

XFLEX HYDRO





XFLEX HYDRO

INTRODUCTION

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The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857832



CONTEXT

XFLEX HYDRO

REACHING EU TARGETS

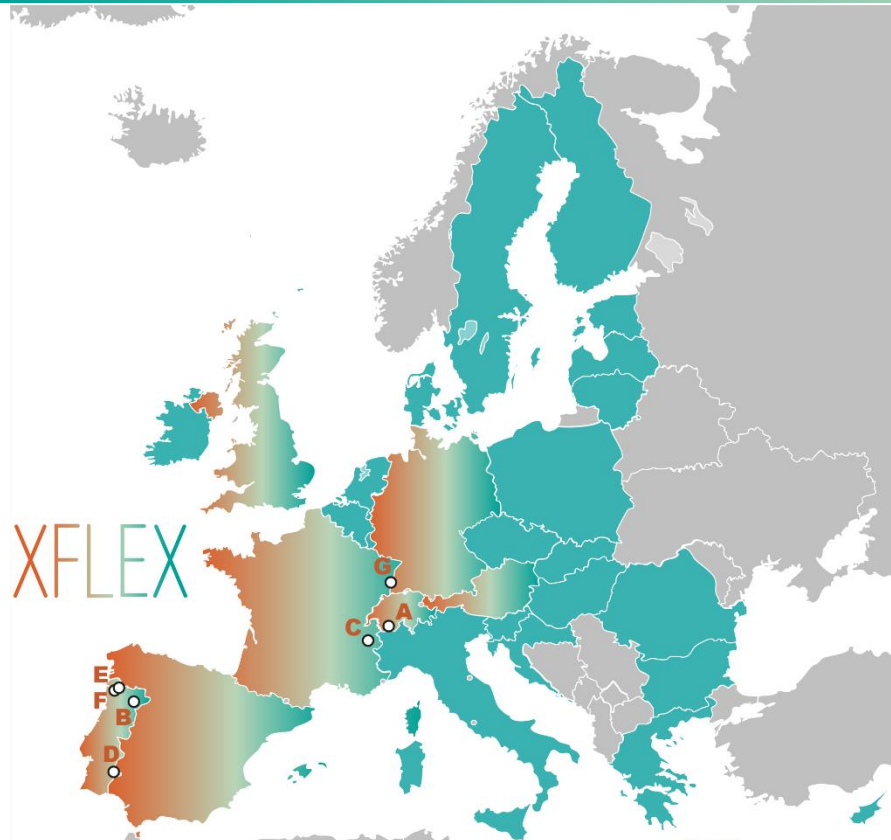
32% By 2030, the EU is targeting at least 32% energy from renewables and longer-term scenarios show an even more drastic decarbonisation, with significant contributions from variable wind and solar energy in the European system. Digitalisation is having a profound impact on the power sector and hydropower is no exception. Hydropower already provides critical power services for integration of other renewables, but the demand for greater flexibility is expected to grow considerably.



THE PROJECT



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



- A. Z'Mutt (Switzerland)
- B. Frades 2 (Portugal)
- C. Grand Maison (France)
- D. Alqueva (Portugal)
- E. Alto Lindoso (Portugal)
- F. Caniçada (Portugal)
- G. Vogelgrün (France)

XFLEX HYDRO

With increasing levels of variable renewables in the energy system, a consortium of partners are collaborating on a 4 year EU-funded project (XFLEX HYDRO) to enhance hydropower's flexibility services and potential impact in modern power markets.

2019

INNOVATION

DEMONSTRATION

DEPLOYMENT

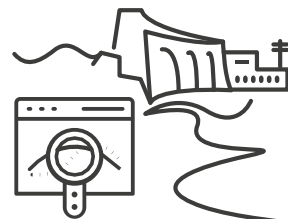
2023



Flexibility Matrix



Smart Power Plant Supervisor (SPPS)



6 demonstrators
1 follow-up

Pumped storage
Variable speed
Hydraulic short circuit

Reservoir storage
Extended modes

Run of river
Battery hybrid



White paper
and roadmap



Market uptake



Dissemination
cross-cut

XFLEX HYDRO

CONSORTIUM PARTNERS

ENERGY LEADERS AND INNOVATORS



INNOVATION ACTION FOUR-YEAR TIMELINE



Erzhausen Pumped Storage Plant © Voith

1

INNOVATION

Optimal collection of heterogeneous data to allow a precise estimate of plant KPIs, and refinement of flexibility services needs.

