Renewable Energy Study of the Malhamdale Area

Centre for Alternative Technology

David Linsley Hood

November 2007

This project is supported by the Yorkshire Dales National Park Authority's Sustainable Development Fund, which is managed by the Yorkshire Dales Millennium Trust.

Executive summary

The aim and intention of this report is to provide information on the current state of energy efficiency and energy consumption in the Malhamdale area, and to provide advice on the possible renewable energy systems that could be employed to reduce energy consumption, bills and CO_2 emissions.

The first stage involved a survey of the 300 properties in Malhamdale to assess their current status, type and level of energy consumption and to draw conclusions on the best strategy for the area. From 300 houses, almost 100 responses were received, allowing conclusions to be drawn about the status of the entire area. It was found that the energy consumption and resulting bills and emissions of the Malhamdale properties is higher than the national average, due to: the lack of mains gas resulting in the need for alternative, more expensive and more polluting fuels, and; The older nature of the hosing stock, comprising mainly of solid walled buildings with lower insulation and draft-proofing.

The second stage assessed the natural resources of the area to locate the most effective methods of reducing bills and emissions. The level of solar, wind and hydro potential makes it feasible to employ small scale domestic energy schemes to provide electricity for individual buildings. It is also technically possible to undertake large scale community energy projects. These however must be balanced against the limitations of being within a National Park. Also, as the majority of energy is consumed in central heating and hot water, these should be the first areas to be addressed in terms of energy generation.

Therefore the recommendations of this report are that: a community project is undertaken to assess the possibility of insulating hard-to-treat buildings within a protected landscape; energy audits are given where requested using the local energy assessors of the Malhamdale Renewable Energy Group; that a pellet biomass heating cluster be suggested in the Malhamdale area for high consumers of oil and LPG; and that Solar Thermal systems be investigated wherever possible and planning allows.

1. Introduction

Malhamdale Renewable Energy Group approached The Centre for Alternative Technology (CAT) Consultancy department to assess the appropriate technologies for the area surrounding Malhamdale. The study is to concentrate on suitability of wind power, solar, hydro and biomass systems for the different areas of Malhamdale, both on a household as well as on a community wide basis. The study was also to look at energy efficiency and methods to reduce fuel consumption and bills.

To give the best initial assessment of the area, three studies were undertaken to assess various aspects of the Malhamdale site and its surroundings. These were:

- Desk based survey
- Site survey
- Questionnaire for residents

The results of these can be seen in Chapter 4. These form the basis of the recommendations given in Chapter 5.

2. Location

2.1. Project Area

The project area covers about 125km^2 of the Yorkshire Dales National Park, and constitutes the following parishes:

Malham Moor, Malham, Kirkby Malham, Hanlith, Scosthrop, Calton, Airton, and Otterburn

On the 1:25,000 OS Explorer map the area lies roughly within the following grid lines:

- North - South from 72000 to 56000, the National Park's boundary marking the southern limit
- East – West from 85000 to 92000

The information given is supplied by the Malhamdale Renewable Energy Group as an initial introduction to the site area

2.2. Housing

The housing stock in the survey area is generally built from traditional local materials (stone walled with tiled roof and box windows)

Housing development is severely restricted by National park planning policies, hence the housing stock is old – some buildings are in excess of 300 years old. Many of the older buildings are Grade 2 listed.

2.3. Businesses

There are many B & B's and holiday homes, three Inns, all with residential accommodation, three camp sites, and one youth hostel, plus a few shops and cafes, one farm shop in Airton (Town end Farm)

Apart from tourism the main industry is hill farming, beef and sheep. Average size of farm is around 400 acres.

There are 2 educational businesses, Malham Tarn Field Study Centre, in Malham Tarn House, and the Centre for Management Creativity in a converted farmstead at High Trenhouse, also on Malham Moor.

There is one primary school at Kirkby Brow about ½ a mile south of Malham.

2.4. Fuels

Malhamdale is not on mains gas. Fuels used are oil, LPG, coal and wood.
There are two farms on Malham Moor not connected to mains electricity, Tennant Gill Farm and Middle house Farm. Both are owned by The National Trust. Tennant Gill has micro-hydro and Middle House has a wind turbine. Both are backed up by diesel gensets. There is at least one other property on Malham Moor not on mains electricity.

There is a business on Malham Moor at Park House Farm called Bowland Forestry that can supply woodfuel in the form of logs and wood chip. Most of this comes from outside the dale. The Yorkshire Dales has very little tree cover.

2.5. Current Renewable Energy technologies installed

The only operational renewables in the area are the two mentioned above plus three solar thermal panels. The locations of these with grid references are:

Micro-hydro – Tennant Gill Farm – 884895
Small scale wind Turbine – Middle House Farm – 909676
Solar thermal panel – West Barn, Friars Garth, Malham – 904628
Solar thermal panel – Beck Hall, Malham –
Solar thermal panel – Ansbo, The Green, Airton -

There are 2 former mill sites with buildings converted to residential accommodation. These were formerly water wheel driven mills, later converted to other purposes with small scale hydro replacing the water wheels, then hydro plants removed to convert to accommodation. They are located at

- Scalegill Mill 899617
- Airton Mill 903593

One other site, Malham Mill, had a water wheel driven mill in the late 19th Century. The building has since disappeared. There is no mill pond or leat etc. but there is evidence of there having been a small dam upstream, probably to control flow to a water wheel. This is located at 898633.

3. Survey

3.1. Desk Survey

In order to provide an overview of the area and to highlight areas suitable for renewable energy technologies, a desk survey was undertaken. This involved reviewing:

- maps of the area for terrain,
- distribution of the villages and housing,
- suitable locations for wind and hydro sites
- average wind speed across the area
- available biomass resource

The results of this are given throughout the relevant sections of the report.

3.2. Site Survey

To follow up the desk study and to further investigate areas of interest, a site visit was undertaken. This enabled a better understanding of the area, including the current housing stock, the requirements of any energy system and the limitations due to aesthetics, planning and access.

It was also necessary to view the current renewable energy installations within the area and speak with people regarding their requirements and interests in terms of energy reduction, energy costs, sustainability and future developments. These views have been included into the body of the report.

3.3. Questionnaire

In order to gain an indication of the state of energy awareness, fuel consumption and interest in renewable energy technologies throughout the houses and businesses of the Malhamdale area, a questionnaire was produced in association with the Malhamdale Renewable Energy Group (MREG). This was distributed to the houses in the area by

the MREG by post, hand delivery and by an online form[1]. A copy of the questionnaire can be found in the appendix, along with associated documentation.
Questionnaires were provided for around 300 houses, farms and businesses throughout the area, and over the period of surveying, 90 were returned giving a return rate of 30%. This is sufficient to assume the results to be representative of the Malhamdale area, and for some indications to be drawn about the levels of energy efficiency and fuel consumption.

The rest of this section will be looking at the results of the survey.

3.4. Questionnaire results

3.4.1. Location

Of the 90 results returned, they were spread throughout the Malhamdale area. The full data from the results is given in the accompanying spreadsheet, and the tables for each figure are summarized in the appendix. Figure 3.1 gives the results for the spread of returned results. As can be seen, the villages of Airton, Malham and Kirkby Malham make up about ¾ of the total respondents, with the rest coming from the smaller hamlets and farms.

