THE INTERNATIONAL ENERGY AGENCY TECHNOLOGY COLLABORATION PROGRAMME ON HYDROPOWER

IEA Hydropower

Hes·so VALAIS WALLIS

Short overview of research projects in Switzerland

Prof. C. Münch-Alligné
University of Applied Sciences – Western Switzerland

IEA – Annex XVI - Workshop on Hidden and Untapped Hydropower Opportunities on existing infrastructures

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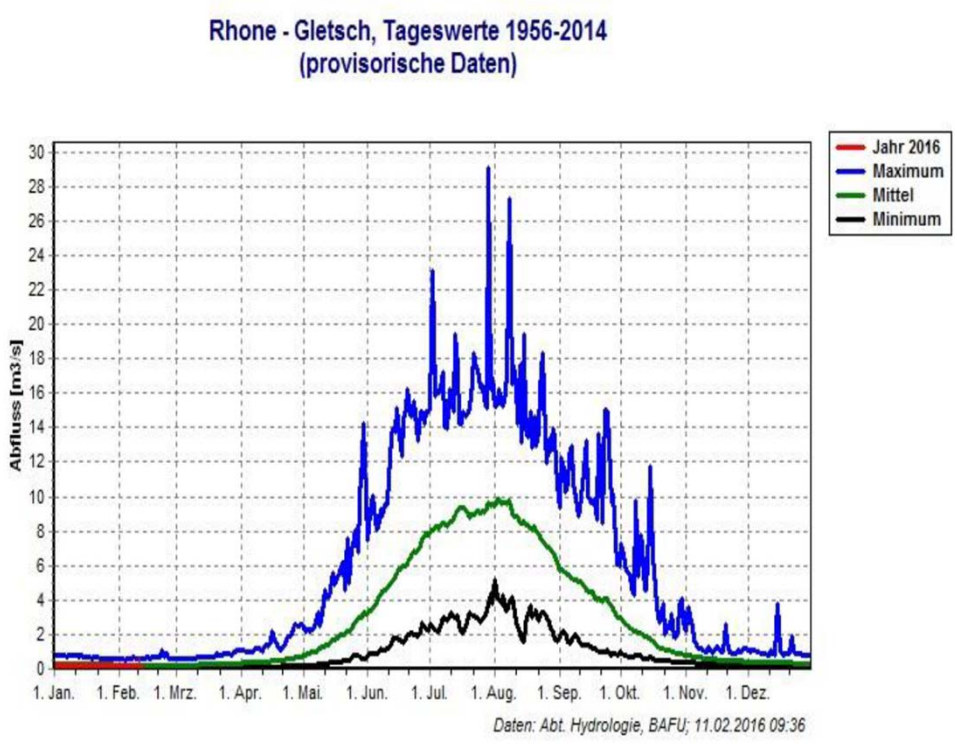
SmallFLEX Case study : KW Gletsch-Oberwald run-of –river HPP



Production : 41 GWh/year
Mean capacity : 4.68 MW
Commissioning : end of 2017

2 Pelton turbine with 6 injectors

Power : 2 x 7MW

Nominal Head : 287 mCE

Discharge :
- **Qmin = 150 l/s**
- **Qnom = 5.8 m³/s**

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Hidden Storage Option & Expected flexible operations

1	2	3	4	5	6	7	8	9	10	11	12

- ✓ Increase the production during low inflow period
- ✓ Reduce the number of start-and-stops
- ✓ Increase the revenue with peak of production
- ✓ Provide ancillary services