2019

- Flexibility matrix
- SPPS

2

DEMONSTRATION

Validation and demonstration of XFLEX HYDRO results across six complementary and challenging HPP real-world scenarios.

- Demonstration scenarios

- Z'Mutt
- Frades 2
- Grand Maison
- Alqueva
- Vogelgrün
- Alto Lindoso
- Caniçada

3

DEPLOYMENT

Building methodology and tools to bring the project activities to their markets, maximising and optimising XFLEX HYDRO solutions potential.

- Market uptake
- Dissemination cross-cut

- Roadmap & White paper

2023

BUDGET AND RESOURCES

The overall cost of the XFLEX HYDRO project (including non-EU funded) is **€ 18,162,950**, of which the EU grant amount totals **€ 15,103,379** (83% of overall cost). Starting September 2019 and lasting 4 years, work packages (WP) have been set up to deliver the project, each involving relevant partners.

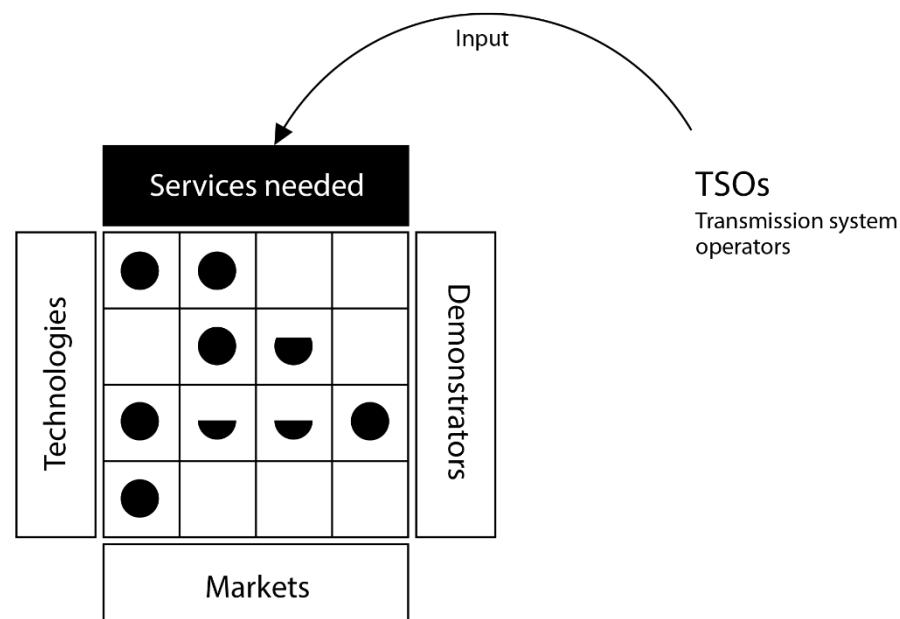
- 1 **Project management**
Lead: EPFL
- 2 **Flexibility services and specification**
Lead: INESC TEC
- 3 **Smart Power Plant Supervisor**
Lead: EPFL
- 4 **Demonstrator (Z'Mutt)**
Lead: ALPIQ
- 5 **Demonstrator (Frades 2)**
Lead: EDP P (Voith)
- 6 **Demonstrator (Grand Maison)**
Lead: EDF (GE)
- 7 **Demonstrator (Alqueva)**
Lead: EDP CNET (GE)
- 8 **Demonstrator (Alto Lindoso & Caniçada)**
Lead: EDP CNET (GE)
- 9 **Demonstrator (Vogelgrün)**
Lead: EDF (Andritz)
- 10 **Demo coordination and monitoring**
Lead: EPFL
- 11 **Benefits, impacts and deployment**
Lead: SUPERGRID
- 12 **Communication and dissemination**
Lead: IHA
- 13 **Ethics**
Lead: EPFL

