

ZEK HYDRO

Rethinking the Kaplan turbine

The StreamDiver takes off in the USA

EREF successfully lobbied for hydropower

Dak Di1 hydropower plant in Vietnam is online

Weir equipped with Switzerland's widest Coanda



NEW ITALIAN SMALL-SCALE POWER STATION IMPLEMENTED AS PART OF A WIDE-RANGING SYNERGY PROJECT

In a way, it was the idea of killing several birds with one stone that inspired the latest process water project at the Stilfser Joch national park in South Tyrol in the Italian-Swiss-Austrian tri-border region. Based on a complete redesign of an existing power station on the Suldenbach by the local Energie-Werk-Prad cooperative, the project also included plans to renew the existing overhead irrigation system, install an all-new drinking water pipeline, and even provide a new bicycle trail up the Stilfser Joch. Around €11 million of the €20 million project went towards the new construction of the Suldenbach hydropower station. Equipped with a new Pelton turbine, the new green-power station has an annual output of around 21GWh – three times the amount achieved by the old facility.



With the old Mühlbach 1 power station the operators in South Tyrol barely ever got above 7GWh a year. The new facility now generates about three times that.

It was its unique machine equipment that made the old Mühlbach 1 power station stand out among other facilities of its kind. Where else would you find a Francis, a Kaplan and a Pelton turbine working together under the same roof? “We used to love to show this arrangement as part of our guided tours. It was a great opportunity for visiting school classes to get an object lesson on our region’s three most prominent types of turbines,” says Mag. Michael Wunderer, managing vice chairman of the Energie-Werk-Prad cooperative, which was founded 100 years ago to foster local hydropower development. Today the cooperative operates a 120km medium-to-low-voltage

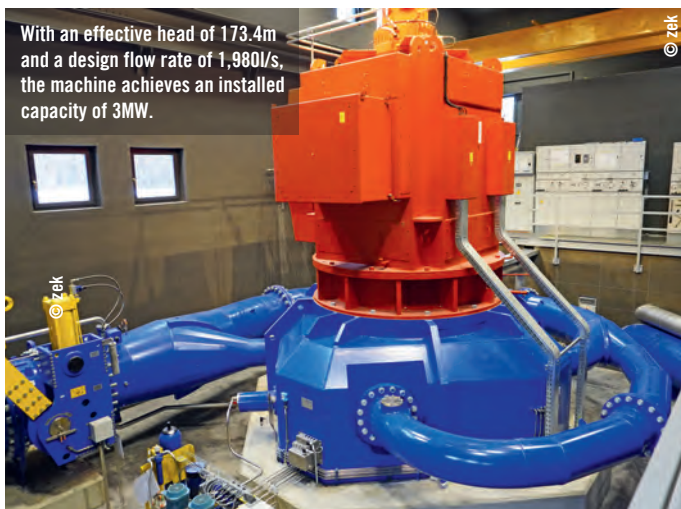
grid, which provides its customers and members with green electricity. It is generated primarily by four hydropower stations and four heat-and-power plants. One of the four small-scale power stations was the Mühlbach 1 facility. Originally built in the early 1980s, it has now been successfully renewed and expanded.

NEW OVERHEAD IRRIGATION AND TURBINE OPERATION

Someone knew all along that the Mühlbach 1 facility had the potential for extensive enlargement: energy pioneer Georg Wunderer, a local from the Vintschgau region. The uncle of today’s managing director and chairman of

the energy cooperative for 40 years, Wunderer was a keen promoter of the guiding principle, “Energy from local sources”. The extension of the Mühlbach 1 power station had always been a matter very close to his heart. After many years of preparation, including a legal dispute with a competitor for the project, the province of South Tyrol finally granted official permission to the Energie-Werk-Prad cooperative in the summer of 2018. Wunderer, the main driving force behind the project, still lived to hear the great news. He died later that year.

Strictly speaking, the existing hydropower station was a twin facility, as the three installed machine units were fed by two pipelines. As



With an effective head of 173.4m and a design flow rate of 1,980l/s, the machine achieves an installed capacity of 3MW.



