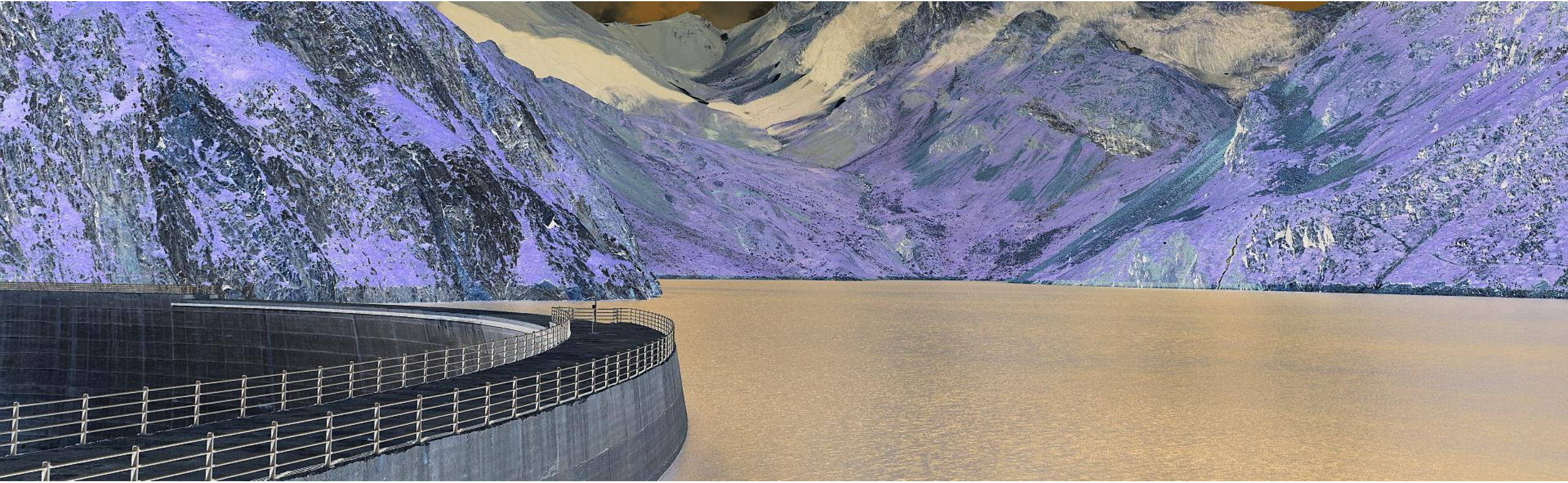

Demonstration of Sustainable Hydropower Refurbishment

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Funded by the European Union

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www.rehydro.eu

Project overview

ReHydro

Key objective

The main objective of ReHydro is to demonstrate how European hydropower can be refurbished and modernized to be fit for the future energy system respecting sustainability requirements and societal needs in a climate change context.

22 Partners from 7 countries

- 6 Operators
- 4 Manufacturers
- 3 Suppliers
- 7 Research Organisations
- 2 Associations

