Water Supply Network Integrated Energy Recovery to Replace Energy Wasting Pressure Regulation Valves for Improving Operational Efficiency and Reducing Operational Carbon Emissions

Jem Irving
University of Strathclyde, 16 Richmond Street, Glasgow
Email: jem.irving@strath.ac.uk
www.hydronationscholars.scot

Scottish Government
gov.scot
Hydro Nation Scholars Programme

Introduction

- Pressure Reduction Valves (PRVs) regulate pressure by releasing it to the atmosphere – this wastes potential energy.
- Around 8.8GWh of energy is wasted every year, from nearly 5000 PRVs.
- Scottish Water have an obligation to deliver clean water at safe pressures.
- Partnered with Scottish Water Horizons

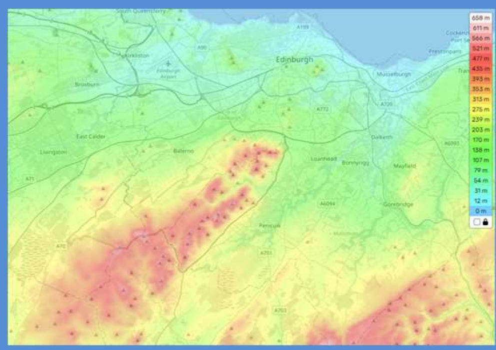
Scottish Water Horizons

Research Questions

- Is it feasible to replace PRVs with in-line hydrokinetic turbines to control greatly variable pressure and recover energy from the SWDN?
- Can this be done in a way that complies with the strict regulatory framework that governs Scotland's water supply.
- What type, scale, and configuration of turbine would successfully execute this task?

Challenges

Scotland's topography



- Edinburgh's water comes from the Pentlands
- This means the water will be incredibly high pressure and needs to be managed.
- Because of population location, combined with topography, the flow rate and pressure requirement will vary incredibly across even one city.

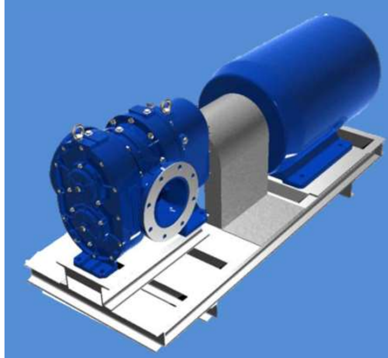
Public Opinion

- Because of previous failures, in-line hydro is deemed unreliable.
- This highlights the need to prioritise robustness of design

Proposed Methodological Approach

- **Priorities** – Pressure regulation ability, robustness of design, large range of operating conditions.
  - Safe and adequate pressure deliverance to customers
  - Reduced down-time and less maintenance
  - Applicability to Scotland's hugely varying water flow conditions
- Analysis of flow data from key Scottish Water sites – pressure, flow rate, rate of variability.
  - Identify flow typical conditions
- Literature review and benchmarking of current technology.
  - Current technology in place does not meet several of the criteria.
- Identification of any missing areas of required knowledge, and plan to fill gaps.
  - Conduct research into the required areas to offer the academic world new and novel information
- Mechanical design of a turbine device with the novel approach of prioritising downstream flow control.

Existing Technology



Pump-as-turbine

- This is a pump that has been redeployed in reverse
- Very small range of effective conditions due to the specific nature of pump designs.

Francis turbine

- Incredibly versatile turbines, can deal with a wide range of pressure
- A very common turbine around the world

Woodend Difgen Hydro

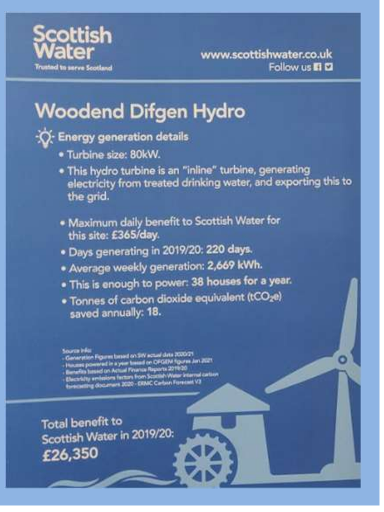
- Pump-as-turbine configuration, so;
  - Small range of operable conditions
  - Not incredibly robust
- Despite issues with other sites, this site operates well, and benefits for Scottish Water can be seen;
  - 18 tonnes of carbon dioxide equivalent saved annually
- If issues around robustness and reliability were resolved with a new design, this benefit could be applied across the country

Expected Outcomes

- Greater understanding of hydrokinetic turbines, and the effect of small-scale geometry variation of internal components.
- A robust and novel methodology for mechanical design.
- Steps towards a hydrokinetic turbine energy capture system that controls water pressure and is reactive to variable flow conditions.

Impact

- Increase in operational efficiencies in the Scottish Water Distribution Network.
- Decrease in operational carbon emissions from Scottish Water.
- Economic impact in the form of reduced energy usage by Scottish Water.



Acknowledgements:

Scottish Water Horizons

Scottish Funding Council
Comhairle Maoineachaidh na h-Alba

University of Strathclyde