



The flexible, environmentally friendly, robust and cost-effective solution for low head applications The Voith StreamDiver

Generating energy from hydropower is not a matter of scale. Aside large reservoirs, even small rivers and waters of limited heights have the potential to generate power. And although hydropower accounts for the largest portion of renewable energies in the world, there is still a huge amount of untapped potential – especially in the small-scale hydropower sector.

The compact StreamDiver propeller turbine can be integrated into existing infrastructures such as weirs, scaled up into a group of multiple units as required and even used in ecologically sensitive environments. With a turbine generator power-train including all bearings exclusively lubricated by water, the oil free operation is especially compatible with the environment. The concept, deliberately kept simple in terms of design, minimizes the probability of failure and avoids any sealing systems at all. This allows maintenance intervals of ten years, effectively cutting operating costs.

In 2011 Voith Hydro started a collaboration with an Austrian energy utility to develop the StreamDiver. The prototype was installed in 2012 in Nussdorf in Austria and achieved a maximum output of 450 kW with an impeller diameter of 1.3 meters. Since the official market launch in 2013, a number of other locations globally, which would not have been used productively otherwise, have been developed for energy generation. Having started out in Europe, the StreamDiver has now established itself around the globe. Today, installations from Austria to Indonesia and from Macedonia to Brazil are proving the efficiency of the solution.

There are enough reasons for this rapid development: the compact propeller turbine can be used wherever conventional turbines are barely viable. The StreamDiver is an almost silent, hardly visible, power plant that requires little construction efforts. In addition to its environmental compatibility and straightforward installation, the StreamDiver offers the advantage compared to other machines of long maintenance intervals of over ten years.

Highly versatile

Therefore, Voith Hydro has expanded the compact turbine to create an entire product line. In combination with four modular solutions for a diverse range of installation situations, every possible requirement can be covered.

These four predefined installation scenarios include a standard solution with inclined inlet and conventional trash rack system, a compact shaft power plant with optional horizontally or vertically aligned turbines, a purely vertical solution, as well as an in-pipe solution for integrating the StreamDiver into closed pipe systems. The associated cost advantages are down to a number of attributes. For example, the standardized layouts, for every installation situation shorten the planning phase. Less installation depth and thus less excavation and concreting compared to other turbine concepts reduce the construction efforts. And the fact that there is just one interface to the civil structure speeds up the processes in the construction phase and provides an easy interface. Added to this is the inherent advantage of all StreamDiver solutions: they do not need a power house. Instead, a small E-container adequately accommodates the electronic controls and monitors the operation.

Installation scenarios

Standard solution



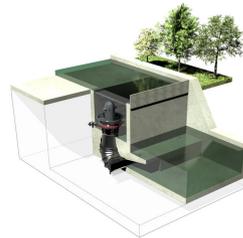
A conventional trash rack system directs the water to the StreamDiver turbine through a inclined inlet.

Shaft power plant



Because it routes the water through a shaft and a horizontal trash rack with underwater trash rack cleaning machine, the shaft power plant is short and compact. This significantly reduces the civil construction costs.

Vertical arrangement



The vertical arrangement of the turbine with rotatable suction pipe permits a change of direction for the water flow. The result is a high degree of flexibility, when replacing turbines in existing systems.

In-pipe



The in-pipe solution makes it possible to integrate the StreamDiver turbine into closed pipe systems.



Low investment costs – high quality

While the annual power generation is comparable to that of conventional, double-regulated turbines, the StreamDiver offers major benefits in terms of investment costs – the civil construction costs in particular. The StreamDiver is able to realize projects with significantly less expenditure on concrete work and excavation – and hence construction costs overall – than conventional solutions. This is mainly down to having foundations that are less deep.