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Wild Metal GmbH
Handwerkerzone Mareit Nr. 6 • I-39040 Ratschings
Tel. +39 0472 759023 • info@wild-metal.com





Stilfserjoch road is one of the highest mountain pass roads in the Southern Alps, and it had a notorious reputation among cyclists, as they had to share the road with all the other vehicles. Now it was finally possible to build the first section of a separate bike trail along the pipe route, which is closed to other vehicles. The official opening is planned for the very near future. The next section will be completed as part of a follow-up project,” as Wunderer explains.

COMPLEX HYDRAULIC STEELWORK ENGINEERING EQUIPMENT

The power station’s entire water intake was completely renewed. The intake construction consists mainly of a weir field with a steel manufactured fish-belly gate and lateral intake, a gravel guard, and a double sand trap. The latter was implemented using the modern HSR desanding system, which enables an uninterrupted operation of the power station without the need for intermittent flushing. It was provided by South Tyrolean hydro steel specialist Gufler Metall of Moos im Passeiertal. They were contracted to provide most of the hydraulic steelwork construction for the water intake. The only exception was the horizontally aligned trash rack cleaner, which was subcontracted to hydraulic steelwork and machine engineering specialist Wild Metal of the town of Ratschings. Their horizontal trash rack cleaners enjoy an excellent reputation in the industry for their exceptional reliability. Delivered straight off the production line at Gufler Metall, the steel manufactured, 12m wide weir baffle is operated sideways by means of a hydraulic cylinder to ensure a constant water level at the weir gate. The steelwork specialists from the Passeier valley also provided the gravel passage lock-gate with attached

Walter Gostner, a planner from the engineering office of Patscheider & Partner, explains, “A Francis and a Kaplan turbine were installed in the early 1980s. This was state of the art at the time to utilise the available water volume. Compared to this new facility the head was much lower – about 20m – although it was possible to utilise 4,500 litres per second. The Pelton machine unit was added in 1987 along with the overhead irrigation system, which was also used for power generating purposes.” The main difference compared to the new project consisted in the use of a separate turbine penstock and an irrigation line that worked independent of the hydropower facility. This is why the new plan called for the installation of an all-new DN1200 penstock with a total length of 3.3km. “Based on our initial efficiency audit we knew from the start that this project held a considerable synergy potential,” says Wunderer. As a result, the original hydropower project was expanded step by step

into a multi-purpose project that is now considered an exemplary model.

LEVERAGING A GREAT SYNERGY POTENTIAL

Besides an improved irrigation quality, the drinking water supply is another essential synergy effect that benefits the residents of Prad. The municipality had been struggling to ensure the proper quality of its drinking water, as Michael Wunderer recalls: “For Prad the project has opened up an opportunity to utilise new, abundant sources of high-quality drinking water in our neighbouring community of Sulden. This will ensure a proper supply of drinking water for years to come.” However, that is still not all. As it turned out, it was possible to develop yet another synergy potential, this time in cooperation with the municipalities of Prad and Stelfs, the local tourist association, the national park, and local council offices: a dedicated bicycle trail leading up the Stilfserjoch mountain saddle. “The





Gufler Metall installed the tried-and-tested HSR system in the desanding system, which ensures that no intermittent desander flushing is required.

Technical data

- Design flow rate: 1'980l/s
- Turbine: 4-nozzle Pelton
- Rotation speed: 500rpm
- Generator: synchronous
- Hydraulic steelwork: Gufler Metall
- Weir flap: width 12m
- Outlet sluice: w: 1.7m h: 2.5m
- Trash rake cleaner: horizontal
- Penstock material: steel
- Planning: Patscheider & Partner
- Commissioning: June 2022
- Net head at Q_{max} : 173.4m
- Manufacturer: Troyer
- Average capacity: 2.99MW
- Design capacity: 3.8MVA
- Desanding system: HSR
- Dam height: 1.5m
- Inlet sluice: w: 7.5m h: 1.0m
- Manufacturer: Wild Metal
- Length: 3'300m DN1200
- Controls & regulation: Troyer
- Average annual output: 21GWh

debris flap, the 6m wide intake gate, and the pipe burst valves for the penstock and irrigation pipeline. It was also Gufler Metall who made another essential contribution to the project: “During the first year of operation we noticed that the water from the overhead irrigation was rather clouded, and small twigs and leaves were passing through the fine-grated rack that has a gap width of 1.5cm. So we had to step in and fix that,” says Walter Gostner. Gufler Metall was contracted again, this time for the installation of an additional Coanda screen. It is very efficient in keeping small floating debris away from the pressure chamber of the overhead irrigation system. The screen is also self-cleaning, which means it is virtually maintenance-free.