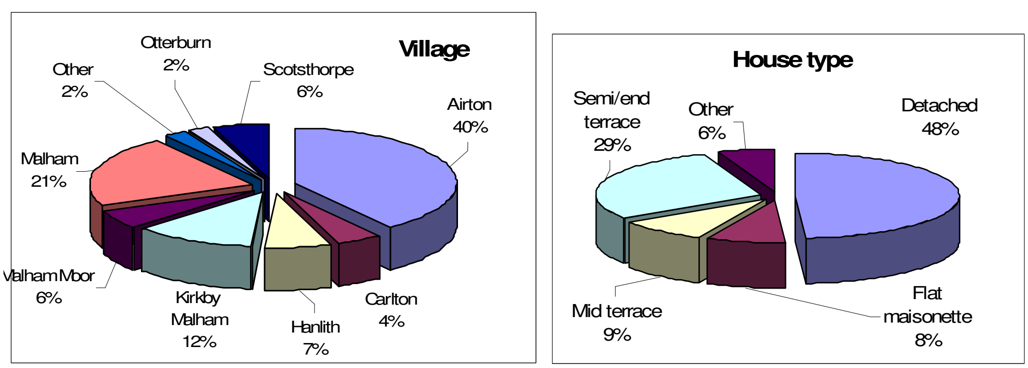


Figure 3.1 – Distribution of returned results by village and house type

The data shows that the majority of the households, 48%, are detached, with semi-detached being the next largest. Of all of the respondents, only two were renting, so

[1] http://www.beckhallmalham.com/energy_survey.htm

98% of the results come from home-owners. The occupancy figures for the 90 houses show that this data covers 206 people, averaging 2.4 people per house.

3.4.2. Fuel Usage

Some of the most interesting data comes from the fuel usage figures. These give an insight into the breakdown of the fuel consumed by the houses in Malhamdale. Figure 3.2 shows the total proportion of fuel that comes from each source in Malhamdale.

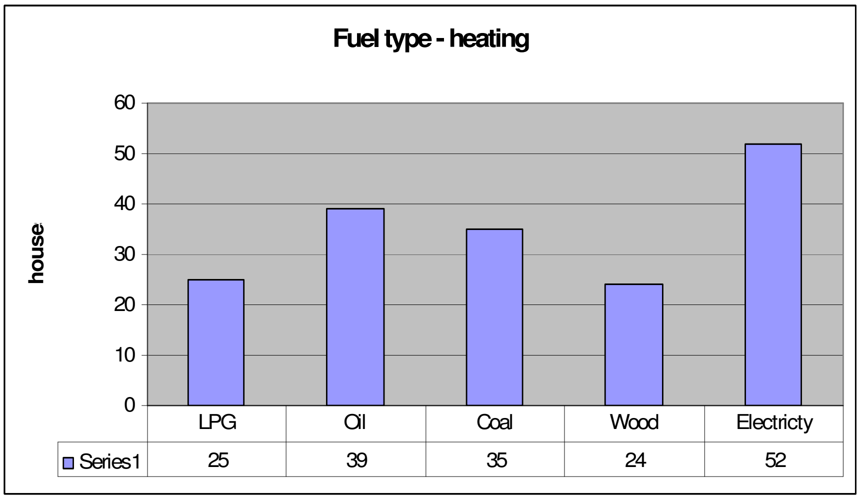


Figure 3.2 – Total proportion of fuel source, by household

This shows that electricity is the biggest proportion of heating, with oil and coal only a little behind. Separate figures were given for water heating systems and this is shown in figure 3.3.

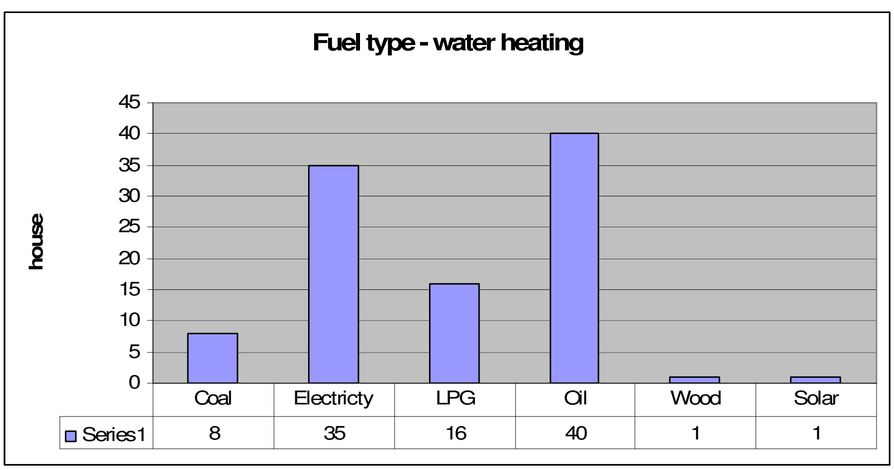


Figure 3.3 – Heat source used for water heating

However this only gives half the picture. If the data is examined in more detail, it becomes clear that a large proportion of the houses use more than one fuel for heating their homes. Figure 3.4 shows the proportion of houses that use one or more fuels for heating.

Numbers of fuels used for heating		
	Space	Water
1	23	73
2	29	14
3	15	0
4	12	0
no response	11	3

Figure 3.4 – Houses using more than one fuel

This means that the majority of houses use more than one fuel source to provide the space and water heating in the house. The matrix showing how the different fuels are used together is given in Figure 3.5. The grey box in each row gives the total number of houses that use that fuel, and the other columns in the row show how many houses use that other fuel as an additional fuel source.

Combinations of fuels used

	LPG	Oil	Coal	Wood	Electricity
LPG	25	6	11	10	13
Oil	6	39	17	14	22
Coal	11	17	35	15	23
Wood	10	14	15	24	16
Electricity	13	22	23	16	52

Figure 3.5 – Fuel use matrix

It shows that electricity is used as a heat source on 58% of the houses, and is most commonly used in association with oil or coal systems, with a variety of other configurations being used.

The additional information from the survey regarding bills for each house allows some estimation of average expenditure by each person in Malhamdale, and their estimated fuel CO_2 footprint each year[2]. This is given in Figure 3.6.

[2] Fuel prices are given from John Willoughby and CO_2 figures are from SAP 2005. – see Appendix

	LPG	Oil	Coal	Wood	Electricity
Rough kWh	481,971.72	1,256,743.52	483,110.48	121,065.99	431,724.28
Unit costs	litre	litre	tonne	load	kWh
£ per unit	0.35	0.37	175.00	65.00	0.12
p per kWh	4.95	3.47	2.1	1.97	11.55
CO2 per kWh	0.23	0.27	0.29	0.03	0.42
total kg CO2	110,853.49	339,320.75	140,102.04	3,631.98	181,324.20
Malhamdale £	£ 23,857.60	£ 43,609.00	£ 10,145.32	£ 2,385.00	£ 49,864.15
total	**£ 129,861.07**				
	£ 630.39	**Approx £ per**	**person per year**		
Malhamdale Kg CO2	369,511.65	1,131,069.16	467,006.79	12,106.60	604,413.99
=	**2,584,108.19**	**kg/CO2/year**			
=	**2,584.11**	**tonnes/CO2 per year**			
=	**12.54**	**Approx tonnes**	**CO2 per person**		

Figure 3.6 – estimated price and CO_2 footprint from fuel use

These show that on average £630 is spent per person on heating and electricity in Malhamdale, with a resulting emission on 12.547 tonnes of CO_2 each year.

If anything these figures will be low in their estimation, because this only covers domestic consumption, and for fuels such as electricity, assumes that the price paid is entirely on-peak, where as a large proportion is probably off peak, meaning the actual kWh electric consumption and resulting emissions will be much higher. Electricity emissions could alter if a large number of people were using green electricity, so this question was also asked in the survey. The results are given over the page on Figure 3.7.

