H2020 PROJECT XFLEX n° 857832

XFLEX
HYDROPOWER
EXTENDING
POWER SYSTEM
FLEXIBILITY

Grant Agreement with
European Commission
Innovation and Networks Executive Agency (INEA)
THE CHALLENGE

By 2030

RENEWABLE ENERGY

27%

Renewable share in energy consumption

By 2050

RENEWABLE ELECTRICITY

64%

High renewable energy sources scenario

97%
THE CALL

“Demonstration of solutions based on renewable sources that provide flexibility to the energy system. Supporting the power grid balancing and increasing the flexibility of the energy system is possible by means of dispatchable renewable energy sources...”

Topic LC-SC3-RES-17-2019
Building a low-carbon, climate resilient future
THE CALL

“... Focus will be on the **improvement of the average annual overall efficiency** of hydroelectric machinery. Projects are expected to provide **high availability** of hydropower plants and to **maximise performance** of hydropower plants of **all sizes**. The aim is adapting to **variable speed generation** the hydropower plants (new, refurbished and uprated and especially existing ones); it is important that by **optimising maintenance intervals** for **all hydro plants** (especially those delivering balancing power because of the related dynamic operation, dynamic loads and increased wear and tear) the outage time will be minimised. **Digitalisation measures** to increase the potential of hydropower in providing flexibility to the energy system can be included.”

Topic LC-SC3-RES-17-2019

**Building a low-carbon, climate resilient future**
PROJECT OVERVIEW

**Flexibility Matrix**
- WP2

**SPPS**
- WP3
- Multi-D hillchart
- Advanced Control

**Demonstrators scenarios**
- WP4: Z'Mutt
- WP5: Frades 2
- WP6: Grand Maison
- WP7: Alqueva
- WP8: Alto Lindoso and Caniçada
- WP9: Vogelgrün

**HPP Types**
- 3 existing
- 2 upgraded
- 2 new

**HPP Size**
- From 4.5 MW to 1848 MW

**Roadmap**
- WP10

**Market uptake**
- WP11
- Impacts
- Benefits
- Business model

**Dissemination cross-cut**
- WP12

**Innovation**
- WP1

**Demonstration**
- PMB M1
- DB M1

**Deployment**
- PMB M6
- DB M6

**Ethics**
- PMB M12
- DB M12
- AB M12

**Management**
- PMB M18
- DB M18

**Ethics**
- PMB M24
- DB M24

**Deployment**
- PMB M30
- DB M30
- AB M30

**Ethics**
- PMB M42
- DB M42

**Deployment**
- PMB M48
- DB M48
- AB M48
HYDRO TECHNOLOGY SOLUTIONS

Mapping hydro technology to the flexibility service needs in new power markets

Base Line
Variable Speed DFIM/FSFC
Hydraulic Short Circuit
Battery Hybrid

“How do different technologies deliver flexibility?”

Smart powerplant supervisor (tool)

Variable speed
METHODOLOGY TO MAXIMISE FLEXIBILITY

Developing an innovative methodology to utilise the demonstrated hydro technologies at new and existing hydropower assets.

Digitalization
CFD & FEM Numerical Simulations
Model Tests
Advanced Monitoring
Unit Control

“How do different technologies deliver flexibility?”

BEFORE

Limited range of operation based on functions that exclude grid needs.
METHODOLOGY TO MAXIMISE FLEXIBILITY

3 Smart powerplant supervisor (100)

How do different technologies deliver flexibility?