TURNING THREE MACHINES INTO ONE

Unlike the intake construction and penstock, the existing power house was not replaced completely. Instead, it was elaborately hollowed out and modified to accommodate a single cutting-edge machine unit. This was because a

single 4-nozzle Pelton turbine with directly coupled synchronous generator was to replace the three different machine units. As for the electro-mechanical and secondary equipment, the operators opted for technology by long-standing South Tyrolean specialist Troyer. The machine they provided was custom tailored to maximise the energy output of the Suldenbach facility. With an effective head of 173.4m and a design flow rate of 1,980l/s, the machine achieves an installed capacity of 3.0 MW.

Thanks to the new machine unit, the Energie-Werk-Prad cooperative was able to achieve the quantum leap in energy production that they had hoped for: “With the old Mühlbach 1 power station we'd barely ever got above 7GWh a year, but the new facility now generates about three times that – 21GWh”, says Wunderer with a smile. For him and the energy cooperative this achievement represents a crucial milestone: “With all our facilities taken together we now generate between 30 and 32GWh of energy. Thanks to this boost in

capacity we're now able to supply our customers with local energy all year round – even during the winter season!”

OFFICIAL INAUGURATION OF A SHOWCASE PROJECT

Overall, it took the engineers a little more than six months to refurbish the entire hydropower station. In June 22 it was finally time to take the new machine unit on-line. The facility has been running smoothly, reliably and efficiently ever since. As for the other synergy projects, they have not all been completed so far. Although the irrigation system was already taken into operation last year, the new drinking water pipeline in Prad is still under construction. Walter Gostner expects Prad's residents to receive most of their drinking water via the new supply pipeline once it is finished. The new uphill bike trail is planned to be opened to the public in late spring this year. Together with the other parts of this comprehensive multi-purpose project, it will be presented to the public and given a proper opening ceremony.



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A bird's-eye-view of the construction site at the Vallember water catchment from August 2022. During the comprehensive renovation period, the structure, originally built in 1970, was equipped with a fish ladder and descent aid, as well as a largely self-cleaning Coanda system made by the South Tyrolean company Wild Metal GmbH.



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VALLEMBER WEIR EQUIPPED WITH SWITZERLAND'S WIDEST COANDA SYSTEM TO-DATE

The Vallember weir infrastructure is part of a multi-stage system comprehensively renovated last year by the operators Engadiner Kraftwerke AG (EKW). Built in the municipality of S-chanf and originally commissioned in 1970, to guarantee ecological continuity the weir infrastructure was enhanced to include a fish ladder and equipped with an almost completely self-cleaning „Grizzly Power Optimus“ Coanda system made by the South Tyrol-based company, Wild Metal GmbH. At a length of approximately 23m, the rake surface is made up of 20 elements, forming the broadest single Coanda screen installed in Switzerland to-date. The 'record-breaking Coanda' screen facilitates the discharge of up to 6,000l/s of works water, while also ensuring a safe descent for fish into the tailwater section below the weir.

Engadiner Kraftwerke AG (EKW) is one of the ten largest electricity producers in Switzerland with an average annual production of around 1,400GWh of green electricity. Major Swiss energy suppliers such as BKW, Alpiq, Axpo, CKW, the Canton of Grisons and several municipalities, are all shareholders in the partnership-oriented public limited company. EKW generates the majority of its electricity with the Ova Spin pumped storage power plant and its two storage power plants, Pradella and Martina, in the Engadine Valley, connected via gravity flow tunnels and high-pressure penstocks. The plants operate a total of 13 machine groups, including five residual water turbines, to produce a joint power capacity of 412MW. Furthermore, EKW holds a 14% stake in the cross-border Inn Joint Power Plant (GKI), which started operations in 2022.