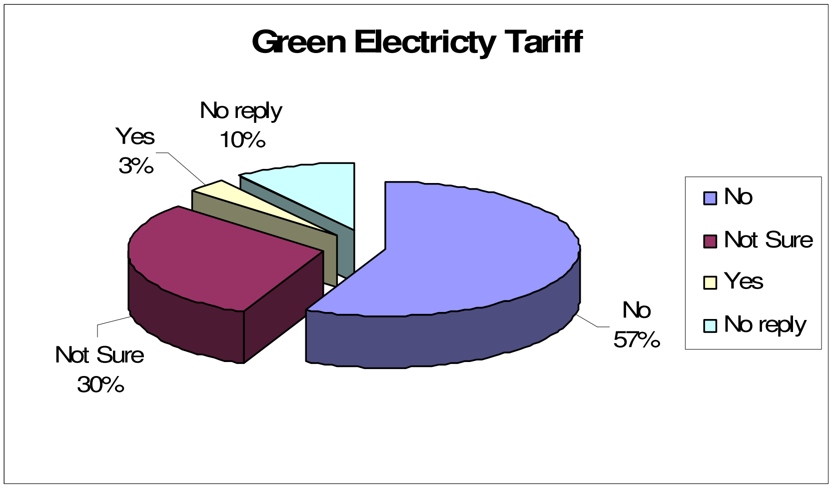


Figure 3.7 – percentage of houses using green electricity

Only 3% of respondents were using a green tariff. The 30% of people who were not sure highlights the problems with public uncertainty as to the nature of green electricity services. For the purposes of this survey, it is assumed that none of the people who were unsure are actually on a green tariff as it is not the typical service to be signed up to without a specific request. Green electricity tariffs are discussed in more detail in Chapter 6.4.

3.4.3. Energy Efficiency measures

The first method to reduce the cost and carbon footprint of any house is to consume less and be more efficient. The survey therefore covered energy efficiency measures that had been put in place throughout the houses who responded. The insulation measures were covered first, as shown in figure 3.8.

Insulation	number	%
Double Glazing	69	77%
Loft Insulation	67	74%
Secondary Glazing	7	8%
Floor Insulation	10	11%
Draft Proofing	26	29%
Cavity Wall	30	33%
Curtains	1	1%
None	7	8%

Figure 3.8 – Insulation measures

This shows a good uptake of double glazing and loft insulation, although a quarter of all houses do not have this done. Floors are notoriously hard to insulate unless renovating, and cavity wall insulation is not always suitable. It is not known from this information what proportion of the houses have cavity walls, and how many of those are insulated. It does show that 8% have no significant insulation measures at all. This should be the first priority, to continue the work on ensuring that all possible and practical measures to insulate houses have been undertaken.

The next step with this is to compare the number of insulation measures undertaken per house, and compare it to the average cost of heating the house, as well as perceived comfort in winter. The results are given in Figure 3.9 below.

Total		Average LPG per house/£	Average Oil per house/£	Average Coal per house/£	Average Wood per house/£	Average Electricity per house/£	Average total cost per house/£
3	**Too cold**	100.00	1000.00	100.00	0.00	385.00	£1,585.00
18	**Bit Chilly**	794.27	821.67	344.29	97.50	480.62	£2,538.33
48	**Comfortable**	941.09	796.63	150.67	96.36	633.56	£2,618.32
15	**Nice & warm**	750	1344.44	231.25	107.5	964.00	£3,397.19
1	**Too Hot**	600	0	100	200	400	£1,300.00
5	**No Reply**						

	Average number of Insulation measures	Average number of Heating systems
Too cold	2.33	2
Bit Chilly	1.88	2.33
Comfortable	2.57	2.01
Nice & warm	2.26	1.75
Too Hot	2	3

Figure 3.9 – analysis of fuel cost in relation to comfort, insulation types and heating systems per house

It is not too surprising to find out that those people who perceive the house to be warm spend more, on average, per year on fuel than those whose homes are cold. Unfortunately it is harder to pick useful trends from the rest of the data, mostly because of the significantly higher amount of data that is available in the comfortable category. Using statistical methods, it is just clear that houses that are comfortable have more insulation measures than those that are a bit chilly or too cold. Those houses that are warmer also tend to have a lower number of heating systems, implying that these properties are easier to heat simply, but this leads to a corresponding increase in expense. More research is needed into this area before any detailed conclusions can be reached.

The use of Low Energy lightbulbs was also measured as another indicator of energy consumption and is an easy way to reduce energy use in the house. See Figure 3.10.

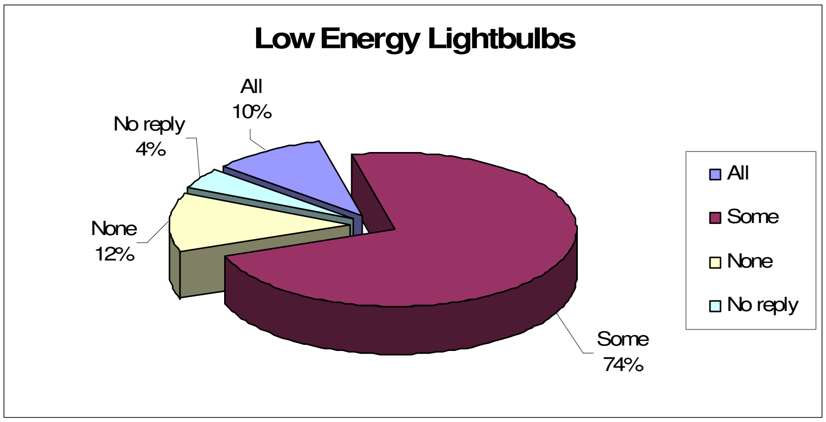


Figure 3.10 – uptake of Low Energy Light bulbs

It shows that there is a high uptake of low energy bulbs in the area, but that there is some scope for their expansion. From previous projects, this trend has been noted, and the biggest area now is in terms of harder to treat light fittings such as Halogen lights and small lamp bulbs. These can be replaced with low energy bulbs, either small specially designed compact fluorescent bulbs or compound LED (Light Emitting Diode) bulbs, which are ideal for replacing Halogen and spot lighting. They represent even greater energy saving, with very long life spans for each light.

Another alternative is to maximise the use of natural light– many older houses, particularly if Grade 2 listed, have poor natural lighting. This could possibly be improved by the use of light tubes (often called sunpipes) which can be relatively unobtrusive externally and reduce or remove the need for electric lighting to have to be on all day. Alternatively it could be possible to fit skylights in some rooms.

The final section of the questionnaire was to do with the perceptions of people towards their energy systems and their interests in future projects. The participants were asked to rank 5 options in order of preference, 1 being the most important, 5 the least. Some amount of misinterpretation took place, and many entries were completed with the same number for several answers, making the results less clear, but some useful information can still be gleaned. The summary is given in Figure 3.11 below.

	1	2	3	4	5	no reply
Fuel Cheap	57	13	7	3	3	7
Fuel Greener	15	11	32	10	11	11
Warmer House	22	20	22	8	7	11
Less Pollution	25	17	20	11	7	10
Ease of use	23	16	17	8	16	10

Figure 3.11 summary of importance of different requirements

The first aspect is that nearly 2/3rds of respondents agreed that cheaper fuel costs were the most important aspect. This is unsurprising given that the average fuel costs per house are above the UK average. With no mains gas and most houses dependant on oil, LPG and electricity, all of which have seen rises in price over the past 12 months, the importance of cheaper fuel is a reality for most people.

The perception of warmth was spread evenly across the first three bands, meaning that it is an important issue, but in many ways secondary to the price. The issues to do with ease of use are split more randomly. There is a definite proportion to whom it is essential to have simple heating systems, and there is a small trend to say that these are the houses with the more complicated heating systems (3 or 4 fuel types), with the rest spread across the range.

What did come from the survey was the result that people were much more interested in fuel systems that are less polluting, rather than those that are greener. It can be argued that the two are very similar, so it is interesting to see a definite trend towards pollution rather than an equal importance in each. This can be interpreted as the majority of awareness of the participants being in favour of systems that are on the whole less polluting, rather than greener, which has connotations of more radical, hippy ideas.

Any further work to promote energy awareness and renewable energy schemes should therefore focus on the price of fuel as a key issue. It should also stress any additional benefits in terms of reduction of pollution, rather than being greener. The information gained from this questionnaire will be summarized and several action points will be highlighted in the conclusion.

