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RevHydro: Transforming hydropower for a sustainable future

RevHydro Newsletter

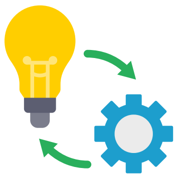
Issue No. 2 | November 2025

Project scope

RevHydro is a pioneering Horizon Europe project aimed at revolutionizing the refurbishment of hydropower systems across Europe. By developing innovative, sustainable, and retrofittable solutions for existing turbines, RevHydro addresses critical energy and environmental challenges. The project strives to enhance turbine efficiency, extend operational lifespan, reduce environmental impacts, and align hydropower operations with EU sustainability and climate goals.

Implementation period

RevHydro was launched in late 2024 and will continue until 2028, ensuring a comprehensive approach to research, development, testing, and implementation.



Regular meetings & ollaboration

Consortium partners meet regularly to align research efforts, share progress, and refine strategies. These meetings foster cross-disciplinary collaboration and keep the project aligned with its goals.

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Consortium partners

Map of Europe

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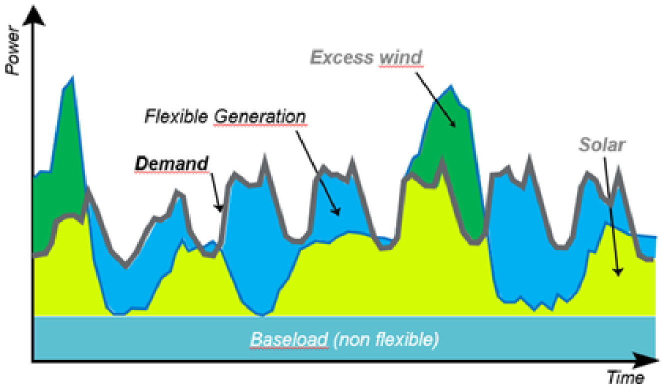
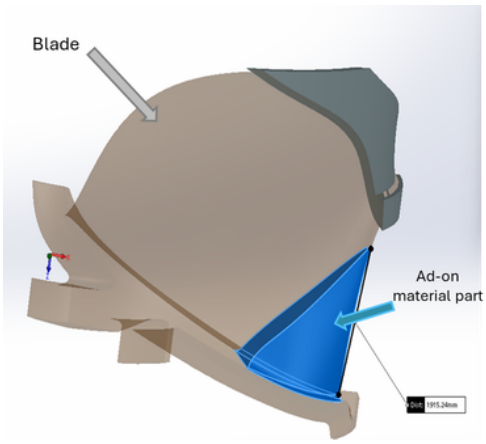
Why is it interesting to extend turbine operating range in hydroelectric power plant?



The power grid always needs to keep electricity production and use in balance. Because renewable energy sources like wind and solar change all the time, the system must react quickly. For hydropower, this means the turbines often work in different conditions, sometimes running at full power, sometimes at very low power, and starting or stopping more often to keep the grid stable.

Summary of actions carried out between GE Vernova and Applus Rescoll



GE Vernova selected 3D-printed plastic materials as an important solution for the project. The manufacturing process should minimize downtime and be flexible enough to fit different turbine designs, with blades of various sizes and numbers.

Summary of collaborative activities between GE Vernova and Applus Rescoll

Stop the system for maintenance → Digitally scan the blade area where the new section will attach → Process the 3D model and print the new component → Apply surface finishing or coating if needed → Clean and prepare the blade surface for bonding → Align and test-fit the parts before bonding → Glue the extension and apply pressure while the adhesive cures

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Global objectives

- Present and evaluate a new software tool and how it can be used in the RevHydro project.
- Apply the software to a real RevHydro example, testing it on both the turbine and the experimental setup at LTU.
- Design and improve methods to reduce vortex rope effects in the turbine.

Evaluating Hexahedral and Polyhedral Mesh Performance in StarCCM+ and CFX

The use of hexahedral cells is the standard approach in turbomachinery simulations. StarCCM+, primarily developed for polyhedral cells in internal flow studies, modifies the domain structure but is also capable of handling hexahedral meshes. The objective is to compare StarCCM+ performance with CFX using hexahedral cells and to assess polyhedral cell behavior in turbomachinery applications. Results show that the hexahedral case in StarCCM+ produces similar flow profiles to those obtained in CFX. However, the polyhedral case shows a noticeable overprediction near the draft tube wall, likely due to the clearance region between the blade and runner wall—an aspect that will be further verified.

Conclusion

StarCCM+ can deliver results very close to those from CFX when using the same mesh.