ACTIVITY 1

CREATING A FLEXIBILITY MATRIX



Kvilldal power station © Statkraft



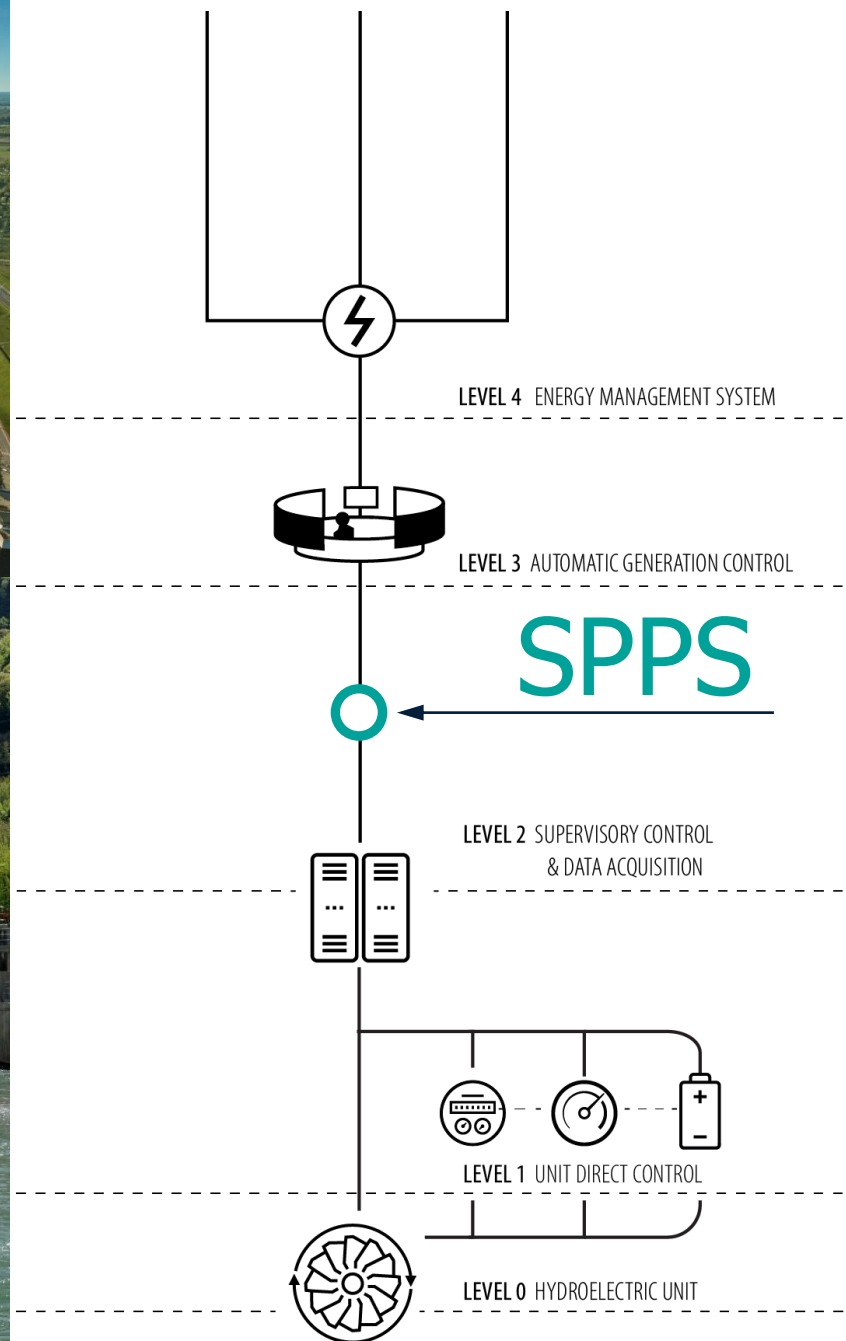
The hydropower flexibility matrix will play a key role in providing a mapping of hydro technology supporting flexibility services and how they enable hydropower to take part in new power markets. It will combine information about the latest flexibility products, flexibility markets and innovative hydroelectric technology solutions that enhance the ability of HPPs to respond to EPS flexibility needs.



