

CASE NOTE

ACS6080 drive enables Alpine pumping station to generate hydropower



Z'Mutt dam, Switzerland.
Source: Alpiq Holding Ltd.

Alpiq

Alpiq is a leading Swiss energy services provider and electricity producer in Europe. The Alpiq Group has more than 1,200 employees and is headquartered in Lausanne.

Alpiq offers comprehensive services in the fields of energy generation and marketing as well as energy optimization. It has been generating climate-friendly and sustainable electricity from carbon-free Swiss hydropower for more than a hundred years. Alpiq's power plant portfolio also comprises shares in two Swiss nuclear power plants as well as flexible thermal power plants, wind farms and photovoltaic systems in Europe.

Alpiq is an international energy trader, active on all major European markets, with expertise in the field of flexibility marketing and cross-border trading. Alpiq uses digital tools to optimize electricity generation and consumption as well as the energy flow between producers, prosumers and consumers in order to stabilize electricity grids.

Grande Dixence hydroelectric complex

The Grande Dixence hydroelectric complex in southern Switzerland produces 2 billion kWh per year, equivalent to the average annual consumption

Hydropower is Switzerland's foremost renewable energy source. Grande Dixence SA, a partnership company (Alpiq, Axpo, BKW, IWB), operates the country's most powerful hydroelectric complex and accounts for 20% of Switzerland's energy storage capacity. Grande Dixence SA upgraded its Z'Mutt pumping station by installing a reversible pump-turbine and ABB variable speed drive, enabling the station to supply electricity to the local grid.

of 500,000 households. It includes two reservoirs, Lake des Dix and Lake Cleuson, four pumping stations and three power stations. Meltwater from 35 glaciers is collected and pumped through 100 kilometers of tunnels to Lake des Dix, which is the largest reservoir in Switzerland. Lake des Dix stores 400 million cubic meters of water behind the Grande Dixence Dam, which is the world's tallest gravity dam.

Z'Mutt is one of the four pumping stations that feed water into Lake des Dix. Located at an altitude of 1,972 meters, close to the legendary Matterhorn, it was originally commissioned in 1964. Its five pumps have a capacity of 88 MW and a maximum discharge rate of 17.4 cubic meters per second. Grande Dixence SA operates the Z'Mutt pumping station and other assets through Hydro Exploitation SA, a facilities management company.

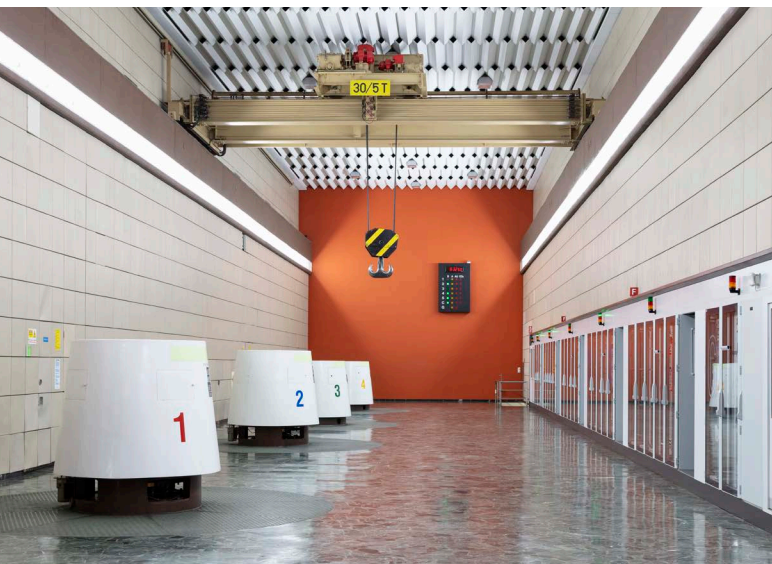
Highlights

Clean power output with no need for additional harmonic filtering

Compliance with grid code requirements on wide over-/undervoltage range

Capability to safely halt backwards spinning turbine from runaway

Four-quadrant capability for two operating modes, pumping and generating



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01 Z'Mutt power station
pump hall for group 1-4
Source: Alpiq Holding Ltd.

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02 Pump for DOL motor
that was replaced with
new design for both
pumping/generating
operation mode.
Source: Alpiq Holding Ltd.

