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Chalford Hydropower Scheme

Renewable Energy Feasibility Study

May 2009

Report

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Executive Summary

Summary of Current Situation

SWEA investigated the possibility of installing a small hydro turbine for electricity generation at Chalford, a small village which lies on the of the river Frome in Gloucestershire. The site, which had been identified by a member of the public, already has a small weir in place. It was envisaged that the turbine would be housed alongside the weir and make use of the ~1.7 m hydraulic head of water at this site.

Following inspection, SWEA concludes that this site is **unsuitable for housing a small hydro turbine**. Our reasons for reaching this conclusion are as follows;

1) Ownership of the land surrounding the proposed site is unclear – it seems likely that there is multiple ownership which will hamper consent. Access to this land will be required during the construction phase; additionally the land will be required for housing the turbine and associated works upon completion.
2) The land adjacent to the proposed site is very close to nearby houses, a public footpath, and a footbridge. The works involved in installing and running a turbine will cause significant disruption in this vicinity.
3) At this site, the hydraulic head of ~1.7 m and flow rate of around 0.40 m^3/s^{-1} gives rise to a theoretical power output of around 3.4 kW. Whilst it is technically feasible to install a small hydro turbine at this site, such a low output makes it economically non-viable, given the likely installation costs. We believe that the nearby site of Chalford Mill may offer a more promising alternative.

1 Introduction

1.1 Background

In 1994, Gloucestershire County Council commissioned a detailed study of small hydropower potential in the Stroud valleys[1]. It concluded that the combined valleys have the potential for 1.3 MW of electrical power which would be enough to supply between 9 and 14% of domestic properties in the region.

Figure 1: Weir and disused mill

The sites considered in the Stroud Valleys were all of relatively low hydraulic head. Hydraulic head is the vertical distance that the water would drop between entering and exiting the hydropower scheme. Most of the *potential* schemes which were considered utilised existing weirs or were situated where weirs could easily be installed (e.g. Fig. 1). During operation, water is taken from above the weir, passed through a turbine, and returned to the river further downstream. The rotation of the turbine spins a dynamo – this motion generates electricity which is fed into the local electricity distribution network via a transformer and regulator. Turbines and associated gearing, transformers etc are housed in a turbine house which, for small scale systems, is typically about the same size as a garden shed. Figure 2 shows an example of a crossflow-design hydro turbine of the type often used in small scale hydropower schemes.

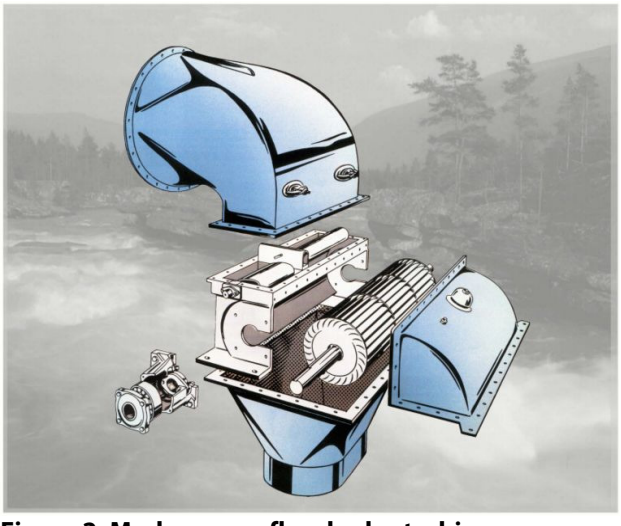

Figure 2: Modern crossflow hydro turbine

[1]Study of Hydropower in the Stroud Valleys, 1994. *Water Power Engineering* in association with *Hebe*

1.2 Small scale hydropower at Chalford, Gloucestershire

Figure 3: Proposed site of hydro

Mindful of the findings of Gloucestershire County Council's 1994 study, Stroud District Council were keen to pursue a small-scale hydropower scheme in their district. Following a lead given by a member of the public (Liam Nolan), they requested SWEA to assess the potential of a community owned hydropower scheme on the upper reaches of the River Frome in the rural village of Chalford, near Stroud (Fig. 3). The site was identified as being potentially viable since a weir was already in place. The weir *could* provide the hydraulic head required to make a hydropower scheme viable.