Digitalization
CFD & FEM Numerical Simulations
Model Tests
Advanced Monitoring
Unit Control

Baseline Database

SMART POWER PLANT SUPERVISOR

Multidimensional hillchart

Advanced Control
State Estimator

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

Multiple operating points depending on needs
Demonstrate flexible technologies in PSP

Z’Mutt (ALPIQ) Unit 5, Switzerland
• FSFC variable speed reversible pump-turbine
  • $P = 5 \text{ MW}, H = 115 \text{ m}, Q = 3.6 \text{ m}^3/\text{s}$

FRADES 2 (EDP), Portugal
• Two DFIM variable speed reversible, OEM: Voith Hydro
  • $P_{\text{Turb}} = 190 \text{ MW} \div 400 \text{ MW}, H_{\text{Turb}} = 407 \text{ m} \div 430 \text{ m}, Q_{\text{Turb}} = 100 \text{ m}^3/\text{s}$,
    $P_{\text{Pump}} = 300 \text{ MW} \div 390 \text{ MW}, H_{\text{Pump}} = 414 \text{ m} \div 437 \text{ m}, Q_{\text{Pump}} = 89 \text{ m}^3/\text{s}$

GRAND-MAISON (EDF), France
• Eight 140 MW reversible 4 stage pump-turbine units, OEM: GE
  • Four 150 MW Pelton turbine units, 5 jets, OEM: GE, $H = 900 \text{ m}$

ALQUEVA (EDP), Portugal
• 2 + 2 reversible single stage pump-turbine units, OEM: GE
  • $P_{\text{Turb}} = 129.6 \text{ MW}, H_{\text{Turb}} = 50.2 \text{ m} \div 76 \text{ m}, Q_{\text{Turb}} = 203.2 \text{ m}^3/\text{s}$
    $P_{\text{Pump}} = 110 \text{ MW}, H_{\text{Pump}} = 50.2 \text{ m} \div 72 \text{ m}, Q_{\text{Pump}} = 140.2 \text{ m}^3/\text{s}$
Demonstrate flexible technologies in Storage HP

ALTO LINDOSO (EDP), Portugal
- Two vertical Francis turbines, OEM: GE
- $P = 317$ MW, $H = 276$ m, $Q = 125$ m$^3$/s

CANIÇADA (EDP), Portugal
- Two vertical Francis turbines, OEM: GE
- $P = 35$ MW, $H = 120$ m, $Q = 34$ m$^3$/s.
Demonstrate flexible technologies in RoR HP

VOGELGRÜN (EDF), France

- Four vertical Kaplan turbines, OEM: GE
- $P = 35$ MW, $H = 12$ m, $Q = 325$ m$^3$/s
The developed technologies will allow plant and system operators to operate successfully in the modern power markets and to make a significant contribution to European renewable energy objectives and policies.”

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EXPECTED IMPACT

Analyse the impact and cost-benefit of the flexible hydropower technologies
The XFLEX Consortium

18 Partners from 7 Countries

- 3 Electrical Utilities
- 3 Hydroelectric Equipment Suppliers
- 2 Consulting Companies
- 1 International NGO
- 3 Research Institutes
- 6 Academic Laboratories

Grant Agreement with European Commission
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The **XFLEX** Consortium

Coordinator: EPFL

Utilities
- EDF, EDP, ALPIQ

OEM
- ANDRITZ, GE, VOITH

Consulting
- PVE, Zabala

Universities
- EPFL, HESSO
- UPC, USTUTT

Research Centres:
- Armines, CEA
- IHA, INESTEC, SuperGrid

Grant Agreement with European Commission
Innovation and Networks Executive Agency (INEA)

4 Years
€ 18,162,950 Budget
€ 15,103,379 EU Grant
The **XFLEX** Consortium

**Swiss & SCCER Partners**
- Coordinator: EPFL

**Utilities**
- ALPIQ, Dr. Chène

**OEM**
- ANDRITZ AG, Mr. Lais

**Consulting**
- PVE, Dr. Nicolet

**Universities**
- EPFL, LMH-Prof. Avellan, PEL-Prof. Dujic, DESL Prof. Paolone
- HESSO Valais Wallis, Prof. Münch

Grant Agreement with **European Commission**
Innovation and Networks Executive Agency (INEA)

4 Years
€ 4,893,434 EU Grant