Pļaviņas Hydroelectric Power Station



Romanche-Gavet



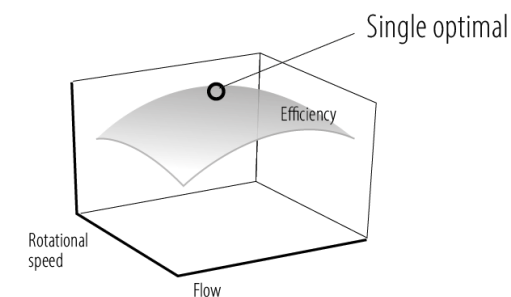
ACTIVITY 2

SMART POWER PLANT SUPERVISOR

Brings the turbine dynamics and conditions knowledge into advanced control unit operation and predictive maintenance

BEFORE

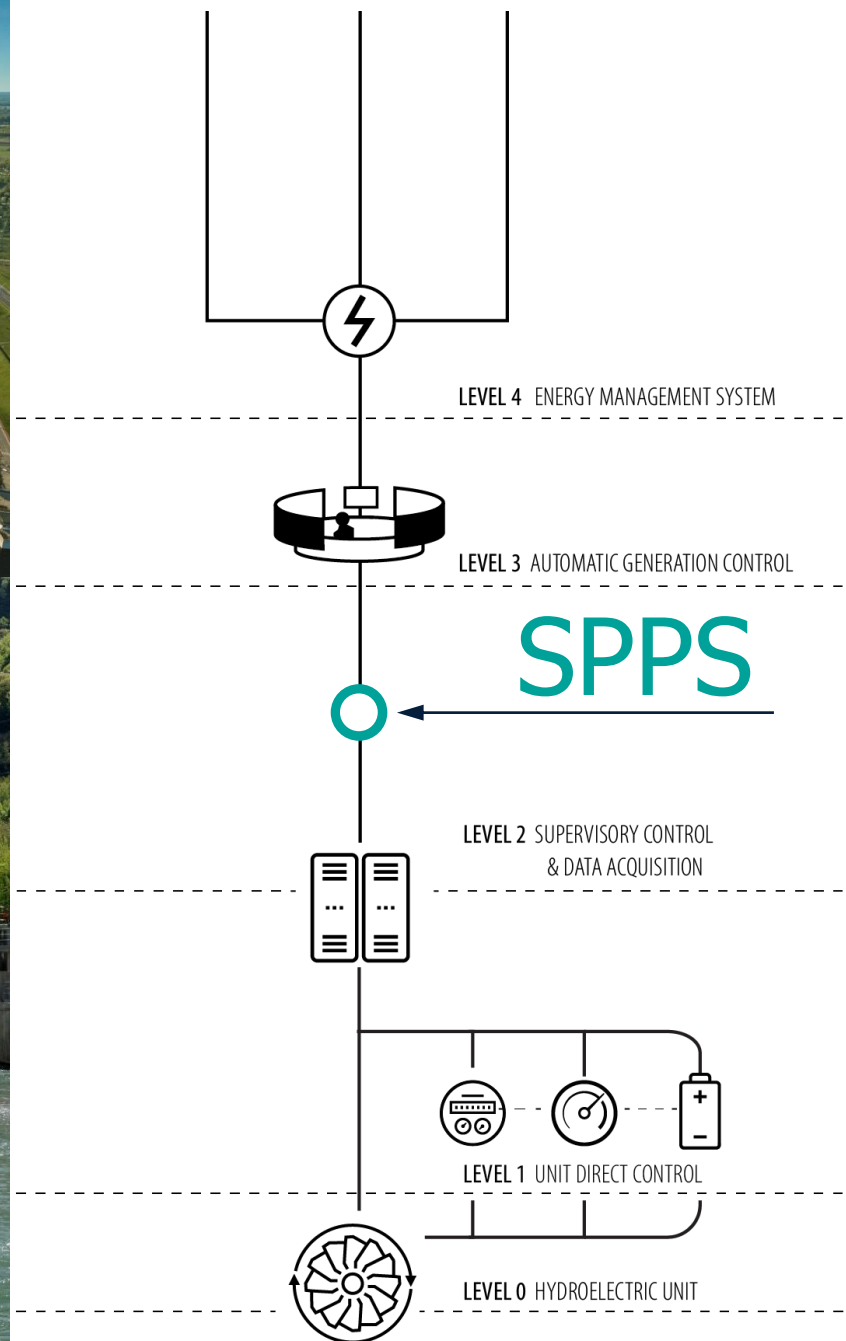
Limited range of operation based on functions that exclude grid needs