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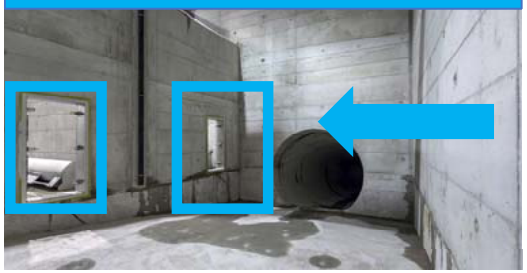
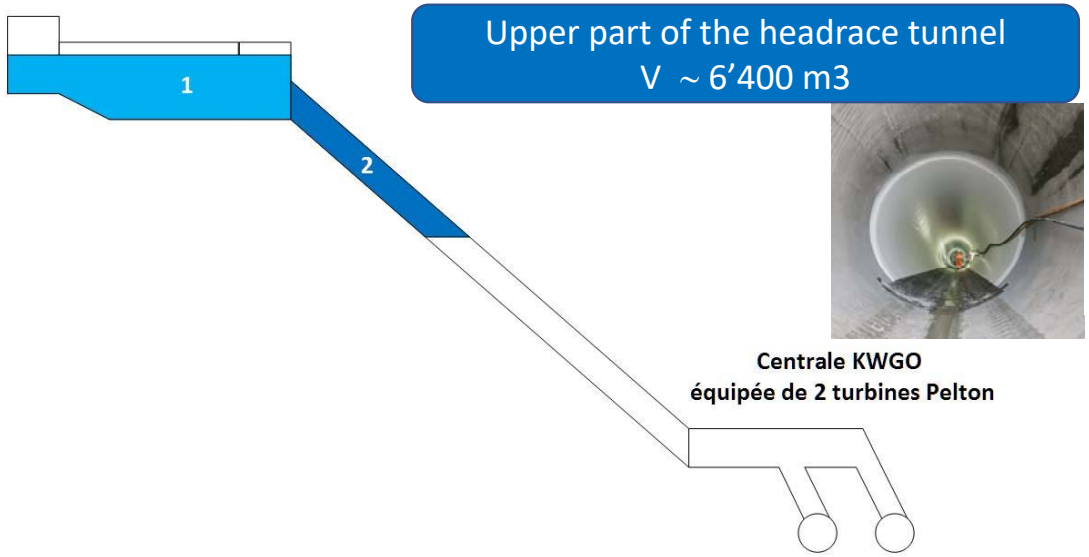
Gletsch (Rhône 1'750 m.s.m)

Settling basin and forebay tank
V ~ 2'500 m3

Specific gates to connect the settling basin and forebay tank





Oberwald (Rhône 1'450 m.s.m)

Upper part of the headrace tunnel
V ~ 6'400 m3

Dewatering of the tunnel with a corresponding head reduction of 35%

Air entrainment, damage of the tunnel by compression/tensile stress, Falaise effect of the turbines

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Hidden Storage Option & Expected flexible operations

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SUMMER

✓ Provide ancillary services

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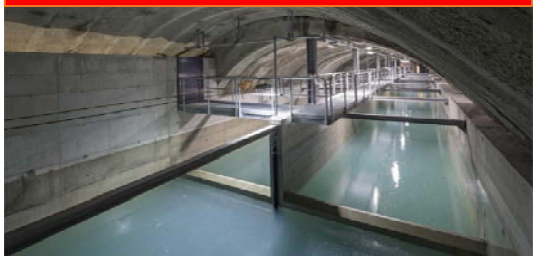
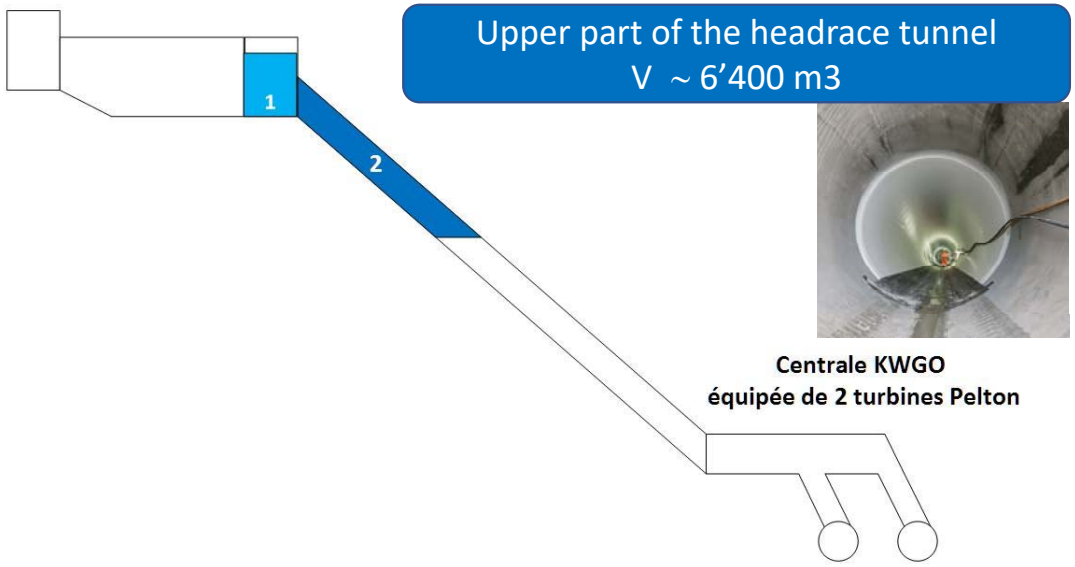
Gletsch (Rhône 1'750 m.s.m)

