The viability of large-scale use of micro hydro-electric power plants in rural Ireland.

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Aim of the Project

- A literature review was intended to be undertaken.
- To assess what percentage of the grid's output is renewable energy.
- To assess the possible production level from micro-hydro electric power plants.
- To compare hydro-electrical systems.
- To assess the pros and cons in relation to cost savings.

Background

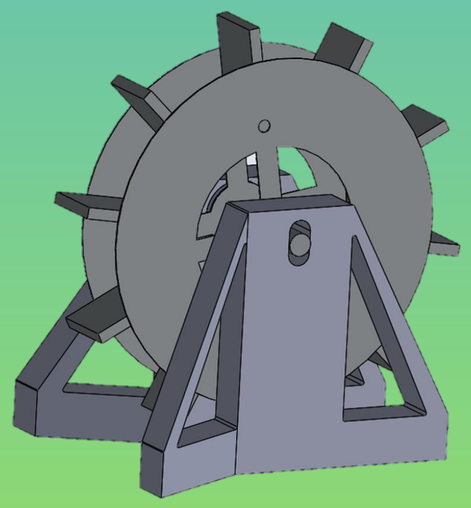
With Ireland transitioning towards renewable energy, micro-hydro power presents a sustainable alternative for rural energy generation. Many rural areas lack direct access to the national grid or face unreliable electricity supply. Micro hydroelectric systems, particularly undershot water wheels, offer a viable solution by utilizing small river streams to generate consistent energy. A comprehensive study was conducted, including literature reviews, field measurements, and computational fluid dynamics (CFD) simulations, to evaluate the viability of such systems in an Irish setting.

Objectives

1. Conduct a critical literature review of existing micro-hydro systems and their applications.
2. Assess renewable energy contributions to Ireland's power grid and identify gaps.
3. Perform fieldwork to analyse river flow rates and head pressure for power generation.
4. Use computational fluid dynamics (CFD) to simulate water flow interaction with a micro-hydro system.
5. Evaluate economic feasibility, including potential costs, expected return on investment, and market interest through surveys.

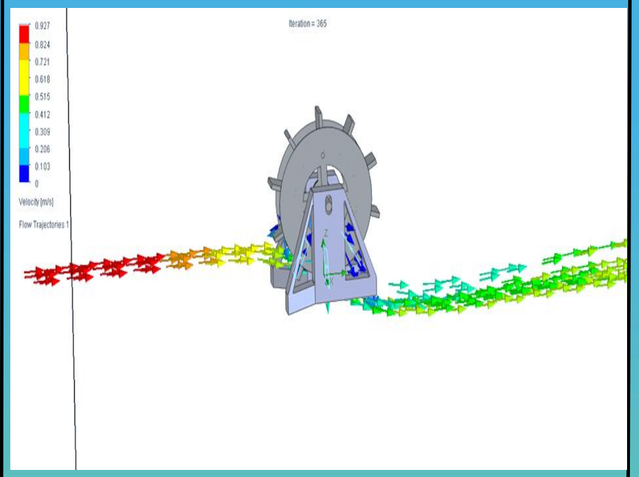
CAD

The CAD modelling was taken from basic principles assessed in the literature review section of this study and a frame to support the main water wheel with paddles.



CFD

This section was used to assess the success of the overall system when in place in a particular stream in which the relevant data has been retrieved from in order to calculate its output.



Survey

A survey was created and dispersed to gain a greater understanding of the importance and potential need for this system throughout rural Ireland.

Calculations

All necessary data was measured from the stream in question and recorded and later converted into an Excell table for use in the upcoming formula.

Specifications of river			
Point in run	Avg. depth (M)	Avg. width (M)	Test length (M)
Point 1	0.194733333	4.8768	6.096
Point 2	0.2032	4.8	
Point 3	0.254	3.81	
Overall average of test length	0.217311111	4.4956	6.096

Test results	
Lap number	Times taken (Sec)
Lap 1	6.24
Lap 2	6.6
Lap 3	8.06
Lap 4	6.38
Lap 5	7.63
Lap 6	5.98
Avg. time (Sec)	6.815

Relevant calculations were completed to assess the velocity of the stream in question.

$$Velocity\ of\ stream = Width\ x\ Depth\ x\ (Distance \div Time)$$

$$Velocity\ of\ stream = 4.496m\ x\ 0.217m\ x\ (\ 6.096m \div 6.815s)$$

Conclusions

The project concluded that increasing water bills on farms are crucial for livestock welfare. To pump addresses this, water was sourced from a nearby river, pumped into a reservoir above water troughs in sheds for gravity-fed distribution.

References

Abeykoon, C., 2022. Modelling and optimisation of a Kaplan turbine — A comprehensive theoretical and CFD study. Cleaner Energy Systems, 3(100017), p.