Pļaviņas Hydroelectric Power Station

Romanche-Gavet



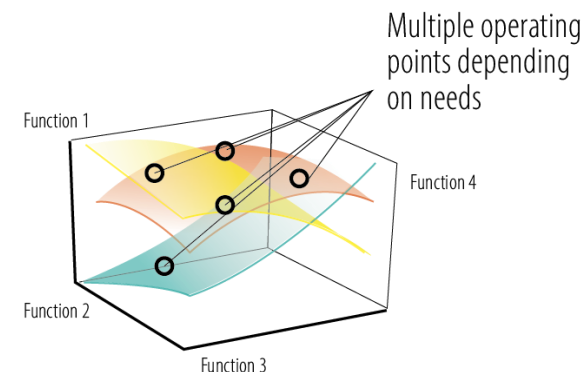
ACTIVITY 2

SMART POWER PLANT SUPERVISOR

Brings the turbine dynamics and conditions knowledge into advanced control unit operation and predictive maintenance

AFTER

Flexible range of operation based on a multidimensional analysis including energy grid needs





XFLEX HYDRO

DEMONSTRATION PROJECTS

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Technologies being demonstrated

The project will demonstrate a set of innovative hydroelectric technologies at selected sites across Europe, covering different types and sizes of hydropower stations. When integrated with the Smart Power Plant Supervisor (SPPS), the following technologies aim to improve flexibility services for operators as well as average annual efficiency and availability.

Variable Speed

‘Variable speed’ provides an added degree of flexibility, as operators can vary rotational speed of reversible units and use this for enhanced grid services in both pumping and generating modes. In particular, variable speed pump-turbines enable power regulation and load following **even in pumping mode**. Variable speed PSP projects can operate at a wider range, higher efficiency and quicker response time – in both modes of operation.

In XFLEX HYDRO, extended flexibility will be demonstrated at Frades II using a Double Fed Induction Machine (DFIM), and at Z’Mutt using a Full Size Frequency Converter (FSFC).

Hydraulic Short Circuit

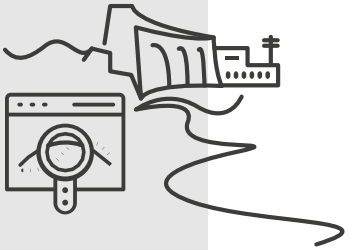
‘Hydraulic short circuit’ is when PSP plants undertake pumping and generating modes at the same time for increased flexibility. Fixed-speed pumping units can be operated to ensure net power consumption from the grid, while in parallel a unit is run in generating mode to regulate the load. This technology will be tested at Grand Maison with four Pelton and pump-turbine units and at Alqueva with two reversible **pump-turbine** units.

Battery hybrid

‘Batteries’ are well suited to fast frequency **control, quick response times and very high ramping rates**, and can be operated in combination with hydropower turbines for optimum flexibility. In XFLEX HYDRO, a battery system will be integrated at Vogelgrün, a run-of-river plant, adding short-period energy storage and frequency control capability, while reducing wear and tear on the existing Kaplan turbine operating control system.

SPPS Extended operating modes

SPPS ‘Extended flexibility’ modes will also be demonstrated at generation-only plants, Alto Lindoso and Canicada, representing high and medium head reservoir storage sites.



