Talybont-on-Usk

Carbon Neutral Community

High Level Assessment Report

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EXECUTIVE SUMMARY

This report sets out the findings from a high level assessment of the Monmouth and Brecon Canal in the Talybont-on-Usk area as a source of heat energy that water source heat pumps (WSHP) can draw on to provide space heating and domestic hot water (DHW) for local buildings and recommendations for next steps.

The canal winds its way behind several of the village buildings slightly elevated but well positioned to be used as a heat source. Unfortunately the depth of the canal isn't ideal for submerging collector coils due to the possibility of getting caught by boats or during fishing activities.

Water extracted from the canal could be used as a heat source; it would not have the same constraint as coils and is common practice for rivers and extracting water from aquifers. British Waterways Board (BWB) approval would need to be obtained to extract water and to penetrate canal bank side.

There are three public houses and twelve warden controlled bungalows that could benefit from the installation of a WSHP system. The bungalows could be heated by a district heating system fed by a small number of interconnected heat pumps housed together. Each building would require detailed assessment to determine energy demand in order to match the heat pump specification.

Henderson Village Hall has several possibilities, WSHP, ground source heat pump (GSHP), air source heat pump (ASHP), biomass, solar PV and solar thermal together with rain water harvesting (RWH) all of which will need detailed assessment to establish the relative cost and benefits.

In addition to the buildings in and around Talybont, the Brecon Basin, Pencelli Castle Caravan and Camping Park and Cambrian Cruisers Marina are discussed.

CONTENTS

INTRODUCTION

Talybont Energy Ltd is a body that manages a micro hydro generating facility on Talybont Reservoir, from which the revenue earned from the electricity generated is invested locally in sustainable projects. It is believed that there are several opportunities in the locality for employing renewable technologies; heat pumps are of specific interest, to reduce the carbon footprint of the Talybont community, reduce CO_2 emissions and energy costs.

ADvantage Projects were commissioned to undertake a high level assessment of the canals suitability as a heat source and buildings close to the canal as candidates for a water source heat pump (WSHP) system.

The initiative was instigated by Mr Peter Williams who is the primary contact for the work and who accompanied Mr Alan Draper on the initial review of the area on 21st July 2009.

It must be stressed that this assessment is to provide an indication of the merit of undertaking a full feasibility study and is not intended to be a definitive feasibility study in its own right.

The stretch of canal to be considered in this initial study was east and west of the Talybont lift bridge number 144 with closer inspection from this bridge to White Hart bridge number 143 and just beyond. Several buildings that could benefit from a WSHP were to be assessed for location and outline potential.

OBJECTIVES

1 Assess whether a full feasibility study for a water source heat pump (WSHP) is worth pursuing using the canal as the heat source, to supply heat to one of a number of buildings adjacent to the canal. The buildings of interest were identified as the village hall (Henderson Hall), Star Inn, White Hart and the Travellers Rest.

2 Report on the merits or otherwise of the possible application of a (WSHP) at the above locations to support the case for a full feasibility study if appropriate.

INITIAL OBSERVATIONS AND DISCUSSION

- **Water source heating ~** the use of water reservoirs, ponds and rivers are all viable as heat sources for heat pump based heating systems provided that there is sufficient depth and volume to yield the heat energy without freezing. Additionally canal marinas are now being used where there is no risk from manoeuvring vessels or from fishing activities. Water courses with flow are generally better as this improves heat transfer and permits higher density heat exchange devices.

  There are three methods of extracting heat from water,

  a. The most common is to use high density polyethylene pipe (HDPE) coils (referred to as a collector) submerged and secured below the surface through which a water antifreeze solution is pumped. This solution carries the low

grade heat from the canal, continuously, through an internal heat exchanger within the heat pump releasing the heat which is subsequently increased in temperature to provide heating.

b. A similar principle is the use of a metal matrix heat collector which is submerged and secured to the bottom of the body of water being used. These systems are used extensively in North America but are less common in Europe.

c. Thirdly, water extraction generally via a water bore hole is pumped from the aquifer, passed directly through the heat pump heat exchanger and returned to the aquifer some distance from the extraction point. In the same way as previous the heat energy in the water is transferred into the heat pump which increases the temperature to provide the heating.

   This approach is also used by extracting water from rivers and is equally feasible for canals. However account should be made of the necessity to obtain a water extraction licence from the rivers authority and environment agency when water is extracted from the aquifers or rivers. In the case of canals a check with the British Waterways Board (BWB) is needed.

   When water is used in this direct way the trace elements have to be checked to ensure that no damage can occur e.g. corrosion damage of the heat pump.

- The **canal** is located at an elevated position and close to several of the buildings, passing beneath the road North West of Talybont lift bridge giving a direct access line for Henderson Village Hall albeit at some distance. From a location perspective the relative position of canal and buildings are well placed for applying a WSHP system.