The survey also allows us to make an initial estimation of the total energy consumption of the Malhamdale area, and accordingly the estimated CO_2 footprint for heating and electricity in the 300 homes across the survey area. This allows us to estimate the required amount of generation of green electricity required to offset the carbon emissions of the Malhamdale area in order to make it equivalent to being carbon neutral in terms of heating and electricity consumption.

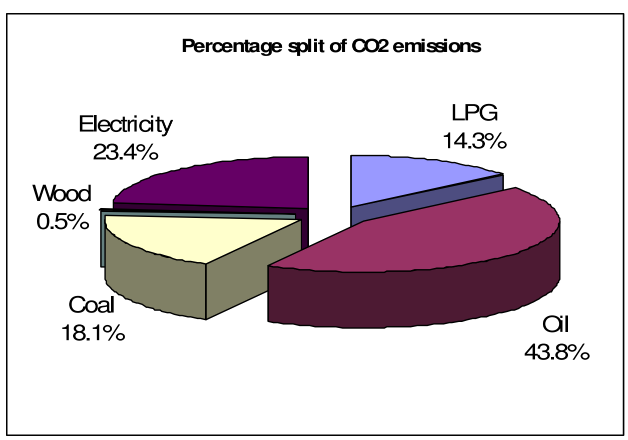
In total, the Malhamdale area consumes over 9 million kWh of energy in various forms, of which 1.5 million kWh are electricity:

9,248,719.92	total Malhamdale kWh/year
1,439,080.92	total Malhamdale electricity kWh/year

If we convert this to kg of CO_2 emitted each year, we see that this equates to about 2600 tonnes of CO_2 each year. The chart below shows that ¾ of this comes from heating fuels.

2,584,108.19	total Malhamdale kg/CO_2 per year
6,009,553.94	kWh green electricity required to offset 0.43 kg/CO_2 per kWh generated

At these rates, the Malhamdale area would need to produce just over 6 million kWh of electricity from renewable sources to offset its emissions. We can address the possible role various technologies can play towards this in various chapters.



4. Energy Strategy

The principal environmental impacts of any community are split between the buildings, the transport infrastructure and the energy consumed by the houses and businesses in that area. The transport issues fall outside the scope of this report, but equate for, on average, approximately 1/3rd of the total emissions from an area. Any comprehensive review of energy consumption and emissions must address this at some point.

The options for renewable energy systems for generation of heat and electricity are detailed in chapters 5 and 6 respectively, leaving buildings as the other major element to be considered. The buildings within an area can be split between existing buildings and new builds. Improving the energy efficiency of the existing housing stock was covered in the last chapter, and the options for reducing energy consumption and production of energy from renewable resources for buildings are covered in the next chapters. As there is some development in the Malhamdale area, it is important to briefly consider the importance of new buildings and the methods that can be put in place to reduce their energy and environmental foot prints.

4.1. New builds

The key considerations with the energy involved in any new building can be split into four key sections:

- The amount of energy that it takes to create the building in the first place,
- The impacts of the construction process
- The amount of energy the building consumes during its lifetime
- The impact of demolition of the building at the end of its life.

Traditionally it is the energy that is used during the operation of the building that has been the most significant. Consequently over the past 15 years the energy standards to which our buildings are constructed have been steadily improving. The latest revision of the building regulations that came into force in 2005 means those new houses will produce 25% less carbon dioxide through energy use than those that are being built today. Any building which is trying to claim to be low impact should exceed even the new building regulations.

It may be argued that the planning process can have little influence on the energy use of a building. However planning should influence the layout of any development so that all buildings have good solar access (i.e. they face south). This alone ensures that each building is getting free solar energy to help meet its heating needs whilst not overheating in summer.

Ideally an environmental performance assessment such as the BREEAM (British Research Establishment Energy Efficiency Assessment Method) Ecohomes (www.breeam.org/ecohomes.html) should be used to get a holistic view. BREEAM is not without its critics as an assessment procedure and as such we would suggest that any construction on the site should achieve an excellent rating. The figure below shows how energy is typically used in a newly constructed UK home.

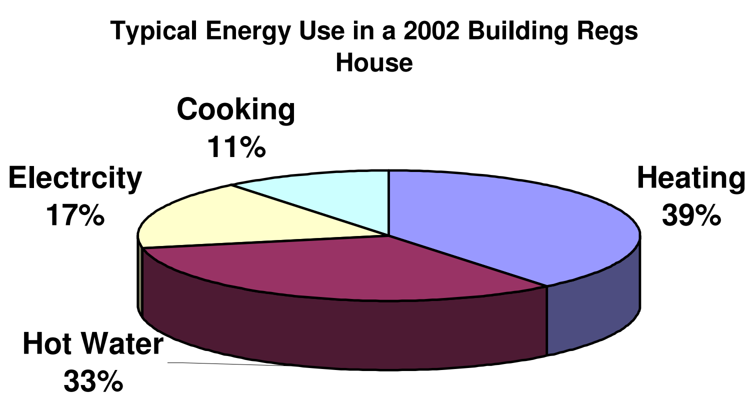


Figure 4.1 – Total annual energy consumption 35MWh

The heating of hot water and the internal areas of the building is still the dominant use of energy. If we were to look at an older building we would find that space heating was easily the largest energy user. Whilst this reduction in energy use is excellent from an environmental and cost point of view it does raise some interesting questions as to how buildings of even lower energy usage should be serviced. Take for example the issue of boiler capacity. The table below shows the typical heating requirements for boilers of different buildings.

House Type	**Typical Boiler Capacity**
Typical UK House	15-20kW
2002 Building Regs	10-12kW
2005 Building Regs	7-9kW
Eco Home	3-5kW or less

Figure 4.2 – typical boiler capacities

As can be seen, boilers need to be getting smaller and smaller. However the boiler manufacturers are not producing smaller boilers to follow this trend. Consequently it is often impossible to find a correctly sized boiler for a new building and so oversized units are used. This results in systems which are less efficient and more costly than they should be.

There are a number of solutions to these problems, some of which have been embodied in the best examples of ecobuilding in Europe. Broadly they split into two approaches:

- Design the building so that it does not require a heating system at all.
- Combine groups of houses to be serviced by common equipment such as biomass boilers.

4.1.1. Houses without heating systems

It is perfectly possible to design houses that do not require a heating system at all. The basic design philosophy is to construct a building which is:

- Very well insulated
- Has an airtight structure
- Is mechanically ventilated. The mechanical ventilation is equipped with a heat reclaim system which uses heat from the exhaust air to preheat the incoming air thus reclaiming up to 80% of the heat lost through ventilation.

- Is orientated south, this enables winter solar gains whilst minimising unwanted summer gains.

In Germany there is a building standard known as Passiv Haus (www.passivehouse.com). It is estimated that by the year 2010, ten thousand of these homes will be built in Germany (ref. Renewable Energy World). The aesthetic of this type of properties can be styled to fit almost any location. The principles of superinsulation and passive solar gain are what is most important.

Figure 4.3 - Houses without heating systems Lindas Sweden,
Note the deep overhangs to give summer shading.

4.1.2. High Density Housing with District Heating

Another approach is to build to a lower standard but to share the heating system between a number of dwellings. This can either be achieved by using centralised boiler plant feeding into a district heating system or have smaller boilers for clusters or terraces of houses. Obviously the further the heat has to be transmitted the greater the costs and so there are real advantages to having a high housing density. One of the highest profile developments that has adopted this kind of approach is BedZed (www.bedzed.org.uk/main.html) in Sutton, South London. The buildings at Bed Zed are very well insulated with south facing conservatories and heat recovery on the ventilation. The small amount of heat they do require, which is principally for domestic hot water, is provided by a centralised biomass fired heating system. Some of these measures can be cost neutral as the removal of the need for a gas connection can save a considerable amount of money.

