Demonstration of Sustainable Hydropower Refurbishment

D10.1 Project Management Plan

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101147310

Deliverable No.	10.1
Deliverable Title	Project Management Plan
Work Package Title	Coordination and management
Dissemination level	Public (PU)
Due date	2024-06-30
Version	1.0
Status	Final
Submission date	2024-06-28

Contributors	Name	Partner	Date
Deliverable Leader	Arnt Ove Eggen	SINTEF	2024-06-26
Work Package Leader	Arnt Ove Eggen	SINTEF	2024-06-26
Contribution Author(s)	Atle Harby Cécile Münch-Alligné Elena Vagnoni Quentin Boucher Line Sundt-Hansen Anne Prieur-Vernat Mauro Carolli Matteo Bianciotto Mario Bachhiesl	SINTEF HES-SO EPFL SGRID NINA ENGIE SINTEF IHA VGBE	2024-06-26
Final review and approval	Atle Harby	SINTEF	2024-06-28

DISCLAIMER / ACKNOWLEDGMENT

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101147310.

Executive Summary 6
Overview of the ReHydro project 7
Introduction 7
Objectives 8
Participants 9
Organisation 10
Schedule 12
Deliverables 13
Milestones 14
WP1 Improved hydropower refurbishment performance 15
Objectives 15
Description 15
Milestones and Deliverables 18
WP2 Flexibility solutions for sustainable refurbishment 19
Objectives 19
Description 19
Milestones and Deliverables 22
WP3 Fit for market 23
Objectives 23
Description 23
Milestones and Deliverables 27
WP4 Environmental improvements of refurbishment 28
Objectives 28
Description 28
Milestones and Deliverables 32
WP5 Societal services 33
Objectives 33
Description 33
Milestones and Deliverables 38
WP6 Upscaling technical and digital solutions 39
Objectives 39
Description 39
Milestones and Deliverables 40

WP7 Benefits from modernisation 41
Objectives 41
Description 41
Milestones and Deliverables 42
WP8 Dissemination, exploitation and communication (DEC) – Part I 43
Objectives 43
Description 43
Milestones and Deliverables 47
WP9 Dissemination, exploitation and communication (DEC) – Part II 48
Objectives 48
Description 48
Milestones and Deliverables 49
WP10 Coordination and management – Part I 50
Objectives 50
Description 50
Milestones and Deliverables 52
WP11 Coordination and management – Part II 53
Objectives 53
Description 53
Milestones and Deliverables 53
Quality Assurance 54
Risk Management 55
Financial Management 61
Payments 61
Keeping records and supporting documents 61
Reporting 62
Final report 62
What happens if reporting is late? 62
References 63
Attachment 1 Staff effort 64

Executive Summary

The Project Management Plan describes the planned activities in ReHydro for the first reporting period, from May 2024 until October 2025, in more details. Each partner has described their contribution to tasks they are involved in, as well as declaring how many person-months they have planned to use in the first reporting period. This document also gives an overview of the project in general, deliverables, milestones and risks from the Grant Agreement. Routines for quality assurance, financial management and reporting are also described in separate chapters.

Overview of the ReHydro project

Introduction

Hydropower and storage capacity need to increase to meet the need for renewable and dispatchable power generation. According to IEA, worldwide hydro-power capacity should increase from 1,360 GW in 2021 to 1,563–1,782 GW by 2030 and up to over 2,500 GW in 2050. At the same time, hydropower refurbishment projects must implement modern sustainability standards that preserve biodiversity and contribute to climate change mitigation and adaptation.

The main objective of ReHydro is to demonstrate how European hydropower can be refurbished and modernized to be fit for a leading role in the future power system respecting sustainability requirements and societal needs in a climate change context. A suite of monitoring and digital tools (performance, cavitation, machine health) implemented at demonstration sites will improve hydropower efficiency. Innovative concepts like retrofitting with pumped hydro and hybridization will make hydropower fit for future markets.

ReHydro will demonstrate how biodiversity can be improved with new fish-friendly turbines, re-establishment of environmental flows, and monitored using new tools such as eDNA. Smarter use of water resources will also be implemented so that more services can be delivered to the power markets, while multi-purpose use of the water resources for navigation and recreation can be expanded and the ability to mitigate flooding and droughts is strengthened.

The results from ReHydro will achieve all the expected outcomes specified in the call. The solutions will give European hydropower industries commercial advantages to utilise the global need for hydropower expansion. It is expected that ReHydro's exploitable results will create 700–1150 new jobs in the manufacturing industry, increasing the global market by 275 mill euros.

ReHydro will introduce a new paradigm to boost European leadership and competitiveness in the hydropower industry and provide new sustainable solutions that are replicable at European and global levels.

Objectives

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. ReHydro propose new methods and tools that will allow to refurbish, upgrade and increase European hydropower capacity. Thanks to this progress beyond the state of the art of hydropower technology, ReHydro will introduce a new paradigm to boost European leadership and competitiveness in the hydropower industry and provide new sustainable solutions that are replicable at European and global levels. The main aim of ReHydro is fully aligned with the Expected Outcomes of the topic HORIZON-CL5-2023-D3-02-09. The sub-objectives of ReHydro are:

- **SO1**: To improve the flexibility of the existing European hydropower fleet ensuring suitability for today and future power markets through hybridization for 5% increased revenue (KPI1.1), extension of the operating range to 20–120% (KPI1.2) and retrofitting with pumping systems to reduce flood spill volumes by 20% (KPI1.3), while improving sediment transport through turbines by 5% (KPI1.4).
- **SO2**: To implement and demonstrate five digital solutions (KPI2.1) and three advanced control systems (KPI2.2). This will progress application of predictive maintenance and inclusion of new environmental constraints and contribute to reach a 2% increased performance (KPI2.3).
- **SO3**: To improve and ensure environmental sustainability and conservation of biodiversity in hydropower refurbishment by developing new turbines that decrease eel mortality during downstream migration by 50% (KPI3.1), implement well-established (environmental flow) and state-of-the-art (eDNA) methods to reduce biodiversity loss and increase taxon richness by 5% (KPI3.2), showing how the suggested solutions improve aquatic habitat suitability by at least 10% (KPI3.3).
- **SO4**: To identify European market needs in 3 different scenarios for future energy system development (KPI4.1), that will enable European hydropower to select the optimal refurbishment solution.
- **SO5**: To use refurbishment of hydropower plants to provide non-energy services to the society by reducing peak flood value by 5–10% (KPI5.1), improving drought management and biodiversity with increased guaranteed environmental flow by 8-12% in low-water period (KPI5.2), by reducing non-navigable days during extreme events by 15–20% (KPI5.3) and increasing the awareness of recreational interests by 30% among local stakeholders (KPI5.4).
- **SO6**: To make European hydropower industry ready for export by creating 8 new market products (KPI6.1), and to attract more qualified personnel to the industry by creating 50 new jobs per year (KPI6.2).
- **SO7**: To provide an overview of the benefit of modernisation for industry and policymakers through 3 key documents (KPI7.1) and 6 software tools (KPI7.2) that highlight the key conclusions of the project, describe their alignment with the EU long-term climate strategy, and identify key barriers for the large-scale implementation of modernising sustainable hydropower.

Participants

Table 1. ReHydro participants.

No.	Acronym	Participant organisation name	Country
1	SINTEF	SINTEF Energi AS (Coordinator)	Norway
2	VGBE	VGBE Energy EV	Germany
3	EDF	Electricité de France	France
4	EDP	EDP - Gestao da Producao de Energia SA	Portugal
4.1	EDPL	LABELEC Estudos Desenvolvimento e Actividades Laboratoriais SA	Portugal
5	CNR	Compagnie Nationale du Rhône SA	France
6	LYSE	Lyse Produksjon AS	Norway
7	GE	GE Hydro France	France
8	ANDRITZ	ANDRITZ Hydro GmbH	Austria
9	VOITH	Voith Hydro Holding GMBH & Co KG	Germany
10	INTOTO	INTOTO AS	Norway
11	ENGIE	ENGIE SA	France
12	INRAE	Institut national de recherche pour l'agriculture, l'alimentation et l'environnement	France
13	NINA	Stiftelsen Norsk institutt for naturforskning	Norway
14	HM	Hochschule für Angewandte Wissenschaften München	Germany
15	SGRID	SuperGrid Institute	France
16	AKSO	Aker Solutions AS	Norway
16.1	AKER	Aker Solutions Hydropower AS	Norway
17	ALPIQ	ALPIQ AG	Switzerland
18	AND_CH	ANDRITZ Hydro AG	Switzerland
19	EPFL	Ecole Polytechnique Fédéral de Lausanne	Switzerland
20	HES-SO	Haute Ecole Spécialisée de Suisse Occidentale	Switzerland
21	HEX	HYDRO Exploitation SA	Switzerland
22	IHA	International Hydropower Association Limited	UK

Organisation

Figure 1 shows the governance structure of ReHydro.

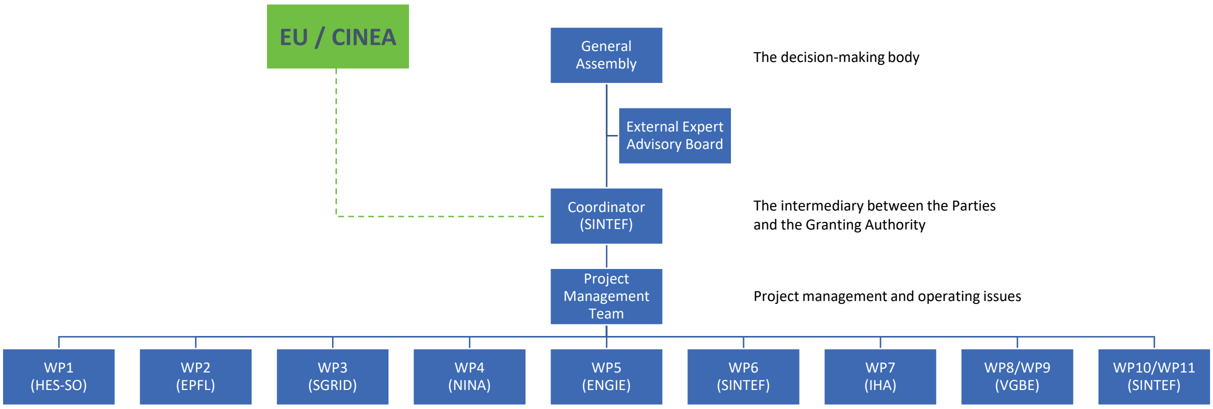

Figure 1. The governance structure of ReHydro.

Figure 2 illustrates the work package structure and the relationships between the work packages.

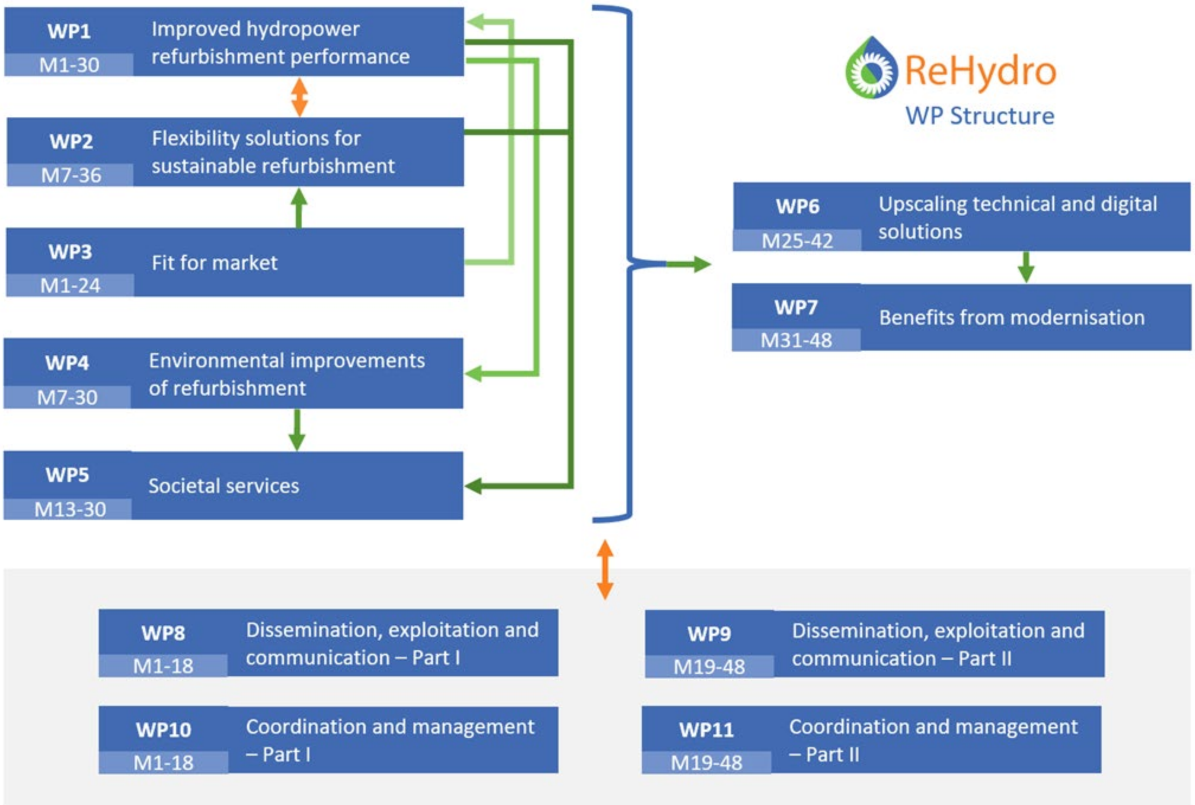

Figure 2. Graphical representation of ReHydro work package structure.

The relationships between the work packages and the five main demonstration sites are illustrated in Figure 3, which also are indicating sub-objectives and contributions to the expected outcomes.

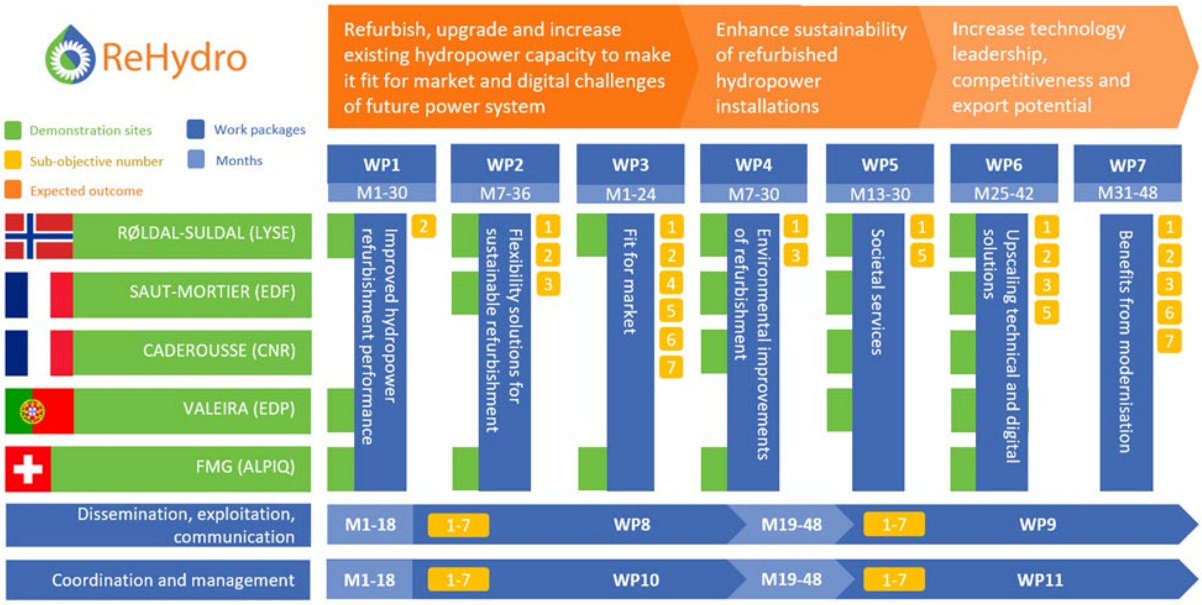

Figure 3. Graphical representation of relationships between work packages, demonstration sites, sub-objectives (numbers in yellow), and expected outcomes.