  The narrowness and tow path of the canal pose problems with a coil or matrix collector due to narrow boat movement and mooring. The only location that would overcome this issue is the weir area opposite to the White Hart public house. Here an area could be protected from boat movement but this would restrict boats from turning as is common practice.

  Spot measurements were taken to assess the depth and flow of the canal, see sketch on page 8. Generally the depth was between 1.0 and 1.3m which is insufficient for a coil or matrix heat collector system. The flow when boat movement was minimal was estimated at approximately 240 litres per second which is sufficient to ensure a very small influence on temperature from a heat pump collector of moderate size, (<1.0°C). A temperature fluctuation of 1.0°C is less than that experienced during normal climatic variation and certainly would not cause any distress to fish.

  The most probable way of extracting heat from the canal is to extract and return water as detailed in option (c) above. This approach will require discussion with BWB as it necessitates work on the canal side and after the recent breach will clearly be critical in the approval process. A design for the extraction intake will need to be determined jointly with the BWB engineers in order to gain approval but this is not prohibitive.

- The **buildings** considered for this initial study were only viewed from the outside, energy usage and demand assessment were outside the remit but this will need to be established before specifying any renewable technology system:-

  a. The Star Inn has a boundary that extends to the tow path with an access path running from the tow path to the premises. This is a perfectly acceptable distance for flow and return pipes to a heat source and will not create excessive pumping losses. The pipes could easily be routed in a trench under the access path at a modest cost. There are outhouses by the access path which could be used as a plant room for a WSHP installation.

  b. The White Hart Public House also benefits from a good location very close to the tow path although there is a minor complication of the White Hart Bridge that may affect the routing of any pipework. In this case it may be beneficial to have a system design with an intermediate heat exchanger just inside the boundary of the White Hart so the canal water only travels a very short distance. It may be preferred by BWB to reduce the length over which extraction takes place.

  The principle of using an intermediate heat exchanger will reduce the seasonal coefficient of performance (COP), a measure of the efficiency of a heat pump, by a small amount due to the addition of a circulating pump.

  There will be a need to dig trenches within the boundary of the White Hart in order to route the flow and return pipes to the premises.

  c. The Travellers Rest Public House is a little more remote from the canal and would require a detailed site survey to define the system collector design and routing for the pipework. Because of this factor an intermediate heat exchanger similar to that for the White Hart would be used. It is believed that the boundary extends to the tow path so all trenching could be accommodated on the Travellers Rest land.

  d. Henderson Village Hall appears to be a 1960s design and construction with a pitched roof that runs east to west; it is located east of the canal with an open direct access line northwards 100m distance to the canal. Although this is a substantial distance it is feasible to size flow and return pipes to operate satisfactorily. It will be necessary to excavate a trench along the side of the sports field which could cause some disruption but only for a limited period.

  The usage of the building is not known clearly at this stage but it is envisaged that there could be a requirement for space heating e.g. for meeting rooms, lounges, changing rooms, etc., for hot water for showers, hand basins and kitchen and for heating the incoming ventilation air. These requirements can be met with a heat pump system but will need careful analysis to match the system to demand.

  There is potentially an issue that needs detailed evaluation which relates to the form of heat distribution system within the building and the occupancy profile. If

the building is used infrequently the response time for the heating system has a major effect on the comfort levels that can be achieved. As an example underfloor heating (UFH) is the most efficient form of heat distribution when used with a WSHP. However speed of respond is slow so advanced planning and a time controller with weather compensation is needed.

e. There are twelve warden controlled homes for the elderly in close proximity to the east of the canal. There is an access road to the rear of these homes with a number of garages on the side directly below the canal, one of which could be used as a plant room for a heat pump district heating system. A system of this type could be used to supply the homes with hot water for heating and DHW needs. If necessary the heat could be metered for billing purposes.

   Heat pump based district heating would be efficient and would help alleviate fuel poverty for the elderly of Talybont.

- **System Design and Heat Distribution.** Correct selection and efficient system design is important as over or under sizing can cause excessive operational costs or inadequate performance. Before committing to renewable energy technologies it is important to reduce the energy demand of the building as much as possible. High temperature hydro-carbon based systems are very tolerant of poor or incomplete sizing of the energy source relative to the building demand. Renewable technologies are not so tolerant and must be designed to match the demand very closely to avoid excess investment costs or excess running costs.

  The manner in which heat is distributed round the building can vary from radiators to UFH to wall heating to warm air fan assisted. Each of these methods has their own characteristics and affects the way they are used and experienced. With heat pumps the COP is affected by the source temperature and the supply temperature. The most efficient is a high source temperature and a low supply temperature.