The result is a smaller volume of concrete for the power house. Savings of over 50% can be realized. The underground structure is less complex than that of standard layouts. This allows projects to be planned and adapted swiftly and simply. In its basic version, the turbine itself is designed as an underwater propeller turbine, meaning that neither rotor blades nor guide vanes are movable. Consequently, there is no need for a visible or accessible power house. A space-saving e-container adequately accommodates the electronic controls and monitors the operating data by means of sensors. Temperature, water level and vibrations are measured and the condition of the bearings is checked. All of the control technology is produced by Voith Hydro itself and designed for operation in full remote mode. These innovations effectively cut the overall project costs by up to 25%.

From a structural perspective, there is no need for an expensive power house, a small, cost-efficient E-container is sufficient. The electronic controls required can be accommodated in the smallest space.

E-container



Environmental compatibility and cost-efficiency goes hand-in-hand

Keeping the structural modifications at the point of use to a minimum allows the StreamDiver project to be realized in an especially environmentally friendly manner. More importantly, the design of the machine itself is suitable for use in ecologically sensitive environments.

Thanks to the use of Voith-patented bearings that are completely lubricated by process water rather than oil, the machine operates without any emissions at all. The experience from years of operation helped to optimize the machine in such a way that long-lasting, uninterrupted operation can be guaranteed. Synthetic bearing supports and shells with a high-strength abrading surface were designed in line with the hard/soft pairing principle. As a result, the water-lubricated bearings enjoy a maintenance interval of over ten years. The main maintenance

interval for exchanging plain bearing modules depends on the machine load, the number hours in operation and the quality of the water.

The cost advantages in terms of servicing and maintenance continue: thanks to its special design, the compact propeller turbine operates without excitation system, cooling water system or lubricating oil system and needs neither a gearbox nor dynamic seals. The maintenance costs for the StreamDiver are less than half those of a conventional system.

The water-lubricated bearings have been optimized on the basis of long-standing experience. These components are key to the StreamDiver's compatibility with the environment.

Water-lubricated bearings



Fish-friendly impellers provide primary fish protection



Primary fish protection is ensured by the fish-friendly impeller shape as well as a fine trash rack with a spacing of 20–35 mm. The trash rack's optimal inclination of around 20° generates a flow velocity that is ideal even to smaller-sized fish to, prevent them from getting too close to the rack. They can swim into the

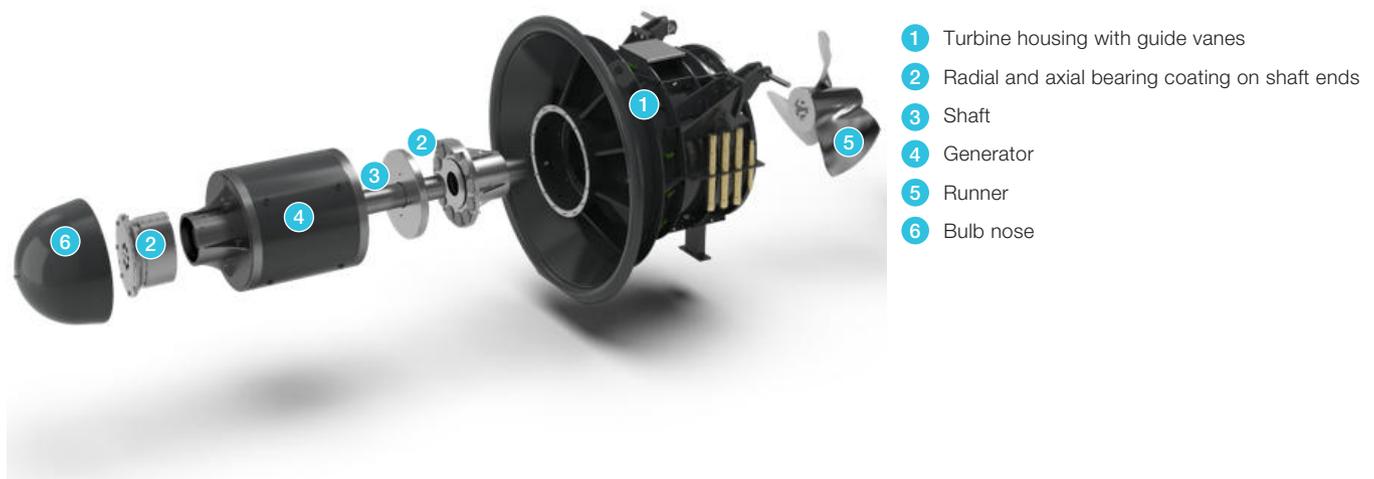
lower water through a bypass without any further detours. A study revealed that various species of fish were unable to penetrate through to the turbine. As the system is totally submerged, the optical and acoustic interference from the power plant is kept to a minimum.

