

VOITH

Voith StreamDiver[®]

New Plant Concepts for
Low Head Hydro Power

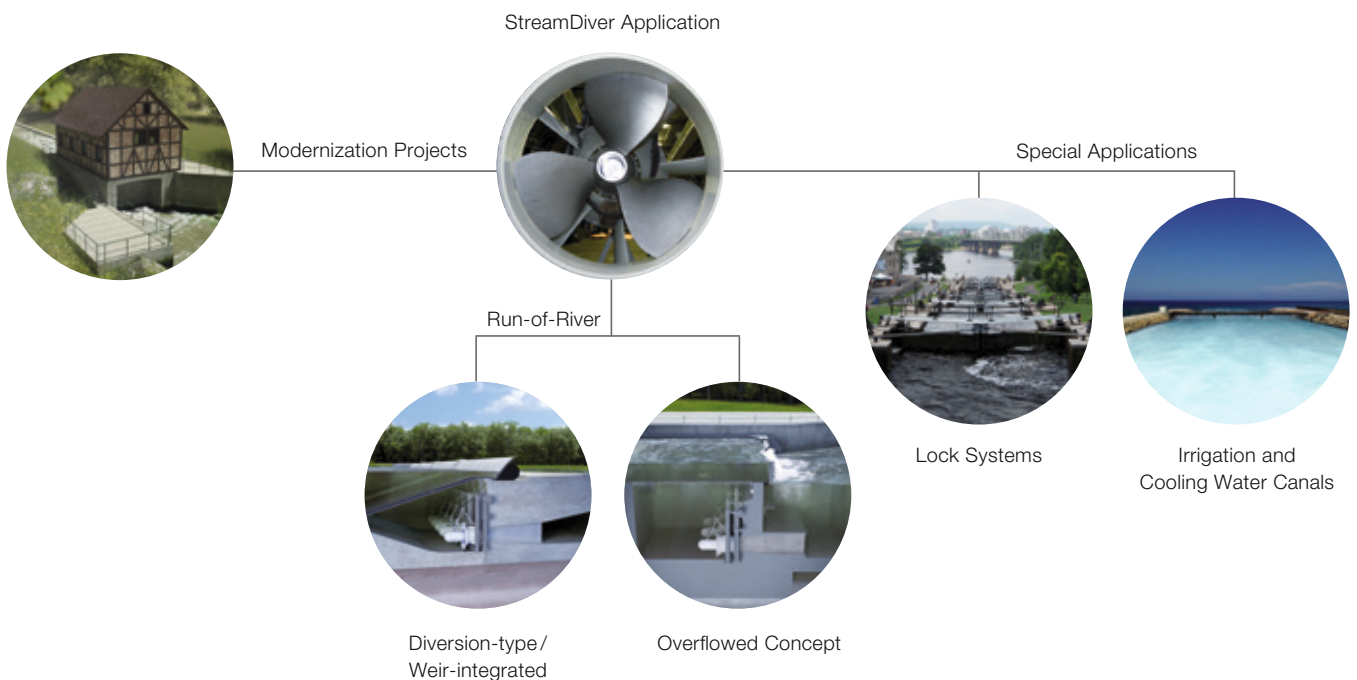


StreamDiver[®] Plant Concepts

Low Head Hydro Power Applications

Low-head hydro offers a variety of new opportunities for power generation. Historically, decentralized hydropower generation at small scale sites has often not been considered as viable due to the high per-kilowatt investment costs and the relatively high efforts for licensing compared. However, this is changing. Lean licensing programs for small-scale hydro combined with new incentive initiatives tip the scales in many regions. In addition, the new StreamDiver technology provides a solution to the low head sector. By design, the innovations tackle all challenges of ecological and economical operation. For example, it allows a flexible and adaptable integration into new and existing civil structures.