Pumped storage
SPPS
Variable speed
Hydraulic short circuit

Reservoir storage
SPPS
Extended operating modes

Run of river
SPPS
Battery hybrid

Z'MUTT SWITZERLAND



x1



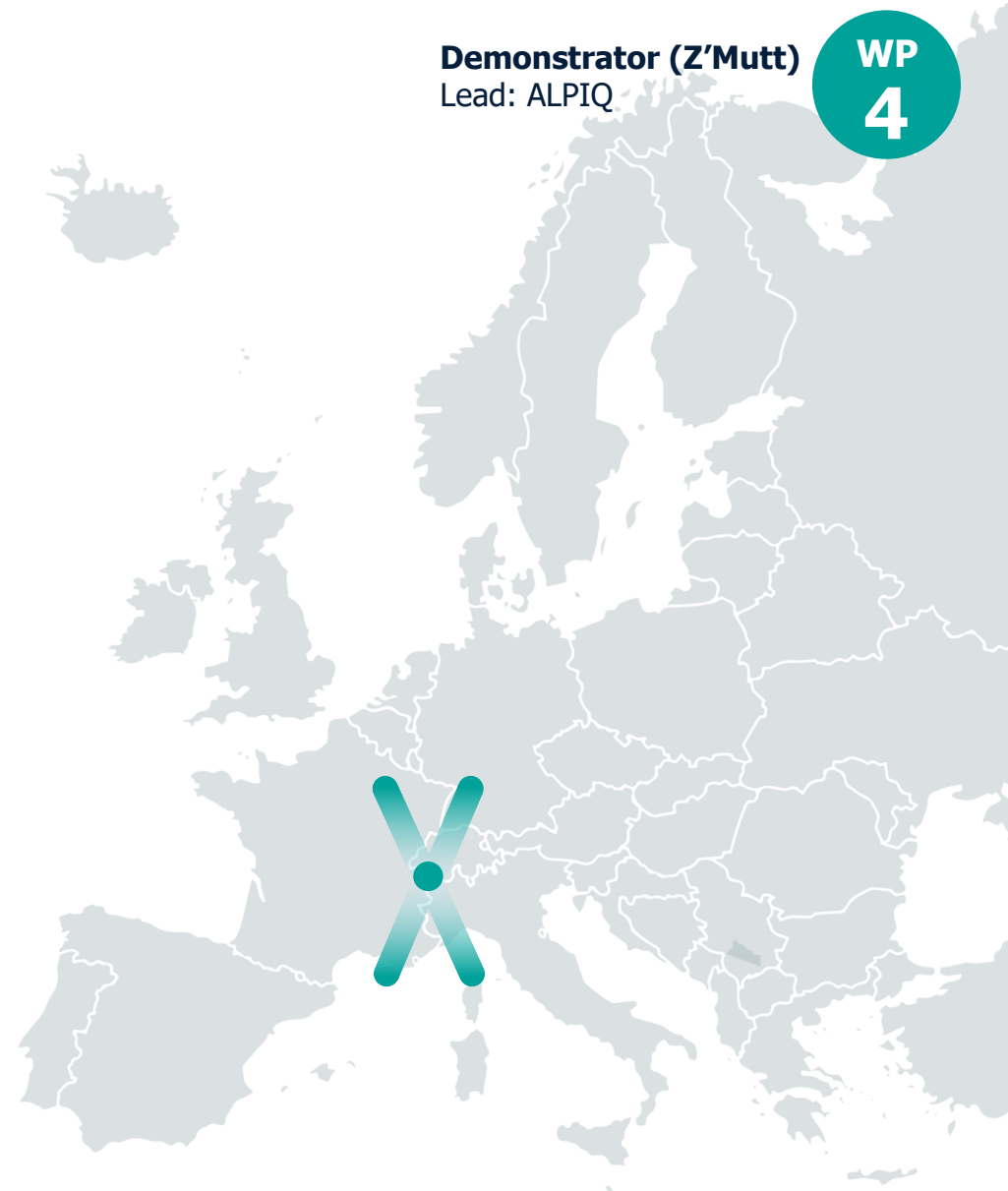
5MW

PUMPED
STORAGE

1964

Objectives:

- Demonstrate the high flexibility of variable speed unit equipped with full size frequency converter (FSFC) for advanced control capabilities. Enhance services will include fast power injection or absorption in pumping and generating mode, inertia emulation, and fast start and stop sequences in turbine and in pump as well as fast transition modes;
- Validate unit components lifetime prediction methods and confirm safe long-term operation under high flexibility operation;
- Evaluate performances of new control strategies including electrical breaking in fast transient phenomenon (load rejection).



FRADES 2 PORTUGAL



x2



390MW

PUMPED
STORAGE

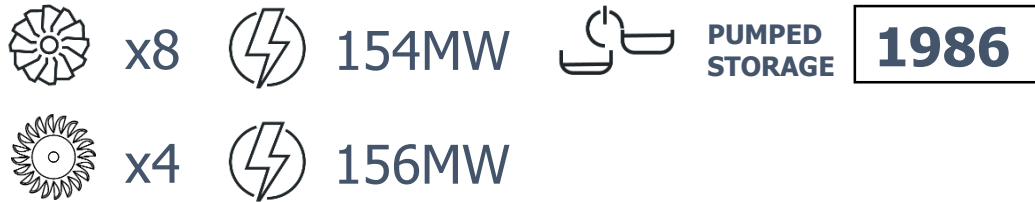
2017

Objectives:

- Extend power range through integration of hydraulic short circuit technology for variable speed machines, and increase potential of renewable dispatchable technologies;
- Enhance high-quality flexibility services of the electric power system by implementing inertia emulation and frequency containment reserve;
- Improve the maintenance intervals and minimising outage times by optimising the plant operation through the application of the multidimensional hillchart and optimised mode change procedures;
- Increase annual energy production by reducing auxiliary equipment power consumption.



