SUBSCREW HYDRO PROJECT:

Low-cost fish friendly solution for river connectivity

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Introduction

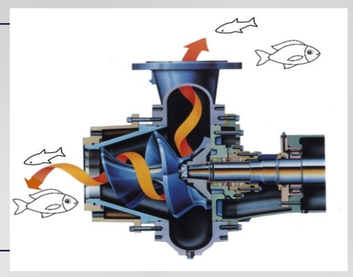
✓ The recently adopted Nature Restoration Law (NRL) aims to restore 20% of terrestrial and marine ecosystems by 2030 [1]. One of its targets is to remove river barriers so that at least 25,000 km of rivers would be returned into free-flowing state. This will threaten the advancement of hydropower especially micro-hydropower as pre-existing barriers will be removed which, initially, eliminated the need for regulatory permissions.

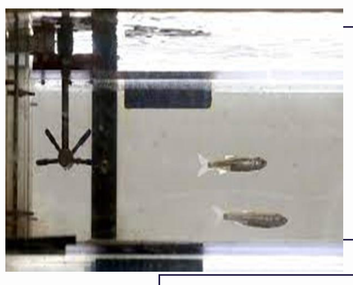
✓ Removal or modification of existing barriers in rivers is a costly exercise with considerable social and environmental impacts. On average, the cost is estimated to range between €250,000 and €500,000 [2] for a single barrier. Ireland is home to an estimated >73,000 existing barriers in rivers which need to be removed or modified to comply with the NRL and due to the aforementioned issues, full barrier removal is impractical in most cases. Therefore, barrier modification to open routes for fish and sediment movement is the most credible option but due to its cost implications requires innovation to increase viability.

✓ This study intends to develop a low-cost river barrier modification system for the safe passage of fish and downstream movement of sediments. Central to the project is the adaptation of submersible centrifugal screw pumps for usage as turbines offering dual capability of pumping and power generation while allowing safe movement of fish across barriers and downstream sediment transport.

Methods

1 Technology Development
- Theoretical studies
- Test Rig design
- Laboratory Experiments
- Computational fluid dynamics studies





2 Fish Friendly Assessments
- Ethical Approval
- Flume testing
- Fish tests

3 Field Tests
- Site identification
- Site design
- Monitoring campaigns

4 Resources & Impact Assessments
- Available resource
- Environmental impact assessment
- Potential project impact

Results

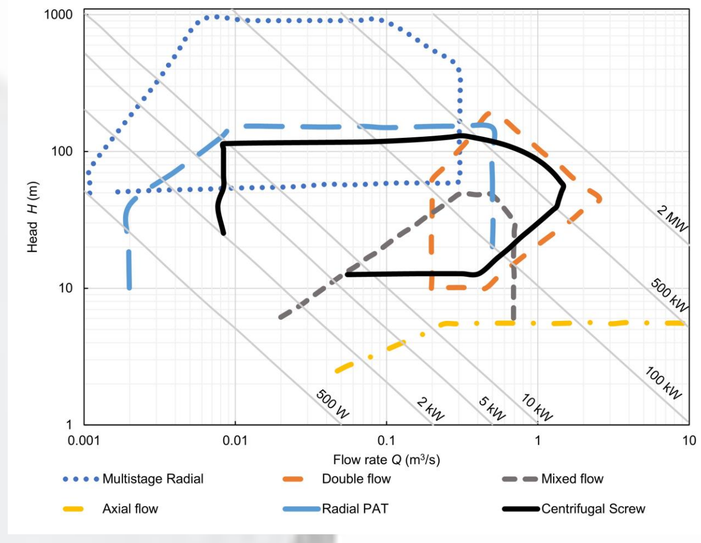
(a)Theoretical characterization of centrifugal screw PATS [3]

✓ Flow rates: 0.002 – 1.65 m^3/s

✓ Heads: 10 – 100 m

✓ Output: up to 750 kW/unit

This will be confirmed from lab experiments

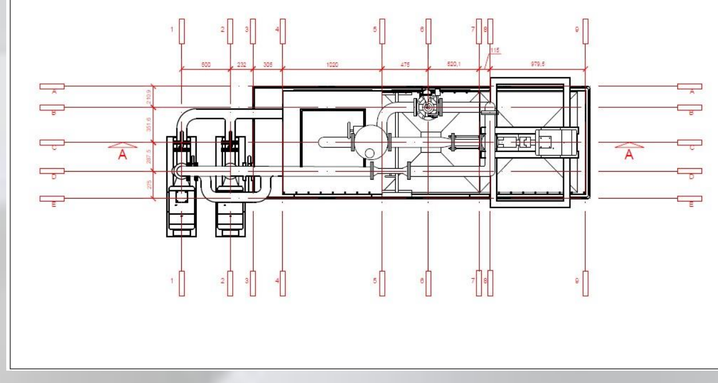


(b) Test Rig Design

✓ Capacity: $6m^3$

✓ Flow rate: 0 – 55 l/s

✓ Shutoff head: 67.5 m



(c) Stakeholder engagements

✓ Widespread demand for community energy projects

✓ Need to overcome challenges to fish and sediment movement across river barriers

✓ Very onerous, costly and time-consuming consenting process for micro-hydropower projects

Conclusion

By providing a means for the partial removal of the large number of existing barriers in Ireland using a bi-directional pump-as-turbine capable of safely transporting fish upstream and downstream, and sediments downstream, we will contribute to the societal challenge of enabling the penetration of a greater amount of intermittent renewable energy in the grid.

The proposed centrifugal screw pump-as-turbine barrier modification system will create value for our stakeholders by;

✓ Reducing the lifecycle cost of modifying the existing barriers via revenue generation from electricity production offsetting initial capital costs

✓ Producing renewable electricity for community energy schemes in rural areas, and reducing the barriers to achieving energy independency by achieving hydropower energy production partially as part of barrier modification programs

Find out more!

References

[1] Directorate-General for the Environment, "The EU Nature Restoration Law", European Commission. https://environment.ec.europa.eu/topics/nature-and-biodiversity/nature-restoration-law_en (accessed Oct. 18, 2023).

[2] Kelly-Quinn, M., Bruen, M., Turner, J. N., O'Sullivan, J., Carlson, J., Bullock, C., Atkinson, S. and Casserly, C. M. (2022). Assessment of the Extent and Impact of Barriers on Freshwater Hydromorphology and Connectivity in Ireland (Reconnect). Report No. 421, Environmental Protection Agency, Wexford.

[3] Stephen, C., Crespo-Chacon, M. and McNabola, A. (2023). Fish friendly micro-hydropower: Centrifugal Screw Pump-as-Turbines. *Proceedings of the 40th IAHR World Congress.* Vienna. Pp 1-6.

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