Typical StreamDiver Project Types





Bruksfors, Sweden: StreamDiver installation in existing power house

Modernization Projects

Even hydro power plants will reach their life expectancy at some point. Especially those applications at lower heads have a demand for technology which offers less complexity, less maintenance and which can be integrated easily. For modernization projects, minimizing modifications of the existing structure is key. For such application, the StreamDiver® can often be the best solution. Modularity and a wide application range make it adjustable to present hydraulic setups. Its compact design allows for a flexible integration and minimizes local civil adjustments. All this while offering world-class quality and performance.

StreamDiver® Benefits for Modernization Projects

- Minimal adjustments to civil
- Cope with existing hydraulic setup
- No customized turbine design necessary
- Standardized solution
- Fast licensing periods/no new license required

Special Applications

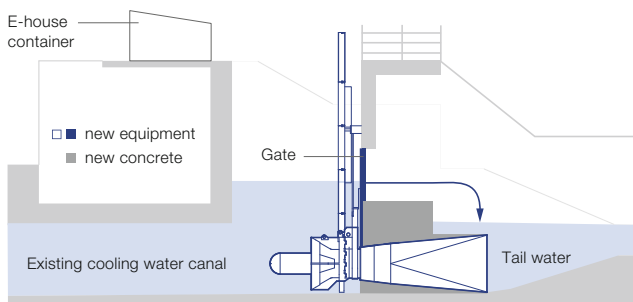
Industrial Water Applications

Canals used for irrigation or cooling water for existing thermal power plants often provide low heads which can be used for power generation. Fast project lead times and short installation time windows during overhauls are typical requirements. Furthermore, no oil or grease may be allowed to maintain the high water quality standards. The StreamDiver can meet all of these requirements. Additionally its minimum requirements to supporting civil structure allow a flexible and cost-effective integration into open water canals or closed pipe systems.

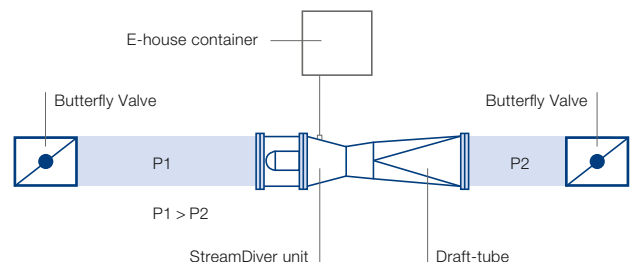
The StreamDiver® Beyond Classical Hydropower Plants

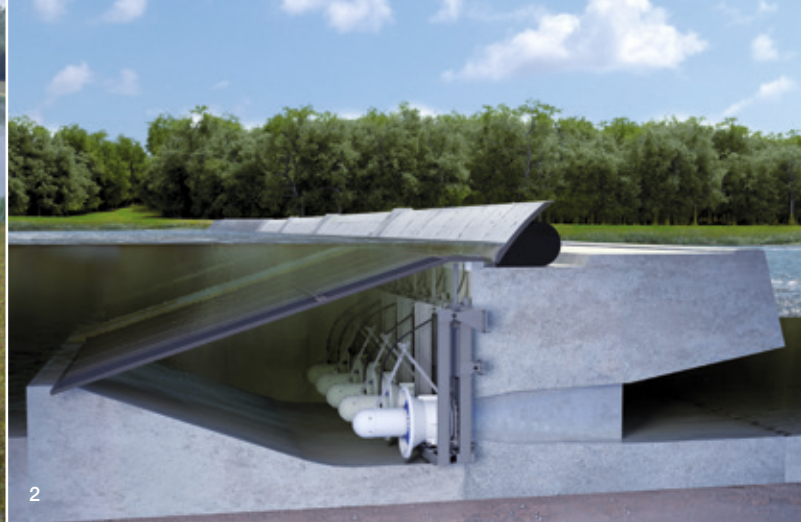
- Irrigation canals (open or closed)
- Cooling water canals of thermal power plants
- Waste water canals
- Pipe systems
- Abandoned or operated lock systems

Open Canals for Irrigation or Cooling Water



Closed Pipe Systems





- 1 Typical weir structure with sluiceway and spillway section.
- 2 StreamDiver power plant in spillway section with head water flap gate.