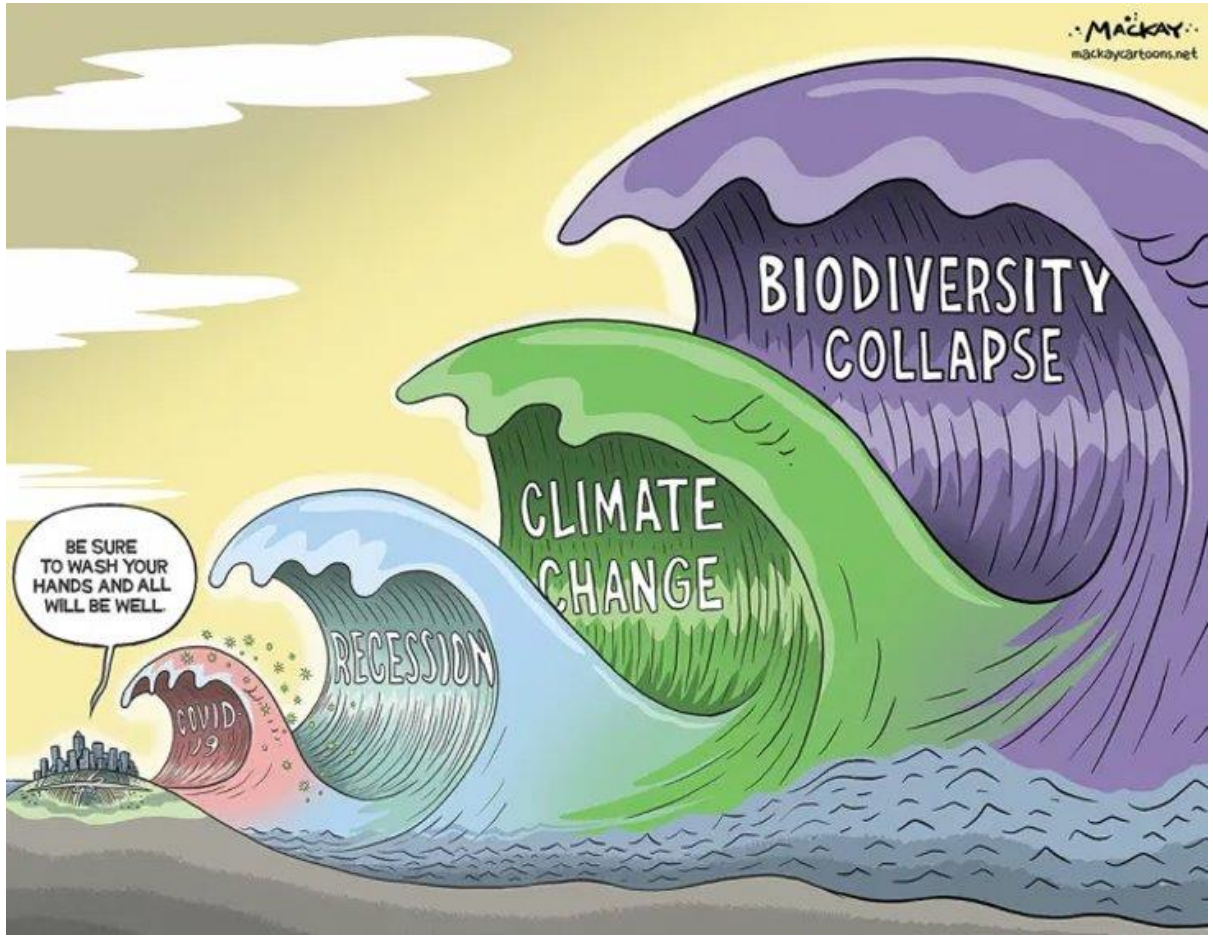
Duration: May 2024 – April 2028

Budget: ~12 mill Euro

Coordinator: SINTEF Energy Research (Atle Harby)

Background

- Energy transition and new markets
  - Integration of variable renewables
  - Market integration across borders
- Climate Change Impacts
  - Resilience and adaptation
- Aging Infrastructure
  - Maintenance and upgrades
- Environmental and Ecological Concerns
  - Ecosystem disruption and biodiversity loss
- Regulatory and Policy Challenges
  - Environmental regulations and water management
- Societal Services and Community Issues
  - Public perception and acceptance



Main expected outcomes

- Refurbish, upgrade and increase existing hydropower capacity
- Increase technology leadership of European hydropower industry
- Enhanced sustainability when refurbishing hydropower installations
- Delivering services to the society
- Addressing EU policy priorities
- Creating more and better jobs