Forebay tank : V ~ 400 m3

Settling basin in operation
-> specific gates closed.





Upper part of the headrace tunnel
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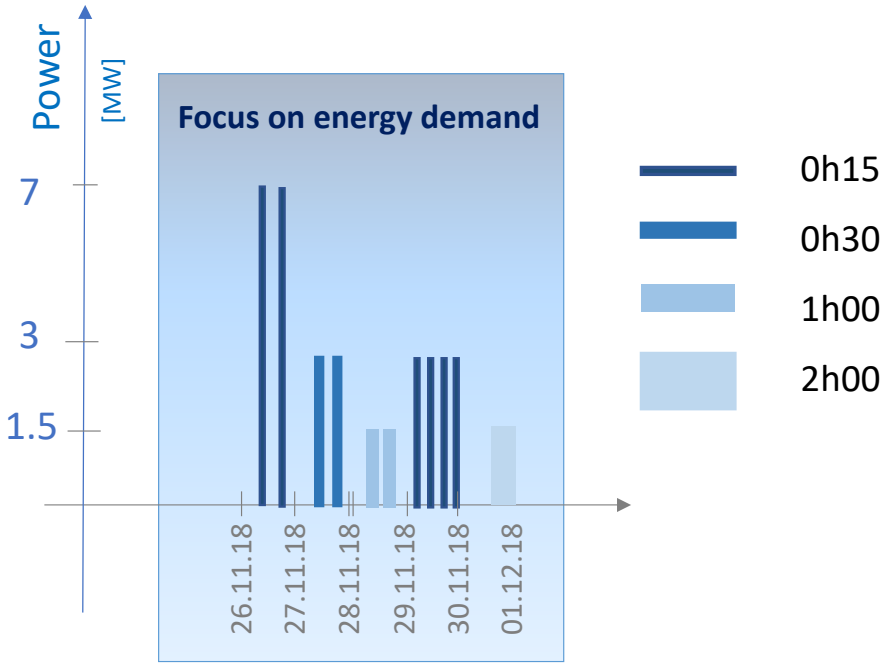
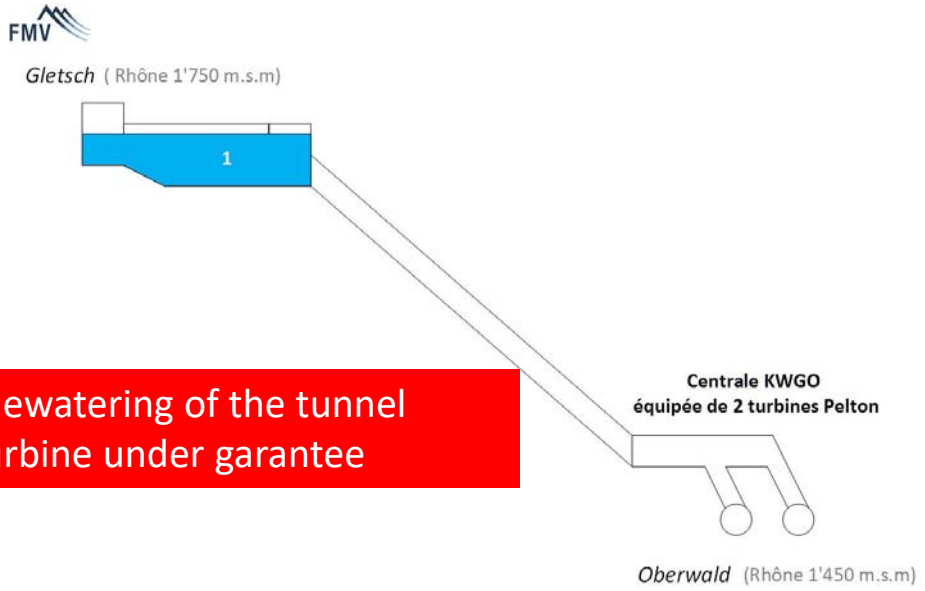
Experimental Investigations
First campaign – November 2018



