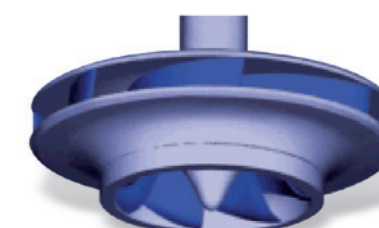
Pump total head:
 Up to the order of magnitude of 500 m per stage and of 1200 m and more in total head in the event of several stages.

Type of construction:

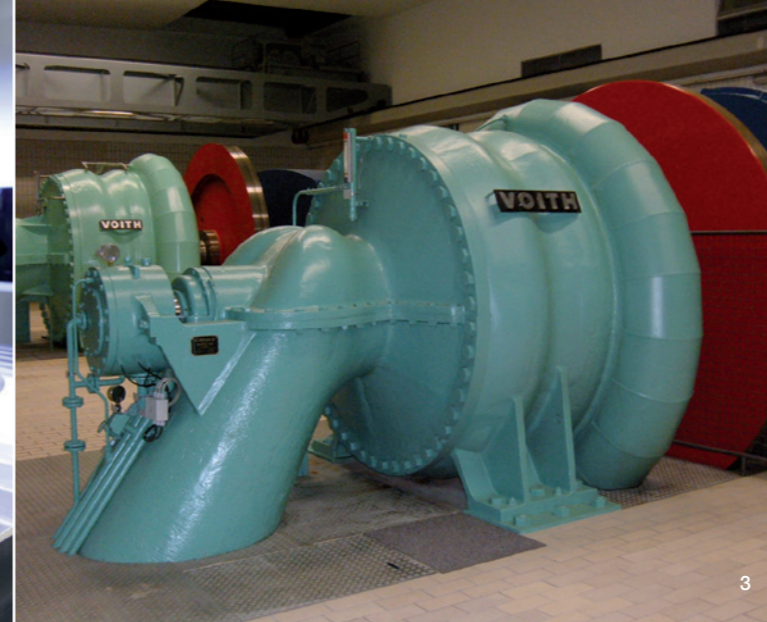
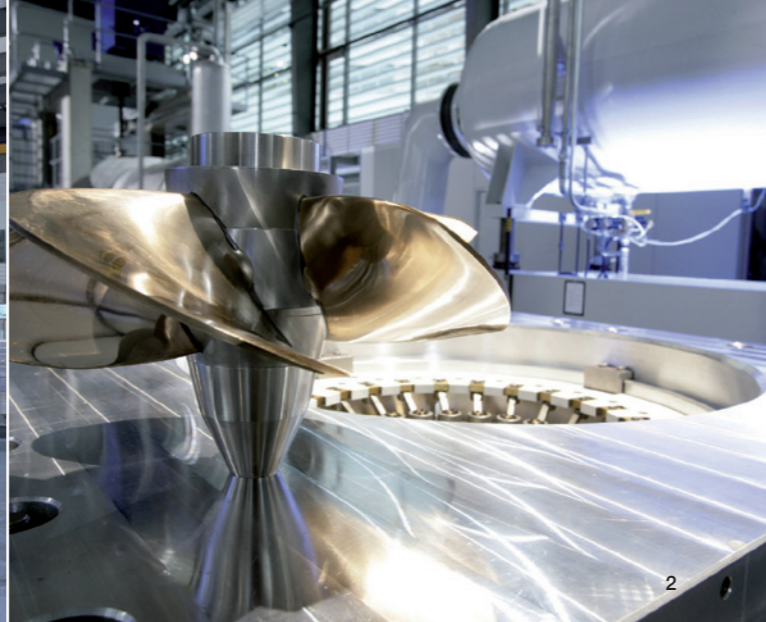
Fixed impeller vanes and guide vanes, single- and double-flow, single- and multi-stage.

Application:

Pumps for irrigation, (drinking) water supply, storage pumps, cooling water pumps, pumps for desalination plants.