Other examples of a similar approach have been undertaken by Gwalia Housing Association at their Plas Y Mor, Burry Port Development, which provides sheltered housing for the elderly. Remarkably the construction costs here are just £751/m^2 the renewable energy features include a biomass district heating system, solar water heating and heat recovery ventilation

Figure 4.5 - Plas Y Mor Burry Port

The options for using district heating at locations throughout the existing housing stock of the Malhamdale area is given later in chapter 5.

4.1.3. Energy efficiency in New Builds

With any building, new or existing, the efficiency is the key to reducing cost and lowering the CO_2 emissions. As heat is the largest consumer of energy in a domestic situation, this is the first area to be considered. Regardless of the heating system, the integrity of the building envelope for preserving heat is paramount. This means insulating the building and cutting down on infiltration. The heat loss from an average house can be split into the different sections as given below.

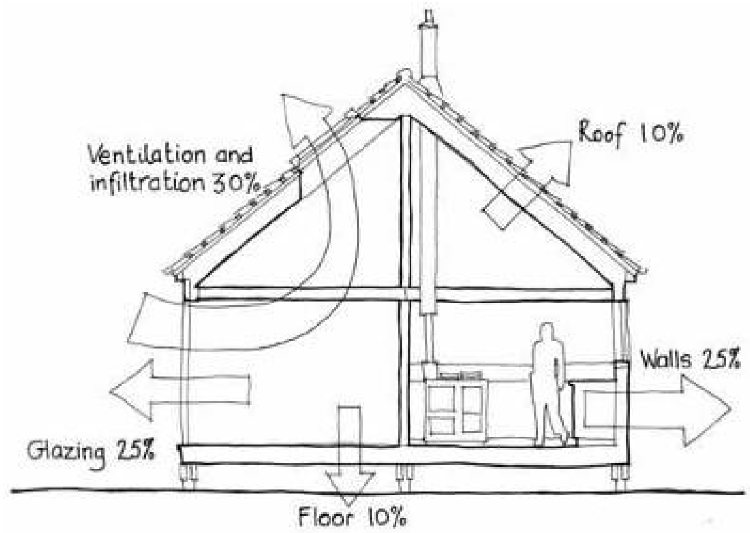


Figure 4.6 – Approximate elemental heat loss from an average house

This means that if it is hard to treat one area, such as solid walls, then improvements can be made in other areas to make up for this. Windows are very important, as they directly relate to ¼ of the heat loss, and indirectly through infiltration with gaps and leaks around older window units. This means that in areas where double glazing is not possible, secondary glazing or sympathetic replacement of windows combined with draftproofing must be considered.

4.2. Reducing energy use

As general advice to any householder or business, the Energy savings trust list 11 tips for reducing personal energy consumption:

- Turn off lights that are not being used
- Close windows that could leak out heat
- Don’t leave your TV or computer on stand by
- Draught proof windows or doors
- Take showers instead of baths
- Only boil water that you need
- Use energy efficient light bulbs

- Only use your washing machine / dishwasher when full
- Turn down your thermostat and ensure you have an efficient boiler
- Insulate your loft, boiler, ground floor and external walls
- Don't drive - walk, cycle or use public transport

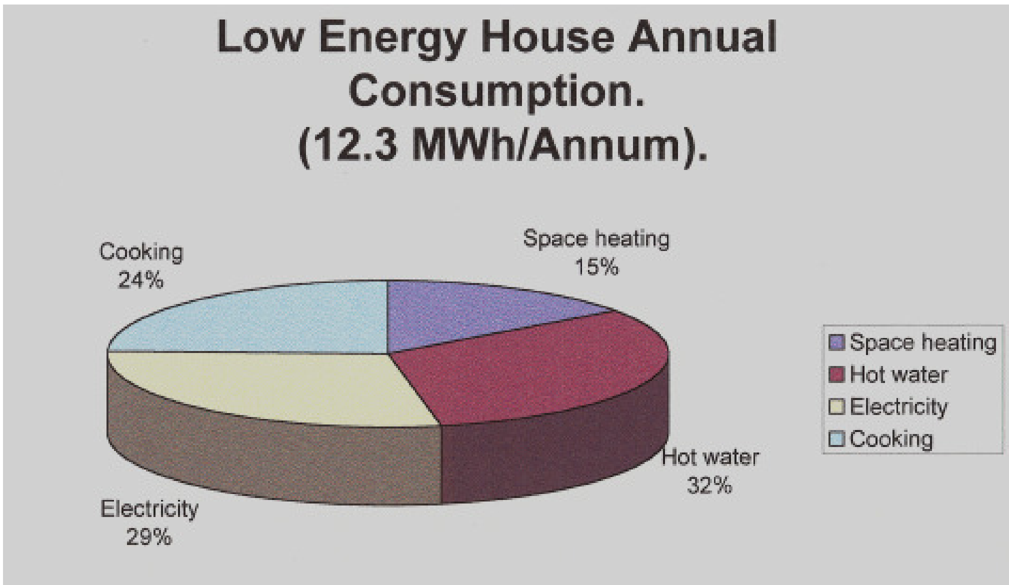


Figure 4.7 – average energy consumption for low energy house – 12.3MWh

The figure above shows the energy consumption and distribution for a well insulated building where energy efficient practices such as those listed before have been adopted. It is interesting to note that the total consumption is 1/3rd of the standard energy profile for a British home.

5. Heating systems

5.1. Solar Water Heating

Solar Water Heating panels convert the energy from the sun to heat. Because the solar resource is so poor in the winter these systems are most effective during the summer months. Unfortunately this is also the time when the heat demands in the buildings are smallest. However there is a requirement for domestic hot water (DHW) throughout the year and it is this requirement that the solar water heating (SWH) is designed to meet. Due to the effectiveness of SHW systems in the summer the requirement for a backup source is minimal during that time. It also stands to reason that the larger your hot water demand as a proportion of the energy consumed, the larger the potential savings from a solar thermal system.

5.1.1. Collector Types

There are two types of solar water heating panel that are suitable for domestic hot water supply. These are flat plate and evacuated tube.

5.1.1.1. Flat Plate Solar Collectors

Flat plate solar collectors consist of an absorbing surface with a system of water channels built into the body of the absorber. To minimise heat loss, the back of the panel is insulated and the front has a clear cover. Typically a 4m^2 flat plate collector will deliver 50-60% of the annual energy required to heat the DHW of an average household. They have the advantage that they are relatively cheap to construct although prices vary enormously and they can be integrated into the roof thus reducing the visual impact of the installation.

The two systems shown in figure 4.1 are examples of roof integrated systems: the left hand photo is of a system in Wales; the right is a similar installation on a listed building in Appledore, Exmoor

Figure 5.1 - 4m^2 Roof Integrated Filsol Flat Plate Collector

5.1.1.2. Evacuated Tube Collectors

In an evacuated tube collector the air is removed from a glass tube and the absorption surface placed inside the vacuum. This makes for a more efficient collector as the heat losses through the vacuum are extremely small. However the cost of manufacture is much higher and so there is little advantage in using evacuated tube systems unless roof space is limited. A typical house would normally install 2.5m^2 of evacuated collector, which would give a similar performance to a 4m^2 flat plate system.

Figure 5.2 - Evacuated Tube Collectors – West Barn, Malham

Figure 5.3 – Freestanding SHW array

Dent Station, Settle - Carlisle Railway Conservation Area

Both figure 5.2 and 5.3 are examples of evacuated tube systems used in sensitive areas: figure 5.2 is in the YDNP; and 5.3 is within the Carlisle Railway Conservation Area. Both demonstrate how solutions can be found that are technologically practical and feasible for aesthetic and planning grounds. Currently, SHW systems do not generally come under permitted development, and would require planning consent in the National Park due to the character of the buildings and the potential effect on the roofscapes. The planning regulations may change in 2008, to make SHW fall under permitted development, but this has yet to be put in place and it is unclear whether this will be carried through within protected landscapes.

It should be noted that there is little advantage in putting up larger arrays as this results in the creation of extremely hot water on the best summer days resulting in the need to 'dump' heat to prevent boiling in the system.

