FISH-FRIENDLY HYDROPOWER

Developing a safer turbine for migrating fish

Interreg Atlantic Area
HY4RES

Co-funded by the European Union

Can hydropower generate renewable electricity while supporting fish migration and river connectivity?

The Centrifugal Screw Pump-as-Turbine (CSPAT) uses a screw-shaped impeller to generate electricity.

HY4RES investigated its hydraulic performance and potential to reduce fish injury.

CSPAT can achieve up to 33.1% efficiency and 12.5 kW output

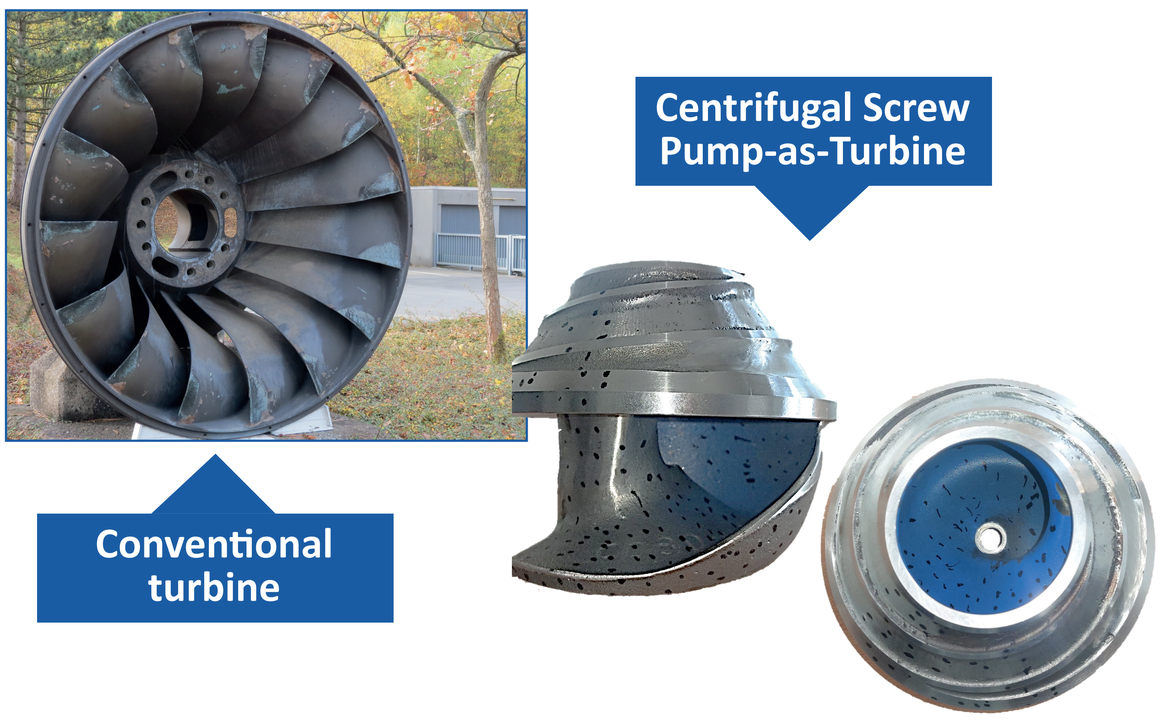
THE CHALLENGE

Conventional hydropower

- ✓ **Renewable, low-emission** electricity generation
- ✓ **Proven technologies** with high hydraulic efficiency
- ✗ **Potential fish injury** and disruption of river connectivity

The CSPAT approach

- ✓ Standard pump technology **potentially more affordable** than conventional turbines
- ✓ Screw-shaped impeller **designed to transport water and live fish**
- ✓ **Potential to combine** electricity generation with fish passage at suitable sites



A fish-friendly alternative is needed

TESTING AND KEY RESULTS

HY4RES combined **theoretical analysis**, **computational fluid dynamics simulations** (CFD) and **laboratory experiments** to assess the hydraulic performance of three CSPAT configurations.

Improved hydraulic performance

1 — 22.8% Peak efficiency

2 — 28.7% Peak efficiency

3 — **33.1%** ***Peak efficiency***

12.5 kW ***Reported CSP-3 output***

*Conventional PAT
> 60%
Peak efficiency

*Lower rotational speeds may **reduce fish injury risk**, but can also **decrease hydraulic efficiency**.*

What the results tell us

Turbine operation confirmed: the pump can generate electricity when operated in reverse

Site-specific design matters: efficiency depends on flow rate, hydraulic head and rotational speed

Laboratory validation achieved: the technology reach TRL 4, with further work needed before real-world deployment

Balancing efficiency and fish-friendliness

POTENTIAL APPLICATIONS AND NEXT STEPS

From laboratory to river applications

The CSPAT could offer an alternative for suitable low-head hydropower sites where fish migration and river connectivity are priorities, including locations with existing barriers.

Next steps

1. **Further design optimisation**
2. **Testing under real operating conditions**
3. **Assessment of fish passage and ecological safety at potential deployment sites**