Schedule

Figure 4 shows the Gantt diagram of ReHydro tasks.

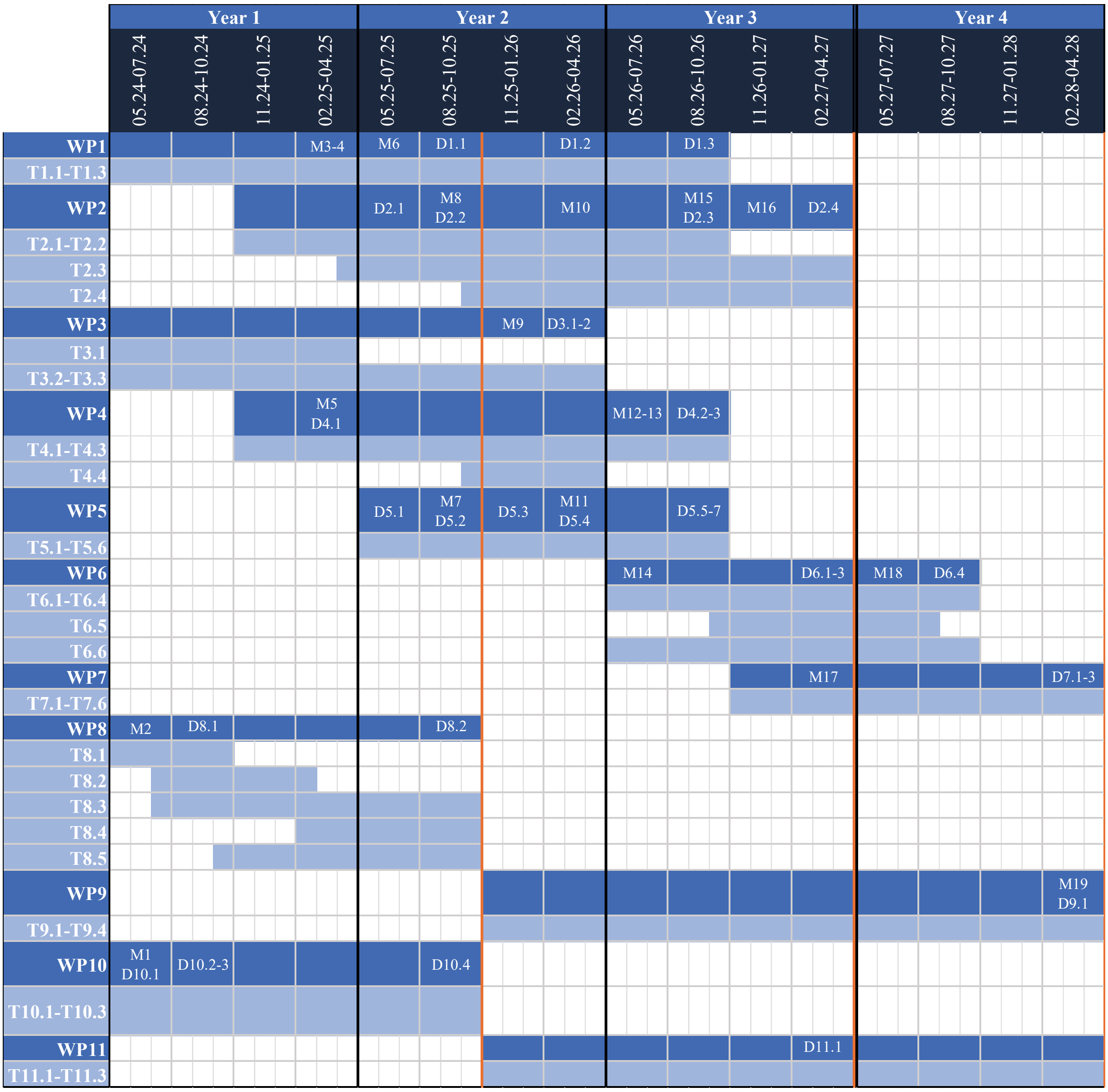

Figure 4. Gantt diagram of ReHydro tasks. The red lines indicate the reporting periods.

Deliverables

Table 2. ReHydro deliverables.

No.	Name	WP no.	Lead partner	Type	Level	Delivery date
D1.1	Demonstration of monitoring technologies	1	HES-SO	DEM	SEN	Oct. 25
D1.2	Monitoring technologies	1	HES-SO	R	PU	April 26
D1.3	Abrasion monitoring	1	AND_CH	DEM	PU	Oct. 26
D2.1	Initial studies for retrofitting with pumped storage	2	EDF	R	SEN	July 25
D2.2	Control algorithm for hybrid systems	2	EPFL	R	SEN	Oct. 25
D2.3	Retrofitting with pumped storage technology	2	EDF	R	PU	Aug. 26
D2.4	Hybridization and digitalization	2	EPFL	R	PU	April 27
D3.1	Business outlook	3	SGRID	R	PU	April 26
D3.2	Multimarket model	3	SINTEF	OTHER	SEN	April 26
D4.1	Eel-friendly turbine development plan	4	GE	R	SEN	April 25
D4.2	Eel-friendly turbine design	4	GE	DEM	SEN	Oct. 26
D4.3	Environmental flow	4	LYSE	R	PU	Oct. 26
D5.1	Hydropower pressures assessment	5	EDF	OTHER	PU	July 25
D5.2	Matrix of future water uses	5	EDF	OTHER	PU	Sep. 25
D5.3	Goal and scope of LCA	5	ENGIE	R	PU	Nov. 25
D5.4	River digital services description	5	INTOTO	R	PU	April 26
D5.5	Services for society	5	ENGIE	R	PU	Oct. 26
D5.6	Result of LCA applied to the refurbishment scenario	5	ENGIE	R	SEN	Oct. 26
D5.7	Biodiversity footprint	5	EDF	OTHER	PU	Oct. 26
D6.1	Upscaling sustainability solutions	6	SINTEF	R	PU	April 27
D6.2	Upscaling environmentally friendly solutions	6	NINA	OTHER	PU	April 27
D6.3	Climate Resilience Guide: comments and recommendations	6	SINTEF	R	PU	April 27
D6.4	Decision support framework	6	ENGIE	DEM	PU	Oct. 27
D7.1	White Book	7	SINTEF	R	PU	Feb. 28
D7.2	Benefits from modernisation	7	IHA	R	PU	March 28
D7.3	Modernisation and EU long-term strategy	7	IHA	R	PU	April 28
D8.1	DEC master plan	8	VGBE	R	PU	Oct. 24
D8.2	DEC master plan update 1	8	VGBE	R	PU	Oct. 25
D9.1	DEC master plan update 2	9	VGBE	R	PU	Feb. 28
D10.1	Project Management Plan	10	SINTEF	R	PU	June 24
D10.2	Risk Management Plan	10	SINTEF	R	SEN	Oct. 24
D10.3	Data Management Plan	10	SINTEF	DMP	PU	Oct. 24
D10.4	Project Management Plan – Revision 1	10	SINTEF	R	PU	Oct. 25
D11.1	Project Management Plan – Revision 2	11	SINTEF	R	PU	April 27

Milestones

Table 3. ReHydro milestones.

No	Name	WP	Lead partner	Means of verification	Date
1	Kick-off meeting	10	SINTEF	Personal attendance and report	May 24
2	Launch of the website	8	VGBE	Online	June 24
3	Online monitoring systems installed in RSK	1	LYSE	Operational acquisition of signals	Feb. 25
4	Online monitoring systems installed in Valeira	1	EDP	Operational acquisition of signals	Feb. 25
5	Planning of bypass flows to reestablish biodiversity	4	NINA	Internal memo	April 25
6	Online monitoring systems installed in FMG	1	ALPIQ	Operational acquisition of signals	June 25
7	Data collection for PBF model	5	EDF	Data available	Sep. 25
8	Meta-code for optimal control of hybrid plants	2	EPFL	Meta-code available	Oct. 25
9	Multimarket model demonstrated by ALPIQ	3	ALPIQ	Test report from demonstrator	Jan. 26
10	Tests completed on hybridization demonstration	2	EPFL	Database available	April 26
11	Stakeholder thresholds for societal services	5	ENGIE	Data available	April 26
12	Eel friendly turbine design simulations	4	GE	Simulations documented	June 26
13	Reestablishment of biodiversity in bypassed river	4	NINA	eDNA indicators improved	June 26
14	Data from WP1-5 consolidated as input to WP6	6	SINTEF	Data available	June 26
15	Pumped-storage retrofitting works at Saut Mortier	2	EDF	Visit hydropower plant	Aug. 26
16	Control algorithm implemented for sediments and operations management at Bitsch power plant	2	ALPIQ	Operational acquisition of control signals	Dec. 26
17	Workshop with relevant EU stakeholders to identify barriers to sustainable modernisation.	7	IHA	Workshop report	April 27
18	Decision support framework	6	SINTEF	Report	June 27
19	Final event (open conference)	9	VGBE	Conference proceedings	April 28

WP1 Improved hydropower refurbishment performance

Duration: M1–M30 **Lead: HES-SO**

Objectives

O1.1 Development of innovative technologies to monitor continuously online turbine performance.

O1.2 Development of innovative technologies to monitor vibration and erosion due to cavitation or sediments to extend operating range and improve maintenance.

O1.3 Development of virtual powerplants for monitoring and control of technical and environmental parameters.

All the objectives are linked to SO2.

Description

Link with the other work packages: Results to WP2 to integrate into a multi-objective optimization, and to WP4 for sediment transport modelling, and to WP6 for upscaling and WP7 for integration in outcomes. WP1 will receive input from WP3 on market needs. Collaborative development with WP2 and WP5 for the performance, environmental and societal aspect to be included in decision-support tools and used in WP6 and WP7.

T1.1 Online cavitation and efficiency monitoring (M1-M30; L: EDP: EDPL, VOITH, HM)

Novel technology for direct cavitation erosion monitoring and detection will be further developed and validated. The project will establish methodologies for optimizing sensor placement and data acquisition, and subsequently develop and integrate algorithms into a software tool. These advancements will lead the installation of the cavitation monitoring system at two units in Valeira powerplant (EDP), validated during regular operations and power ramp tests for enhanced consistency and system refinement. In parallel, a system measuring on-line discharge flow and operational data will be refined and validated. This will ensure high-repeatability and continuous efficiency monitoring. This solution will enable long-term monitoring of performance degradation, crucial for operational and maintenance decisions. Leveraging data from both the cavitation monitoring and efficiency systems, the project will establish an advanced monitoring and diagnostic tool. Analysing data from prior advanced sensing technologies at Valeria powerplant will validate their suitability in understanding power unit behaviour. The lower part load limit will be re-evaluated and extended towards lower values while maintenance intervals will be optimized.

<u>Extended description for the first reporting period</u> Delivering data/information to T6.1, T7.2.
EDP (05.24–10.25, 23.0 PM, Valeira) EDP will provide operational data and share it online with task partners. EDP will also contribute to coordinate the installation of the cavitation system at the Valeira site.
EDPL (05.24–10.25, 2.0 PM, Valeira) EDPL will support EDP in the technical tasks of this WP and in the coordination of the technical activities.
VOITH (05.24–10.25, 23.0 PM, Valeira) For the cavitation monitoring VOITH will design and install the cavitation system at the Valeira site. Establish methodologies for optimizing sensor placement and data acquisition, followed by the development and integration of algorithms into a software tool. For the efficiency monitoring VOITH will contribute to establish the exchange of operational data, analysis of the operational data (also under incorporation of experience from prototype efficiency measurements), identification of feasible implementation approach w.r.t. to existing software toolset and digital product portfolio and implementation of the efficiency monitoring.
HM (05.24–10.25, 17.0 PM, Valeira) HM will contribute by analysing SCADA data, implementing efficiency monitoring algorithms with flow measurements, exploring virtual flow metering using SCADA data, and developing algorithms for cavitation damage monitoring based on ultrasound signals.

T1.2 Online monitoring of turbine performance (M1-M30; L: ALPIQ; P: AND_CH, EPFL, HES-SO, HEX)

A monitoring system will be developed and implemented at the FMG and ELM (ALPIQ) hydropower plants to predict abrasion caused by suspended sediments. The turbine performance monitoring will track discharge, power and efficiency based on a combination of the sliding-needle and Gibson methods, using pressure sensors and new turbine regulation sequences. A machine learning enhanced camera-based system for automated visual inspection of the runner will enable precise quantification of the evolution and severity of the abrasion damage through visual data analysis. Additionally, 3D simulations (CFD-FEM) will be performed to gain insights into the abrasion process. The partners will study the correlation between sediment concentration, visual abrasion damage, and efficiency losses, which will be used for predicting permissible sediment concentrations and estimating runner lifespan based on accumulated sediments. Finally, a vibrational digital twin will also be developed and applied to the FMG (ALPIQ) to predict and monitor the vibrational responses of the units under different operational conditions and different failure hypotheses, including abrasion damage. These simulations will build a library of vibrational responses, that can be used in an online monitoring system for early fault detection. Moreover, fatigue data extracted from the simulations will contribute to a longer-term health index monitoring tool.

Extended description for the first reporting period Delivering data/information to T2.4, T6.1, T7.2.
ALPIQ (05.24–10.25, 4.0 PM, ELM, FMG) Coordinate the works on the demo sites between Asset Managers, ReHydro partners, and external partners. Provide support on the various tasks, contribute to the analysis of the results, and ensure that the outputs can be transferred to other work packages.
AND_CH (05.24–10.25, 5.0 PM, ELM) Design and integration of the camera system for Bitsch powerplant. Installation, commissioning, and start of systematic image taking and storage.
EPFL (05.24–10.25, 4.0 PM, ELM, FMG) EPFL will perform the modelling of erosion/abrasion on Pelton buckets to understand the phenomenon of material detachment through numerical simulations and analyse how various factors contribute to the wearing of surfaces. Boundary conditions of the model, material properties, environmental conditions, and operational parameters will be defined in collaboration with ALPIQ, ANDRITZ and HES-SO to ensure that the simulation results are robust and applicable to real-world scenarios, ultimately aiding in the development of efficient operational and maintenance strategies.
HES-SO (05.24–10.25, 10.0 PM, ELM, FMG) HES-SO will provide CFD/FEM simulations of two Pelton turbines, one of ELM and one of Vissoie, focusing on the correct prediction of the jet development and its impact on the runner. Modal analysis of the runner will also be performed to predict the influence of sediment erosion on the runners eigen modes. These numerical results will serve as a reference to analyse vibration monitoring performed by HEX and for the modelling of erosion carried out by EPFL.
HEX (05.24–10.25, 6.0 PM, ELM, FMG) HEX will ensure the implementation of the various measurement systems at the demonstration sites. The way in which the efficiency of the plant is measured will be tested depending on the power plant configuration and will serve as an evaluation parameter for performance degradation due to erosion. The vibration fingerprint will be generated regularly, and the analysis will show the correlation between the wear of the turbine and the change in the fingerprint.

T1.3 Virtual powerplants for monitoring and control (M1-M30; L: AKER; P: LYSE)

This task will deploy a digital virtual powerplants (digital twins) for real-time monitoring of discharge, efficiency, head losses and power for all individual parts. The digital twin will find and iteratively include the most relevant environmental parameters (e.g., water quality, sediment transport, rate of change of levels and discharge). It will perform real-time calculations on maximum production within any chosen parameter constraint. The task will set the foundation for a later fully automatic, and optimized, production control of entire plants and collection of plants.