RENOVATION OF THREE WATER CATCHMENTS

The uppermost section of the three-part plant network is the Ova Spin pumped storage power plant, whose works water is sourced from the Livignio reservoir and a total of four water catchments. The Tantermozza catchment had already been restored when comprehensive renovation work was commenced in the spring of 2020 on the other three water catchment infrastructure sites: S-chanf, Varusch and Vallember. These three water catchments are loca-

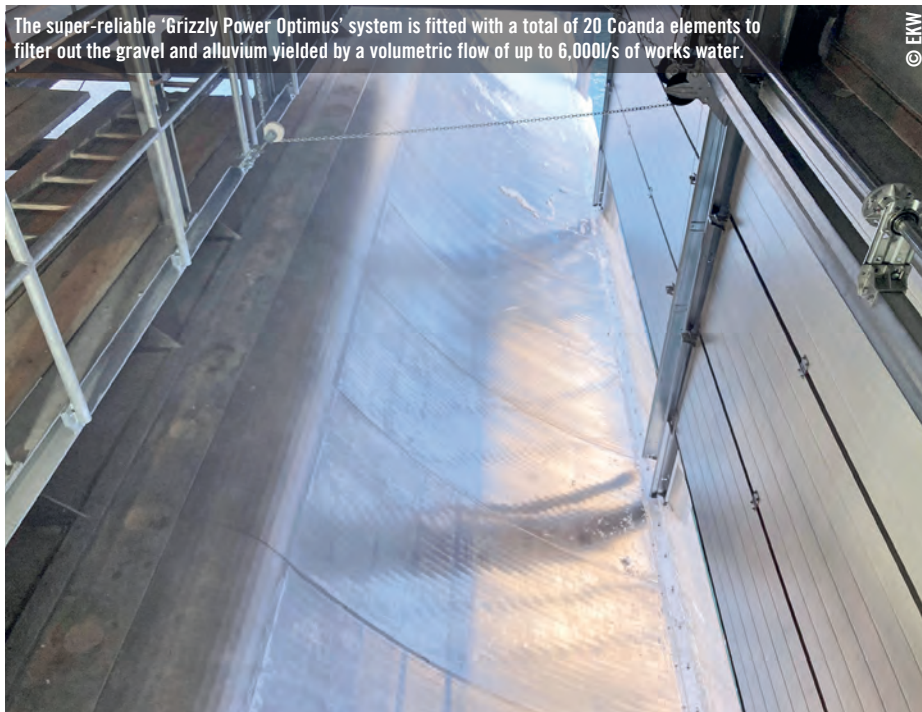
ted in the municipality of S-chanf and first went online in 1970, so some parts were in urgent need of repair and replacement. The hydraulic systems controlling various regula-



Exit area of the fish pass

© Wild Metal

The super-reliable 'Grizzly Power Optimus' system is fitted with a total of 20 Coanda elements to filter out the gravel and alluvium yielded by a volumetric flow of up to 6,000l/s of works water.



ting and shut-off valves were renewed in all the water catchments, and a number of protective screens, associated screen-cleaning machinery and items of structural infrastructure were repaired, replaced or renovated. The electrotechnical control and regulation equipment at each plant was modernised, too. "Renovation of the three water intakes had been planned for several years, but had been postponed, among other things, due to lack of personnel. Once final official approval had been granted in spring 2020, the way was clear for project implementation," explained EKW's project manager Curdin Barblan. In order to minimise water loss and the concomitant plant power generation reduction during the construction period, work at the three sites was staggered in three phases. Plans for the Vallember catchment along the run of the eponymous river included the renewal of structural and technical infrastructure, and the implementation of a means to ensure safe passage for fish and river-dependant life.

MINIMISED WATER LOSS

General renovation planning for the Vallember dam was carried out by EKW's technical office. Straub AG, an engineering firm with a proven track record in the hydropower sector and member of the Swiss Pini Group, also played an important role in the planning process. Straub AG was charged with the analysis of the current situation, and identification of deficits prior to project implementation, and also carried out a study of options to ensure the best variant was developed for implementation by the construction management team. EKW awarded the contract for the entire con-

struction portfolio to Costa AG, based in Pontresina, Engadine. Curdin Barblan explains: "Time limitations were a major challenge for the project as work had to be completed within a single construction season to minimise water loss. Necessary watercourse diversions were dependent on construction progress on the respective infrastructure. Rather than engineering one major watercourse diversion, a variant with three smaller diversions was chosen, and worked very well."