Radial-flow pumps



1 + 2 Brunnenmühle, our hydraulic research and development laboratory in Germany

3 + 4 Süßenmühle: Customized multistage pumps for e.g. drinking water

Voith Pumps – features

Our pumps are characterized by compact arrangement and robust design. Due to sophisticated hydraulic shapes our pumps reach high efficiency levels. They are easy to maintain and standardized motors and gear units can be used as drives. By arranging pumps in different ways we assure an optimum integration into buildings, in new and existing ones.

We use different materials in order to ensure suitability for diverse water qualities. Thus, by using adequate materials and technologies we produce highly qualitative pumps.

Our products and services are always designed to our customers' specific needs proving engineered reliability. As a result of decades of continuous optimization based on the latest hydro-dynamic researches, we are ready to offer technologically sound solutions.

Our own research laboratories are developing competitive hydraulic and electrical application layouts for new and existing pumps. We offer hydraulic model testing customer acceptance tests and provide special engineering support on materials, coating, etc.

Typical design solutions

- Tailor-made design according to the specific application
- Horizontal-shaft, vertical-shaft or inclined-shaft design
- Single or double suction, single or multi-stage
- Adjustable and fixed impeller blades for axial and mixed flow design
- Steel volute or concrete volute casings for mixed flow and radial design
- Drives: electric motors, diesel engines or turbines; direct driven or by a gear unit
- Pump shaft:
 - supported by water-, grease- or oil-lubricated bearings (thrust bearings can be arranged directly at the pump, at the drive or at the gear unit)
 - rigidly coupled or flexibly coupled
 - sealed off by a stuffing box with a protective sleeve seated on the shaft or by mechanical seal
- Shut-off valves (e.g. non return valves, butterfly valves or ball valves/spherical valves)
- Governing equipment and pump control systems

Materials

Steel, cast iron, cast steel, NIRESIST, stainless steel, bronze, Duplex, Super-Duplex

Development/layout of hydraulic machines

Voith offers an extensive range of combined methods of simultaneous engineering, model tests and plant measurements for manifold applications like new hydraulics, improvements, modernization and assessment of specific phenomena under certain conditions.

Simultaneous engineering

- Hydraulic design based on a data bank of model tested proven hydraulic shapes which have been developed in our research department
- Computational Fluid Dynamics (CFD) analysis for highly sophisticated flow calculations
- Structural analysis: up-to-date Finite Elements (FE) analysis, Voith data base/programs
- Cost analysis: design, manufacturing methods, materials