Run-of-River Applications

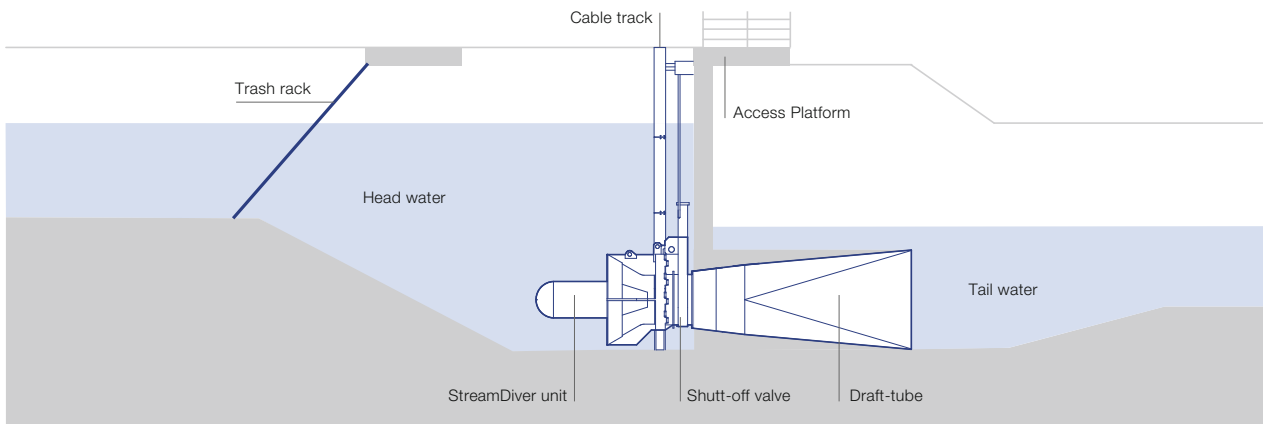
Diversion-type and Weir-Integrated Applications

The classic application is a run-of-river power plant. Existing dam or weir structures along waterways have a huge potential for decentralized power production. A conventional hydro approach would require a diversion type plant. In contrast, the StreamDiver would not require a power house and thereby minimizes the civil impact. For instance, if the weir structure needs to be refurbished, the StreamDiver could be directly installed into the spillway or sluiceway section which would minimize the impact on the surrounding environment.

Benefits of StreamDiver vs. Conventional Solution

- Lower grounding level and shorter power plant
- No power house required
- Simplified civil structure
- Reduced concrete volume
- Low visual impact
- No noise emission
- Oil free power unit

General Run-of-River Power Plant Concept with StreamDiver



The New Ecological Concept: Shaft Hydropower

The Basic Concept

This Innovation for ecological hydropower was developed by the Technical University of Munich in Germany (chair of Hydraulic Engineering and Water Resources Management). All main elements of the power plant, including the generator, are located below the water surface. The water inflow into the water chamber is through a horizontal trash rack which includes a dedicated trash rack cleaning device. The water leaves the chamber through the turbine and draft tube. A small fraction of the discharge is spilled above the turbine chamber through the head water gate. Fish will use this overflow to migrate from head to tail water and a significant water cushion above the draft tube allows for safe downstream fish migration. All elements are fully submerged which makes the power plant invisible from the outside.