Extended description for the first reporting period Delivering data/information to T2.3, T6.1, T7.2.
LYSE (05.24–10.25, 12.0 PM, Røldal power plant) Deliver plant information to build a model. Make available operational measures from Røldal power plant to the model. Integrate the model in the decision-making process how to operate the plant to gain more value of the production.

AKER (05.24–10.25, 11.6 PM, Røldal power plant)
Assemble the transient model of the plant and waterways in LVTrans and calibrate it against existing measured data, typically footprints, commissioning reports and efficiency measurements. Install the model into the digital twin environment, meaning a system that automates transient simulations for specific tasks. Typically, several simulations are done simultaneously in parallel. This environment consists of an embedded or industry PC with specific IO to the plant and SCADA and to existing data management systems for storage and visualisation, typically cloud based. Røldal also has an online turbine efficiency system that can be included as input. The digital twin(s) is dependent on very few input data to function. In its basic form only reservoir levels, power setpoints and gate openings are needed, but other data can be included for special purposes. The final result will be an online system for monitoring and storing data as described. This also includes the maximum possible power the plant can produce at any given time together with the corresponding total plant efficiency. When this is up and running, additional environmental data, as described, will be investigated and included.

Partner	RP1			RP2			RP3	Total
	T1.1	T1.2	T1.3	T1.1	T1.2	T1.3	-	
EDP	23.0			8.0				**31.00**
EDPL	2.0			2.0				**4.00**
LYSE			12.0					**12.00**
VOITH	23.0			9.0				**32.00**
HM	17.0			8.0				**25.00**
AKER			11.6					**11.60**
ALPIQ		4.0						**4.00**
AND_CH		5.0			4.5			**9.50**
EPFL		4.0			5.8			**9.80**
HES-SO		10.0			12.0			**22.00**
HEX		6.0						**6.00**
Total PMs	**65.0**	**29.0**	**23.6**	**27.0**	**22.3**	**-**	**-**	**166.90**

Milestones and Deliverables

No.	Name	Lead partner	Type	Dissemi-nation level	Date
M3	Online monitoring systems installed in RSK	LYSE	Operational acquisition of signals		Feb. 25
M4	Online monitoring systems installed in Valeira	EDP	Operational acquisition of signals		Feb. 25
M6	Online monitoring systems installed in FMG	ALPIQ	Operational acquisition of signals		Jue 25
D1.1	Demonstration of monitoring technologies	HES-SO	DEM	SEN	Oct. 25
D1.2	Monitoring technologies	HES-SO	R	PU	April 26
D1.3	Abrasion monitoring	AND_CH	DEM	PU	Oct. 26

WP2 Flexibility solutions for sustainable refurbishment

Duration: M7–M36 **Lead: EPFL**

Objectives

O2.1 Demonstrate the potential of hybridisation with batteries for multiple hydropower plants on the same cascade (linked to SO1, SO2).

O2.2 Showcase the benefits of a refurbishment project to increase flexibility and water storage capacity with a new pumping system (linked to SO1, SO3).

O2.3 Demonstrate the benefits of advanced control and monitoring systems for sediment management (linked to SO1, SO2, SO3).

O2.4. Improve monitoring and control of hydropower plants by using real-time digital twins (linked to SO2, SO3).

Description

Link with the other work packages: Results to WP6 for upscaling and WP7 for integration in outcomes, input from WP3 on market needs and collaborative development with WP1 and WP5 for the performance, environmental and societal aspects to be included in decision-support tools and used in WP6 and WP7.

T2.1 Hybridization of cascade hydropower with batteries (M7-M30; L: EPFL; P: EDF, ANDRITZ, AND_CH)

This task investigates the integration of a Battery Energy Storage System (BESS) into multiple hydropower plants in a cascade. A framework will be designed to increase the flexibility while effectively managing hydropeaking and water regulation along the Rhine River cascade including Vogelgrün run-of-river power plant. This optimization includes a real-time simulation platform for flexible power output, water management and hydropeaking mitigation.

Extended description for the first reporting period Delivering data/information to T6.1, T7.1 and T7.2.
EPFL (11.24–10.25, 6.0 PM, Vogelgrün and Rhine cascade) Development of a model predictive control algorithm to optimize the use of a BESS in a multi-objective framework including improvement of water management and minimization of turbines wear considering a cascade of run of river power plants. Preparation of reduced scale model testing to be performed in the battery-hybrid test rig at EPFL by April 2026.
EDF (11.24–10.25, 3.4 PM, Vogelgrün and Rhine cascade) Selection of Rhine River plant cascade to be included in model. Operational data base provision. Wear and tear KPIs selection. Specification of scenarios to be modelled in lab platform. Hybrid unit operation and algorithm upgrade.
ANDRITZ (11.24–10.25, 10.0 PM, Vogelgrün and Rhine cascade) Wear and tear KPIs selection. Hydraulic, mechanical and numerical studies. Analysis of past inspections regarding wear of blades' bearings. Hybrid unit observation, algorithm developments and upgrade. FCR statistics on the evolution over the last years.

AND_CH (11.24–10.25, 2.7 PM, Vogelgrün and Rhine cascade)
The work is related to: • Wear and tear KPIs selection, extension to all systems • Hydraulic, mechanical and numerical studies. • Creation of synthetic data for selected plants on the Rhine River cascade. • Aggregation of FCR statistics to isolate the specific costs of frequency control.

T2.2 Retrofitting with variable speed pumped hydro (M7-M30; L: EDF; P: EPFL)

The Saut-Mortier power plant (EDF) will be retrofitted with variable-speed reversible generating and pumping units equipped with full-size frequency converters and advanced joint controls. The goal is to optimize facility usage, enhance water regulation for multiple users, and provide peak power and storage capacity. This includes reducing hydropeaking intensity, lowering temperatures, and controlling algae through managed water releases. Numerical models and hydro-thermal indicators will assess river flow, energy flexibility, and water usage across scales. Changes in flow and temperature will be informed by climate trajectories from the French DRIAS web platform. Insights from the Vouglans Saut-Mortier (EDF) demonstration will guide the transfer of this methodology to other sites. Moreover, the project will produce a manual for implementing the new pumping system using hydrological and thermal models.

<u>Extended description for the first reporting period</u>
Delivering data/information to T4.3, T4.4, T5.4, T6.1, T7.1 and T7.2.
EDF (11.24–10.25, 5.3 PM, Saut Mortier) Provide a methodology to design a PSP as part of a retrofit or modernisation of an existing hydro facility. Study of the influence of the operation of a PS on the downstream dam temperature: i) description of the hydro-thermal models (1D and 3D reservoir models) including pumped-storage retrofitting, ii) first results on thermal potential gain.
EPFL (11.24–10.25, 0.5 PM) Follow-up of activities to develop a global control framework for water management.

T2.3 Operating range extension of storage hydropower (M12-M36; L: LYSE; P: SINTEF, AKER, NINA, EPFL)

This task aims to extend the operational range of multiple units within a storage hydropower plant cascade in the Røldal-Suldal hydropower system (LYSE). Building on T1.3 results, the focus is on enhancing these units for grid power and energy regulation. The aim is to minimize hydropeaking's impact by using FIThydro hydropeaking tool, optimize water regulation, and manage sediment transport. The project will employ hydraulic numerical simulations to study the stability of the full hydraulic layout and verify the safety of the operating range extension during transients. This dual-purpose approach will ensure the hydraulic layout's stability during changes and provide a thorough assessment of benefits in water management and economic performance. This task will investigate both fixed-speed and variable-speed hydroelectric units with high-head reversible pump-turbines to pinpoint the optimal pumping technology for the Røldal-Suldal system. This exploration will yield a comprehensive framework, evaluating technical alternatives to boost capacity and ensure the asset's efficient, sustainable operation.

<u>Extended description for the first reporting period</u> Depending on data/information from T1.3. Delivering data/information to T4.2, T5.1, T6.1, T7.1 and T7.2.
LYSE (04.25–10.25, 6.0 PM, Røldal-Suldal) Contribute with information about the Røldal-Suldal water system including power station. Describe the challenges in the system to be able to simulate different scenarios.
SINTEF (04.25–10.25, 1.0 PM, Røldal-Suldal) Application of the FIThydro tool to quantify the hydropeaking in different scenarios simulated based on the results of T1.3. The FIThydro tool was developed for the Atlantic salmon, grayling and Iberian barbel in rivers. It consists of Excel tables in which the user inputs values for the effects on fish species and vulnerability parameters of the studied river into the respective tables. SINTEF will contribute to identify a river reach where hydropeaking might be possible and where the application of the FIThydro tool to the T1.3 results is feasible. The tool will be applied for the Atlantic salmon.
NINA (04.25–10.25, 0.5 PM, Røldal-Suldal) Contribute to the assessment of environmental impact of hydropeaking using data from salmonid populations specific for the south-western part of Norway (alternative “region of Norway”) where the LYSE demo site, Røldal-Suldal, is located.
AKER (04.25–10.25, 2.5 PM, Røldal-Suldal) Investigate the possibilities of including various environmental parameters into the digital twin installed in T1.3. This includes, but is not restricted to, sediment transport. Other possible parameters are rate of change of discharge, temperature, O_2 etc. Focus is to investigate which parameters are practical to include in the particular modelling used, and which mathematical models are best suited for those parameters. The results will later be the basis for a predictive controller of the plant(s) where these models are included.
EPFL (04.25–10.25, 0.4 PM) Follow-up of activities to develop a global control framework for water management.

T2.4 Sediment informed operational optimization (M18-36; L: ALPIQ; P: AND_CH, EPFL, HES-SO, HEX)

In this task, the sediment abrasion, vibration, and unit performance monitoring system from WP1.2 will be integrated into an advanced control system. This integration will enable a multi-objective operational optimization of the units at both FMG and ELM (ALPIQ) hydropower schemes. A real-time digital twin will be implemented to monitor and manage hydropower plant operations, enhancing unit flexibility. Building on the Smart Power Plant Supervisor methodology developed within the XFLEX HYDRO project, this task will combine operational statistics, numerical simulation results, and field test measurements to construct a multi-dimensional hill chart. This chart will encompass sediments erosion, vibrations, and hydraulic performance, and will feed into a model predictive control (MPC) framework. The MPC, based on short-term probabilistic forecasts, will guide control actions on a second timescale. Its aim is to minimize component aging, optimize performance, and enhance environmental key performance indicators (KPIs).

Partner	RP1				RP2				RP3	Total
	T2.1	T2.2	T2.3	T2.4	T2.1	T2.2	T2.3	T2.4	-	
SINTEF			1.0				2.0			**3.00**
EDF	3.4	5.3			3.4	5.3				**17.40**
LYSE			6.0							**6.00**
ANDRITZ	10.0				8.6					**18.60**
NINA			0.5				1.5			**2.00**
AKER			2.5				2.5			**5.00**
ALPIQ								2.0		**2.00**
AND_CH	2.7				2.7			2.8		**8.20**
EPFL	6.0	0.5	0.4		6.0	0.5	0.5	16.5		**30.40**
HES-SO								4.0		**4.00**
HEX								1.5		**1.50**
Total PMs	**22.1**	**5.8**	**10.4**	**-**	**20.7**	**5.8**	**6.5**	**26.8**	**-**	**98.10**

Milestones and Deliverables

No.	Name	Lead partner	Type	Dissemi-nation level	Date
D2.1	Initial studies for retrofitting with pumped storage	EDF	R	SEN	July 25
D2.2	Control algorithm for hybrid systems	EPFL	R	SEN	Oct. 25
M8	Meta-code for optimal control of hybrid plants	EPFL	Meta-code available		Oct. 25
M10	Tests completed on hybridization demonstration	EPFL	Database available		April 26
M15	Pumped-storage retrofitting works at Saut Mortier	EDF	Visit hydropower plant		Aug. 26
D2.3	Retrofitting with pumped storage technology	EDF	R	PU	Aug. 26
M16	Control algorithm implemented for sediments and operations management at Bitsch power plant	ALPIQ	Operational acquisition of control signals		Dec. 26
D2.4	Hybridization and digitalization	EPFL	R	PU	April 27

WP3 Fit for market

Duration: M1–M24 **Lead: SGRID**

Objectives

O3.1 Deliver a business outlook that identifies the future flexibility needs, which role hydropower could have in Europe towards 2030 and 2050 and how the European market design enables such role. Linked to SO5 and SO6.

O3.2 Deliver a prototype of a multi-market tool for hydropower refurbishment that calculates multiple revenue streams for flexibility. Linked to SO2 and SO7.

O3.3 Deliver flexibility metrics in hydropower refurbishment that can be part of the decision basis when comparing refurbishments options. Linked to SO1 and SO4.

Description

Link with the other work packages: Results from T3.1 will be used by WP1 and WP2. All results from WP3 are relevant for WP6 and WP7.

T3.1 Identification of future market needs and solutions (M1-M12; L: SGRID; P: SINTEF, VGBE, EDF, EDP, CNR, LYSE, IHA, ALPIQ)

Based on the HydroFlex, XFLEX HYDRO, VGBE, IHA, IEA Hydro, EERA and ETIP-Hydropower networks, a survey will be conducted within the hydropower sector. The result will be discussed and elaborated with ReHydro partner and stakeholder groups in a series of workshops before the work is summarized in a business outlook for sustainable hydropower refurbishment. Topics that will be included in the business outlook are the specificities of hydropower investments, investors' expectations and, the need of flexibility in the power grid. In combination with expectation for future markets regarding the services hydropower can deliver and available information regarding price-levels, expected refurbishment needs and potentials can be described. Technical and regulatory drivers and barriers to hydropower refurbishment will be identified.

<u>**Extended description for the first reporting period**</u> Delivering data/information to D3.1 jointly created with T3.3.
SGRID (05.24–04.25, 10.6 PM) Coordinate T3.1 and WP3. June – October 2024: Literature review on hydro modernisation and on the future of electricity markets across Europe. Related contribution to D3.1. September – October 2024: Preparation of operators' survey on modernisation. Carry out interviews of ReHydro internal respondents and adjust survey accordingly. November – December 2024: Sharing operators' survey across IHA network. January – March 2025: Collect and analyse responses to the survey. Prepare IHA workshops with operators, service providers and TSOs.