1.3 Assessment of hydropower viability

1.3.1 Power output calculations

The financial viability of an installed turbine at any given site is largely determined by hydraulic head and flow rate. The most productive sites will be those with the greatest hydraulic head and flow rate, whilst lower hydraulic heads and flow rates will reduce productivity. The power available from falling water is calculated as follows:

Power (kW) = Head (m) x Flow (m^3s^{-1}) x Gravity (ms^{-2})

Although gravity is a constant 9.81 ms^{-2}, inefficiencies brought about by friction and other system losses enable us to approximate it to 5 ms^{-2}. Consequently, we can redefine theoretical power output as:

Output (kW) = Head (m) x Flow (m^3s^{-1}) x 5 ms^{-2}

This expression enables quick estimates of *theoretical* output from any site to be evaluated.

1.3.2 Site description

Chalford is a small village located on the south-facing slopes of the Frome valley, known locally as the Golden Valley. The river, which flows from east to

Figure 4: Downstream view from proposed site

west, is highly variably and in spate floods the gardens of the local houses. The site identified for a small hydropower system is at the top (east) end of the village. It lies adjacent to a small arched footbridge which crosses the river immediately downstream of the weir. Approximately 30m further downstream of the weir and footbridge lie two new dwellings. A new bridge crosses the river at this point offering vehicular access to the dwellings (Fig. 4).

Between the weir and the new bridge, the river is channelled through a steeply sided culvert – there is very little gradient in the river bed along this stretch. Upstream of the weir, the river follows a gravel road which services some nearby dwellings on the river's northern bank - the bank is approximately 0.75 m high. The river's southern bank is slightly higher and flanked by fields.

Figure 5: Upstream view from proposed site

Ownership of the land adjacent to the weir is unclear. Initial investigations indicate that some is unregistered, some belongs to the local authority and some belongs to local property owners. However, boundaries are particularly unclear.

1.3.3 Potential power output at Chalford

The 1994 report had already assessed the viability of a small scale hydropower system at nearby Chalford Mill. Chalford Mill, which is about 1 km downstream of the site under consideration here, has a weir with a 5 m hydraulic head and an annual median flow of 0.6 $m^3 s^{-1}$. The flow rate was taken from an NRA (now Environment Agency) gauging study. The 1994 report concluded that Chalford Mill was indeed a viable site for a hydropower system with the potential for an annual output of around 230 MWh .

Figure 6: 1.7m hydraulic head

The site under consideration here is somewhat different. First, the flow rate is considerably lower – we estimate it to be around 0.4 $m^3 s^{-1}$. The main reason for the large difference is that a tributary joins the river Frome between Chalford and Chalford Mill. Second, the hydraulic head is considerably less. We estimate it to be around 1.7 m (Fig. 6). Consequently, we calculate an average power output of around **3.4 kW** (30 MWh annually).

1.3.4 Grid connection

Any hydropower system would need to be connected to the National Grid – this could possibly be arranged at a nearby local property or at the nearest electricity sub-station.

1.3.5 Costs

The installed and commissioned cost of a crossflow hydropower scheme at the proposed site is in the region of £40k. As there is no building linked to the site the scheme would not be eligible for a grant from the Low Carbon Building Programme or the Community Sustainable Energy Programme.

2 Summary and Conclusions

We conclude that the Chalford site is **unsuitable for housing a small hydro turbine**. Our reasons for reaching this conclusion are as follows.

First, ownership of the land surrounding the proposed site is not well defined. It appears that there is multiple ownership of the land, and this will hamper consent. Access to this land will be required during the construction phase; additionally some land will be required for housing the turbine and associated works upon completion.

Secondly, the land adjacent to the proposed site is very close to nearby houses, a public footpath, and a footbridge. The works involved in installing and running a turbine will cause significant disruption in this vicinity – strong objections are likely.

Finally, and as outlined above, the theoretical power output of around 3.4 kW is low compared with the likely costs associated with the scheme. Whilst it is technically feasible to install a small hydro turbine at this site, such a low output makes it economically non-viable.

Based on the findings of the Stroud Valleys Hydropower report, we believe that the potential of the nearby Chalford Mill site should be investigated more closely.

3 Further Information

3.1 Contact Details

Please contact *Sean Hayward* at SWEA to discuss the findings of this report.

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