5.1.2. Solar System Costs

Typically a flat plate solar water heating system will cost around £3000 to install. This would normally be including the hot water cylinder. An equivalent evacuated tube system would be £4000-4500.

Set against the capital cost of the SHW systems there will be savings of around £40-£140 per year depending on the energy source that is being replaced to heat the water and the hot water usage patterns of the household.

The environmental benefits of SHW systems depend entirely on which fuel is being replaced for water heating. The different CO_2 emissions for each kWh of fuel is given on the John Willoughby fuel pricing sheet in the appendix, and are taken from SAP 2005[3]. A SHW system could save between 1-2000kWh of fuel per year. Depending on the fuel, this could be equivalent to about 270-540kg CO_2 for an oil fired system or 420-840kg CO_2 for an electric heating system each year. In total, this means that if each house had a correctly sized solar thermal system, this would replace between 3.2% - 6.5% of Malhamdale's carbon emissions.

5.1.3. Summary

Solar thermal are typically the most viable small scale renewable energy system for most domestic properties, and is therefore the best initial choice (after energy efficiency measures). As was stated previously, the buildings with the larger hot water demands will benefit more, so it is a technology that is also very suitable for B&B's, hotels, guesthouses and campsites. Therefore if one technology is pursued in terms of its potential viability in the Malhamdale region, this would be a good choice. We would suggest that even if solar water heating is not installed in any new houses built, they should be made SHW ready by installing twin-coil cylinders suitable for use with solar water heating. This will enable solar water heating to be easily retrofitted at any time in the future. The biggest constraint is restrictions relating to planning in the National Park. These issues are mentioned on pg 27 and covered in more detail in Chapter 7.

[3] Standard Assessment Procedure 2005 – the government buildings assessment tool.

5.2. Solar Thermal Space Heating Systems

In Sweden, it has been possible to produce district heating systems that utilize solar thermal collectors to provide space heating for the site. These, however, require a huge surface area of collectors and a massive inter-seasonal thermal store to provide heating when most required. A system demonstrated in Sweden uses 2 hectares of land for the solar collectors. In Germany, there have been successful solar kombi systems which use about $40m^2$ of collectors and a large accumulator tank to contribute to the space heating. In CAT, we operate the second largest solar thermal array in Britain ($112m^2$ with a 4,000l accumulator tank – as seen in figure 5.4) and although it is enough to provide under floor heating to the building it is mounted on in Spring and Autumn, and it still needs to import heat in winter. Such a system can be ruled out in the Malhamdale area on space requirements alone. Any use of solar thermal energy for space heating should be limited to passive solar gain as described in Chapter 4.

Figure 5.4 – $112m^2$ drainback solar thermal system on Ateic building at CAT

5.3. Ground Source Heat Pump

Ground source heat pump (GSHP) systems have been likened to refrigerators operating in reverse. They use a large collector area placed into the ground to gather a large amount of low grade heat, and convert this into a smaller amount of high grade heat suitable for space heating. They use electricity to power the compressors or heat exchange system, but use it very efficiently. Depending on the system they are powering, they can have a Coefficient of Performance (COP) of between 2 and 4, meaning that for every kW of electrical energy put in, they can provide between 2 and 4 kW of heat energy.

GSHP are most suited to connection with under floor heating systems, as these require lower temperatures in the heating coils (30-40^{o}C), therefore allowing the system to operate most efficiently (COP of around 4 is feasible), whereas if the GSHP is set up to operate space heating through radiators, or to provide domestic hot water (DHW), then the systems require a higher operating temperature (60-75 ^{o}C), and run less efficiently with a COP closer to 2 or 2.5.

A GSHP system requires the heat exchanger coils (or slinky's) to either be placed in trenches or in boreholes. If the trench system is chosen then it typically requires 10m of slinky for every 1kW of heat pump. This would mean roughly 120m of trench per 2500 sq ft house, which would be hard to achieve on this site with the density of properties at this site. If the borehole system is chosen, then a borehole of between 70 and 120m is required for each system, and several may be needed on larger systems. Boreholes are more expensive than trench systems to install. Both ground heat exchanger technologies are dependant on the type of geology in the area as to the actual size and feasibility. Archaeological surveys may also be required in some areas before groundworks can commence. Planning permission is rarely sought, although officially is required. It is recommended to approach the planning department to inform them of the trenching work.

Figure 5.5 – Slinkeys and boreholes for GSHP heat exchanger loops
(borehole photo courtesy of Geoscience)

In terms of cost, a typical system will be around £400-600 per kW, with trenches at £300 per kW and boreholes at around £500. Typically a 10kW GSHP with ground coil would cost in the region of £10,000 per system.

If GSHP's are chosen, it must also be noted that the refrigerant often used in these systems is Hydroflurocarbons (or HFC's). Each heat pump contains approximately 2 kilos of HFC, and if it leaks at any point, the HFC's are 1600 times more potent as a greenhouse gas than CO_2, and this can seriously undermine its potential as a green heating source. This can be combated by replacing the HFC's with natural hydrocarbon refrigerants such as R290 or R600a (propane or isobutene) which are much less damaging if leaked.

The advantage of the GSHP system is the minimal continued contact with the system. As the fuel is electricity, it requires no storage and had reduced supply issues where stable grid connections exist. It is therefore possible in locations where no contact in fuel handling and management are required, such as rural homes with elderly occupants. Although GSHP technology is an option for the individual houses in the

Malhamdale area, it is more expensive to install in this situation than other technologies, and would not be running at its greatest efficiency through the requirement to supplement the DHW for the properties. It is therefore not the preferred choice for most properties, unless they are well insulated with underfloor heating or oversized radiators. There still remains scope for the installation of GSHP systems if the particular conditions allow, but the systems should be ones with attainable COP of at least 3.5.

5.4. Air Source Heat Pump

Air source heat pump (ASHP) systems operate in a similar way to GSHP systems, but use the heat from the outside air as the primary source. These have been widely talked of in recent years and are often used in the USA. They have the advantage of having no groundworks required and therefore cost less to install. Recent advances in variable speed motors have also improved the efficiency of these systems. They are, however, less efficient then comparable GSHP systems, due to the cooler nature of the primary heat source – air temperature is lower than ground temperature during winter, when the most heating is required.

Accordingly, ASHP systems are not covered under the LCBP grant scheme, and have been removed from the list of Low Carbon technologies for the Code for Sustainable Homes. They can be used successfully in some situations, but for space heating in the Malhamdale area, it is unlikely that they would offer significant savings in running costs or emissions due to low efficiencies during the time of most need. They will therefore not be considered any further in this report.

5.5. Biomass heating systems

On the face of it, burning Biomass (typically wood) may not seem to be a sensible option for a development attempting to reduce its ecological footprint due to the problems of deforestation and carbon emissions. This is only the case if the fuel is harvested unsustainably. Given that 14% of respondents use wood fuels as part of their heating systems, it is not too far fetched to propose wood as a fuel to provide the bulk of the heating for a property or group of properties under community district scheme. Numerous schemes have appeared in Britain over the past few years copying Scandinavian systems of forest management and sustainable fuel production. If a tree is planted for every tree that is cut down, then the CO_2 released into the atmosphere is equivalent to the CO_2 absorbed by the new tree to grow. This means that in theory wood fuels can be carbon neutral. In practice, a small amount of energy is required to cut and transport the wood, so this does provide a small carbon footprint, but this is at least 6 times less[4] than the equivalent CO_2 production from a kWh of gas (the cleanest of the fossil fuels). It is also possible to produce all of the wood within close proximity of the site, therefore reducing transportation and invigorating local wood industries.

There are several technologies possible for individual houses or large or district scale heating systems and some of those are discussed below:

5.5.1. Log Batch Boilers

The typical method of burning logs is either in open fire places or in cast iron stoves. These are traditional, well proven methods, but are inefficient in their ability to extract as much heat as possible from the wood. An open fireplace is typically between 25 and 30% efficient, and a cast iron stove better at 40-60%. There are, however much better systems that can burn logs at their optimum burn temperature to liberate the most amount of energy without losing much as hot flue gasses.

