Helpu Cymru i leihau ei Hôl Troed Carbon
Help Wales reduce its Carbon Footprint

Llywodraeth Cymru
Welsh Government

www.cymru.gov.uk

Case Study 12

River Bain Hydro Project

Owner:
River Bain Hydro Ltd

Location:
Wensleydale, North Yorkshire

Development Type:
Community

Project Description

The River Bain Hydro project is a community owned micro hydropower scheme constructed in 2010 and located in the Yorkshire Dales National Park, in Bainbridge, on reputedly the shortest river in the country.

Key Drivers

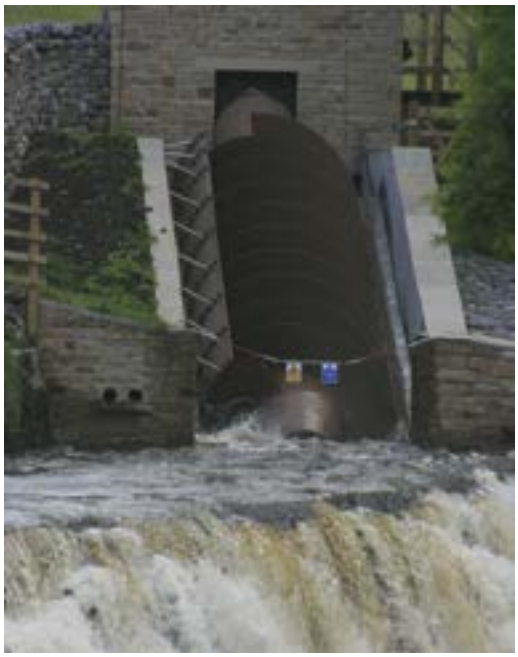
The key objective of the scheme was to develop a community–owned hydro facility to generate income and fund other energy and environmental projects in the area, whilst reducing the community's net carbon emissions.

Several studies had identified the potential for micro hydro generation in the village, but it was the drive and enthusiasm of the local people to act as a collective to own and enjoy the profits from electricity generation that catalysed the project.

Due to Bainbridge's position within the Yorkshire Dales National Park, another significant issue was that any technology implemented was sensitive to the local surroundings.

Key features

The scheme comprises a 45 kW reverse Archimedean screw hydropower installation, which utilises the natural fall of the river to generate electricity.



Reverse Archimedean screw hydro installation
Reproduced with permission of H2oPE

Renewable & Low Carbon Technologies

- Low head hydropower installation

"Micro hydro is the unsung hero of community owned renewables – predictable, reliable, bankable and above all sustainable."
David Slee
Technical Director, Water Power Enterprises

Procurement

The Bainbridge hydro scheme was developed through a partnership between River Bain Hydro Limited and Water Power Enterprises (H2oPE). River Bain Hydro Ltd is an industrial and provident society (IPS) which was set up to act as long term owners and managing agents of the hydro scheme. H2oPE is a Community Interest Company which provides specialist services facilitating the development of micro hydropower schemes across the UK, including "at–risk" development on behalf of communities.

The 10m long, 8.5 tonne Archimedean screw was supplied by Ritz–Atro, a German manufacturer, now a subsidiary of Andritz. The sluice gates were procured from OSBIT–Power while the control and grid interface plant were sourced from Sustainable Control Solutions (SCS).

Scheme costs and finance

The capital cost of the project was in the region of £450,000, with equipment and construction costs comprising around £395,000.

The scheme is expected to generate an annual revenue of approximately £30,000, primarily through the Government Feed–In Tariff (FiT).