In the runner, polyhedral cells tend to overestimate near the walls and underestimate torque due to the narrow clearance between the blade and shroud.

In the draft tube, polyhedral cells perform well and can be applied effectively.

The best approach is to combine both methods—using hexahedral cells in the runner for accuracy and polyhedral cells in the draft tube for efficiency in the project.

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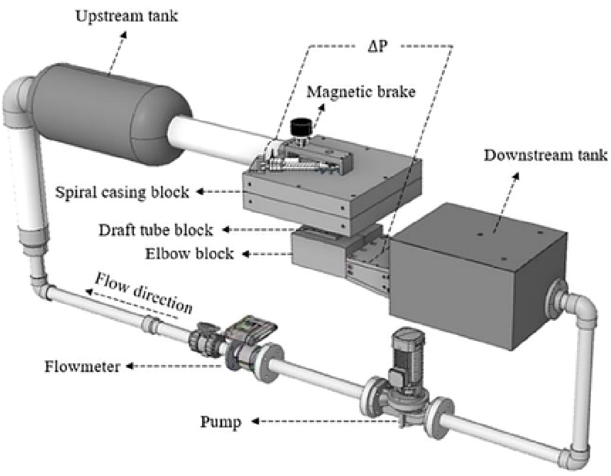
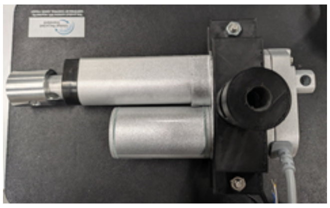
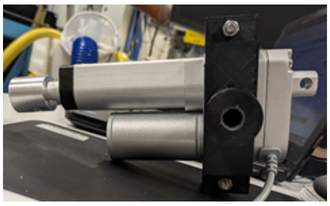
Innovative Testing on a Scaled Kaplan Turbine Model

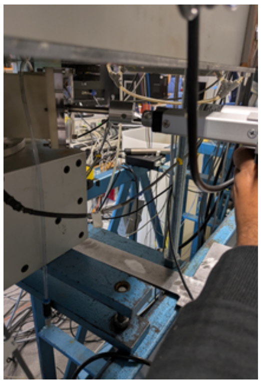
As the hydropower sector advances toward smarter and more sustainable technologies, laboratory-scale experiments are becoming essential for understanding and improving turbine performance. Within this framework, researchers conducted a detailed study using a 98/1550 scale model of the Porjus U9 Kaplan turbine, aiming to analyze hydraulic behavior and enhance efficiency under controlled conditions.

The experimental setup featured eight stay vanes, ten guide vanes, and six runner blades, with a runner diameter of 98 mm and a fixed blade incidence angle of 0.8°. A comprehensive Hill Chart was developed to map turbine efficiency across different operating conditions and to identify the formation of Rotating Vortex Rope (RVR) — a phenomenon linked to pressure fluctuations and flow instabilities.



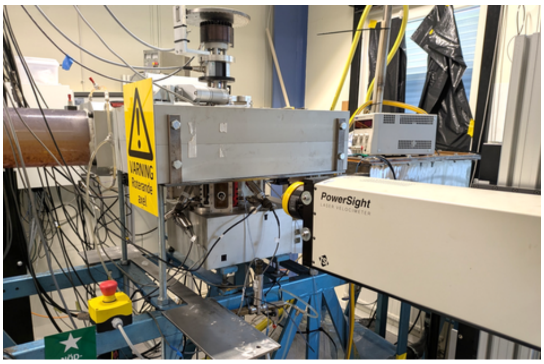






Further analysis involved Laser Doppler Velocimetry (LDV) measurements in the draft tube at three axial planes, focusing on the RVR operating region where high-amplitude pressure pulsations were observed. Tests were conducted across multiple rotational speeds (600–800 RPM) and guide vane angles (18°–36°), complemented by pressure mapping throughout the system. The setup was also prepared for the installation of a Draft Tube Flow Control (DFC) mechanism to explore future mitigation strategies.

These findings provide valuable insights into turbine behavior under variable load conditions and support the development of more stable and efficient hydropower systems.