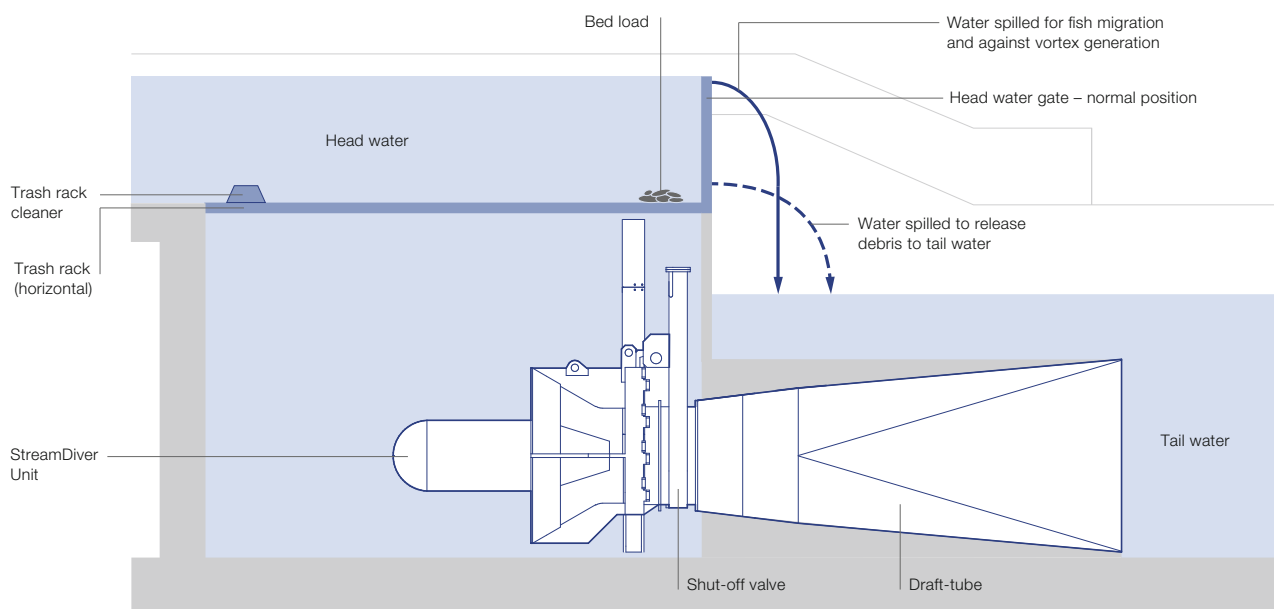
The head water gate can be moved into different positions besides the regular operating position. In cleaning position, all of the bed load and sediments which have been moved towards the gate by the trash rack cleaning device are flushed downstream. In flooding position, the gate is fully open into the shaft, thereby allowing unobstructed flow of water in case.

Therefore, the existing fixed weir is being converted into a flexible weir with all the advantages of it (especially in terms of control of the water level). As a result, the new concept is combining significant ecological advantages with improved flooding protection and therefore meets the requirements of new run-of-river power plants to date.

Key Benefits and Features of the Shaft Hydropower Concept

- No impact on sensible river banks
- Proved concept for fish downstream migration
- Integrated management of bed load and debris
- Improved characteristics in case of flooding
- Improved connection between head and tail water
- Cost-efficient compared to conventional solutions (low concrete volume, no power house)
- No impairment of surrounding environment (all construction elements submerged, no noise impact)
- Modular setup for multiple unit applications
- Oil free design

The Principle of the New Ecological Concept





Multiple Units – From Single- to Multiunit Power Plants

Single-Unit Application – The Prototype

In 2009, the idea for the new Hydropower Plant type was developed at the chair of 'Hydraulic Engineering and Water Resources Management' at the Technical University Munich in Germany. Based on the results of a first physical model, a larger prototype has been built and thoroughly tested since 2013. As one key element, intensive testing has been conducted to develop a robust, modular trash rack with integrated cleaning machine. Extensive fish tests with different fish species have been conducted to prove the safety of downstream fish migration.