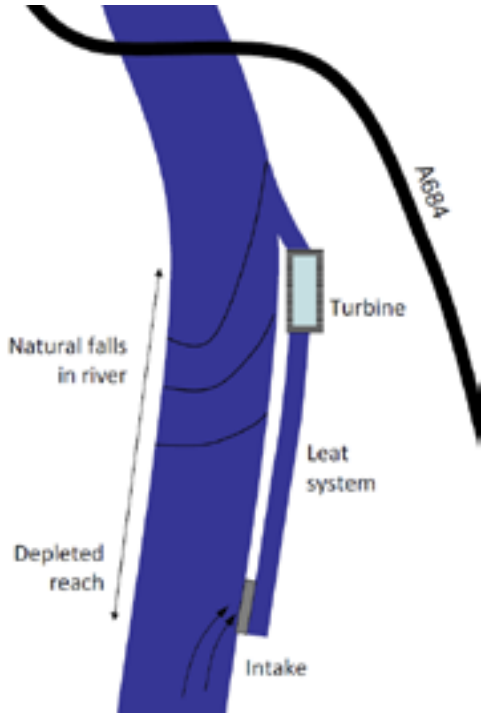
A significant proportion of the capital cost (approximately 40%) was raised through shareholders, who, as members of River Bain Hydro Limited, invested in the scheme. Shares were made available to individuals, voluntary organisations, the public sector and corporate bodies. While the financial return on investments is expected to be relatively low, tax savings can be made for investors through the Enterprise Investment Scheme (EIS). Additionally, shareholders gain the satisfaction of knowing that their investment is contributing to locally produced green energy.

Around £100,000 of the cost was sourced through a number of grants, including contributions from CO_2 Sense and Yorkshire Dales National Park Authority's Sustainable Development Fund, who are managed by the Yorkshire Dales Millennium Trust. The remainder of the capital cost was borrowed from Charity Bank, via an ethical loan on commercial terms to be repaid over a period of around 17 years.

Revenue generated from the scheme will be shared between the shareholders and contributions to the loan repayment, with surplus reinvested in community projects including the Raydale Project, a community scheme which seeks to protect the catchment of the River Bain and increase its resilience to climate change by improving water quality and wetland habitat.

Technology selection process

To install a hydro scheme requires construction of an artificial hydraulic system often incorporating a weir, which results in a depleted reach i.e. the area of the river where water is diverted through the hydro installation which reduces flow levels in that length of the river. The local impact of changes in flow on morphology and ecology as a result of the depleted reach is usually one of the key issues associated with hydro schemes.



Schematic diagram of low head turbine at Bainbridge
Adapted from information provided by H2oPE

A primary consideration of the scheme was selection of a suitable site for a low head hydro scheme. A historic study of potential hydro sites in the area identified Bainbridge as having up to 10 m of hydraulic head. However, harnessing such a large head would impact several landowners, contradict good practice recommendations for low head hydropower and result in a long depleted reach in an ecologically and visually sensitive location. It was therefore decided to locate the turbine at a site where there was a lesser 3.2 m hydraulic head and smaller length of depleted reach (50 m). An added benefit and an unusual feature of the chosen site was that a series of natural cascades provided the required drop in water level so no weir (natural or man–made) was required.

Based on an annual mean river flow of approximately 2 m^3/s and a net hydraulic head of 2.5 m, an Archimedean screw turbine was considered the most suitable technology. A 2 m deep inlet channel to supply flow to the turbine was constructed with an intake and manual sluice gate located upstream and the screw located at the downstream end (see diagram). The maximum power generating potential of the hydrological conditions on site was estimated to be approximately 45 kW water power with about 37 kW of electricity delivered to the grid. The total annual energy capture of the system is around 130 MWh, sufficient to meet the demand from around 30 rural households.

The risk of fish mortality can be a major barrier to development of hydro schemes and close liaison with the relevant Environmental authority (the Environment Agency in England and Wales) is necessary to incorporate mitigation measures such as setting appropriate abstraction license conditions or building fish passes.

Intake to leat channel for turbine
Reproduced with permission of H2oPE

Fish mortality was not considered to be a notable issue at the development site as only a few migratory species travel as far upstream as Bainbridge, being hampered by other cascades downstream. The scheme does not include a weir, and the natural falls and cascades are unaffected which continue to form a natural barrier to migration. Additionally, Archimedean screw turbines have been found to have a relatively low impact on fish, which can pass downstream through the turbine unharmed. As a result, no fish pass or fine intake screening was felt necessary for the River Bain Hydro scheme.

The stretch of the River Bain in the site vicinity is, however, an important nursery site for white clawed crayfish which are a protected species. Care had to be taken during construction to minimise the impact on the crayfish habitats, and as part of the scheme, an additional wall was constructed at the project for flood protection "in–river". This was constructed using natural limestone and recessed mortar joints to create a new crayfish habitat.