March - April 2025: Organize and participate to 3 (or 4) IHA workshops on modernisation to discuss the main findings from the survey: • 1 meeting just with operators • 1 meeting operators + service providers • 1 meeting operators + regulatory bodies (TSOs +....) • 1 meeting just with operators (optional) Summarize the findings regarding modernisation process into D3.1.
SINTEF (05.24–04.25, 1.5 PM) June – October 2024: Literature review on flexibility needs, flexibility providers and on the electricity markets (present and future) in the Nordics / across Europe. Related contribution to D3.1. SINTEF will focus on policy review and the review of future electricity markets in the Nordics/across Europe as laid forward by EU regulations, mid-September and deliver a short memo on the findings, end of October. Contribute with input and review of surveys and results etc.
VGBE (05.24–04.25, 2.5 PM) June – October 2024: Literature review on flexibility needs, flexibility providers and on the electricity markets (present and future) in Germany, Austria, Netherlands and Belgium. Related contribution to D3.1. September – October 2024: Preparation of operators' survey on modernisation. November – December 2024: Sharing operators' survey across VGBE network.
EDF (05.24–04.25, 1.3 PM) June – October 2024: Short literature review on "consultation publique sur le soutien au développement des stations de transfert d'énergie par pompage (STEP)" by DGEC and flexibility needs, flexibility providers and on the electricity markets (present and future) in France. Related contribution to D3.1. October – November 2024: Response to initial survey regarding hydropower modernisation process at EDF and interviews on the same topic. It is expected to reach relevant people within EDF to discuss drivers, business cases, financing of modernisation projects and potentially discuss past projects. Statistics on the last 5-10 years would be appreciated.
CNR (05.24–04.25, 1.1 PM) June – October 2024: Short literature review on flexibility needs, flexibility providers and on the electricity markets (present and future) in France. Related contribution to D3.1. September – October 2024: Response to initial survey regarding hydropower modernisation process at CNR and interviews on the same topic. It is expected to reach relevant people within CNR to discuss drivers, business cases, financing of modernisation projects and potentially discuss past projects. Statistics on the last 5-10 years would be appreciated.
LYSE (05.24–04.25, 1.4 PM) June – October 2024: Short literature review on flexibility needs, flexibility providers and on the electricity markets (present and future) in Norway + the Nordics. Related contribution to D3.1. October – November 2024: Response to initial survey regarding hydropower modernisation process at LYSE and interviews on the same topic. It is expected to reach relevant people within LYSE to discuss drivers, business cases, financing of modernisation projects and potentially discuss past projects. Statistics on the last 5-10 years would be appreciated.
ALPIQ (05.24–04.25, 1.0 PM) June – October 2024: Short literature review on the recent public consultation regarding PSPs and on flexibility needs, flexibility providers and on the electricity markets (present and future) in Switzerland, Italy and Spain. Related contribution to D3.1. October – November 2024: Response to initial survey regarding hydropower modernisation process at ALPIQ and interviews on the same topic. It is expected to reach relevant people

within ALPIQ to discuss drivers, business cases, financing of modernisation projects and potentially discuss past projects. Statistics on the last 5-10 years would be appreciated.
IHA (05.24–04.25, 3.0 PM) June – October 2024: Literature review on hydro modernisation and on the future of electricity markets across Europe. Related contribution to D3.1. September – October 2024: Preparation of operators' survey on modernisation. Carry out interviews of ReHydro internal respondents and adjust survey accordingly. November – December 2024: Sharing operators' survey across IHA network. January – March 2025: Collect and analyse responses to the survey. Prepare IHA workshops with operators, service providers and TSOs. March – April 2025: Organize and participate to 3 (or 4) IHA workshops on modernisation to discuss the main findings from the survey: One meeting just with operators • 1 meeting operators + service providers • 1 meeting operators + regulatory bodies (TSOs +....) • 1 meeting just with operators (optional) Summarize the findings regarding modernisation process into D3.1.

T3.2 Multi-market optimization tools (M1-M24; L: SINTEF; P: SGRID, ALPIQ)

The existing ProdRisk stochastic optimization tool developed by SINTEF will be used to enable multi-market valuation of hydropower assets. The developed tool will be applied to the FMG demonstrator (ALPIQ) where the multi-market approach will enable a precise market valuation of different refurbishment scenarios: Vissoie refurbishment, Moiry dam heightening, and increased max flow rate of the lower stage of FMG (Vissoie-Navizence gallery). The tool will be compared to the current operational optimization model that does not have multi-market capabilities and to a deterministic model demonstrated within XFLEX HYDRO. During the project, the multi-market tool will be freely available in a virtual laboratory to ReHydro partners for work that is relevant to the ReHydro project.

Extended description for the first reporting period Delivering data/information to T6.5 and T6.6.
SINTEF (05.24–04.26, 8.6 PM, FMG) Discuss and support setting-up the ProdRisk model for ALPIQ's case study (January 2026). Case study planning and definition with description in a short memo (September 2025). Planning and specification of multi-market tool aligned with recent functionality development in ProdRisk (October 2024). Publication style description of algorithm and background (April 2025). Implement methodology for multi-market optimization in ProdRisk investigated in HydroBalance. (January 2025 – July 2025). First draft of the user manual (July 2025). Reporting results in Memo together with ALPIQ (January 2026). Submit first version of publication of results (April 2026).
SGRID (05.24–10.25, 5.0 PM, FMG) Work regarding data collections for price forecasts in Switzerland: 1) Spot and tertiary reserve markets (December 2024) 2) All other reserve markets (June 2025) Base data will be made of price forecasts from ALPIQ, and past market data adapted to future forecast using an existing methodology provided by SINTEF.

Basis is the survey in T3.1 and the aim is as accurate and consistent prices as possible within budget and available data.
ALPIQ (05.24–04.26, 2.0 PM, FMG) Collect data and set up the ProdRisk model and test by running comparison with ALPIQ's operative tool with single market representation and the XFLEX-HYDRO tool (December 2024). Complied findings and results from the three models in a memo. Run ProdRisk with 2 markets, spot and tertiary reserve reservation in both regulation directions (July 2025). Run ProdRisk with all markets, compare with the 2 market step, and with the single market model result (December 2025). Reporting results in memo together with SINTEF (January 2026).

T3.3 Value of hydropower flexibility (M1-M24; L: ALPIQ; P: SINTEF, EDF, SGRID, IHA)

The task will explore project benefits beyond profitability. The key is to assess the adaptability of refurbished hydro assets to changing conditions and their contribution to accommodating variable renewable generation. This involves evaluating refurbishment projects from a systemic viewpoint. For this, a power planning model developed by ALPIQ will be applied to Switzerland and neighbouring countries. The model will be enhanced for this purpose, defining key indicators to quantify the flexibility value of a hydro asset: ability to balance renewable intermittency, reducing renewable curtailment, and lowering carbon emissions by replacing fossil-fuelled backup plants. These indicators will be tailored for different refurbishment projects, particularly the FMG (ALPIQ) and Saut-Mortier (EDF) demonstration sites, providing a guideline for other projects.

Extended description for the first reporting period Depending on data/information from T3.1. Delivering data/information to T6.5.
ALPIQ (05.24–04.26, 3.0 PM, FMG and other demo sites) Define flexibility KPIs with all partners that could be used in the context of a systemic model. Implement the KPIs in the systemic power planning model of Switzerland already developed by ALPIQ (May 2025). Carry out analysis on future refurbishment projects associated to the demo sites with the energy trilemma as an objective for the Swiss system: Security of supply, Affordability, Sustainability (August 2025). Use the analysis of the results to provide guidelines to apply the approach to other countries and demo sites (April 2026).
SINTEF (05.24–04.26, 1.5 PM) SINTEF will participate in the discussions and provide our recommendations to the work. Based on existing work in SINTEF a summary of valuation of flexibility is collected and reported in a memo for comparison with the key findings in the modelling of Switzerland and neighbouring countries (April 2026).
EDF (05.24–10.25, 1.0 PM) Contribute to a methodology allowing to quantify the cost of flexibility from hydro power units; application of methodology to FCR supplied by run of river plants (August 2025).
SGRID (05.24–04.26, 2.0 PM) Coordination and contribution to D3.1 shared between T3.1 and T3.3 (April 2026).
IHA (05.24–04.26, 0.5 PM) Contribution to D3.1 shared between T3.1 and T3.3 (April 2026).

Partner	RP1			RP2			RP3	Total
	T3.1	T3.2	T3.3	T3.1	T3.2	T3.3	-	
SINTEF	1.5	8.6	1.5		3.0	0.4		**15.00**
VGBE	2.5							**2.50**
EDF	1.3		1.0			0.3		**2.60**
CNR	1.1							**1.10**
LYSE	1.4							**1.40**
SGRID	10.6	5.0	2.0			1.0		**18.60**
ALPIQ	1.0	2.0	3.0		1.0	1.0		**8.00**
IHA	3.0		0.5			0.5		**4.00**
Total PMs	**22.4**	**15.6**	**8.0**	**-**	**4.0**	**3.2**	**-**	**53.20**

Milestones and Deliverables

No.	Name	Lead partner	Type	Dissemi-nation level	Date
M9	Multimarket model demonstrated by ALPIQ	ALPIQ	Test report from demonstrator		Jan. 26
D3.1	Business outlook	SGRID	R	PU	April 26
D3.2	Multimarket model	SINTEF	OTHER	SEN	April 26

WP4 Environmental improvements of refurbishment

Duration: M7–M30 **Lead: NINA**

Objectives

O4.1 Refine and demonstrate best practice methodology and technology for environmental sustainability.

O4.2 Achieve environmentally sustainable refurbishment of hydropower plants. SO1, SO3.

Description

Link with the other work packages: Results from WP1 will be used in WP4. Results from WP4 will be input to WP5, WP6 and WP7.

T4.1 Safe downstream passage of eels at large hydropower plants (M7-M30; L: GE; P: EDF, EDP, EDPL, CNR)

GE will design an eel-friendly turbine optimized for a wide range of operating conditions to retrofit Kaplan machines. New advanced assessment tools will enable the combined evaluation of hydraulic efficiency, mechanical reliability, and reduction of main risk factors for eel survival. Performance of the design in an operational environment will be demonstrated through a semi-homologous model test conducted on the GE's hydraulic platform for Belver hydropower plant (EDP) and compared with existing data on eel survival collected by CNR and EDF. Innovative solutions for determination of downstream fish migration periods will be assessed on the Caderousse hydropower plant (CNR).

<u>Extended description for the first reporting period</u> Delivering data/information to T6.2.
GE (11.24–10.25, 22.6 PM, Belver) Gather information on eel survival criteria from experts and existing experimental data. Adapt accordingly numerical survival assessment tool and model scale experimental assessment procedure. Design Eel friendly Kaplan Turbine taking Belver demo site as a reference.
EDF (11.24–10.25, 1.2 PM, Golfech) Follow-up the semi-homologous model test conducted on the GE's hydraulic platform for Belver hydropower plant to validate the comparison with existing data on eel survival collected by EDF on Rhine HPP (Fesenheim and Ottsmarsheim). The objective is to apply the retrofitting on the hydraulic platform to Golfech HPP (Garonne River).
EDP (11.24–10.25, 2.0 PM, Belver) EDP will provide inputs to GE's hydraulic platform for the Belver hydropower plant and contribute their experience from a utility perspective.
EDPL (11.24–10.25, 2.5 PM, Belver) EDPL will provide inputs regarding eel biology and fish-friendly turbine specifications.

CNR (11.24–10.25, 2.1 PM, Belver and Caderousse) Follow-up the semi-homologous model test conducted on the GE's hydraulic platform for Belver hydropower plant to validate the comparison with existing data on eel survival collected by CNR on Rhone HPP (Beaucaire). Assess how the retrofitting approach on the hydraulic platform could inform on head increase (or how to switch from Belver Kaplan turbines 15-m head to Bollène Kaplan turbines 25-m head) and on technology change and head decrease (switching from Belver Kaplan turbines 15-m head first to Belver Bulb turbine 15-m head and finally to Caderousse Bulb turbines 9-m head). In parallel, work on the combination of innovative solutions to reduce fish mortality and support biodiversity while increasing hydropower generation through forecasting of downstream fish migration periods, assessment of behavioural barriers efficiency to divert eels through a safe way or eel-friendly turbines and application of these solutions to the Caderousse hydropower plant.
NINA (11.24–10.25, 1.0 PM) Contribution with historical data on eel migration that may assist in improvement of solutions for determination of downstream passage. Evaluation and synthetization of innovative methods for determining eel survival in hydropower plants.

T4.2 Innovative methods for environmental flow to bypassed rivers (M7-M30; L: LYSE; P: SINTEF, NINA)

Innovative solutions to provide guaranteed environmental flow to bypassed river reaches at Røldal-Suldal plant (LYSE) will be developed/demonstrated by i) pumping water from a downstream reservoir, and ii) installing a mini hydropower plant to release water and at the same time generate power in. The consortium will build and install the solution i) in the Brattlandsåna River and ii) the Roalkvamsåa River in Røldal-Suldal system (LYSE). The purpose of environmental flow in bypassed river is to re-establish lost biodiversity. Reestablishment of biodiversity will be measured before, during and after introducing environmental flow through eDNA metabarcoding in water and sediments (invertebrates), as well as standard WFD limnological assessments.

Extended description for the first reporting period Depending on data/information from T2.3. Delivering data/information to T5.6.
LYSE (11.24–10.25, 4.5 PM, Brattlandsdalåa) Site installation: Planning, engineering, procurement and installation of new pump facility between Suldalsvatn and defined area in Brattlandsdalåa to improve lost biodiversity. In Roaldkvamsåa there is a similar problem, here the problem will be discussed, and possible solutions will be described, as well as the solution we have selected.
SINTEF (11.24–10.25, 2.0 PM, Røldal-Suldal / Brattlandsdalåa) Data collection: Drone image and video collection in Brattlandsdalåa. Structure from Motion (SfM). Build high resolution terrain/bathymetry model including overlapping substrate classification maps. Hydraulic simulation: Based on previous step, set up and calibrate hydraulic model for river section. Set up relationship between discharge and relevant abiotic parameters (depth, velocity, shear stress). **Habitat simulation:** Optimize seasonal discharge levels and patterns for the re-establishment of lost biodiversity in Brattlandsdalåa based on generic biotic preferences for comparison to eDNA metabarcoding results. Use scenarios for pumped hydro water release.

NINA (11.24–10.25, 7.0 PM, Brattlandsdalåa, Roaldkvamsåa) Data collection: Collect data on biodiversity, with focus on fish and invertebrates, before and after reestablishing environmental flow to estimate if and to which extent the refurbishment will facilitate re-establishment of biodiversity. The methods drift diving censuses, electro fishing and eDNA analyses will be used to assess variation in biodiversity.

T4.3 Geomorphology, habitat modelling and environmental flow (M7-M30; L: EDF; P: SINTEF, INRAE, NINA)

The generic simple method for estimating hydraulic habitat indicators will be showcased at Saut Mortier (EDF), for estimating how the combination of refurbishment and climatic scenarios will affect key habitat indicators. A generic method will be compared to more detailed versions of habitat models, identifying the potential and limits of the generic method. The task will use available information to identify ecohydraulic and thermal habitat indicators at the site (2Dhydrodynamic model, 1D temperature model, knowledge on present aquatic communities and habitat requirements). The availability of these simulations allows to map the change in habitat indicators and understand how their spatial-temporal configurations may provide risks (fish stranding, cyanobacteria development) or solutions (thermal refuges) for different scenarios.

<u>Extended description for the first reporting period</u> Depending on data/information from T2.2. Delivering data/information to T5.4, T5.5, T6.6.
EDF (11.24–10.25, 4.3 PM, Saut-Mortier) Simple generic <u>method</u>: EDF will work with INRAE to develop a simple generic method for assessing hydraulic and thermal habitats. Results from hydrological and thermal models developed by EDF will be provided to assess actual habitat conditions and potential gain with refurbishment. Ecohydrological indicators: Hydrological, thermal and biological data available to characterize ecological status, risk of fish stranding, cyanobacteria development and thermal refugia will be inventoried and collated. Data analysis and synthesis will enable us to characterize the spatial gradients of abiotic and biotic parameters in order to assess the relative or combined role of hydrological and thermal factors in structuring river communities. A review of ecohydrological and ecothermal indicators will be initiated (including a comparison of the FIThydro tool applied in T2.3 with similar tools).
SINTEF (11.24–10.25, 0.5 PM, Saut-Mortier) SINTEF will contribute to the expert panel for the identification and selection of appropriate eco-hydro-thermal impact indicators.
INRAE (11.24–10.25, 12.0 PM, Saut-Mortier) <u>Detailed habitat models</u>: A 2D hydrodynamic model will be combined with aquatic species preferences to assess the habitat conditions of the entire reach downstream of the last dam of the Vouglans Saut-Mortier hydroelectric system (50 km). The thermal conditions required by species throughout the reach will be assessed on the basis of available knowledge of current aquatic community preferences. Ecohydraulic and thermal habitat indicators will be identified on the basis of literature and recent work to characterize biological responses to different flow and temperature scenarios.