EXTRA-WIDE COANDA SYSTEM

The basic functional principle of extracting works water laterally was also retained after renovation of the water collection basin. Prior to reconstruction, the water passed through a

coarse screen and on into a desander basin. From the desander, the water flowed over a spillway edge into a stilling basin and was channelled down a tunnel to the central S-chanf catchment weir. During reconstruction the coarse screen and spillway edge were removed, and a partition wall was erected in the middle along the length of the desander basin. Works water now flows over the partition through a Coanda rake, is collected in a trough before reaching the existing stilling basin at the end of the structure and disappearing down the tunnel. The 'Grizzly Power Optimus' Coanda system was supplied by the South Tyrolean industry experts at Wild Metal. The patented system is an almost completely self-cleaning protective screen for water catchments, and is suitable for use in the hydropower sector, for drinking water and for fish farms. The system takes its name from the Coanda effect, and floating debris is automatically flushed from the fine screen surface without the aid of any additional components. The entry of sand into the water intake is minimised by the extremely small screen gaps. Wild Metal relies on Inodur stainless steel to produce the Grizzly series, as it offers supreme abrasion resistance qualities. The South Tyrolians at Wild Metal supplied a total of 20 Coanda elements for the Vallember catchment, each combined with another along an approximate total width of 23m, forming the broadest Coanda system in Switzerland – and also armoured the diversion stream bodywork with 15mm Hardox steel.

VERTICAL-SLOT FISH LADDER

The Grizzly's fine screen was designed to provide fish with a gap of 0.6mm through which they can descend into lower water beyond the



View from below of the Coanda system fine screen with 0.6mm gaps, guaranteeing the safe passage of fish into the tailwater below.

weir, explains Curdin Barblan: “The fish pass through the partition wall in the desander and, via the screen, reach the trough to guide them safely into the tailwater below. The considerable length of the desander basin required a solution that guaranteed uninterrupted partition wall overflow. This was achieved by installing four smaller and four larger control flaps along the desander to ensure a constant water level in the headwater area, and provide the fish with a sufficiently large transition area to the Coanda system.” The flaps, which were also included in Wild Metal’s scope of delivery, optimise water intake volume instantaneously, says Curdin Barblan: “If more than 6,000l/s were taken in it would exceed the volumetric flow capacity of the penstock and cause undesired water back-up. The control flaps allow excess water to be released into the stream bed if inflows are too voluminous.” A 23-pool vertical-slot pass made of concrete elements was engineered to provide a fish ladder. After entering the tailwater area, the fish swim along a steel pipe of around 15 metres in length to the first basin below the weir. During the autumn and winter, the fish ladder is doped with a residual water discharge of 200l/s. In the spring and summer, the prescribed residual water discharge is 400l/s. Additional residual water is released through a separate pipeline into the lowest section of the fish ladder. This prevents excessive flow velocity in the tailwater, which can prove an obstacle for fish species less able to swim against strong currents.

POSITIVE OPERATING EXPERIENCE

As well as the installation of a fish passage and a Coanda system, the project also involved renovation of existing hydraulic steelwork components – such as the weir segment,

A vertical slot pass fish ladder consisting of 23 basins was constructed at the water intake. Monitoring of the fish ladder commences in May 2023.



flushing gate, inlet flap and bottom outlet gate. Renewal work was carried out here by the Swiss company Föh Maschinen & Anlagenbau AG. Project implementation commenced in mid-March last year, and the renovated water intake and fish ladder were already operating in November. “Construction work involved multiple challenges, and we knew from the test drillings we were dealing with a frost depth of about 2.30m, which of course made the job all the more difficult. It took two weeks longer than estimated to install the sheet piling, with strict safety measures required during excavation. Furthermore, the original plans for the existing infrastructure were not of requisite quality. There were no design details of the lower section of the desander. Since the

base element had been embedded in solid concrete, the dismantling work required to facilitate the installation of the new partition wall was extremely tough and time-consuming. A concrete block of more than 27m in length had to be extracted using rope cutting techniques. Ultimately, a challenging and fascinating project was brought to a successful conclusion,” Barblan affirmed. At present various tasks are being completed at the catchment site, including regreening and the installation of safety fencing. Monitoring the success of the fish ladder is to commence in May, and continue throughout the summer months. EKW is confident monitoring will produce positive findings. Initial operational observations have already shown that the fish ladder has been accepted by the river inhabitants.



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Wild Metal GmbH
Handwerkerzone Mareit Nr. 6 • I-39040 Ratschings (BZ)

Tel. +39 0472 759023
Fax +39 0472 759263

www.wild-metal.com
info@wild-metal.com