Having the choice of seven standard sizes selected by Voith means that the turbines can be delivered in a much faster time than custom-built turbines.

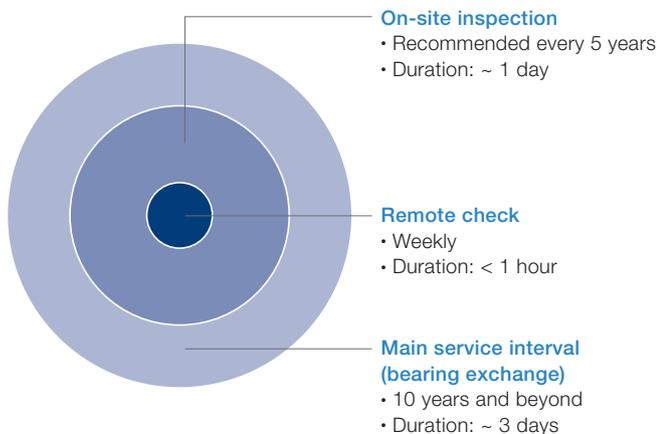
The simple mounting system of the machines and underwater connectors guarantee that the machines can be removed within a matter of minutes. As an option, the system can be equipped with a LARS (Lift And Recovering System), which allows the machine to be removed and lifted out without dewatering.

The main service is carried out at Voith every ten years. Within three days, the bearings, sensors and seals are replaced and the cables and connectors, and the electric motor as an option, are inspected. The service costs for the StreamDiver are 55% less than those for conventional Kaplan-Bulb-turbines.

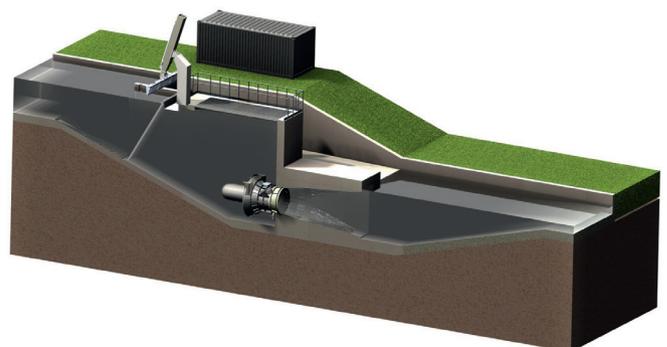
Structure and installation/removal of the StreamDiver



Service



The StreamDiver can be installed and removed without having to dewater the turbine.



Case study Serayu, Indonesia

Beside its use in new systems, the StreamDiver was also designed as a "retrofit solution" for existing dam structures. It offers a high degree of flexibility for integration into existing hydraulic structures and therefore presents an excellent opportunity for exploiting hydropower potentials for low investment costs.