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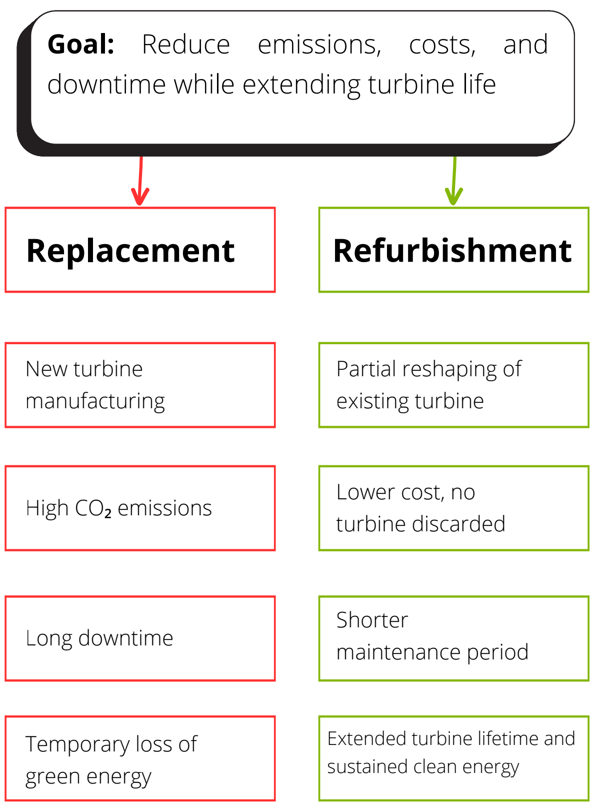
Extending the Life of Hydropower: Smarter, Cleaner, and More Efficient Solutions

The modernization of hydropower plants is becoming a priority across Europe as the energy sector seeks to balance sustainability, cost efficiency, and technological innovation. New research and industrial initiatives show that refurbishing existing turbines - rather than replacing them - can significantly cut environmental impact and costs while improving performance and reliability.
To better assess these impacts, experts apply advanced Life Cycle Assessment (LCA), Life Cycle Inventory (LCI), and Life Cycle Costing (LCC) methodologies, helping identify where emissions can be reduced, resources saved, and efficiency maximized.

Hydropower Refurbishment vs. Replacement



This visual comparison highlights how reshaping existing turbines requires fewer materials, reduces downtime, and extends the system's lifespan, while replacement leads to higher emissions and expenses.
By integrating digital diagnostics and AI-based monitoring, hydropower operators can further optimize performance and make refurbishment a key model for sustainable innovation in Europe's green transition.

Results & Benefits

- 30% CO_2 reduction (environmental gain)
- 50% lower costs (economic gain)
- 10% less downtime (operational gain)
- Better performance and efficiency

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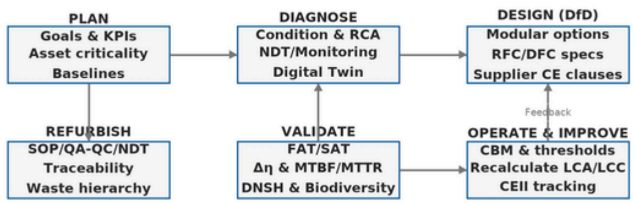
Circular Refurbishment – The Future of Sustainable Hydropower

In modern hydropower, refurbishment is no longer just maintenance, it represents a complete circular approach that extends the life of critical assets, reduces environmental impact, and aligns with the European Green Deal's sustainability goals.

High-Level Circular Refurbishment Cycle (PD²RVO)



The High-Level Circular Refurbishment Cycle (PD²RVO) introduces a systematic framework that connects planning, diagnosis, design, refurbishment, validation, and operation. Each phase integrates advanced monitoring tools, digital twins, and circular economy principles to ensure traceability, waste reduction, and optimal turbine performance. This closed-loop process guarantees that every intervention contributes to efficiency, resilience, and biodiversity protection.

Decision-making in refurbishment projects is guided by a Refurbishment Option Selection flow, which helps engineers choose between repair, remanufacture, or replacement based on cost, criticality, and sustainability. The process emphasizes reliability, quality assurance, and minimized downtime, supporting both operational excellence and long-term environmental value.

Integrating Research, Digital Tools, and Circular Economy in Hydropower

Research activities complement this process through systematic literature analysis, identifying trends in circular economy applications within hydropower. Advanced methods such as Life Cycle Assessment (LCA) and Life Cycle Costing (LCC) are used to quantify environmental and economic benefits. Meanwhile, artificial intelligence supports energy forecasting, fault detection, and optimization, ensuring smarter, data-driven decisions. By combining engineering innovation with sustainability standards (ISO, IEC, DNSH, EU Taxonomy), hydropower refurbishment becomes a model of efficiency and circularity. The result is a resilient energy infrastructure capable of delivering clean, affordable power while protecting natural ecosystems.