The most common of these is a log batch boiler, as shown in figure 5.3. These systems burn all of the wood at one time at a high temperature to extract the most

[4] CO_2 figures taken from SAP 2005

energy. The burn process can take about 2-4 hours, and all of this heat is then stored in an accumulator tank. The heat for the domestic hot water and heating system is then drawn from this accumulator source. These boilers can easily run at 80-90% efficient and only require to be lit every 1-2 days (depending on heat demand).

Figure 5.6 – A Froeling Turbomatic log batch boiler with accumulator tank

These systems are ideal for individual farm houses currently using solid fuels or oil/LPG, especially those with their own supply of wood to provide a cheap fuel source. Accumulator systems are ideal for properties with underfloor heating systems, although it is not essential.

A typical log batch boiler can cost between £3-7000, depending on the complexity of the boiler. The accumulator will cost an additional £1000, plus parts and installation of the entire system, so it can easily cost between £5-10,000 installed. The systems are eligible for grant funding under LCBP to a maximum of £1200 per household.

5.5.2. Pellet fired systems

Pellets are wood in the form of sawdust or extra cuts from sawmills that are ground down and compressed into a pellet of dense wood. There is no glue involved, as the lignin in the wood binds the pellet together, and they have a very low moisture content with a correspondingly high energy content. They have been used successfully in Austria and Germany for nearly 20 years, and the technology has been taken up here over the past few years.

There are generally two sizes of pellet system; pellet stoves and pellet boilers.

5.5.2.1. Pellet Stoves

These are room stoves that burn the pellet in a visible fire. The heat is both transferred through a wet-back heat exchanger into the central heating system or domestic hot water, or through a convective fan system and blown into the room. The system is well insulated, and only a small proportion of the heat is lost through the casing, allowing it to be used for domestic hot water when no heat is required. They are designed to be aesthetic and be a central point of the room (see figure 5.7).

Figure 5.7 – examples of two room pellet stoves

The stoves typically contain a small pellet stove, sufficient to last a day or two, and can be filled through a hopper on the top. A typical pellet stove can provide between 7 and 12kW, with some going as large as 15kW. You would expect to pay between £2,500 and £5000 for an installed pellet stove, and they are eligible for a £600 LCBP grant.

5.5.2.2. Pellet boilers

A pellet boiler is a much larger version of a pellet stove, and they are more industrial in appearance than a pellet stove (see figure 5.5). These are the most common types of pellet fired system, ranging from 15kW to 100kW+ in output, they are fully automated modulating boilers with external pellet stores capable of containing months of fuel at a time. Their operation is similar to that of oil boilers in as much as they require the fuel to be delivered and stored in a tank, of comparable size to an oil tank. The only additional requirement is that the ash must be emptied once or twice a month.

Figure 5.8 – Okofen and Baxi pellet boiler systems, as installed

The cost of operating pellet fired systems is dependant on the source of pellets. The following is taken from the Log Pile Website, an online resource for wood fuel suppliers and installers of equipment. '*There is now an emerging pellet industry in the UK with pockets of activity in a number of regions. Pellets are now produced in the UK by Welsh Biofuels in South Wales, Premier Waste in Durham and on a smaller scale, by Renewable Heat and Power Ltd in Devon. A number of European and North American manufacturers are also willing to export pellets in bulk to the UK.*

Brands of Swedish, Danish and Austrian pellet fired boilers and several makes of pellet stove from Europe and North America are now available in the UK. There are currently two UK manufactures of wood pellet boilers based in Suffolk and Staffordshire.

Being a source of renewable energy, wood pellets are exempt from the Climate Change Levy.' Log Pile Website[5]

The biggest UK supplier is Balcas in Northern Ireland, who produce pellets using their biomass CHP powered site, and they are planning to open another production plant in Scotland shortly. However, production of pellets in the Yorkshire area is limited at present. Details of quotes from the nearest possible suppliers are given in Appendix 6.

This equates to 4.72 kWh/kg. The prices per kWh are given in the following table for different delivery systems.

Pallet of 16kg bags	£ 236.37	inc vat (5%)	£ 236.37
	£ -	inc vat (17.5)	£ -
		total	**£ 236.37**
kWh per pallet	per pallet =	4023.33	kWh
		£ 0.059	per kWh

650 kg Bag	£ 97.80	inc vat (5%)	£ 102.69
delivery	£ 35.00	inc vat (17.5)	£ 41.13
		total	**£ 143.82**
kWh per bag	650kg bag =	3069.44	kWh
		£ 0.047	per kWh

Blown delivery	£ 132.00	inc vat (5%)	£ 138.60
number of tonnes delivered	4	£ 554.40	
delivery	£ 250.00	inc vat (17.5)	£ 293.75
		total	**£ 848.15**
kWh per tonne		1000kg =	4722.22
		£ 0.045	kWh

Blown delivery	£ 132.00	inc vat (5%)	£ 138.60
number of tonnes delivered		10	£1,386.00
delivery	£ 250.00	inc vat (17.5)	£ 293.75
		total	**£1,679.75**
kWh per tonne	1000kg =	4722.22	kWh
		£ 0.036	per kWh

[5] - *http://www.nef.org.uk/logpile/pellets/introduction.htm*

Due to the fixed cost of blown pellet delivery to the Malhamdale region, it is only cost effective to get blown delivery at volumes of 4 tonnes and over. Below this, it is cheaper to get the 650kg bagged deliveries. This means that for pellet schemes to be most viable, it will require either small boiler plants capable of using bagged pellet supplies (such as pellet stoves or Baxi type hopper boilers), or for there to be a network of pellet boilers in the area to ensure enough demand for cheap fuel deliveries to take place.

5.5.3. District Heating System with Community Woodchip Boiler

Woodchip boiler systems can also be centralised boiler plants that provide the entire heating requirement, both for space heating and domestic hot water, of the properties on site. They have the advantage of combining all of the loads for the properties into one plant room and central fuel store which reduces the problems of maintenance and fuel supply. They distribute the heat to each of the properties through use of a district heat main system, which is a well-insulated pipe running from the boiler accumulator tank across the site (see above right), with connections for each residence. It is possible to monitor each residences heating demand from the system by means of a heat meter, which can be used to bill each householder on the proportion of heat they use.

Modern wood chip systems are automated providing controlled fuel and air supply to the boiler to maximise efficiency. They typically operate at efficiencies of around 80%. This also means that they require little maintenance, except for intermittent de-ashing and checks of the fuel supply. Both of these should fall under the remit of the maintenance company for the site, and it would be recommended to have a warranty agreement in place with the supplier for regular servicing and emergency repairs.

Figure 5.9 - Wood chip boiler system in Whitegates, Lochgilphead

The system will also include a smaller backup boiler system. Depending on the suppler, either a second wood chip boiler or a gas fired condensing boiler system has been suggested. The purpose of the backup boiler is: to provide additional heating in times of peak load; provide auxiliary heating if there is a problem with the primary system; and in times of low demand, to allow for only the smaller boiler to be fired to increase operating efficiency. It is possible to install a system without a backup boiler, but this would run the risk of cutting heat supply to the district heating system if the primary boiler fails.

5.6. CHP – Combined Heat and Power

When fuel is burned in a power station to generate electricity, a great deal of heat is also produced. This is a consequence of fundamental physics and thermodynamics. Over time, the proportion of the energy in the fuel converted to electricity has risen gradually, but even the most efficient power stations still waste nearly half the energy in the fuel. In the UK, the average efficiency of conversion from fossil fuel to electricity is around 40%, and of this a further 10% is lost in transmission. Thus only about 36% of the energy content of the fuel is delivered as useful electricity to customers.