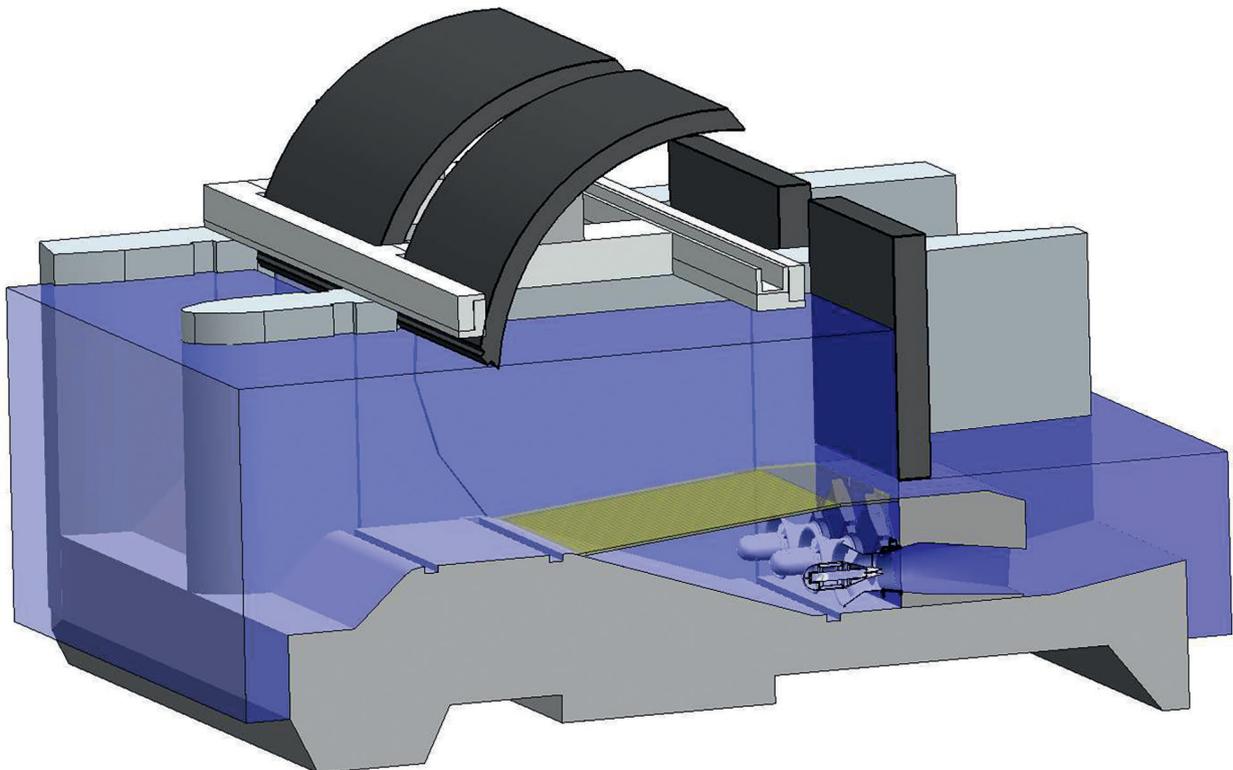
The Voith StreamDiver can be integrated into existing dam structures with few structural modifications – In Serayu, the weir fields in which StreamDiver was installed were equipped with an additional roller gate.

The use of the water lubricated bearings ensures that there is no risk of machine famage or contamination of water. At Serayu, Indonesia, a StreamDiver project that perfectly illustrates the unique character and flexibility of this solution is currently

being realized. As part of the modernization Initiative, a power plant is installed in an existing dam, erected in the mid 1990s for an irrigation canal. The idea was to plan this project with the minimum impact on the existing concrete structure and hence achieve a maximum flow rate. In terms of assembly and service, only the existing infrastructure is being used.

Three StreamDivers units which, by means of simple structural changes and the retrofitting of a further roller gate are able to achieve an output of approx. 770 kilowatts each at a head of 7.5 meters have been planned for each of the two weir fields on the right bank.

The StreamDiver as a retrofit solution



Case study Nogueira, Brazil

In Nogueira, Parana, Brazil, there is a natural cascade. Energias Renováveis MAZP planned to use this cascade for a modern small-scale hydropower plant. Because of the increased cost efficiency compared to conventional Kaplan turbines, and also the higher probability of the project being approved due to the outstanding environmentally friendly technology of the system concept, the choice fell to the Voith StreamDiver. The use of oil-free bearing and the fish-friendly design were crucial to this decision. With a head of 8.2 meters, seven StreamDiver units deliver an output of approx. 5 MW.



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