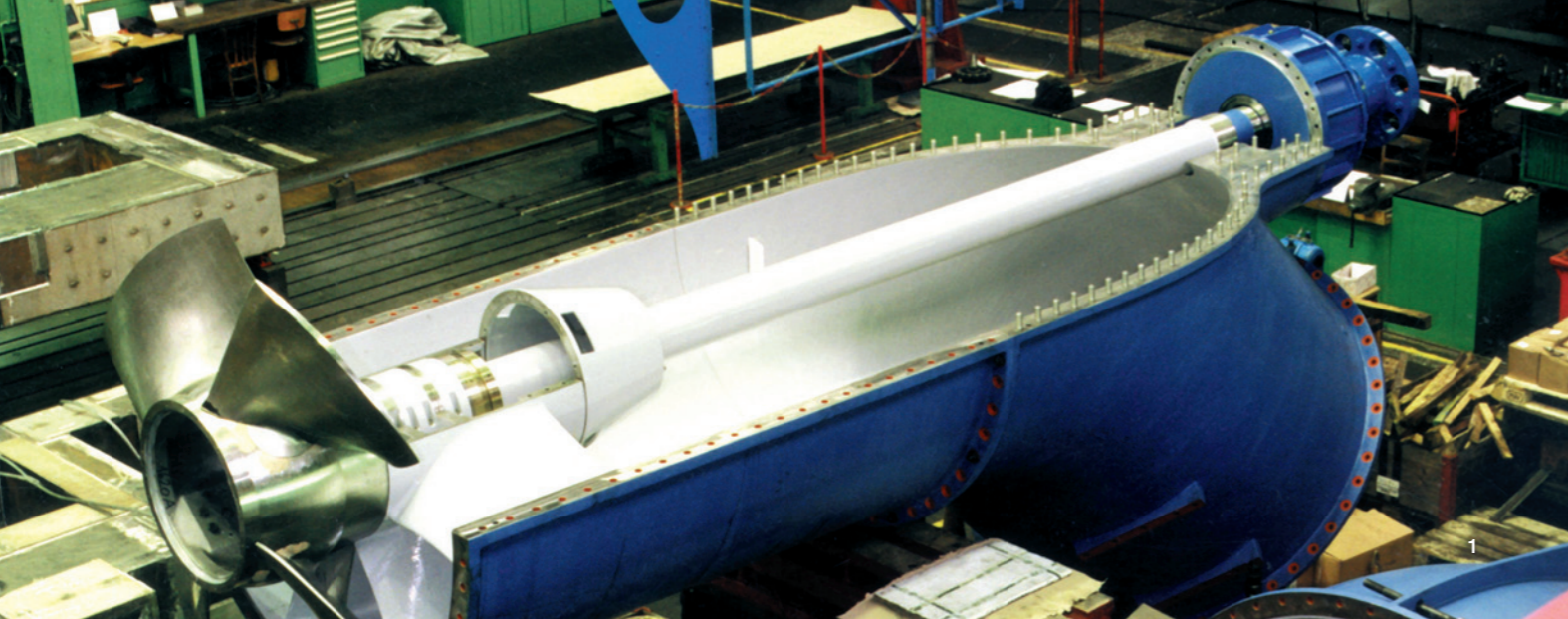
Witness test procedures

- Provision of reports describing pump characteristics based on already existing model tests
- Model tests for new developments and model acceptance tests according to IEC: testing of complete performance characteristics inclusive dynamic behavior on the modern and efficient precision test rigs in our own hydraulic research laboratories in Germany and USA; since its establishment in 1908 the testing facilities have been continuously modernized and supplemented with additional equipment according to the demanding requirements imposed by the hydropower business. Voith has always been aiming to provide state-of-the-art technologies and therefore we achieved to be one of the market-leaders in the hydropower sector worldwide.
- Plant tests/measurements: at commissioning, for output- and efficiency evidence as well as for development of optimization possibilities in existing plants.

Pumps from Voith

- 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





1 Pump for El Max, Egypt



2 Pump assembly at Voith workshop, Austria



3 Assembly of the runner, final stage, Kops II, Austria

Milestones and selected references

With production facilities for hydraulic and electrical machines in Europe, Asia, North and South America we are close to our customers and active in all major hydro markets worldwide.

- 1912** Viverone, Italy:
First pump, delivered to the Piedmont region in Italy.
- 1928** Niederwartha, Germany:
First pump exceeding power of 20,000 kW.
- 1938** Traição, Brazil:
First Kaplan pump for pump-turbine operation.
- 1954** Luenersee, Austria:
First pump with a head exceeding 1000 m.
- 1960** Taum Sauk, USA:
First pump-turbine with power exceeding 200,000 kW for pump-turbine operation.
- 1962** Wagboden I, Austria:
First inclined-shaft Kaplan pump not operating as a pump-turbine.
- 1970** Hornbergstufe-Wehr, Germany:
Four horizontal two stage double suction radial pumps for pumped storage,
P: 250,000 kW, H: 666 m, Q: 36 m³/s.
- 1970** Süßenmühle, Germany:
4 horizontal 3-stage radial pumps for drinking water supply,
P: 7,320 kW, H: 330 m, Q: 2 m³/s.
- 1973** Malta Hauptstufe, Austria:
Two storage pumps with 140,700 kW each

and 1100 m head, equipped with synchronizing converters with gear coupling.