GRAND MAISON FRANCE



Objectives:

- Demonstrate a simultaneous use of very high head pumps and Pelton turbines, and corresponding enhancement of flexibility services for the power system thanks to an innovative system integration of the hydraulic short circuit technology.

According to a full automatic optimisation algorithm, while the pumped storage plant is globally in pumping mode, a Pelton turbine regulates the overall load based on grid frequency support signal.

ALTO LINDOSO PORTUGAL



x2



317MW



STORAGE

1992

Objectives:

Evaluate low CAPEX opportunities to extend services offered by an existing reservoir storage plant (Francis turbine type) and compare them to a conversion to variable speed. Options to investigate are:

- Extension of the operating range targeting an almost continuous power output from near zero to rated power;
- Advanced joint control allowing to adapt the dispatching rules according to the optimisation criteria (efficiency, wear and tears, maintenance plan, etc.).

These opportunities will be compared to a conversion to variable speed for a high head, large output reservoir storage hydropower plant – through numerical analysis and reduced scale model on electrical test bench.



VOGELGRÜN FRANCE



x4 units  35MW  RUN-OF-RIVER

1959

Objectives:

- Hybridise the turbine unit with a battery of suitable energy capacity and power converter rating, to improve capability of providing primary frequency response;
- Contribute to frequency response with high-dynamic response;
- Significantly reduce turbine wear and tear and quantify it.
- Evaluate the possibility of upgrading fixed speed double-regulated Kaplan turbine units by enhanced variable speed single-regulated propeller unit.



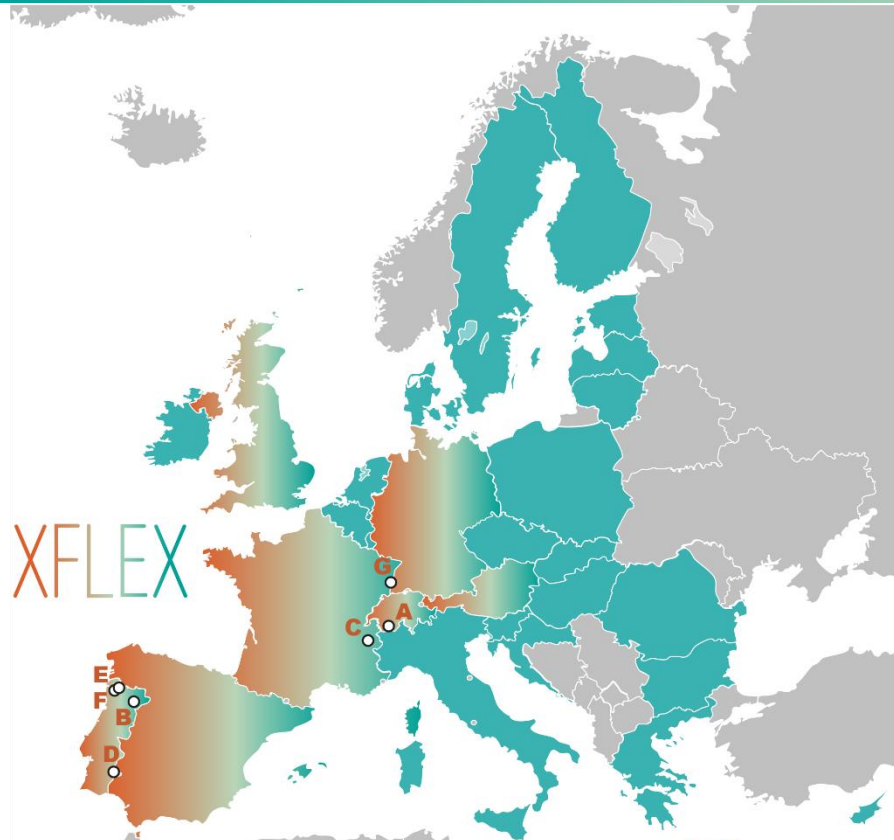
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Ethics
Lead: EPFL

WP
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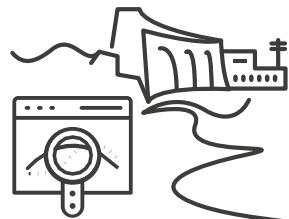
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Hydropower Extending Power System Flexibility

Thank you



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Find out more at
www.xflexhydro.net