- ✓ Assess the methodology to predict the production program
- ✓ Assess the monitoring system



No dewatering of the tunnel
Turbine under garantee

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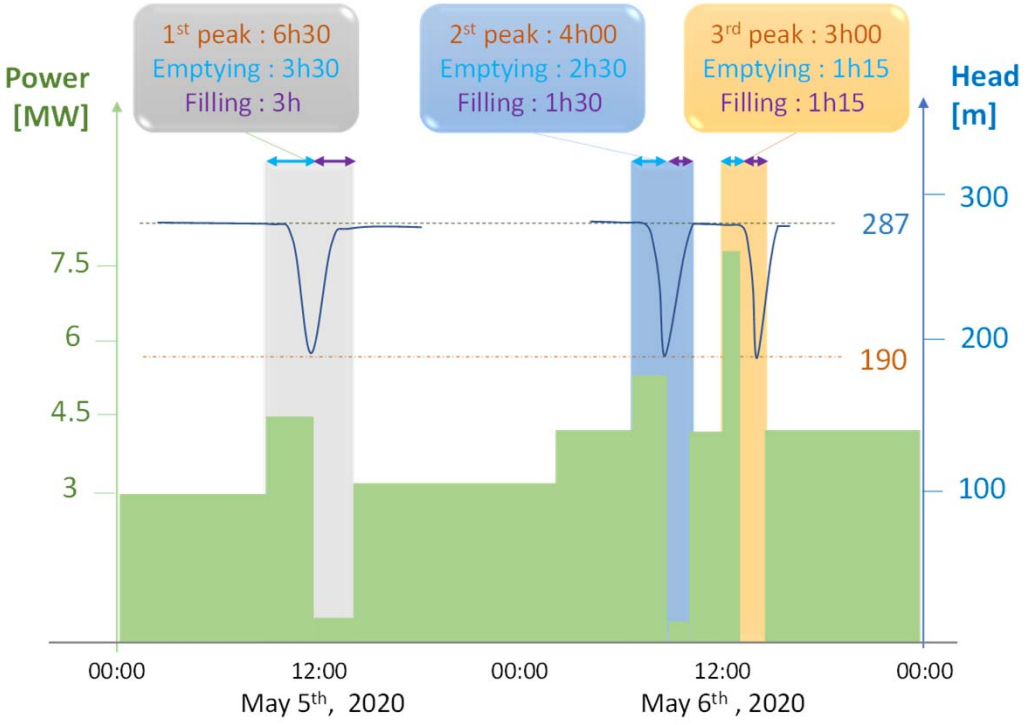
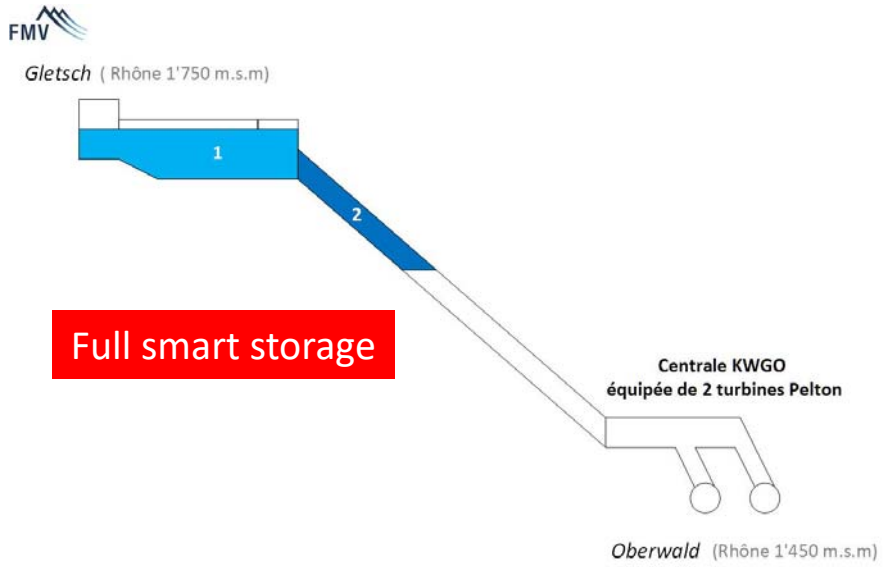
Experimental Investigations
Second campaign – May 2020