<u>Simple generic method</u>: A generic method will be proposed based on hydraulic geometry models, statistical hydraulic models and biological preference models. It will be compared with the results of detailed habitat models. Elements will be provided to apply this generic method to other demonstration sites.
NINA (11.24–10.25, 0.5 PM, Saut-Mortier) NINA will contribute to the expert panel with expertise in ecological preferences of aquatic species during identification of appropriate ecological hydro-thermal impact indicators.

T4.4 Sediment connectivity at different turbine operating conditions (M18-M24; L: SINTEF; P: ALPIQ, EPFL)

The CASCADE model will be applied in the FMG (ALPIQ) site to calculate different sediment scenarios accounting for new turbine operating conditions developed in WP1 and WP2. The scenarios are built by changing the trapping efficiency of the dam according to the new sediment-passing operating conditions of the turbines. The data necessary for CASCADE are available from ALPIQ including a digital terrain model (DTM), hydrological model with climate change scenarios and sediment grain size distribution. The final result of the task will be a model that quantifies sediment connectivity in the catchment at the reach scale.

Partner	RP1				RP2				RP3	Total
	T4.1	T4.2	T4.3	T4.4	T4.1	T4.2	T4.3	T4.4	-	
SINTEF		2.0	0.5			1.0	0.5	2.0		**6.00**
EDF	1.2		4.3		1.3		4.3			**11.10**
EDP	2.0				3.5					**5.50**
EDPL	2.5				4.5					**7.00**
CNR	1.5				0.6					**2.10**
LYSE		4.5								**4.50**
GE	22.6									**22.60**
INRAE			12.0				13.4			**25.40**
NINA	1.0	7.0	0.5		1.0	4.0	0.5			**14.00**
ALPIQ								1.5		**1.50**
EPFL								0.8		**0.80**
HEX								1.5		**1.50**
Total PMs	**30.8**	**13.5**	**17.3**	**-**	**10.9**	**5.0**	**18.7**	**5.8**	**-**	**102.00**

Milestones and Deliverables

No.	Name	Lead partner	Type	Dissemi-nation level	Date
D4.1	Eel-friendly turbine development plan	GE	R	SEN	April 25
M5	Planning of bypass flows to reestablish biodiversity	NINA	Internal memo		April 25
M12	Eel friendly turbine design simulations	GE	Simulations documented		June 26
M13	Reestablishment of biodiversity in bypassed river	NINA	eDNA indicators improved		June 26
D4.2	Eel-friendly turbine design	GE	DEM	SEN	Oct. 26
D4.3	Environmental flow	LYSE	R	PU	Oct. 26

WP5 Societal services

Duration: M13–M30 **Lead: ENGIE**

Objectives

O5.1 Demonstrate that refurbishment contributes to maintaining or producing societal benefits.

O5.2 Demonstrate that refurbishment contributes to climate mitigation and adaptation.

O5.3 Demonstrate benefits to society by taking a life cycle perspective. SO1 and SO5.

Description

Link with the other work packages: Results from WP1, WP2 and WP4 will be utilized in WP5. Results from WP5 will be input to WP6 and WP7.

T5.1 Digital water services (M13-M30; L: INTOTO; P: SINTEF, EDP, IHA)

The task will demonstrate a digital river service at RSK (LYSE) and Valeira (EDP), setting standards for sharing river conditions and status (e.g., discharge, water temperature, flood risk, drought conditions) to society and relevant stakeholders, maximizing services without compromising or conflicting hydropower production. This will bridge the gap between the physical and digital relationship to hydropower and rivers as sustainable shared environments and resources.

Extended description for the first reporting period Depending on data/information from T2.3. Delivering data/information to T5.2, T5.3 and T6.6.
INTOTO (05.25–10.25, 12.0 PM, Røldal-Suldal) INTOTO will interview participants in ReHydro consortium and analyse best practices and relevant knowledge. Then INTOTO will develop and iterate on a framework together with task group, including synergies with other tasks. INTOTO can also contribute with in-situ water level sensors where relevant. Expected result is a prototype of an online digital tool in demonstration sites setting a new standard, relevant for scaling with participants in ReHydro.
SINTEF (05.25–10.25, 0.7 PM, Røldal-Suldal) Data collection and display: Build statistics on collected data on discharge/water level and water temperature and share and display real-time river condition and statistics to the public. *Directly connected to INTOTO's work in current task.* Visualization: Use satellite imagery to make the digital transition from discharge/water level to wetted area in relevant river sections, with emphasis on temporal and spatial resolution along with digital visualization of river conditions and status. Prognosis: Use statistics along with relevant public data for river condition prognosis in coming periods or risk of severe events like droughts, floodings and extreme temperatures, including potential duration and local/regional consequences in affected areas in or adjacent to the river. Societal services: Connect real-time data on river conditions to local power production data

to display and showcase potential effects of power generation on current or future river status (e.g., withholding flood water in upstream reservoir, release of water during droughts, temporal hydro- or thermal peaking patterns)
EDP (05.25–10.25, 0.2 PM, Valeira) EDP will provide operational data and contribute their experience in managing navigation locks on Douro River.
IHA (05.25–10.25, 0.5 PM) Identify the appropriate language to enable stakeholders to understand the benefits of digital water service. Assist INTOTO in the review of existing digital water services solutions currently implemented among project partners. Present the work to IHA stakeholders, informing the community and possibly identifying additional parties interested in supporting the development.

T5.2 Recreational services and value (M13-M30; L: ENGIE; P: SINTEF, CNR, INTOTO)

The task will analyse how a new operational regime linked to refurbishment potentially reshape societal benefits like fishing, accessibility, tourism, recreational navigation, landscape values and cultural services at Caderousse/Bollène (CNR). User tolerance range will be established for physical conditions in rivers by focus group interviews and integrated into a tool available at ReHydro website. The task will investigate how potential impacts of refurbishment on recreational benefits will be perceived by local stakeholders and partners, as well as the relevant authorities.

<u>Extended description for the first reporting period</u> Depending on data/information from T5.1. Delivering data/information to T5.4, T6.5, T6.6.
ENGIE (05.25–10.25, 2.0 PM, Caderousse / Bollène) Data collection: - Conduct interviews with local stakeholders and NGOs. - Conduct a comprehensive literature review on the positive and negative impacts related to hydroelectricity and site renovation. - Understand the scope and value of recreational services at sites managed by CNR. - Determine how refurbishment processes can impact local issues related to recreational services. Modelling: - Develop a preliminary framework outlining recreational services linked to hydropower infrastructures. - Incorporate results from other tasks concerning societal services.
SINTEF (05.25–10.25, 0.5 PM, Caderousse/Bollène) Data collection: collection of hydro-morphological data for the hydraulic model. Group interviews will define user tolerance ranges or suitability curves for different ecosystem services (e.g., recreational fishing, recreational navigation). Modelling: By applying habitat modelling methods, which combines 1 or 2D hydraulic models with suitability curves, we simulate scenarios of suitability under the different operational regimes linked to refurbishment (for an example, see Carolli et al. 2017). SINTEF contributes with the preparation of the hydraulic model and the habitat modelling method application. Other benefits such as accessibility can be assessed using remote sensing data in a GIS environment.

CNR (05.25–10.25, 0.4 PM, Caderousse/Bollène) CNR will list recreational services close to Caderousse/Bollène HPPs as well as environmental studies related to these services. Seeing that these HPPs are respectively 50 and 70y old, CNR will identify the evolution of the services from the construction phase up to now and assess how past rehabilitation operations have already impacted positively or not these services. Interviews with groups of users of these recreational services will allow identifying users' needs as well as the evolution of their needs and potential new expectations. Based on interviews feedback, CNR will assess whether these new needs can be addressed through new rehabilitation projects to come while ensuring dam safety and power generation.
INTOTO (05.25–10.25, 2.5 PM, Caderousse/Bollène) INTOTO will interview, analyse and study how works from for example T5.1 can provide value in topics of recreational services. How these topics are handled, varies across Europe, so one goal is to identify "best practise", and how a refurbished setup should be. There is a goal of identifying how a digital river service can be used within recreational fishing, navigation etc. INTOTO will contribute with expertise in web-based technologies, in-situ water levels sensors if relevant, and report and/or prototype example of how a new solution could be.

T5.3 Navigation impacts (M13-M30; L: EDP; P: SINTEF, CNR, INTOTO)

Navigation related with tourism and goods transport is impacted by extreme events (floods, droughts). The ReNew project (SINTEF is partner), is developing a digital twin to predict the effects and optimize the navigability under extreme events on the Douro River. The consortium will use the Valeira site (EDP) and Caderousse/Bollène (CNR) in synergy with the ReNew to show how hydropower impacts the navigability of waterways during extreme events.

<u>Extended description for the first reporting period</u> Depending on data/information from T5.1 and ReNew (project ID 101069682). Delivering data/information to WP6 and WP7.
EDP (05.25–10.25, 1.0 PM, Valeira and Caderousse) EDP will provide operational data and contribute their experience in managing navigation locks on Douro River.
SINTEF (05.25–10.25, 0.5 PM, Valeira and Caderousse) Data collection: collect hydrology and hydraulics models and data available from former tasks, activities and projects (e.g., ReNew). Navigation on the Douro River requires a minimum water depth in selected river cross-sections during low flows. Modelling and scenario development: By using hydrological and hydraulic data, combined with discharge data from hydropower production, we develop scenarios about how hydropower might contribute to improve navigability during extreme events, in particular during low flow events.
CNR (05.25–10.25, 0.5 PM, Valeira and Caderousse) Follow-up of the activities in Valeira in synergy with ReNew project. CNR, through the operation of its Navigation Control Center, will also share its experience of the last drought and flood events. Feedback of the operation of the Rhone waterway on the very dry year 2022 will be particularly interesting.
INTOTO (05.25–10.25, 2.0 PM, Valeira and Caderousse) INTOTO will interview, analyse and study how works in T5.1 can provide value in topics of navigation. How these topics are handled, varies across Europe, so one goal is to identify "best practise", and how a refurbished setup should be. There is a goal of identifying how a

digital river service can be used within navigation etc. INTOTO will contribute with expertise in web-based technologies, in-situ water levels sensors if relevant, and report and/or prototype example of how a new solution could be.

T5.4 Climate change adaptation by improved water management (M13-M30; L: EDF; P: SINTEF, ENGIE, IHA)

Based on T2.2 results, the task activities will assess downstream water use for aquatic habitats, fishing and other recreational interests under different scenarios of climate change and operational regimes at Saut-Mortier (EDF). A technical report will summarize the demonstration providing a methodological approach for future water uses in climate change scenarios.

Extended description for the first reporting period Depending on data/information from T2.2, T4.3, T5.2. Delivering data/information to T6.6.
EDF (05.25–10.25, 0.7 PM, Saut-Mortier) Creation of a multi-criteria analysis tool for user's satisfactions on VSM/CNR demo sites. This tool will be based on survey data from as many sites as possible (Norway, France, etc., and from other tasks of WP5) and will be consolidated with literature data. The tool will be applied on digital twin of VSM (from T2.2) to assess the water uses and biodiversity satisfaction under different climate change scenarios.
SINTEF (05.25–10.25, 0.5 PM, Saut-Mortier) Examples of application of both multi-criteria analysis (MCA, Barton et al. 2020) and building block methodology in Norway in relation to environmental design of hydropower operations in rivers will be summarized and provided as a basis for analysis and comparison to the T5.4 multicriteria tool. Furthermore, additional information on relevant downstream water uses and linked assessment methods in Norway will be summarized and used in the MCA.
ENGIE (05.25–10.25, 0.5 PM) ENGIE's role is to draw up a link with task 5.2 concerning recreational benefits and, if possible, to provide relevant information on the CNR case study.
IHA (05.25–10.25, 1.1 PM) Explore existing knowledge on hydropower's response to climate change, industry's initiative in climate resilience. Develop case study on hydropower's response to climate adaptation, focusing on hydropower's impact to river systems. Synthesise and interpret partners' work in plain language that is accessible to the general public.

T5.5 Environmental Life-cycle Assessment of refurbishment projects (M6-M30; L: ENGIE; P: CNR)

The task will assess the environmental performance of the refurbishment of Caderousse/Bollène (CNR). A standard Life Cycle Assessment (LCA) will be performed to get environmental impacts indicators (impacts on resources, ecosystems, and human health), through mid-point impact indicators such as resources depletion, GHG emissions, and land use. Based on up-to-date assessment methods, it will be completed by additional circularity indicators. Results for the refurbishment scenario will be compared to a reference scenario without refurbishment. Through workshops with CNR, stakeholders and authorities, the partners will evaluate the results and define the minimum data to be collected that should be included in the LCA tool. The project will make the tool available for demonstration in T6.6 for improved decision.

Extended description for the first reporting period Depending on data/information from T4.3. Delivering data/information to T6.6.
ENGIE (05.25–10.25, 4.0 PM, Caderousse/Bollène) Goal and scope of the LCA: The first step of the LCA as defined by ISO standards is the goal and scope definition. This step defines the perimeter of the assessment, including system definition, boundaries, impact assessed etc. The first deliverable of the task will be the associated report in May 2025. Data collection: Another action including in the first reporting period is the preparation and launching of data collection with CNR. A data collection sheet will be done so that the actual collection of inventory starts as soon as possible (as it may be a bottleneck for the LCA modelling).
CNR (05.25–10.25, 0.8 PM, Caderousse/Bollène) System description, contribution to the goal and scope definition. Preparation of data collection.

T5.6 Biodiversity footprint analysis (M13-M30; L: EDF; P: SINTEF, EDP, EDPL, ENGIE, NINA)

The task will validate an environmental design process based on a combination of the principles of LCA, biodiversity footprint and the Fish Hazard Index from FIThydro to assess the environmental impact of facilities refurbishment and select the best environmental design solutions. Aquatic biodiversity will be introduced in the Product Biodiversity Footprint method and adapted to the specific characteristics of hydropower. The footprint will be compared before and after refurbishment at Saut-Mortier (EDF) and Valeira (EDP).

Extended description for the first reporting period Depending on data/information from T4.2. Delivering data/information to T6.6.
EDF (05.25–10.25, 5.5 PM, Saut-Mortier) Information sharing among partners. Consolidation of the PBF Aquatic biodiversity module with partners and new literature. Test on demo sites and comparison of the actual situation and the project assessment.
SINTEF (05.25–10.25, 0.3 PM, Saut-Mortier and Belver) Sharing knowledge about the Fish Hazard Index from FIThydro. SINTEF will contribute to the integration of the Fish Hazard Index in the PBF.
EDP (05.25–10.25, 0.2 PM, Belver) EDP will provide operational data and contribute their experience from a utility perspective.
ENGIE (05.25–10.25, 1.0 PM) Information sharing and contribution to the analysis of results and assessment of reproducibility of the method for other sites.
NINA (05.25–10.25, 3.0 PM, Røldal-Suldal) Contribution to on-site testing of the extended PBF model through data-sharing (predominantly from the LYSE demo site) and participation in co-developmental activities.