Challenge

Unit G5 at Z'Mutt pumping station previously operated in pumping mode only. It was connected directly to the network and ran at fixed speed. The purpose of the upgrade project was to convert it to operate as both a pump and generator, and at variable speed and load.

Generating mode is required when there is an urgent demand for power in the nearby village of Zermatt. When power is needed, unit G5 must quickly switch over from pumping to generating mode and feed power into the grid. Otherwise it will normally operate in pumping mode.

As an additional safety feature to prevent abnormal system conditions, the drive is expected to be capable of catching the potentially backwards spinning pump-turbine 'on the fly' - even up to runaway speed - and braking it under full control to bring it to a standstill.

Solution

The pump in unit G5 was replaced with a reversible pump-turbine that can operate in both pumping and generating modes. The motor was also replaced. An ABB ACS6080 medium voltage drive was installed to provide variable speed operation and feed the generated power into the grid.

The replacement of the unit G5 at Z'Mutt is part of the European Union XFLEX Hydro project. The new unit serves as a demonstrator for variable speed reversible pump-turbine.

The drive is rated at 5.7 MW and features an Active Front End (AFE) for four-quadrant operation at variable speed. ABB also supplied the transformer and was responsible for transportation of the equipment to the site and into the powerhouse, as well as installation, cabling and commissioning.



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Final commissioning of the equipment was completed in 2022.

Benefits

This project has made the pumping station much more flexible: unit G5 now not only pumps water up to Lake des Dix, but it can also reverse and generate power for the grid.

Variable speed operation enables the rotation speed of the pump – and therefore its power consumption – to be controlled. The water flow can be regulated in the range of 50% – 100%.

The drive's four-quadrant operation at variable speed ensures the best system efficiency and operational flexibility. The AFE produces a clean output to the grid, and no additional harmonic filtering is required. Additionally, the AFE was able to compensate to maintain converter operation in both pumping and generating mode during grid disturbances down to 60%.

The ACS6080 is the first drive featuring ABB's innovative Model Predictive Pulse Pattern Control (MP3C) technology. MP3C offers the highest level of dynamic performance provided by ABB's well-proven and robust Direct Torque Control (DTC), combined with an unprecedented power output quality. It maximizes efficiency and motor friendliness, enabling operation at higher motor output power and frequency.

The drive enables fast but smooth starting and stopping of the pump-turbine. This helps to increase component lifetimes. In particular, it is predicted that damage to the pump-turbine that could occur during start-up in generating mode will be much lower than with fixed speed operation. Fast transitions from pumping to generating and back allows a quick response to changes in energy demand.

ACS6080 medium voltage drive

ACS6080 offer high dynamic performance, reliability and safety for demanding applications. On top of ABB's new MP³C control technology, the drive provides easy-to-use interfaces to simplify operation, inbuild connectivity to benefit from advanced ABB Ability™ remote services and many other features that are crucial for high-power industrial applications.

Modularity and flexibility

The ACS6080 medium voltage drive is all about modularity: it is built from a set of standardized modules that work seamlessly together depending on the exact requirements. It is an engineered drive, designed to meet the specific needs of the application and for easy integration into the processes and systems. The drive ensures a high, constant power factor with optional reactive power compensation and low network harmonics.

Highest level of safety

With ACS6080 people and goods are protected from electric arcs as the drive features an advanced arc resistant design. Certified functional safety

features, an integrated DC grounding switch and door interlocking make the VSD systems even safer and more reliable.

The best in class control method

The new MP3C control allows to achieve higher drive output powers, make use of smaller drive and motor frame sizes and increase the lifetime of the complete system by lowering stress on driven equipment. Lower losses in the drive and the motor result in higher efficiencies of the whole system.

ACS6080 key data

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|--------------------------|---|
| Inverter type | Three-level Voltage Source Inverter (VSI) |
| Power range | Up to 36 MW |
| Output voltage | 2.3 – 3.3 kV |
| Motor type | Induction, synchronous and permanent magnet |
| Input harmonics | Compliance with IEC61000-2-4 and IEEE 519 |
| Cooling type | Liquid |
| Maximum output frequency | 0 – 150 Hz (higher upon request) |
| Converter efficiency | >99% |

ACS6080 for Pump Unit G5 at Z'Mutt pumping station