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Refurbishment as a Sustainable Solution for Hydropower Turbines

From an economic perspective, refurbishment proves equally beneficial. By avoiding the full replacement process, capital expenditures can be reduced by up to 50%, as refurbishment consumes fewer resources, demands less workforce, and lowers reintegration costs. This approach not only maintains profitability but also supports continuous clean energy production while aligning with the European Green Deal's circular economy principles.
The project aims for a 30% reduction in CO_2 emissions and significant cost savings through innovative refurbishment practices - transforming hydropower modernization into a model of sustainable engineering and responsible resource management.

The findings demonstrate a clear advantage for refurbishment

Producing a new turbine from raw materials increases the carbon footprint through manufacturing emissions, resource extraction, and transportation. It also generates additional waste and leads to long operational downtime, which temporarily reduces renewable energy output.

In contrast, reshaping the existing turbine requires only new components, minimizes waste, and allows the hydropower plant to remain operational during shorter maintenance periods. Over its extended lifetime, the upgraded turbine can deliver improved performance and higher energy efficiency, contributing to long-term sustainability goals.

Comparison: Replacement vs. Refurbishment

Replacement

- **High emissions** - producing a new turbine from raw materials increases CO_2 emissions during manufacturing and transport.
- High cost - involves significant capital expenditure for materials, labor, and logistics.
- Long downtime - extended system interruption during turbine replacement.

Refurbishment

- **Lower emissions** - reshaping the existing turbine requires only specific new components, reducing environmental impact.
- Lower cost - refurbishment consumes fewer resources and reduces production and integration expenses.
- Minimal downtime - shorter maintenance period, keeping the system operational for most of the process.

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Impact & statistics

🌐 7 social media platforms active, with regular content updates and engagement.

👥 3,180 people reached, with 387 impressions across platforms (M6 report).

📝 26 publications produced, including simulation datasets and experimental results for the global hydropower community.

🔬 100+ stakeholders engaged through workshops, webinars, and dissemination events.

Stay connected

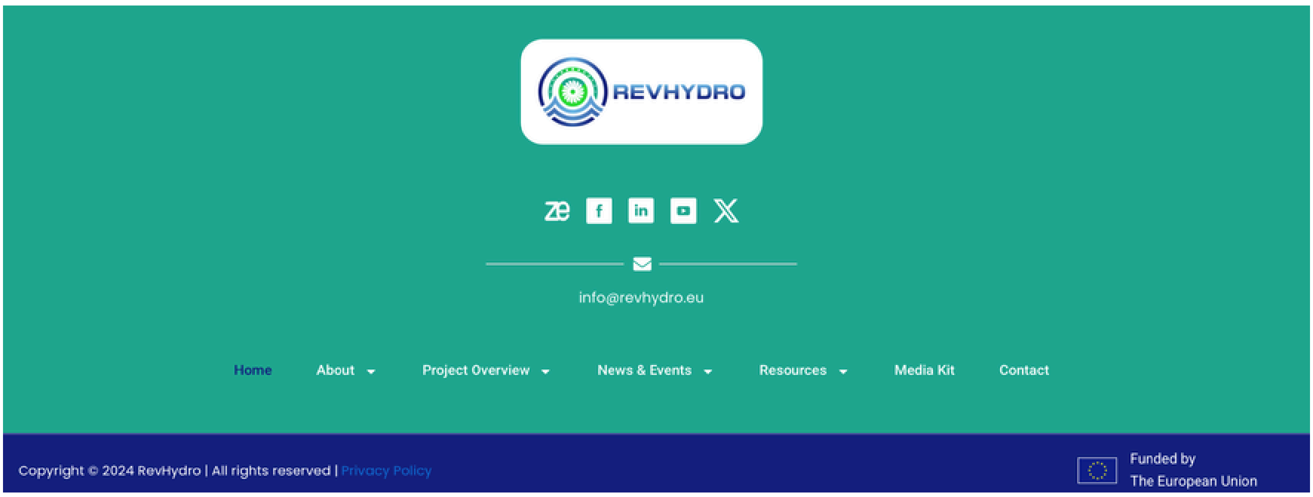
- Follow RevHydro on LinkedIn, Facebook, X (Twitter), Instagram, and YouTube.
- Visit revhydro.eu for updates, publications, and project news.

Looking ahead

Upcoming milestones include the launch of the RevHydro YouTube channel, technical workshops and demo days, and continued refinement of turbine and fish barrier solutions. As we move forward, we invite stakeholders, researchers, and enthusiasts to engage with our journey towards a more sustainable hydropower future.

Thank you for your support!

Stay tuned for our next edition, where we'll share new insights, data, and stories from the RevHydro project.



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