  UFH and wall heating yield the highest COP, whilst radiators have a lower COP due to the higher operating temperature. However although radiators operate on a higher temperature relative to say UFH, with a heat pump the temperature is lower than that which can be achieved with conventional boilers e.g. 50°C vs. 80°C. As a result of this reduced operating temperature radiators are resized to ensure that the heat output is sufficient for individual rooms/spaces.

- **Brecon Basin** has potential for a WSHP using a coil form collector; this would be located in the end of the basin seen here and would require some protection from manoeuvring boats. The depth of the basin is similar to the canal at 1.3m (estimate based on boat operator experience) but it has a larger area available and a flow from the Usk. Although this is a distinct possibility the recipient building for the energy would need to be determined, perhaps the Theatr.

- **Cambrian Cruisers (Pencelli) Marina** could be a viable water source but little is known at the time of the site visit about the energy demand but it is believed that there is an amenities facility which could benefit. If there is a requirement of this type, a WSHP could provide heating and hot water for washing, showers, etc. The

positioning of the collector would need to be investigated before confirming this opportunity.

- **Pencelli Castle Caravan and Camping Park** was not visited on 21st July but should be included in a more detailed assessment as this is close to the canal and clearly has a demand for hot water for the amenities facility. The use of renewable technology should embrace solar thermal heating for the hot water if viable as the output matches some of the high demand periods.

OPPORTUNITIES FOR RENEWABLE ENERGY

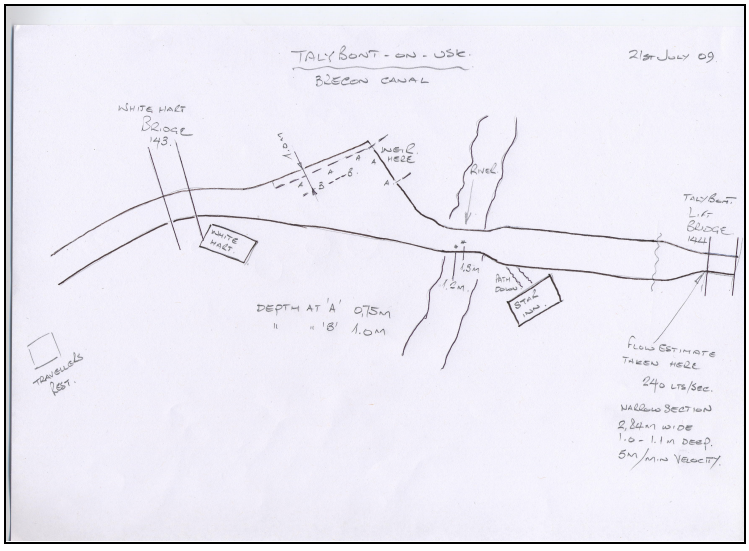
It is stressed that when using renewable energy forms the energy demand of the building is clearly known and the systems are designed to match. Failure to do this can result in either an over or under specified system. The consequences are either failure to satisfy the heating and hot water demands or in the case of over specifying, experiencing excessive running costs hence not yielding the benefits in costs but also carbon footprint and CO_2 reduction.

The primary remit for this high level assessment is to establish whether there is merit in pursuing a full feasibility study. It is considered that there is potential for WSHPs in a number of locations given that BWB are willing to approve the extraction and return of water as detailed earlier. There are also several other opportunities for renewable technologies that need investigation, some of which are identified here.

Henderson Hall has an excellent pitched roof south facing that can be used for solar PV or/and solar thermal, the latter can of course be used in conjunction with a heat pump system. A ground source or air source heat pump could be used in the same way as the WSHP discussed in this report albeit with different levels of performance, COPs and costs. A biomass heating system should also be considered as there are locally sourced supplies of wood. Other technologies may be viable and worthy of investigation e.g. rain water harvesting (RWH), waste heat recovery (WHR).

The three public houses may have some potential for biomass heating, solar energy usage, RWH, WHR as well as the aforementioned WSHP.

The warden controlled bungalows have potential for solar energy usage as well as a WSHP district heating system however other forms of renewable technology may be inappropriate due to the capabilities of the occupants.



RECOMMENDATIONS

1. Within the limitations of the study it is apparent that the use of WSHPs is possible for the buildings considered, given cooperation and approval by BWB for extraction of heat source water. It is recommended that BWB be contacted for detailed discussions regarding water extraction.
2. Gain BWB approval for further investigations into water extraction.
3. The owners or managers of the three public houses should be approached after gaining BWB cooperation to test interest in renewable technology (RT) applications.
4. Undertake energy assessments and energy demand reduction for any building considered for applying WSHP heating or other RT.
5. Alternative heat pump types and other renewable technologies should be considered for Henderson hall.
6. Investigate the feasibility for WSHP district heating for the warden controlled bungalows.
7. Commission a feasibility study into one of the above as a pilot for broader applications.