Flooding issues were another key issue in the design of the scheme. Bunds on either side of the leat channel were constructed using excavated material to deepen the leat channel and improve the usable head. The outer bund acts as a flood defence whilst the inner bund can be overtopped, allowing flood waters to escape back into the river. The building which houses the power system for the hydro scheme was designed to withstand flooding, as it has no damp proof course, the floor is sloped to allow drainage of flood waters, and all electrical plant was mounted on the walls at a high level. In addition, natural building materials were selected in preference to materials such as plasterboard which would be damaged from water ingress.

Monitoring and operation

The River Bain hydro scheme has been operational since May 2011 and is estimated to result in carbon dioxide emissions savings of approximately 80 tonnes per annum, with a total of around 3,000 tonnes over the expected 40 year lifetime of the scheme. The turbine operates at an efficiency of approximately 75% "water to wire" on average across all operating conditions and will run about 85% of the time in winter and about 45% of the time in summer, depending on the amounts of rainfall driving river level. Maintenance downtime is estimated at 2% of the year, around 7 days, and scheduled where possible into the summer to avoid lost productivity.

Leat channel and inlet debris screen to screw
Reproduced with permission of H2oPE

H2oPE have been involved throughout the design, development and construction of the Bainbridge hydro scheme and representatives of H2oPE acted on the board of River Bain Hydro Limited to ensure that the community company developed adequate management expertise to operate a community

power generation business. Following commissioning and handover of the scheme to River Bain Hydro Limited, H2oPE continue to monitor the scheme, provide strategic advice and help local people carry out operations and maintenance duties.

Early output data from the turbine reflects lower than predicted rainfall in the Bain catchment through the summer of 2011, along with a "bedding in" period where minor technical problems were resolved by the suppliers. Data from October 2011 shows expected levels of performance, although it should be noted that a large number of months of data will need to be collected in order to validate long term climactic predictions versus the short term nature of weather.

Lessons learnt

Technological supply issues:

- Keeping contractual terms 'lightweight' but effective between the community group, the civils contractor and specialist equipment suppliers was an important aspect when dealing with project delays and technical issues; and
- The supply chain is evolving rapidly and whilst the turbine technology is mature, the control and balance of plant equipment continues to evolve offering greater productivity and lower through life cost of ownership set against technological advance risks.

Occupant involvement:

- Close liaison with the planning officers from the National Parks Authority from an early project stage greatly aided the scheme development;
- Developing and promoting good public relations is vital to secure funding from shareholders; and
- Community schemes can only be successful where there is a strong community drive to support the scheme.

Financial lessons:

- Obtaining grants can be difficult during early project stages before a scheme has been finalised and developed;
- Compatibility between funding sources can be a challenge e.g. grants versus FiTs; ethical investments versus commercial rates of return; and
- The provision of cost and programming contingency is very important when developing run of river hydro schemes due to the potential for climactic impacts on civil engineering (e.g. flooding events, freezing in winter).

Awards & Achievements

- Yorkshire and Humber Microgeneration Partnership Best Community Installation 2011.

References and Acknowledgements

David Slee,
Technical Director,
Water Power Enterprises

Further information

Enterprise Investment Scheme (EIS)
www.hmrc.gov.uk/eis

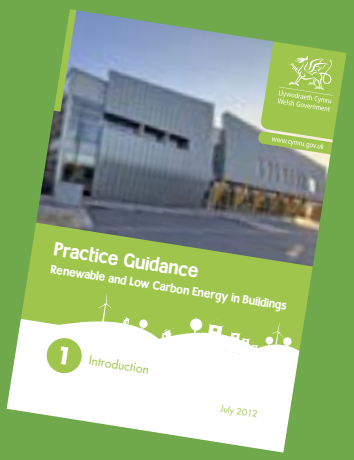
Environment Agency (Wales)
www.environment–agency.gov.uk

CO_2 Sense
www.co$_2$sense.co.uk

Water Power Enterprises
www.h2ope.co.uk

"Good practice guidelines to the environment agency hydropower handbook: The environmental assessment of proposed low head hydropower developments"
Environment Agency, August 2009

These case studies are presented to show examples of how buildings can be designed and built to be low carbon and incorporate renewable and low carbon technologies. This case study is part of a series of case studies supporting a separate practice guidance document on low carbon buildings.
For further information see www.wales.gov.uk/planning



WG14120 ISBN 978 0 7504 7713 0 Crown Copyright 2012