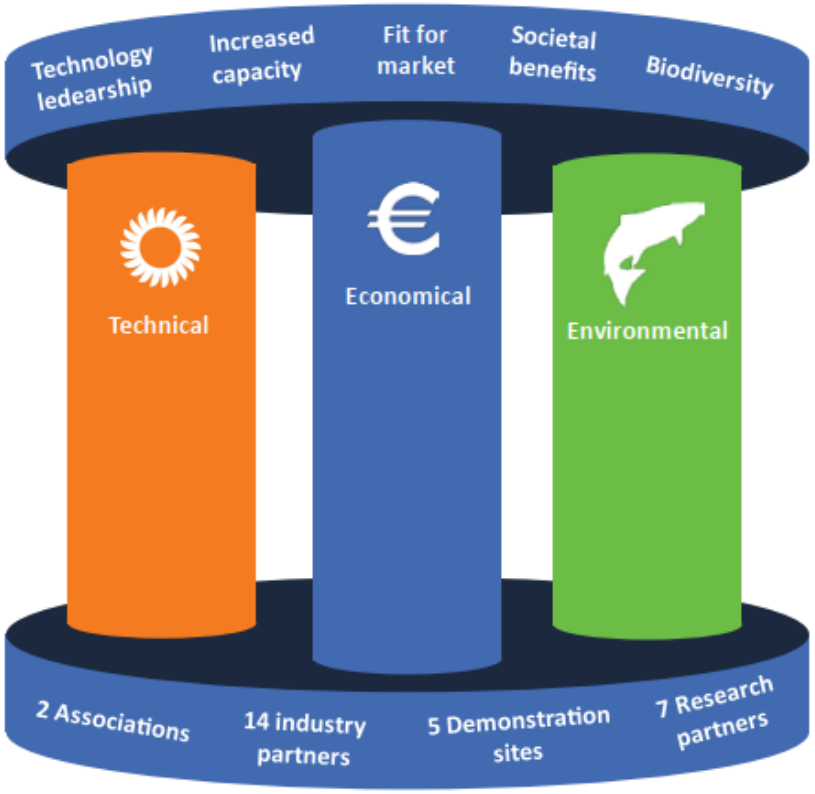
Scientific Impact

Societal Impact

Economic Technological Impact

Innovation by refurbishment

- Reducing abrasive erosion of turbines
- Developing digitalisation tools to reduce maintenance needs and downtime
- Hybridization with batteries for flexibility and environmental benefits
- Advanced control for variable speed pumped storage retrofitting
- Multi-market optimization tools to operate in future markets
- Developing eel-friendly turbines
- Using eDNA metabarcoding sampling for improved assessment of environmental impacts
- Adapting life-cycle analysis to hydropower and developing the method for biodiversity footprint
- Building a multi-criteria decision support framework to assist in the choice of refurbishment solutions



The pillars of ReHydro

Demonstration sites

The project will **use demonstration sites** to implement and **showcase innovative solutions within specific parts** of each pillar, as well as inter-disciplinary work, to **show how to combine and optimize different objectives to a common platform.**

Røldal-Suldal Power System (RSK), Norway (Lyse)

Saut-Mortier, Ain River, France (Edf)

Force Motrice de la Gougra,
Rhone River, Switzerland (Alpiq)

Caderousse, Rhone River, France (CNR)

Valeira, Douro River,Portugal (EDP)

Røldal-Suldal Power System (RSK), Norway (Lyse)

Objectives in ReHydro:

- Develop a digital twin of Røldal powerplant to improve operation and maintenance
- Pumping water to be released as environmental flow in the diverted River Brattlandsdalsåi
- Release environmental flow through a small power plant to River Roalkvamsåi

Technical facts:

- The RSK system includes 9 power plants
- Developing 5 new power plants and pumped storage hydropower in existing power system
- Increase installed capacity from 630 MW to 1,230 MW
- Annual generation will be ca 3,45 TWh

Saut-Mortier, Ain River, France (EDF)

Objectives in ReHydro

- Retrofit cascaded power system with pumped storage hydropower and increase reservoir capacity
- Provide flexibility and resilience to climate change
- Reducing the ecological impact of hydropeaking in downstream river
- Reducing the summer temperature and remove algae by water releases

Technical facts

- The Ain River system includes 6 power plants of 450 MW in total
- Installation of a reversible pump-turbine with a capacity of 60 m^3/s and an output of 17 MW