- ✓ Use the full storage capacity
- ✓ Assess the emptying/filling speed limit
- ✓ Assess the powerplant efficiency
- ✓ Determine the falaise effect limit



Full smart storage

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Conclusions

From December to March :

- ✓ Increase of 130% of production
- ✓ Strong decrease of the number of start-stops

In April, May, October & November :

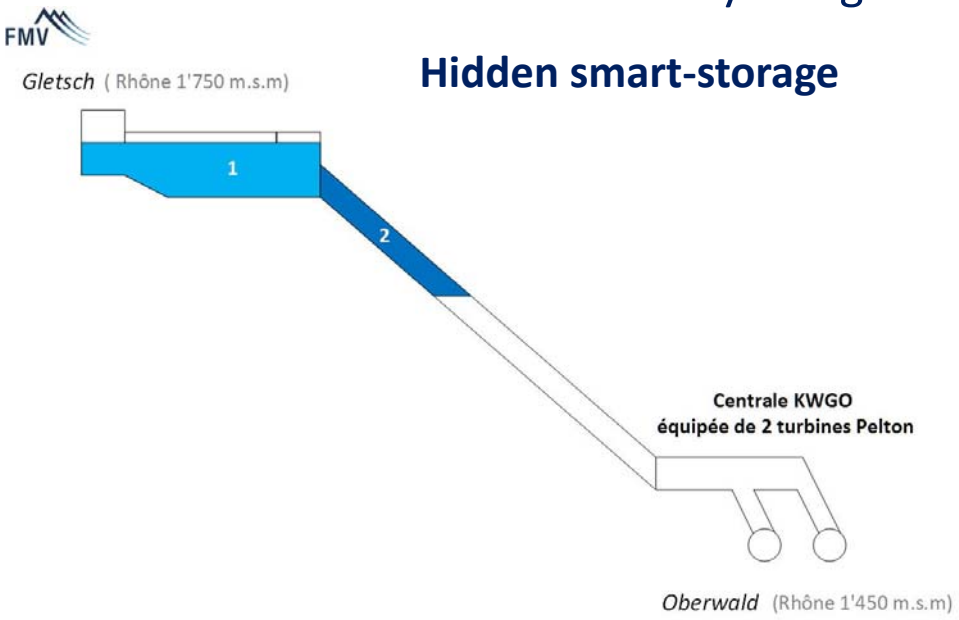
- ✓ Possibility to plan peak of production but the actual energy market limits the benefit

During the whole year :

- ✓ Primary services of +/- 1.5 MW
- ✓ Possibility to integrate the KWGO HPP in a virtual pool of small run-of-river HPPs