Partner	RP1						RP2						RP3	Total
	T5.1	T5.2	T5.3	T5.4	T5.5	T5.6	T5.1	T5.2	T5.3	T5.4	T5.5	T5.6	-	
SINTEF	0.7	0.5	0.5	0.5		0.3	1.2	1.0	0.5	0.5		0.3		**6.00**
EDF				0.7		5.5				1.4		11.1		**18.70**
EDP	0.2		1.0			0.2	0.8		2.5			0.8		**5.50**
CNR		0.4	0.5		0.8			0.4	0.5		0.7			**3.30**
INTOTO	12.0	2.5	2.0											**16.50**
ENGIE		2.0		0.5	4.0	1.0		2.3		0.5	6.3	3.2		**19.80**
NINA						3.0						4.0		**7.00**
IHA	0.5			1.1			1.5			2.8				**5.90**
Total PMs	**13.4**	**5.4**	**4.0**	**2.8**	**4.8**	**10.0**	**3.5**	**3.7**	**3.5**	**5.2**	**7.0**	**19.4**	**-**	**82.70**

Milestones and Deliverables

No.	Name	Lead partner	Type	Dissemi-nation level	Date
D5.1	Hydropower pressures assessment	EDF	OTHER	PU	July 25
D5.2	Matrix of future water uses	EDF	OTHER	PU	Sep. 25
M17	Data collection for PBF model	EDF	Data available		April 27
D5.3	Goal and scope of LCA	ENGIE	R	PU	Nov. 25
D5.4	River digital services description	INTOTO	R	PU	April 26
M11	Stakeholder thresholds for societal services	ENGIE	Data available		April 26
D5.5	Services for society	ENGIE	R	PU	Oct. 26
D5.6	Result of LCA applied to the refurbishment scenario	ENGIE	R	SEN	Oct. 26
D5.7	Biodiversity footprint	EDF	OTHER	PU	Oct.26

WP6 Upscaling technical and digital solutions

Duration: M25–M42 **Lead: SINTEF**

Objectives

O6.1 Demonstrate the applicability of existing and newly developed solutions to other demo sites (upscaling) (SO1, SO2).

O6.2 Develop a decision support tool that accounts for indicators of sustainability (SO3, SO5).

Description

Link with the other work packages: WP6 will use results from WP1 to WP5. It will also produce material with T7.4 in WP7.

T6.1 Increased flexibility (M25-M42; L: EDF; P: ANDRITZ, SGRID, IHA, EPFL, HES-SO)

The task addresses the potential deployment of the technical solution developed in WP2 to the European hydropower fleet evaluating the specific contribution to the overall flexibility needs from run-of-river plants with hybridization technologies or retrofitted pump storage schemes. This contribution will be evaluated in terms of net improvements to various solutions likely to provide similar contributions at scale. The task will be facilitated by the internal power plant database, members and network which will allow to identify other European and international sites.

T6.2 Solutions for turbine passage of migratory fish (M25-M42; L: NINA; P: EDF, EDP, EDPL, CNR, GE)

Numerical analysis will upscale T4.1 developments to other configuration of plants with fish migration challenges to extend the applicability the European low head fleet equipped with Kaplan and Bulb turbines such as Golfech, Bollène and Caderousse. User-friendly recommendations on selection and use of solutions with high TRL-level will be established for i) determination of important fish migration periods, ii) prevention of fish entering turbines and iii) guiding fish into bypasses under varying hydraulic conditions and rehabilitation configurations.

T6.3 Climate change adaptation guidelines (M25-M42; L: SINTEF; P: EDF, EDP, EDPL, CNR, LYSE, ENGIE, IHA, ALPIQ)

The Hydropower Sector Climate Resilience Guide helps operators identify and manage the risks of climate change. Its methodology will be applied at the demo site selected in the project to demonstrate the benefit associated with the application of the Guide on a European level. The task will review the outcomes obtained in WP1, WP2, WP4 and WP5, and prepare a list of recommendations to enhance the Guide and incorporate climate resilience into hydropower refurbishment.

T6.4 Upscaling of societal services (M25-M42; L: ENGIE; P: SINTEF, CNR, INTOTO, SGRID)

A key challenge for developers of refurbished infrastructure projects is to demonstrate that planned societal benefits materialize. Building on WP5, this task involves producing and disseminating a societal assessment framework tailored to refurbishment projects. It is focused on the identification and evaluation of benefit criteria linked to recreational activities and socio-environmental values.

T6.5 Economic sustainability (M30-M40; L: SINTEF; P: CNR, SGRID)

The task shows the application of the criteria for economic sustainability and the demonstration of how the results from WP3 can be expanded to hydropower refurbishment cases in general. This includes practical recommendations for how to apply the tools from T3.2 (multi-market tool) and T3.3 (flexibility metrics).

T6.6: Decision support framework (M25-M42; L: ENGIE; P: SINTEF, EDF, CNR, VOITH, HM, SGRID, IHA, ALPIQ)

The task builds on FIThydro DSS and develops a methodology enabling multi-criteria evaluation of refurbishment options. It will define KPIs for the different criteria, describe the methodology for the attribution of weights, vetoes, thresholds, etc. and how they are combined to bring different criteria in a sensible way for decision-makers. It will combine a set of indicators related to the various dimensions of the sustainability of hydropower plants such as markets and electrical systems (T3.2, T6.5) environmental sustainability (WP4, T6.2) societal & climate change (WP5, T6.3, T6.4) and technical and maintenance aspects (WP1, WP2, T6.1) that will be applied to a specific case study. Two approaches will be proposed, depending on the objective of the comparison: a comparison of several refurbishment options for a given site and a comparison of a given refurbishment scenario of a hydropower plant to alternative solutions for energy production and/or storage (with a smaller set of indicators).

Milestones and Deliverables

No.	Name	Lead partner	Type	Dissemi-nation level	Date
M14	Data from WP1-5 consolidated as input to WP6	SINTEF	Data available		June 26
D6.1	Upscaling sustainability solutions	SINTEF	R	PU	April 27
D6.2	Upscaling environmentally friendly solutions	NINA	OTHER	PU	April 27
D6.3	Climate Resilience Guide: comments and recommendations	SINTEF	R	PU	April 27
M18	Decision support framework	SINTEF	Report		June 27
D6.4	Decision support framework	ENGIE	DEM	PU	Oct. 27

WP7 Benefits from modernisation

Duration: M31–M48 **Lead: IHA**

Objectives

O7.1 Identify key outputs and results and provide a comprehensive set of guidelines to industry stakeholders on technological, environmental, social and economic aspects of modernization projects.

O7.2 Identify possible alignments between the wide deployment of technologies studied in ReHydro and the long-term objectives established by the EU for future development of the energy sector and identify possible gaps in existing markets and regulation limiting the adoption of solutions from the project. SO1, SO2, SO3, SO6, SO7.

Description

Link with the other work packages: WP1, WP2, WP3, WP4, WP5, WP6, WP8 and WP9.

T7.1 Tools for environmental and societal benefits (M31-M48; L: EDF; P: SINTEF, EDP, EDPL, CNR, ENGIE, NINA, IHA)

The project will provide a set of tools to enable stakeholders in assessing the environmental and societal benefits of different refurbishment solutions. These tools will be used in the basic design of new or refurbished hydroelectric projects. A guide will be produced to describe how to estimate environmental and societal benefits (floods and droughts, water warming, biodiversity) expected from refurbishment solutions in the context of climate change. ReHydro will also produce a hydropower project's biodiversity footprint assessment framework.

T7.2 Dynamic performance and reducing wear and tear (M31-M48; L: HES-SO; P: EDF, EDP, EDPL, VOITH, HM, SGRID, IHA, ALPIQ, AND_CH, EPFL, HEX)

The task will provide compiled analysis about the benefits of real-time monitoring of cavitation erosion and sediment abrasion, power range extension and hybridisation including an advanced control strategy. The trade-off between turbine performance improvement and wear and tear reduction will be analysed. A guide for decision- makers will be provided including assessment of the best management strategy of water resources through different control techniques, as well as the evaluation of sediment management solutions depending on site characteristics including flushing sediments through the hydraulic machine and innovative robotic techniques.

T7.3 Business model and fit for market (M31-M48; L: SGRID; P: SINTEF, EDP, EDPL, IHA)

This task will build on WP3 and T6.5 results and provide analysis about the potential revenue streams for hydropower. The work will summarize the results drawn from different demonstrators in terms of financial efficiency on changing electricity markets. The aggregated information will feed into T7.5 and T7.6 to guide decision-makers and inform policy makers.

T7.4 Decision making and best practices for industry (M31-M48; L: SINTEF; P: EDF, EDP, EDPL, CNR, ANDRITZ, ENGIE, SGRID, IHA)

This task will produce a "White Book" containing the results relevant for hydropower producers and industry from D7.1. The document will include a detailed step-by-step process for making relevant choices for refurbishment when selecting and implementing technologies, depending on the features of the asset considered, market opportunities and legislation and societal requirements.

T7.5 Modernisation guidelines based on project findings (M31-M48; L: IHA; P: SINTEF, CNR, SGRID)

This task will focus on what actions hydropower decision-makers should consider during modernisation projects and will be based on the results of the previous work. The task will result in a comprehensive document (D7.2) that gathers key conclusions and results of the project in a simplified manner that is easy to understand for decision-makers and will cover. Starting from the great wealth of results generated by the project, T7.5 will explore where research and innovation could be conducted in future, to be included in a section of D7.2.

T7.6 Decision making and best practices for policymakers (M31-M48; L: IHA; P: SGRID)

The task will provide guidelines that policymakers can use in the decision making on hydropower modernisation, in line with environmental and social considerations, technical improvement opportunities, and a fit for purpose business model. Project results will be compared to the long-term goals of the EU on security of supply, energy affordability and sustainability to ensure alignment. The guidelines will be based on the outputs of deliverables D7.1 and D7.2, previous EU hydropower projects, and a special workshop organised with relevant EU stakeholders to identify key barriers to sustainable modernisation of hydropower. The results will be presented in D7.3 and will provide policymakers with good practice principles for hydropower refurbishment.

Milestones and Deliverables

No.	Name	Lead partner	Type	Dissemi-nation level	Date
M17	Workshop with relevant EU stakeholders to identify barriers to sustainable modernisation.	IHA	Workshop report		April 27
D7.1	White Book	SINTEF	R	PU	Feb. 28
D7.2	Benefits from modernisation	IHA	R	PU	March 28
D7.3	Modernisation and EU long-term strategy	IHA	R	PU	April 28

WP8 Dissemination, exploitation and communication (DEC) – Part I

Duration: M1–M18 **Lead: VGBE**

Objectives

O8.1 Enhance awareness and communicate project outcomes.

O8.2 Foster dynamic dissemination and engagement of stakeholders from all target groups (TGs). Develop a comprehensive plan detailing target audience, communication channels, and pivotal messages for efficient project outcome dissemination and progress.

O8.3 Maximize the potential impact of the ReHydro project through strategic coordination and collaboration.

O8.4 Establish partnerships with key players in the hydropower sector and relevant associations, leveraging their networks for efficient project result dissemination.

O8.5 Enhance opportunities for innovation and business growth, facilitating the transfer of knowledge to industry partners and interested parties (SOs1-7).

Description

Link with the other work packages: The task descriptions, objectives, results, outcomes and impacts of the WP1-WP7 are the base for the work in WP8 and WP9.

T8.1 Developing dissemination, communication and exploitation (DEC) master plan (M1-M6; L: VGBE; P: All)

A comprehensive DEC master plan stems from section 2.2's requirements and follows the outlined structure in that section. DEC plans incorporate objectives, strategies, target groups, channel descriptions, tools, materials, message guidelines, and ongoing result metrics. The effectiveness evaluation employs diverse KPIs, assessing various activity facets, with continuous tracking and analysis for insights and refined strategies. Partners contribute data, ideas, and feedback, allocating resources from their organizations. An internal DEC-Team workshop convenes in M6 to encourage collaboration. The DEC master plan is regularly reviewed and updated during PMT meetings.

<u>Extended description for the first reporting period</u> Delivering data/information to T8.2-5.
VGBE (05.24–10.24, 3.0 PM) VGBE will establish the framework of the DEC master plan, including but not limited to the development of a project website and social media strategy. Communication materials will be drafted and shared with partners for feedback. Presentations will be created showcasing the

current status of the DEC master plan and other communication materials for partners to give feedback.
SINTEF (05.24–10.24, 0.5 PM) SINTEF will contribute with input to the DEC plan and provide comments on drafts of this plan as well as any communication materials developed in this initial phase.
Other partners (05.24–M6, 1.0 PM) All partners are asked to contribute by giving input on the DEC master plan as well as any other communication materials (content for the website, news postings…).

T8.2 Stakeholder mapping and identification of target groups (M3-M10; L: VGBE; P: SINTEF, IHA)

A stakeholder analysis will be conducted to identify and map target groups to effectively communicate information about ReHydro, disseminate the results, and exploit the applications throughout the research project. Therefore, a structured stakeholder mapping approach will help to identify the individuals, groups, organisations and communities that have a legitimate interest in or are affected by ReHydro. In addition, a stakeholder platform will be set up in accordance with the provisions of the General Data Protection Regulation (GDPR) to disseminate news, information and announcements as well as to conduct planned surveys.

<u>Extended description for the first reporting period</u> Depending on data/information from T8.1. Delivering data/information to T8.3-5, WP9.
VGBE (07.24–02.25, 2.0 PM) VGBE will develop different strategies and implementation plans to identify and reach relevant stakeholders, those being individuals, groups, organizations, companies, and communities that have a legitimate interest in or are affected by ReHydro. To identify the target groups and address them appropriately, VGBE will follow the approach of - Identifying the purpose of different stakeholders - Defining relevant stakeholders - Categorizing relevant stakeholders - Analysing stakeholders to learn about potential opposition - Defining target audiences - Determining engagement strategies - Reviewing and updating the stakeholder list and mapping/identification process to align with the progress of the project A stakeholder platform to disseminate news, information and announcements will also be developed and implemented alongside the website.
SINTEF (07.24–02.25, 0.5 PM) SINTEF will contribute with input to the content of the stakeholder mapping and specifically ensure that Norwegian stakeholder groups are identified and included.
IHA (07.24–02.25, 0.5 PM) IHA will contribute with input to the content of the stakeholder mapping, drawing on their existing networks and expertise.

T8.3 Implementation of the communication plan – Part 1 (M3-M18; L: VGBE; P: All)

Communication starts with the launch of the project and continues throughout its lifetime. The communication strategy, including the measures to be taken, is outlined in T8.1 DEC master plan including creation of the website and visual identity, defining messages to be communicated, development of a brochure, and infographics.

<u>Extended description for the first reporting period</u> Depending on data/information from T8.1, T8.2. Delivering data/information to T8.4, WP9.
VGBE (07.24–10.25, 10.0 PM) VGBE will wrap up the development and launch the project website. All previously created templates (such as presentation templates, graphics, news releases, a brochure, the visual identity and colour scheme) will be finalized and used in communication and dissemination. In order to achieve this and maximize the impact of ReHydro, the DEC-Board will oversee the communication efforts until the end of the project by - Reviewing the consortium members communication capabilities - Ensuring that all consortium members contribute to communication actions - Assessing the results
Other partners (07.24–10.25, 9.55 PM) All other partners are expected to assist VGBE during the implementation, mainly by providing relevant information and materials when asked (such as company logos and figures) as well as participating in communication actions.

T8.4 Implementation of the dissemination plan – Part 1 (M10-M18; L: VGBE; P: All)

The dissemination plan includes stakeholder engagement and aims at targeting more experienced audiences with a focus on transferring results through peer-to-peer communication. Dissemination of results will be tailored and offered through various channels and tools to make them accessible to specific audiences based on the stakeholder mapping process. Activities include creation of infographics, short videos, topic-specific webinars, generating website/social media posts, press releases, scientific articles, and conference presentations. In addition, contribute, upon invitation by the CINEA, to common information and dissemination activities to increase the visibility and synergies between Horizon Europe supported actions.

<u>Extended description for the first reporting period</u> Depending on data/information from T8.1-3. Delivering data/information to T8.5, WP9.
VGBE (02.25–10.25, 7.0 PM) VGBE will create dissemination materials in accordance with the project's progress and the stakeholders that need to be reached, including but not limited to relevant news releases, social media posts, videos and webinars. The previously established dissemination tools and channels will be utilized.