Saut-Mortier power plant

Forces Motrices de la Gougra (FMG), Upper Rhône River Basin, Switzerland (Alpiq)

Objectives in ReHydro

- Developing a digital twin of power plants
- Optimise operation for multi-market participation
- Improve sediment management
- Sediment monitoring for abrasion

Technical facts

- Two reservoirs and three powerplants
- Average annual generation is 650 GWh
- Refurbishment to increase capacity from 184 MW to 241 MW
- Dam-heightening of Moiry dam

Moiry dam

Caderousse, Rhône River, France (CNR)

Objectives in ReHydro

- Improve continuity for eel migration by constructing new fish passage and developing eel-friendly turbines
- Improve effects on navigation
- Increase of derivate flows
- Restoration of fish continuity

Technical facts

- Turbines: 6 (Bulb)
- Installed Capacity [MW]: 195
- Constructed: 1975
- One of 19 power plants on the Rhône River

Caderousse power plant

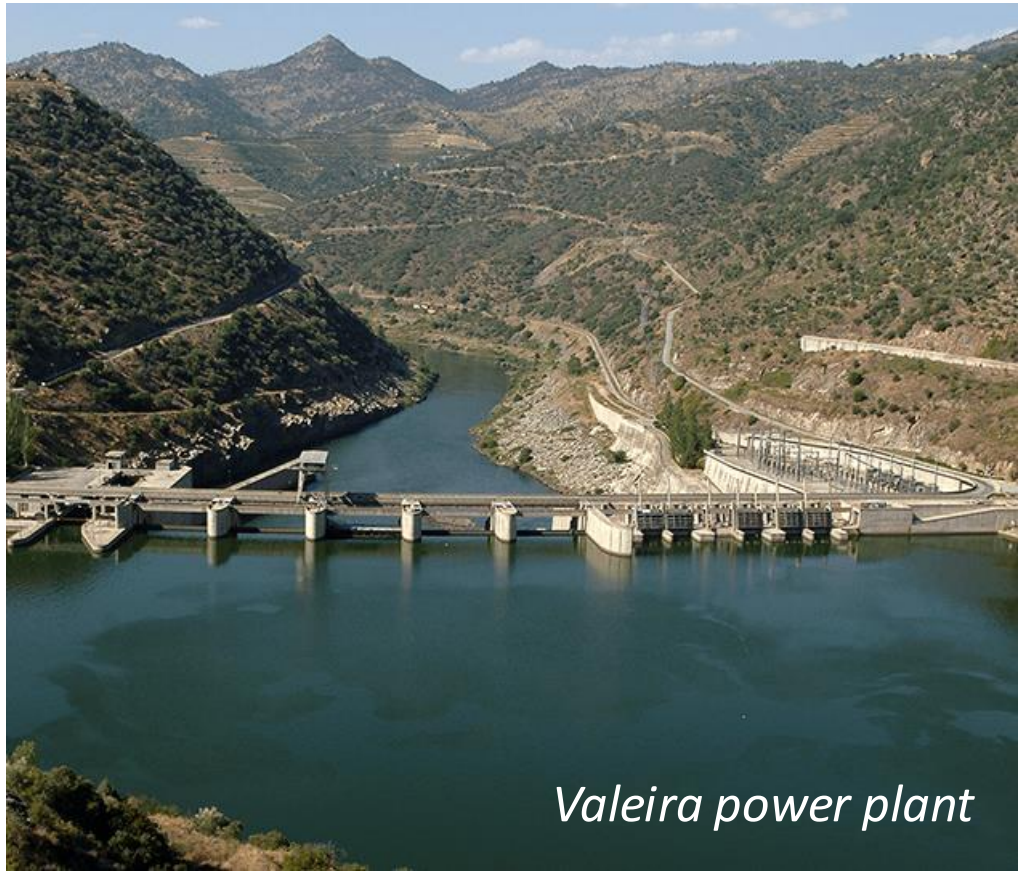
Valeira, Douro River, Portugal (EDP)