- 1974** Cordoba, Argentina:
Highest output from mixed flow cooling water pumps with 3,900 kW.
- 1975** Alhama, Spain:
Six vertical radial pumps for irrigation,
P: 2,240 kW, H: 116 m, Q: 1.75 m³/s.
- 1977** Embaba, Egypt:
Eight raw water and six drinking water double suction radial pumps for drinking water supply,
P: 284 kW, H: 16 m, Q: 1.6 m³/s
P: 708 kW, H: 60 m, Q: 1 m³/s.
- 1978** Al Jobail I-IV, Saudi Arabia:
Eight vertical mixed-flow pumps for cooling water, sea water application,
P: 557 kW, H: 11.4 m, Q: 4.16 m³/s.
- 1981** Häusling, Austria:
Two storage pumps with 178,500 kW each and 726 m head, equipped with synchronizing converters with gear coupling.
- 1986** Mers El Hadjadj IV + V, Algeria:
Four vertical mixed-flow pumps for cooling water, sea water application,
P: 533 kW, H: 13.4 m, Q: 3.4 m³/s.
- 1987** Large Cavitation Channel, USA:
Largest axial-flow pump impeller with a diameter of 5.52 m.
- 1990** Säckingen, Germany:
One storage pump with 84,400 kW and 410,8 m head, in addition to three storage pumps from Voith Hydro.

- 1992** Riva del Garda, Italy:
One storage pump consisting of mixed-flow booster pump (H: 27 m) and radial flow pump (H: 543 m, three stages) connected to the shaft line of a Pelton generator motor.
- 1992** Yang Zhuo Yong/Tibet, China:
Four storage pumps with 19,100 kW each, six stages with gear coupling for connection in standstill.
- 1992** El Salam 1-3, Egypt:
Inclined axial Kaplan pumps with electro-mechanical drives for adjustable impeller blades for irrigation.
- 1992** Süßenmühle, Germany:
2 horizontal 3-stage radial pumps for drinking water supply,
P: 10,030 kW, H: 325,5 m, Q: 2,78 m³/s.
- 1993** Altenheim, Germany:
Three vertical axial Kaplan pumps with adjustable impeller blades for flood control,
P: 516 kW, H: 6.4 m, Q: 6 m³/s.
- 1994** El Tabia, Egypt:
Six vertical axial pumps for drainage of waste water,
P: 479 kW, H: 6.3 m, Q: 7 m³/s.
- 1996** El Max, Egypt:
Modernization of six inclined axial pumps for drainage of waste water,
P: 700 kW, H: 4.6 m, Q: 14 m³/s.
- 1996** Rurberg, Germany:
Modernization of three vertical mixed-flow booster pumps combined with three vertical radial pumps for drinking water supply,
P: 74 kW, H: 12.6 m, Q: 0.52 m³/s
P: 917 kW, H: 145.7 m, Q: 0.52 m³/s.

- 1997** Linker Donausammler, Austria:
Two vertical axial pumps for storm water,
P: 1,540 kW, H: 13.9 m, Q: 10 m³/s.
- 1997** Niederaussem, Germany:
Two vertical mixed-flow pumps for cooling water purpose for a thermal power plant,
P: 3,770 kW, H: 26.5 m, Q: 12.1 m³/s.
- 1999** Pont Ventoux, Italy:
One storage pump with 73,400 kW and 519 m head, connected to the shaft of a splitter type Francis turbine with gear coupling.
- 2000** Alamos, Portugal:
Two vertical radial pumps for multi-purpose irrigation,
P: 6,244 kW, H: 85.5 m, Q: 6.88 m³/s.
- 2003** Kassaby, Egypt:
Modernization of four inclined axial pumps for drainage,
P: 302 kW, H: 3.6 m, Q: 7.5 m³/s.
- 2004** Kops II, Austria:
Three vertical three stage radial pumps for pumped storage,
P: 152,000 kW, H: 784 m.
- 2008** Koralpe, Austria:
One vertical three stage radial pump for pumped storage,
P: 38,000 kW, H: 740 m.
- 2011** Hongrin Leman, Switzerland:
2 vertical 5 stage radial pumps for pumped storage (under construction),
P: 117,700 kW, H: 865 m.

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