Increase of the flexibility using

Hidden smart-storage



C Münch-Alligné *et al* 2021
IOP Conf. Ser.: Earth Environ. Sci. **774** 012037

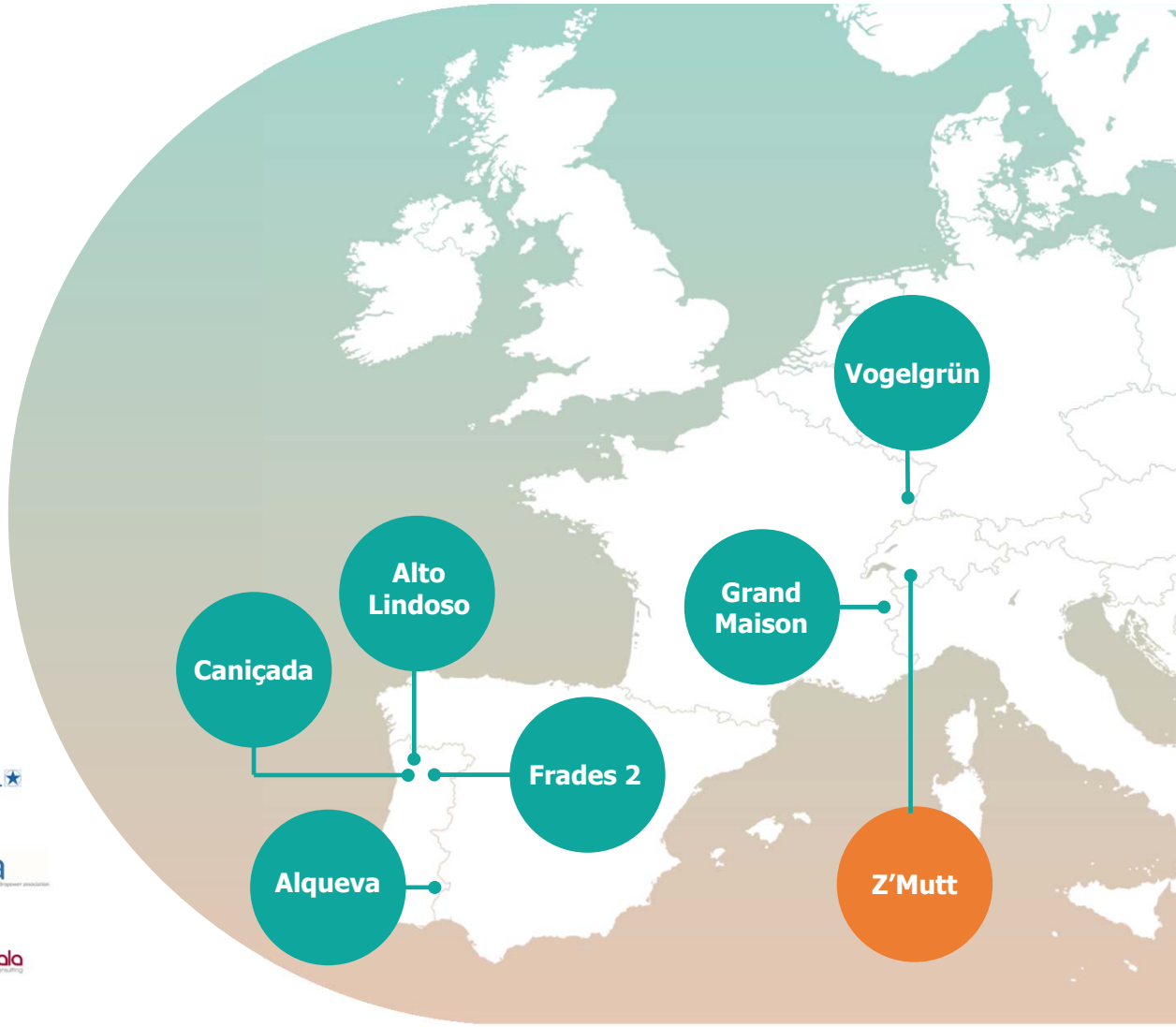
XFLEX HYDRO

THE PROJECT

With increasing levels of variable renewables in the energy system, a consortium of partners are collaborating on a four-year EU-funded project (XFLEX HYDRO) to enhance hydropower's flexibility services and potential impact in modern power markets.

19 project partners

ALPIQ · ANDRITZ · ARMINES · cea · EPFL · MINES ParisTech PSL · EDF · edp · NEW ENERGY WORLD · Hes·so · INESCTEC · iha · POWER VISION ENGINEERING · GE · SuperGrid Institute · Universität Stuttgart · UPC · VOITH · zabala



The Hydropower Extending Power System Flexibility (XFLEX HYDRO) project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857832

XFLEX HYDRO

WP **4**

Demonstrator (Z'Mutt)
Lead: ALPIQ

DEMONSTRATOR

Z'MUTT SWITZERLAND

x1

5MW

PUMPED STORAGE

1964

VARIABLE SPEED (FSFC) TECHNOLOGY

Z'Mutt is a pumping station feeding the main reservoir of the Grande Dixence hydroelectric scheme in Canton Valais, Switzerland. During XFLEX HYDRO, a new variable speed pump-turbine will be enhanced with modern electronics to demonstrate highly flexible performance.

