

Monitoring of small hydropower plants with a digital clone

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SmallFlex motivation

- To show how small-hydropower plants (SHP) can provide winter peak energy and ancillary services, whilst remaining eco-compatible.

Overarching research question

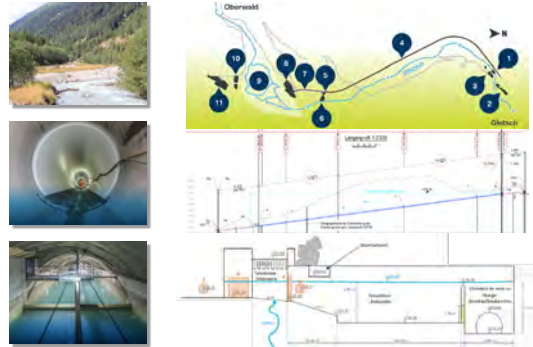
- What are the consequences of enlarging the operational range of the Pelton turbines in case of large head variations ?

Hydro-Clone® contributions

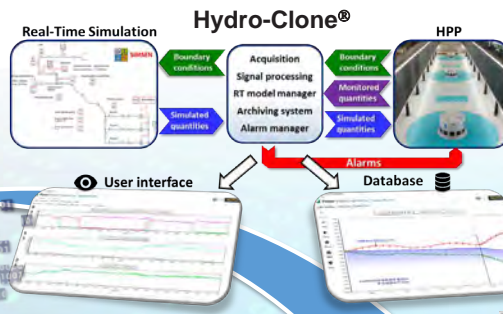
- Monitoring of the power plant
- Estimation of the available power/energy for ancillary services



Demonstrator site : the Gletsch-Oberwald SHP



Digital clone implementation



Live monitoring and data archiving

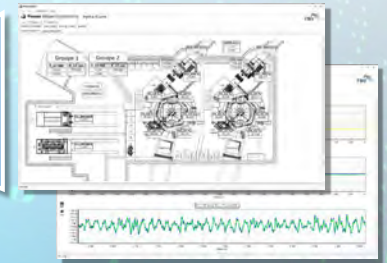
- Monitoring of non-measurable quantities
- Detection of abnormal pressure transients prior to reach admissible limit
- Detection of Hydraulic/Electrical anomalies
- Anticipation of power plant damages

Numerical modeling of the power plant

- Complete 1D-model of the power plant with SIMSEN
- Calibration of the model based on powerplant real operating sequences

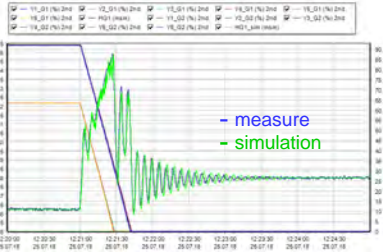
Hydro-Clone real-time simulation

- Real-Time numerical "cloning" using the complete 1D-model of the power plant
- Boundary conditions measured in-situ and fed to the model in real-time
- Data processing and diagnosis of the power plant health



Benefits and outcomes from real-time simulation monitoring

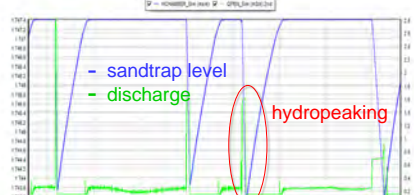
1. Commissioning follow-up



- Comparison of the measured and simulated pressure at the penstock bottom during an emergency shutdown

2. Monitoring of the power plant during hydropeaking

- Recording of the time evolution of the sandtrap water level and discharge during hydropeaking operating mode



3. Available power/energy assessment for ancillary services

Power setpoint P_{ref} **Permanent droop**

Speed setpoint ω_{ref} **Anti-Reset Windup** **PID regulator**

Calibrated numerical model used to explore the behavior of the power plant → assessment of the primary control potential

Swissgrid criteria OK

$$BS = \frac{\Delta f / f_{ref}}{\Delta P / P_{ref}} = 1\%$$

Contributors



Acknowledgments

This work is funded by SFOE, Swiss Federal Office of Energy (grant funding SI/501636-01), within the framework of the project «Demonstrator for flexible Small Hydropower Plant»