Other partners (02.25–10.25, 6.64 PM) All other partners are invited to give input on the created dissemination materials and suggest their own.

T8.5 Knowledge and technology transfer via exploitation activities – Part 1 (M6-M18; L: VGBE; P: All)

This task aims to initiate tailored exploitation plans as per the introduced concept by establishing the foundation and starting to conduct thorough analysis for effective knowledge and technology transfer. It includes i) KER Identification: Identify Key Exploitable Results (KERs) based on project outcomes and achievements, assessing their potential for real-world applications; ii) IPR and KER Alignment: Align the intellectual property rights (IPR) data with the identified KERs to establish a clear framework for protection and utilization; iii) Business Evolution Analysis: Analyse the evolving business landscape in sustainability, clean energy, manufacturing, and services sectors to identify areas where the project's results can contribute; iv) Business Model Generation: Develop innovative business models that leverage the project's outcomes, aligning with the identified business opportunities.

Extended description for the first reporting period Depending on data/information from T8.1–4. Delivering data/information to WP9.
VGBE (10.24–10.25, 3.0 PM) VGBE will analyse the project’s outputs and use those to identify KERs with potential for market uptake as well as determine intellectual property rights. Based on those KERs, KTPs will be created, detailing customised transfer activities for the target and end users. The KTPs will be shared with the Innovation Board for review and later use. The knowledge management and technology transfer will consist of three phrases: Collect and Understand: Internal identification and description of KOs. Validate and Analyse: KOs are reviewed and assessed for potential application and impact. Transfer and Exploit: Knowledge transfer activities are being carried out and reported on whilst measuring the impact of activity and application of the users’ knowledge.
Other partners (10.24–10.25, 2.71 PM) All other partners will contribute to the exploitation of results by being aware of and sharing exploitation opportunities.

Partner	RP1	RP2	RP3	Total
	T8.1–T8.5	-	-	
SINTEF	4.00			**4.00**
VGBE	25.00			**25.00**
EDF	0.10			**0.10**
EDP	0.50			**0.50**
EDPL	0.50			**0.50**
CNR	0.40			**0.40**
LYSE	0.50			**0.50**
GE	0.50			**0.50**
ANDRITZ	0.30			**0.30**
VOITH	0.40			**0.40**
INTOTO	0.40			**0.40**
ENGIE	0.30			**0.30**
INRAE	0.20			**0.20**
NINA	0.30			**0.30**
HM	2.00			**2.00**
SGRID	0.20			**0.20**
AKSO	0.00			**0.00**
AKER	0.50			**0.50**
ALPQ	0.40			**0.40**
AND_CH	0.40			**0.40**
EPFL	0.40			**0.40**
HES-SO	0.40			**0.40**
HEX	0.40			**0.40**
IHA	8.30			**8.30**
Total PMs	**46.40**	**-**	**-**	**46.40**

Milestones and Deliverables

No.	Name	Lead partner	Type	Dissemination level	Date
M2	Launch of the website	VGBE	Online		June 24
D8.1	DEC master plan	VGBE	R	PU	Oct. 24
D8.2	DEC master plan update 1	VGBE	R	PU	Oct. 25

WP9 Dissemination, exploitation and communication (DEC) – Part II

Duration: M19–M48 **Lead: VGBE**

Objectives

O9.1 Enhance awareness and communicate project outcomes.

O9.2 Foster dynamic dissemination and engagement of stakeholders from all target groups (TGs). Develop a comprehensive plan detailing target audience, communication channels, and pivotal messages for efficient project outcome dissemination and progress.

O9.3 Maximize the potential impact of the ReHydro project through strategic coordination and collaboration.

O9.4 Establish partnerships with key players in the hydropower sector and relevant associations, leveraging their networks for efficient project result dissemination.

O9.5 Enhance opportunities for innovation and business growth, facilitating the transfer of knowledge to industry partners and interested parties (SOs1-7).

Description

Link with the other work packages: The task descriptions, objectives, results, outcomes and impacts in WP1-WP7 are the base for the work in WP8 and WP9.

T9.1 Update of DEC master plan (M19-M48; L: VGBE; P: All)

The DEC master plan will be regularly reviewed and updated in the PMT meetings and the progress as well as the achievement of specific goals will be tracked with a KPI dashboard for the DEC activities. Regular monitoring and analysis of these indicators provide insights into the effectiveness of these actions and help refine strategies to achieve better results. More in-depth DEC actions will be clarified in an internal workshop with the DEC-Team. The regular update and review of the DEC master plan will continue in the PMT meetings, the implementation of the activities will be determined, and all partners will be informed about the upcoming actions.

T9.2 Implementation of the communication plan – Part 2 (M19-M48; L: VGBE; P: All)

Update and review of the existing communication material according to the progress in the different WPs. Using the website for further communication and social media channels for postings to raise awareness of ReHydro's research activities.

T9.3 Implementation of the dissemination plan – Part 2 (M19-M48; L: VGBE; P: All)

Further activities regarding the implementation of the dissemination strategy will be carried out in close coordination with all partners according to the developed dissemination plan (i.e., publishing scientific articles, topic-specific webinars, and a final project event). In addition, contribute, upon invitation by the CINEA, to common information and dissemination activities to increase the visibility and synergies between Horizon Europe supported actions.

T9.4 Knowledge and technology transfer via exploitation activities – Part 2 (M19-M48; L: VGBE; P: All)

This task continues the work done in T8.5 with the added focus on implementing and optimizing the exploitation plans. It includes: i) IPR Assessment and Knowledge Management: Conduct a thorough assessment of IPR implications, ensuring proper protection, and establish efficient knowledge management practices; ii) Marketing and Promotion Strategies: Craft effective marketing and promotion strategies tailored to the specific business opportunities identified, ensuring the project's outcomes gain visibility; iii) Utilization Plans for KERs: Develop individual utilization plans for each KER, incorporating tailored measures that optimize their application in real-world scenarios; iv) partner Input and Refinements: Administer questionnaires to project partners to gather input on knowledge creation, exploitation potential, and protection approaches. Use market feedback to refine exploitation strategies for enhanced penetration; v) Monitoring and Impact Assessment: Establish a monitoring mechanism using the DEC dashboard to track the progress and impact of the implementation, ensuring alignment with project goals.

Milestones and Deliverables

No.	Name	Lead partner	Type	Dissemination level	Date
D9.1	DEC master plan update 2	VGBE	R	PU	Feb. 28
M19	Final event (open conference)	VGBE	Conference proceedings		April 28

WP10 Coordination and management – Part I

Duration: M1–M18 **Lead: SINTEF**

Objectives

O10.1 Secure compliance and fulfilment of Grant Agreement with the European Commission.

O10.2 Conduct the project in accordance with the Consortium Agreement.

O10.3 Ensure adequate execution of the overall project, including management and reporting (SOs1-7).

Description

Link with the other work packages: All.

T10.1 Administrative and financial coordination – Part 1 (M1-M18; L: SINTEF; P: All)

SINTEF will be responsible for the management of the project in close cooperation with the WP leader group. SINTEF will provide a Project Management Plan (D10.1, M2). It will monitor the progress of work and contribute to ensure day-to-day follow-up of the project by allowing the control of budget allocation as well as progress and quality of the work performed by each partner, and, if necessary, the subsequent updating or refinement of the workplan. SINTEF will oversee the monitoring and updating of the risks of the project and the mitigation strategies. A Quality Plan will include procedures meant to ensure the high quality of the deliverables produced in the project, as well as indicators to measure and document the effectiveness of the project actions compared to the initial proposal and objectives. The External Expert Advisory Board, composed of representatives of the network of experts will evaluate project results.

<u>**Extended description for the first reporting period**</u>
SINTEF (05.24–10.25, 7.0 PM) SINTEF is responsible for this Project Management Plan (D10.1), and for continuously monitoring the progress of the project. SINTEF is also responsible for quality assurance and submitting deliverables to EU, and for any needed contact with EU. SINTEF is also responsible for planning and preparing PMT, EEAB and General Assembly meetings, including progress reporting. SINTEF, together with the PMT, should facilitate crucial cross-disciplinary collaboration between partners in all the other work packages. SINTEF should also exchange information and knowledge, and if relevant collaborate with other related EU projects.
Other partners (05.24–10.25, PM within partner's total budget) All partners should participate in the kick-off meeting and in the General Assembly meetings. All partners should also prepare status reports on request, typically before meetings in the General Assembly, and prepare information needed for the first periodic report to the EU (to be submitted after October 2025).

T10.2 Technical coordination and risk management – Part 1 (M1-M18; L: SINTEF; P: All)

SINTEF will oversee technical advancements in risk management, encompassing the identification of unforeseen risks beyond the proposal stage and ensuring effective execution of contingency measures alongside WP leaders. An initial risk management report will be generated and regularly updated thereafter (D10.2, M6).

<u>**Extended description for the first reporting period**</u>
SINTEF (05.24–10.25, 1.0 PM) SINTEF is responsible for the Risk Management Plan (D10.2), and for continuously monitoring and mitigating any risk in the project.
Other partners (05.24–10.25, PM within partner's total budget) All partners should contribute to, and verify, the Risk Management Plan. All partners should also report any risk management issues to SINTEF as Coordinator.

T10.3 Data management and procedures – Part 1 (M1-M18; L: SINTEF; P: All).

SINTEF will elaborate a detailed Data Management Plan (DMP) (D10.3, M6). It will detail the data management policy to be implemented in the project especially in accordance with the openness and accessibility requirements of data, tools and models developed during the project as well as GDPR requirements. SINTEF will follow-up the data management throughout the project to make sure it follows the DMP. The DMP will outline how the different project data will be collected, used, and made accessible and how they will be handled during and after the project, and will be updated throughout the project. Some data will be confidential, and the plan will describe management of those data.

<u>**Extended description for the first reporting period**</u>
SINTEF (05.24–10.25, 1.0 PM) SINTEF is responsible for the Data Management Plan (D10.3), and for follow up on data management issues during the project.
Other partners (05.24–10.25, PM within partner's total budget) All partners should contribute to, and verify, the Data Management Plan. All partners should also report any data management issues to SINTEF as Coordinator.

Partner	RP1	RP2	RP3	Total
	T10.1–T10.3	-	-	
SINTEF	9.00			**9.00**
VGBE	1.50			**1.50**
EDF	0.60			**0.60**
EDP	1.00			**1.00**
EDPL	1.00			**1.00**
CNR	0.70			**0.70**
LYSE	0.40			**0.40**
GE	1.90			**1.90**
ANDRITZ	0.50			**0.50**
VOITH	0.50			**0.50**
INTOTO	1.00			**1.00**
ENGIE	0.50			**0.50**
INRAE	0.90			**0.90**
NINA	0.30			**0.30**
HM	1.00			**1.00**
SGRID	1.00			**1.00**
AKSO	0.40			**0.40**
AKER	0.30			**0.30**
ALPQ	0.80			**0.80**
AND_CH	0.80			**0.80**
EPFL	1.50			**1.50**
HES-SO	1.00			**1.00**
HEX	0.80			**0.80**
IHA	1.40			**1.40**
Total PMs	**28.80**	**-**	**-**	**28.80**

Milestones and Deliverables

No.	Name	Lead partner	Type	Dissemination level	Date
M1	Kick-off meeting	SINTEF	Personal attendance and report		May 24
D10.1	Project Management Plan	SINTEF	R	PU	June 24
D10.2	Risk Management Plan	SINTEF	R	SEN	Oct. 24
D10.3	Data Management Plan	SINTEF	DMP	PU	Oct. 24
D10.4	Project Management Plan – Revision 1	SINTEF	R	PU	Oct. 25

WP11 Coordination and management – Part II

Duration: M19–M48 **Lead: SINTEF**

Objectives

O11.1 Secure compliance and fulfilment of Grant Agreement with the European Commission.

O11.2 Conduct the project in accordance with the Consortium Agreement.

O11.3 Ensure adequate execution of the overall project, including management and reporting (SOs1-7).

Description

Link with the other work packages: All.

T11.1 Administrative and financial coordination – Part 2 (M19-M48; L: SINTEF; P: All)

SINTEF continues to lead project management, overseeing progress, budgets, quality, and interactions with CINEA. They update risk assessments and ensure quality through a Quality Plan. The External Expert Advisory Board evaluates outcomes.

T11.2 Technical coordination and risk management – Part 2 (M19-M48; L: SINTEF; P: All)

SINTEF maintains responsibility for overseeing technical advancements linked to risk management and will ensure consistent updates to the risk management plan (D10.2) throughout the project.

T11.3 Data management and procedures – Part 2 (M19-M48; L: SINTEF; P: All)

SINTEF ensures overseeing DMP adherence, outlining data collection, usage, accessibility, and confidentiality. The DMP (D10.3) is regularly updated.

Milestones and Deliverables

No.	Name	Lead partner	Type	Dissemination level	Date
D11.1	Project Management Plan – Revision 2	SINTEF	R	PU	April 27

Quality Assurance

The procedure for quality assurance of deliverables is as follows:

1. Each deliverable has a lead beneficiary, see Table 2. ReHydro deliverables. The lead beneficiary shall appoint a person that is the main responsible for the development and the quality of the deliverable. This person shall ensure that the deliverable has high scientific quality and is contributing to fulfilling the objectives of the relevant WP and the overall objectives of ReHydro. Furthermore, the responsible person shall ensure that the deliverable is developed in due time to follow this procedure for quality assurance before it is submitted to CINEA. A complete draft must be available for quality assurance one month prior to the official due date.

2. For each deliverable the lead beneficiary shall propose two persons that is responsible for quality assurance of the deliverable. These persons shall not have been involved in the development of the deliverable. He or she may be employed at the lead beneficiary or not. The proposed persons shall be approved by the PMT.

3. The leader of the relevant WP has the overall responsibility for the quality of the deliverable and that the deliverable is finalised in due time.

4. The Coordinator shall do an overall check and approval of the deliverable before it is submitted to CINEA.

5. The Coordinator submits the deliverable to CINEA.

Risk Management

The risks identified in ReHydro are presented in Table 4. The table will be updated whenever new risks are identified or identified risks are no longer relevant.

Table 4. Risk management. "R" refers to risk level low (L), medium (M) and high (H). "S" refers to serenity level low (L), medium (M) and high (H).

No.	Description	R	S	WP	Proposed Mitigation Measures
1	Demo site RSK (Norway); delay in concession for pumping arrangement for environmental flow.	M	M	4	Work closely together with landowners, local community and local and national authorities. Prepare the application for concession well and plan the project in due time.
2	Demo site RSK (Norway); Outage or failure of pumped water to environmental flow.	M	M	4	Plan the arrangement with duplicated pumps, robust grid connection and energy backup solution. Install online monitoring to survey the performance of pumping as well as the flow situation in the river.
3	Confidentiality issues in data sharing among partners.	L	M	All	Include an agreement about the data sharing between partners in the Consortium Agreement.
4	Difficulties in sharing long-term market outlook for confidentiality reasons.	M	L	3	Interview of utilities involved in the project will be performed regarding trends and vision, not detail long-term contracts. Use insight from other utilities as TSOs and literature for long-term market outlook to complete the understanding of the topic.
5	Delays of data collection can occur if water flow in our demo sites changes because of unexpected weather conditions. It is necessary that conditions during sampling is safe for field workers retrieving the samples. If events such as floods occur, fieldwork will need to be postponed. Weather initiated delays in hydrological and biodiversity data collection and analysis of DNA.	M	M	4, 5	The data sampling will be planned to occur at a relatively early phase to ensure flexibility in the project. This will allow for samples to be collected, when conditions are favourable and still within the project plan. Thus, data collection will be planned and timed so that it ensures flexibility to allow for delays because of unpredictable weather conditions. Further, to make sure data collection is successful, the ability to deploy on short notice when conditions are beneficial will also be prioritized. To ensure that samples collected are analyzed and that results from analysis are ready in time, we will reserve laboratory capacity to ensure results from analysis are in accordance with the project progress plan.
6	Difficulty in collecting the 3D-geometry of the demo turbine	M	H	4	Apply approximation techniques and use this in the further work.