Key Objectives:

- Demonstrate use of a 5 MW variable speed pump-turbine, equipped with full size frequency converter (FSFC) and smart software supervision for advanced control.
- Enhanced services will include variable pumping load, fast power injection or absorption, synthetic inertia, and fast start and stops in pumping and generating modes.
- Validate component lifetime and safe long-term operation under high flexibility operation.

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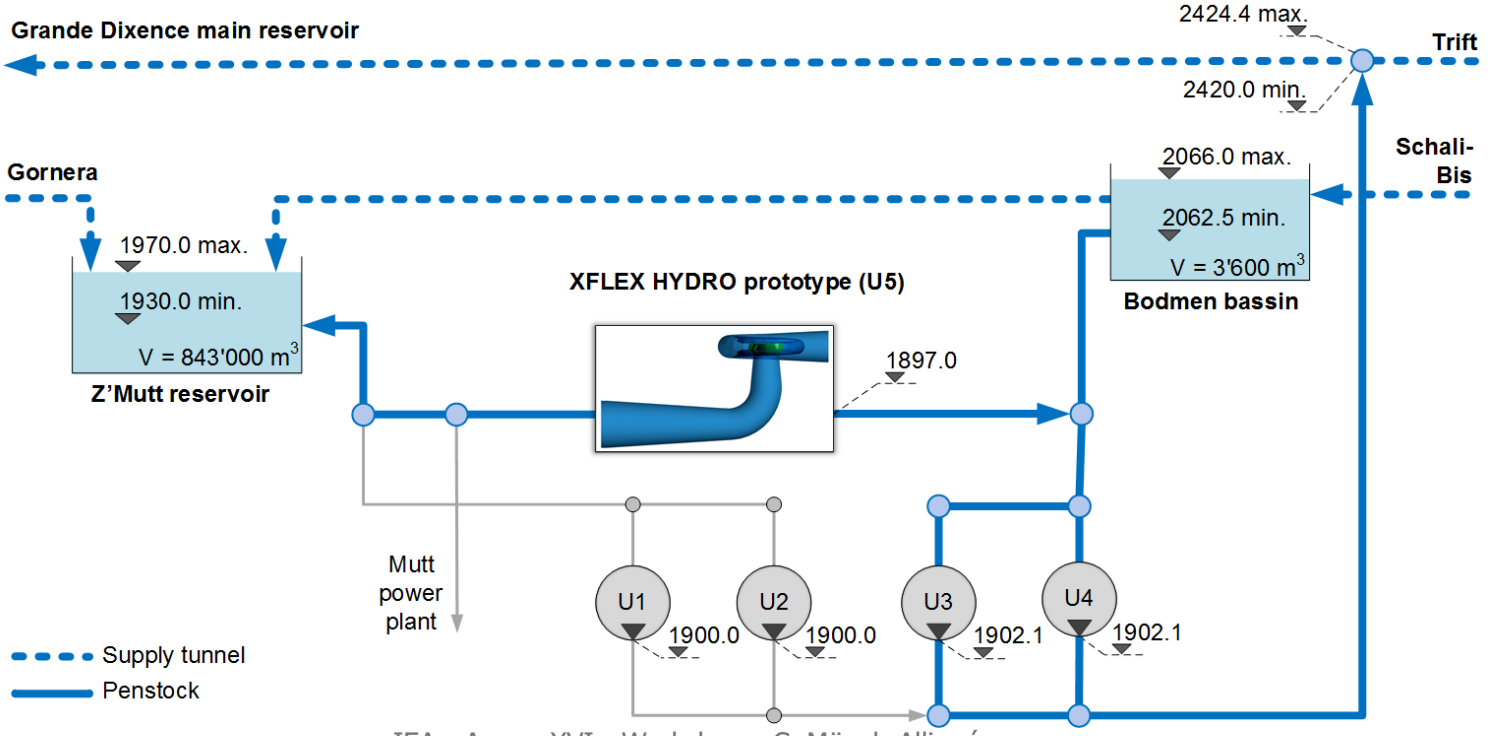
XFLEX HYDRO – Z'Mutt Demonstrator

Variable speed PSHP units

Z'Mutt pumping station: Hydraulic layout



XFLEX HYDRO

Advanced numerical simulations

Damage × 30 !!