Objectives in ReHydro

- Optimize predictive maintenance and replacement strategies for critical components
- Improve trade-offs in operations and refurbishment decisions
- Ensure navigability under extreme events while protecting biodiversity

Technical facts

- Turbines: 3 (Kaplan)
- Installed Capacity [MW]: 240
- Constructed: 1976
- Reservoir capacity [mill m^3]: 13

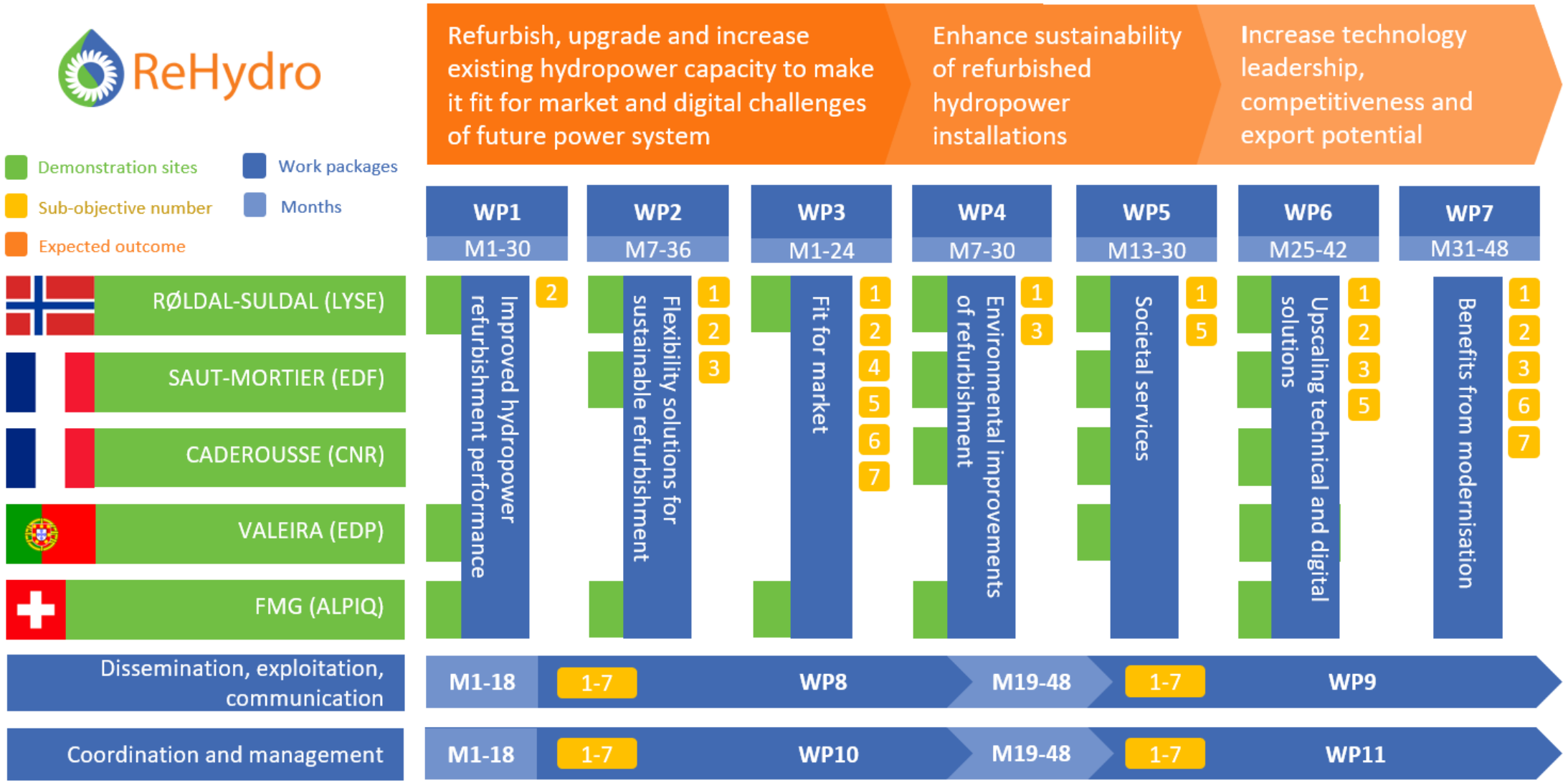


Valeira power plant

In collaboration with HEU ReNEW

ReNEW
Resilience-centric Smart, Green, Networked EU Inland Waterways

Project structure



ReHydro

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Consortium partner of ReHydro