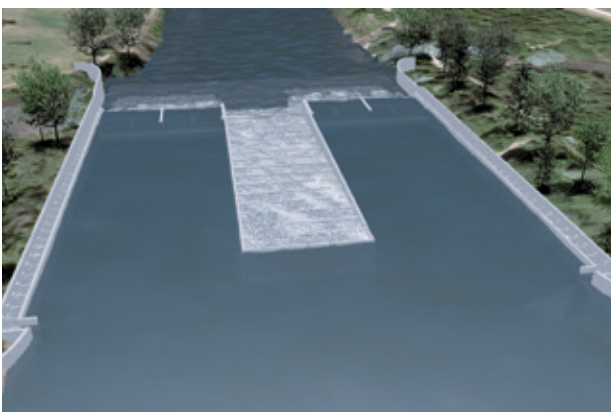
- Turbine output: 35 kW
- Discharge: 1.5 m³/s
- Head: 2.5 m

Large Multishaft Power Plants with Multiple Chambers (1 + 2)

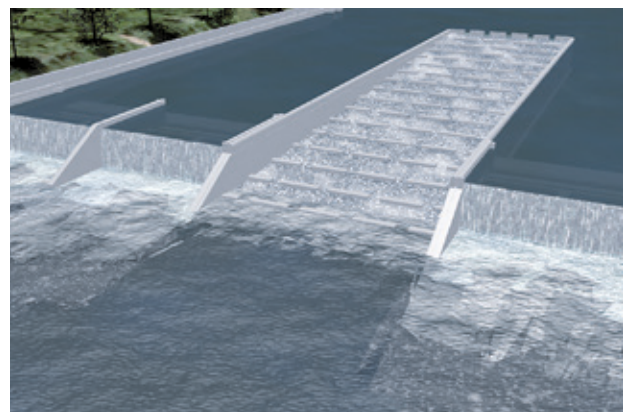
Due to the modular setup, the shaft-concept is highly flexible regarding the size of installations. In smaller rivers, only one chamber or a double chamber (with two turbines) might be installed. Even so, there remains an option to place several chambers in parallel.

The main new element in such a multiunit power plant is the central Eco-Channel. It provides a near natural habitat with varying flow structures, and combining head and tail water, thus allowing for improved fish-upstream migration (fish downstream migration will occur over the gates). On account of the modular setup, power plant installations with multiple chambers can be realized in larger rivers with high discharges.

Multichamber Application (1)



Multichamber Application (2)



- 3 Prototype and demonstration plant.
- 4 Gate section with fish window for optimized downstream migration.

Integration Types

The new power plant concept can not only be realized in new installations but can also be integrated in existing transverse structures, such as fixed and flexible weirs.

Fixed Weirs

A fixed weir existing of a curved spillway section is utilized for power generation. To avoid structural intervention with the existing concrete structure, three chambers are placed downstream of the weir body. In addition, a fish pass is integrated on the side. Minor or no modifications of the existing weir is required.

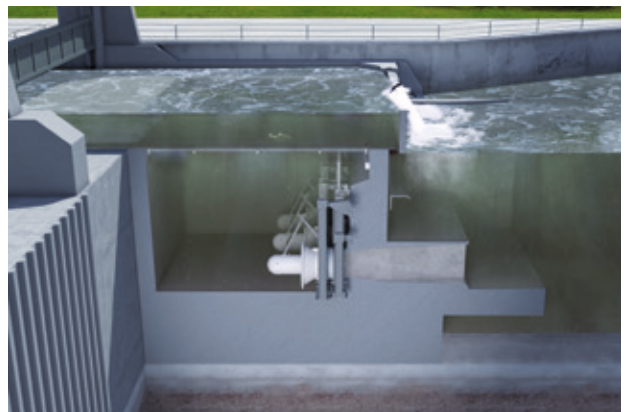
Fixed Weirs



Flexible Weirs

Existing flexible weirs often consist of several bays with sluice- or radial gates. If no structural intervention into the existing weir is permitted, the bays of the flexible weir can be extended towards the tail water. The shaft is positioned in the extension direction in downstream of the new gate. The existing gate of the weir is now used as an intake gate of the plant, for example, if dewatering of the turbine chamber is required. Therefore, no structural intervention into the existing weir body is necessary and all capacity for flood water is being kept.

Flexible Weirs



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