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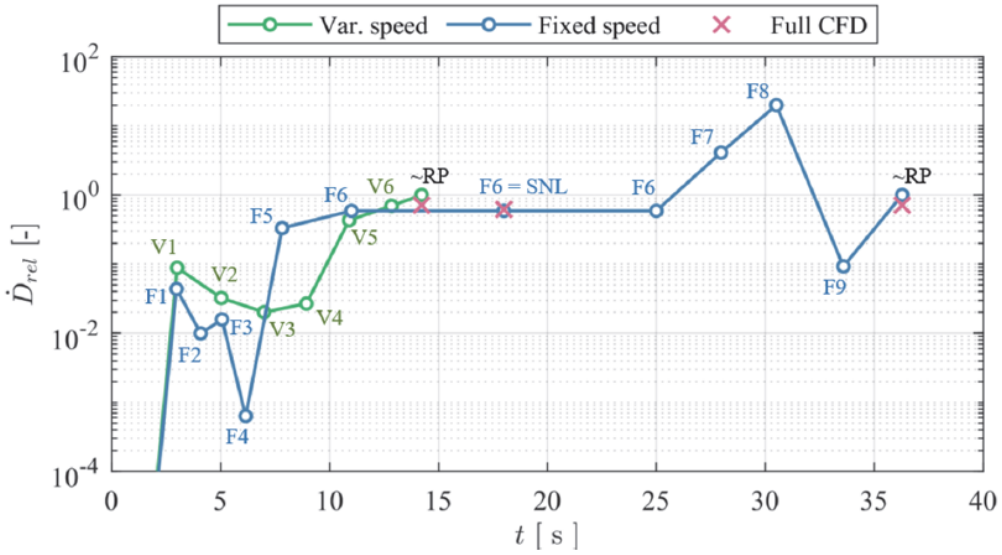
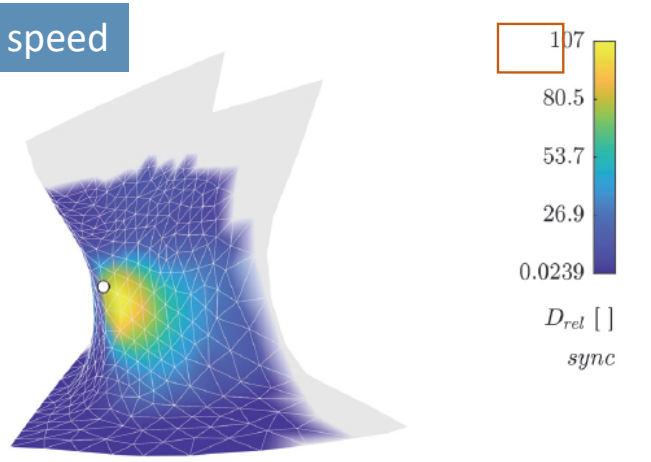
- Cumulative damage

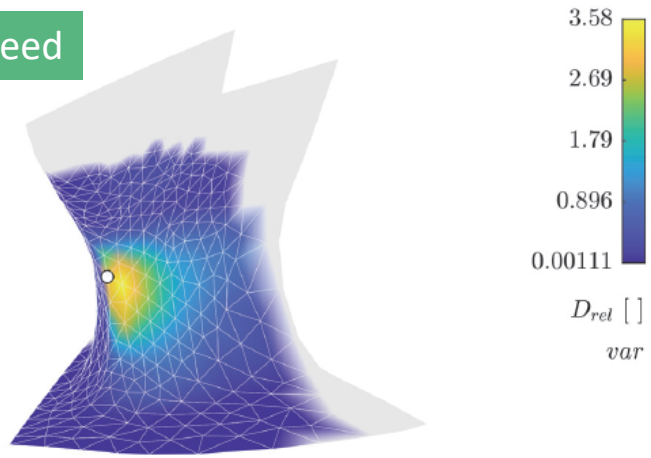


D. Biner et al 2021
IOP Conf. Ser.: Earth Environ. Sci. 774 012070

Fixed speed



Var speed



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Thank you for your attention