7	Solutions developed in WP1-WP5 encounters difficulties in up-scaling, applicable at several demonstration sites.	M	M	6	The upscaling of the solutions consists in a modelling application of the results from previous WPs. The first option, in case the solutions cannot be upscaled to the desired case studies, is to identify alternative demo sites. The chosen case studies will be discussed with the project partners and case studies from the project operators will be prioritized to minimize the effort for the data collection. In case technical solutions cannot be installed in the specific sites (ELM, FSG), modelling methods will be explored to upscale to other case studies. In case of delay in the CNR case study, data from similar case studies can be used as proxy. In case a before-after assessment cannot be performed and upscaled, a space-for-time approach will be discussed with the project partners. On Vouglans Saut-Mortier, as the end of the work is scheduled after the end of the project, modelling will be used to evaluate the gains before after refurbishment. If necessary, we will also apply the simple generic method (T4.3) on a large scale.
8	Delays in key deliverables and milestones with dependencies for other tasks.	M	H	All	Close monitoring of critical deliverables or milestones in the PMT meetings.
9	Weak involvement of one partner or activities not aligned with D10.1.	L	M	All	Frequent monitoring. Define plan at the start of each task and close monitoring. If needed, reallocate tasks to other partners if GA approves.
10	Demo site FMG: missing the planned unit outages (M9-15) linked to the Vissoie refurbishment project to perform the equipment installation for the WP1 tasks due to delays in equipment delivery.	M	M	1	Anticipate feasibility studies and sensor selection to order equipment as soon as possible. Identify alternative outages where equipment installation could be performed ahead of time using an already available tool to compute outage costs and select the optimal window of opportunity. Optimize the outage time necessary by a detailed preparation ahead. Favor solutions enabling plug-in of sensors during operation.
11	Demo site FMG: lack of resources for equipment installation and tests during the planned unit unavailabilities (M9-15) linked to the Vissoie refurbishment due to prioritization of new unit	M	M	1	Allocation of resources planned before project start for availability for end of year 2024. Use of simulations and prototype tests on a third and less critical powerplant before installation on Vissoie units to reduce on-site effort during the refurbishment. Coordination with refurbishment project management for

	commitment over research project.				optimal integration of ReHydro tasks in refurbishment project.
12	Demo site ELM: missing of the year 1 winter outage (M8-13) for equipment installation due to lack of available resources on site during a generally high activity period (winter maintenance).	M	H	1	Allocation of resources planned before project start for availability for end of year 2024. Eventual externalization of some equipment installations to alleviate the workload on the operator's resources. Coordination with operator management to find synergies between planned maintenance tasks and equipment installation.
13	Demo site ELM: missing of the year 1 winter outage or other planned outages (M8-13) and planned plant outages for equipment installation due to delays in equipment delivery.	M	H	1	Anticipate feasibility studies and sensor selection to order equipment as soon as possible. Identify alternative outages where equipment installation could be performed. Favour solutions enabling plug-in of sensors during operation.
14	Demo sites FMG and ELM: rise in spot prices forcing the operator to push back planned outages.	M	M	1	Identify alternative outages ahead of time using an already available tool to compute outage costs and select the optimal window of opportunity. Optimize the outage time necessary by a detailed preparation ahead.
15	Demo site Vouglans-Saut-Mortier: Insufficient quality of digital representation of the hydro-thermal dynamics of the hydro-electric chains.	M	H	2	Consolidated weather-thermal measurement networks, based on expertise. Mobilization of a set of limnological statistical descriptors to ensure the relevance of the models deployed.
16	Demo site Vouglans-Saut-Mortier: Incompatibility of the calculation time of digital solutions for an industrial application.	L	H	3	Close relationship between industrial operational teams and product development. In a first step, the development of the tool will seek to respond to the sensitivity study of the refurbishment project (simulation of use scenarios, definition of hydrothermal management margins, etc.). In a second phase, the industrialisation of the tool, aimed at operational management, will seek to integrate weekly and seasonal forecast data sets specific to the management of the hydroelectric production fleet.
17	Demo site Vouglans-Saut-Mortier: Uncertainties about the assessment of the effects on aquatic communities of hydrological, hydraulics and thermal conditions,	M	M	4	Good knowledge of the habitat models used and provision of a hydraulic model on the section influenced by the refurbishment. Test with operating conditions during the construction phase (transitory agreement). Collection and analysis of available historical hydraulic, thermal and biological

	before and after refurbishment, for different climate change scenarios.				data to assess the relationship between biocenoses and environmental parameters
18	Demo site Vouglans-Saut-Mortier: Uncertainties about the assessment of biodiversity footprint of the Vouglans-Saut-Mortier project compared to current scheme.	M	M	5	Test of a biodiversity footprint tool before the beginning of the VSM project on another hydropower plant refurbishment project. This test on another study site will make it possible to validate the introduction of aquatic pressures into the product's biodiversity footprint (PBF) by i) checking the data and application results of the environmental LCA ii) verifying the pressure analysis grid and their semi-quantitative assessment (thresholds retained for the indicators, combination of sub-indicators, application of corrective factors).
19	Valeira demo: Data quality not sufficient to achieve demonstration goals.	M	L	1	Evaluate data quality, sensor accuracy and sensor placement early-on and continuously. Employ signal conditioning and data enhancement techniques. Perform data analytics early on to assess usability of measured data. Consider alternative sensor modalities, sensor placements, or data acquisition equipment if necessary.
20	Valeira demo: Infeasible to install instrumentation.	M	M	1	Identify non-intrusive sensing modalities that could provide comparable results.
21	Valeira demo: Delay in power plant availability for system installation and technical incidents at the demonstration site.	M	L	1	Integrate a detailed plan with on-site O&M activities, ensuring vigilant monitoring; in the event of a breakdown, reschedule measurements to maintain the project timeline.
22	Belver demo: Delay in power plant availability for demonstration site.	M	L	1	Integrate a detailed plan with on-site O&M activities, ensuring vigilant monitoring; in the event of a breakdown, reschedule measurements to maintain the project timeline.
23	Demo site Caderousee (CNR): installation of the equipment dedicated to the detection and monitoring of peak migration of eels.	L	M	4	Installation will be based on CNR good practices for safety regarding working close to water (use of lifejacket in particular) and in good coordination with the operator which is common to many CNR projects, including detailed monitoring and hydro-meteo forecasting to ensure safe working conditions.
24	Demo site Caderousse (CNR): timing of installation of the equipment depending on both flow variations (in	L	L	4	Flood event should not delay installation by more than a couple of days and up to one week which is definitely manageable. Considering the monitoring of eels' peak migration, as the project starts in May 2024,

	case of flood for example) and peak of eels' downstream migration.				there is enough time to purchase and install equipment prior to 2025 migration season (starting end of August - beginning of September up to December/January) and monitor until end of summer 2027 (i.e. during year 2 and year 3 of the project). So, year 1 will be dedicated to feasibility study, equipment purchasing and testing prior installation.
25	Demo site Caderousse (CNR): loss of data due to vandalism, destruction by floating debris or outages.	L	M	4	In addition to CNR experience based on previous projects (NORMANDEAU, DAARAC, Vigilife...), the equipment will be installed inside the enclosure of CNR power station. Peak of floating debris may not last more than a couple of days during which the equipment could be removed. A close monitoring of the equipment will be implemented during the migration peak to make sure to avoid outages or to detect them very soon in order to fix the equipment accordingly. To limit the financial risks that may result from damage to equipment, insurance may be taken out by CNR.
26	Lack of relevant and reliable data for the LCA.	M	M	5	In case of difficulties to get reliable data in time from the demonstrations to perform a full LCA, the environmental experts will identify and use proxies and generic databases to replace actual data that may not be available. The proxies used may be of different types: choice of a generic material category if the specific grade is not known (e.g., for steel or other metals), use of a wider region for the supply of materials if the specific country of supply is not known, use of expert judgement or data from the literature to complement the data collection. Moreover, to anticipate this potential risk, a data collection sheet will be shared and explained at the very beginning of the LCA task with the partners in charge of the demonstrations, so that they are aware as early as possible of the type of information needed.
27	Demo site RSK (Norway); Pump flow into river does not meet objective of increasing trout habitat.	M	M	4	Closely monitor and observe habitat before and after implementation of pump. Proper work to identify before installation of pump is vital to identify all possible improvements.
28	Demo site Vouglans (France): Hybrid Unit becomes unavailable	L	M	2	Monitoring and maintenance of battery system and controls; information to TSO about ReHydro demonstration

Each partner has the responsibility to report immediately to their respective WP leader and to the Coordinator any change in risk that may arise and may affect the project objectives or their successful completion. Any change in the schedule of the deliverables or in the allocated budget must be reported to the corresponding WP leader or to the Coordinator.

In case of problems or delays, the PMT will be consulted, and it may set up task forces to take the necessary actions. In case there is no resolution, the General Assembly will be consulted and will establish mitigation plans to reduce the impact of risk occurring.

In every semi-annual evaluation of the progress of ReHydro each identified risk will be assessed.

Financial Management

Payments

Prefinancing will be paid by the Coordinator to the Beneficiaries after receipt of payments from the Granting Authority in separate instalments as agreed below:

30% of prefinancing	initial pre-financing on receipt of prefinancing by Coordinator	20 days after receipt of prefinancing by Coordinator
15% of prefinancing	further pre-financing	6 months after starting date of the Project
15% of prefinancing	further pre-financing	6 months after the preceding payment
40% of prefinancing	further pre-financing	6 months after the preceding payment

As interim payments, the Beneficiaries will receive, upon receipt of the interim payment by the Coordinator, the difference between the further prefinancing instalments already received and the Lump Sum Contributions approved by the Granting Authority. The initial prefinancing will not be taken into account for this calculation and remains as a float.

Keeping records and supporting documents

According to article 20.1 of the Grant Agreement, all beneficiaries must, for a period of at least 5 years after the payment of the balance, keep records and other supporting documents to prove the proper implementation of the action and the costs they declare as eligible.

Reporting

The project reporting is the procedure used by the CINEA to assess and follow up the financed projects. Periodic reporting is compulsory to CINEA and the project continuity depends on these reports.

Project reporting is a responsibility of the whole Consortium, and every partner must be involved in it. The Coordinator is responsible for gathering the information and reports from the different partners and consolidating it before sending it to the CINEA.

ReHydro is divided into three reporting periods:

1. RP1: from month 1 to month 18, i.e., from 01.05.2024 to 31.10.2025.
2. RP2: from month 19 to month 36, i.e., from 01.11.2025 to 30.04.2027.
3. RP3: from month 37 to month 48, i.e., from 01.05.2027 to 30.04.2028.

The project reporting obligations consist of:

- Periodic Report (within 60 days following the end of each reporting period) according to article 20 of the Grant Agreement:
    - Periodic technical report
    - Periodic financial report
- Final Report (in addition to the periodic report for the last reporting period):
    - Final technical report – summary for publication
    - Final financial report – Certificate on the financial statements (CFS)

Reports must be in English.

Final report

A final report must be submitted within 60 days after the end of the project (following the same procedures as the periodic reporting). Accordingly, the due date for submitting the final report to CINEA is the 30th of June 2028.

What happens if reporting is late?

If one beneficiary is late, the Coordinator can decide to submit the report without that beneficiary. Beneficiary's costs will be considered ‘zero’ for this reporting period, but it can declare its costs with the next reporting period.

If the Consortium is late: CINEA sends a reminder, the payment deadline is suspended. If still not submitted after 30 days, CINEA may terminate the Grant Agreement.

References

Barton, D. N., Sundt, H., Adeva Bustos, A., Fjeldstad, H-P., Hedger, R., Forseth, T., Köhler, B., Aas, Ø., Alfredsen, K., Madsen, A. L. (2020). Multi-criteria decision analysis in Bayesian networks - Diagnosing ecosystem service trade-offs in a hydropower regulated river. Environmental Modelling & Software 124. https://doi.org/10.1016/j.envsoft.2019.104604

Carolli, M., Zolezzi, G., Geneletti, D., Siviglia, A., Carolli, F., & Cainelli, O. (2017). Modelling white-water rafting suitability in a hydropower regulated Alpine River. Science of The Total Environment, 579, 1035–1049. https://doi.org/10.1016/j.scitotenv.2016.11.049

Attachment 1 Staff effort

Staff effort according to Grant Agreement, Part A.

Participant	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9	WP10	WP11	Total
SINTEF		3.0	15.0	6.0	6.0	13.0	8.0	4.0	8.0	9.0	14.0	**86.0**
VGBE			2.5					25.0	21.5	1.5	2.0	**52.5**
EDF		17.4	2.6	11.1	18.7	7.4	5.8	0.1	0.3	0.6	1.2	**65.2**
EDP	31.0			5.5	5.5	8.0	5.5	0.5	0.5	1.0	1.0	**58.5**
EDPL	4.0			7.0		7.5	8.8	0.5	0.5	1.0	1.3	**30.6**
CNR			1.1	2.1	3.3	3.5	2.5	0.4	0.7	0.7	1.2	**15.5**
LYSE	12.0	6.0	1.4	4.5		1.5		0.5	0.4	0.4	1.8	**28.5**
GE				22.6		16.9		0.5	0.5	1.9	1.9	**44.3**
ANDRITZ		18.6				5.6	2.1	0.3	0.2	0.5	0.8	**28.1**
VOITH	32.0					7.0	4.5	0.4	0.5	0.5	0.8	**45.7**
INTOTO					16.5	8.5		0.4	0.7	1.0	1.5	**28.6**
ENGIE					19.8	13.9	2.8	0.3	0.4	0.5	1.0	**38.7**
INRAE				25.4				0.2	0.4	0.9	1.3	**28.2**
NINA		2.0		14.0	7.0	7.0	2.0	0.3	0.4	0.3	1.0	**34.0**
HM	25.0					3.0	3.0	2.0	2.0	1.0	1.0	**37.0**
SGRID			18.6			13.0	14.8	0.2	0.2	1.0	1.0	**48.8**
AKSO										0.4	0.4	**0.8**
AKER	11.6	5.0						0.5	0.5	0.3	0.4	**18.3**
Total PMs Beneficiaries	**115.6**	**52.0**	**41.2**	**98.2**	**76.8**	**115.8**	**59.8**	**36.1**	**37.7**	**22.5**	**33.6**	**689.3**
ALPIQ	4.0	2.0	8.0	1.5		2.0	1.0	0.4	0.4	0.8	1.2	**21.3**
AND_CH	9.5	8.2					1.4	0.4	0.4	0.8	1.2	**21.9**
EPFL	9.8	30.4		0.8		5.0	5.0	0.4	0.9	1.5	2.0	**55.8**
HES-SO	22.0	4.0				2.0	4.0	0.4	0.4	1.0	1.0	**34.8**
HEX	6.0	1.5		1.5			1.0	0.4	0.4	0.8	1.2	**12.8**
IHA			4.0		5.9	8.5	20.7	8.3	8.1	1.4	2.5	**59.4**
Total PMs	**166.9**	**98.1**	**53.2**	**102.0**	**82.7**	**133.3**	**92.9**	**46.4**	**48.3**	**28.8**	**42.7**	**895.3**


Lyse
NINA
SINTEF
AkerSolutions
intoto
HM
VOITH
vgbe
ENERGY IS US
iha
eDF
engie
CNR
INRAE
SuperGrid Institute
Shaping power transmission
GE
edp
edp
Labelec
ANDRITZ
ALPIQ
EPFL
ANDRITZ
Hes·so
HYDRO