ReHydro Objectives (1/4)

Progressing beyond the state-of-the-art

Most of the European hydropower plants were built and optimized for power systems that have since changed, making them unflexible and unsustainable by modern standards.

ReHydro will use state-of-the-art technology as a starting point to improve on key technologies.

Decision support framework

Today, multi-criteria evaluation methods are in use and well-established in several sectors and industries as a tool to support decision-making. In hydropower refurbishment, this has not yet happened.

ReHydro will propose a framework for the use of multi-criteria decision-making methods based on sustainability indicators, including but not limited to previously neglected social aspects.

Advanced monitoring for sediment erosion

Currently, assessing turbine erosion requires physical access and costly tools, such as measuring devices and 3D scanning, halting hydropower plant operation during inspection.

ReHydro aims to simplify this by using computer vision to detect and measure damage, eliminating the need for shutdowns and enabling more frequent component checks, thus enhancing digitalization capabilities.

ReHydro Objectives (2/4)

Digitalization tools

With the aid of a plant digitalization tool, the use of plant health information will support asset management, thereby reducing maintenance needs, plant outage time, and avoiding harmful operating conditions.

ReHydro will build on this foundation by demonstrating digitalization tools that will support smart decision-making for sustainable refurbishment of critical hydropower components by analysing and investigating additional sensor information.

Hybridization with batteries

Another achievement of the project will be the implementation of a control system for a hybrid hydropower plant equipped with a battery. This advancement enhances grid services and minimizes wear and tear, leading to lower maintenance costs.

ReHydro will continue to demonstrate the upgraded digital control of this technology by considering a multi-objective optimization that will make rivers more navigable.

Eel migration

While there have been past efforts to develop technologies that reliably reduce the risk hydropower plants pose to aquatic life, especially the European eel, no sufficient solution has been found for the retrofit of large Kaplan turbines.

ReHydro will develop and retrofit demonstration sites with an eel-friendly turbine design, the amount of which will cover several operating conditions, site specifics and retrofit configurations. A noticeable benefit to the eels is expected.

ReHydro Objectives (3/4)

Multi market optimization tools

Today, there is no off-the-shelf hydropower scheduling tool capable of fully optimising uncertainty and operation in multiple markets. A prototype for calculating revenue streams from multiple markets has been tested in a laboratory setting on real data together with the industry.

ReHydro will add a multimarket methodology tool that has previously been tested in a laboratory setting to the commonly used stochastic hydropower scheduling tool ProdRisk.

eDNA metabarcoding

Environmental DNA (eDNA) is a non-invasive sampling method that assesses biodiversity by detecting the presence of a species through detection of their genetic material (DNA) in the environment.

In ReHydro, we will sample eDNA from water and substrate in a regulated river and aim to demonstrate the application of eDNA. We will also recommend guidelines for the development of a standard protocol for its use in verifying effects on biodiversity caused by refurbishment.

Advanced control for variable speed pumped storage retrofitting

In the future, advanced control for variable speed pumped storage retrofitting will be tested via simulations to show that joint control methods can increase flexibility in terms of operating range.

ReHydro will retrofit one of its demonstration sites with an advanced joint control system of variable speed pumped storage to further test and showcase the implementation.

ReHydro Objectives (4/4)

Life-cycle assessment (LCA) and biodiversity footprint

As a well-established methodology, LCA already serves to evaluate environmental impacts on the whole life cycle of a product. However, it does not fully cover biodiversity issues as well as insights on the circularity of solutions.

ReHydro will be added those missing indicators and specifically adapted to the refurbishment of hydropower plants.