A 'Combined Heat and Power' or CHP plant is effectively a miniature on-site power station. Because it is on-site, the low grade heat that would otherwise be wasted can be used in addition to the electricity. The overall efficiency of use of the fuel is therefore potentially very high. In practice, the pattern of demand for heat and electricity determines whether CHP is feasible. In particular, if the heat cannot be disposed of, the electricity cannot be generated. This can mean plant sitting idle in the summer, when the heat is not needed, or the heat simply being dissipated as waste to allow the electricity to be generated. In the latter case it is almost certainly more efficient to go back to grid electricity: major power stations may throw their low grade heat away, but they are more efficient at converting fuel into electricity than small scale CHP plants.

There are two types of CHP plant for community scale projects that are currently being demonstrated in the UK. These are Gas fired CHP (e.g. Woking CHP plant), and biomass CHP (e.g. BedZed development). Gas fired CHP is a fairly well established technology, and has been installed in numerous locations, especially when existing boiler plants are being replaced, or in large new developments involving both business and leisure premises. The technology does, however, still operate on fossil fuels, and produces CO_2 emissions. Biomass CHP plants, if fuelled from sustainable sources, are CO_2 neutral and can potentially offset other CO_2 emissions by providing a green source of electricity. They are a much newer technology and only a few systems exist in operation in the UK. CAT is planning to trial a system in its new WISE building.

The main disadvantages with this technology are that it is still new, and has encountered teething problems. Biomass CHP plants to date have not been 100% reliable, and although new systems are entering the market, they have yet to be proved in practical applications. For this reason, biomass CHP is not currently recommended for this development, although could become move viable in time. If so, it would need to undergo a feasibility study similar to that for the community biomass projects.

5.7. Fuel Supply

The main issue to be resolved with any biomass heating systems is the provision of fuel. The Yorkshire Dales National Park has a very limited resource in terms of standing biomass at present. '*Tree cover in the National Park is very low compared to the national average of about 9%. We have about 1.6% cover of broadleaves and 2% cover of conifer plantations. In 1994 the Dales Woodland Strategy was published with an aim to double the amount of woodland.*[6]'

Therefore any fuel must either be brought into the area or grown in a dedicated programme onsite. After discussions with the NPA woodland and trees office, it was understood that there is no problem with the theory of growing wood for harvesting biomass fuel supply, but any practical application of this would need to be discussed to ensure that it does not adversely impact the aesthetic of the NP. The main concern is that the woodland should look as natural as possible, and this is in contradiction with most planting of wood as a crop where typically rows are used for ease of management and harvesting. In order to look natural, trees planted in a more random fashion would be preferred. The type of wood planted would also be an issue, with pines being preferred for wood fuel due to their regular and fast growing nature, where as broadleaf woodland is favoured by the NP, which grows irregularly and slowly. This does not mean that there is no possibility of such a scheme being viable, especially as the NP woodlands office are supportive of the type of project, but it would require a compromise agreement between the NP, community group and landowner for wood fuel production.

[6] http://www.yorkshiredales.org.uk/index/living/trees_and_woodlands_advice.htm

5.8. Feasibility

Houses in villages are generally close together. The best solution would appear to be a group of houses linked to a single large consumer such as a hotel, village hall, etc. This reduces the need for lengthy district heat mains which increase the cost of the scheme considerably.

Possible locations where this could be investigated are:

- Malham – Youth hostel – surrounding houses individually owned although they are not particularly close
- Malham – potential new housing development at Cove Centre. At least some of the houses to the North of this site on Cove Road are owned by Craven District Council so a partnership with the local council might be a possibility
- Kirkby Malham – Parish Church hall – the hall badly needs refurbishment including a new heating system, and development. It is closely surrounded by a cluster of individually owned properties. A problem would be that the hall isn't used continually although if developed/refurbished that could change and if connected to the Victoria Inn across the road would help.

All of these could be investigated and would require a feasibility study to assess the cost implications and benefits. The location of a suitable fuel store would need to be considered and assessed as part of the proposal, as this would require an additional building. Other similar schemes have utilised farm buildings that have been underused nearby as a storage facility. This could be addressed as part of the feasibility study.

There are important lessons to be learned from other community biomass schemes that have taken place. The first is that the scale of the system is essential. In Llanwddyn, one of the first retrofitted community biomass schemes to go ahead in the country; the system was set up to serve a school and community centre, as well as 30 houses in the village. The buildings are supplied heat and monitored on their consumption. It is operated by an Energy Supply Company (ESCO) – in this case

Dulas Ltd, who operate and maintain the boiler and fuel supply as well as the heat distribution and billing of the customers for the heat consumption.

The main difficulty is that the cost of heat distributed is tied to the price of fuel and the costs of monitoring and billing. This means that it is borderline in this scheme for the ESCO to operate the project in a financially viable fashion. It is agreed that another project nearby, or a larger project in total would increase the viability. Therefore there is a critical size for a scheme to operate under ESCO conditions, and unfortunately this will vary from location to location. The second difficulty with this site is that the council has recently said it may close the school, which was unexpected at the time of installation and would adversely affect the scheme.

What is true is that the more schemes undertaken in an area, the more effectively it can be operating. This means that one scheme on its own might not be feasible, but two or more in an area might be. This is similar in a way to the smaller scale pellet boiler systems, where one on its own will be expensive to get appropriate deliveries of fuel, where as 4 or more boilers would make the fuel delivery cost effective. Therefore the biomass boiler schemes should ideally be looked at as a community or district scale project to disseminate the technology, rather than just individual locations.

5.9. Issues relating to community schemes

Any community scheme has many steps to be worked through with all relevant bodies, and most importantly the local community that it will affect to ensure that the project is suitable in terms of type and scope. There are then several steps involving the type of community organization that is to be set up. As of December 2005 there were some 500 renewables projects in the UK carrying the 'community' label. They include wind, solar and hydro-electric schemes, wood and solar heating projects and energy efficiency drives. Generally speaking, these schemes are locally inspired and locally supported. Many of them are also project-managed and even owned by the local community. For a brief guide to the stages of setting up a successful community project, see Appendix 5.

The first issue with any community group is their type of organization, as this effects how the scheme is run, and how any project is owned. There are two main types of legal structure for an organization[7].

- **Unincorporated**
    - Associations,
    - Trusts
- **Incorporated**
    - Companies limited by guarantee,
    - Industrial & Provident Societies,
    - Community Interest Companies,
    - Limited Liability Partnerships,
    - (Charitable Incorporated Organisations once introduced under the Charities Act 2006).

Also, the charitable status of the organization must be decided. As well as the previous points, the legal and charitable status affects the types of funding that the project can apply for. An alternative option is to get a company to install and operate the system as an ESCO, as described in chapter 5.8.

[7] See http://www.wcva-ids.org.uk/wcva/1035 for detailed descriptions and advantages/disadvantages of each structure.

6. Electricity Generation

6.1. Solar Electric (Photovoltaic)

Photovoltaics (PVs) use a semiconductor to convert light to electricity. There are a number of different production techniques which result in typical panel efficiencies of 12-18%. The most cost effective of these at the present time use wafers of polycrystalline silicon and have an efficiency of around 13%.

Figure 6.1 – Close up and ground level photo of PV Array on Gibson Mill, Grade II listed building

PVs produce direct current electricity (DC). To enable the output of the PV to be connected to the building grid supply an electronic device known as an inverter is required. The inverter converts the DC of the PV to the alternating current (AC) of the grid. In systems such as these the building becomes a miniature power station. If for example the appliances within the building are using 2kW of electrical power and the PV system is producing 3kW, then 2kW will go to the appliances and 1kW will be exported on to the local grid and be used by a nearby building. Now if the sun goes in and the PV output drops to 1kW, the 1kW short fall will be made up with electricity from the grid. In this way the demand from the appliances is met at all times whilst the occupier experiences lower electricity bills. The drawing below shows how a typical PV system is connected to the building's electrical system.

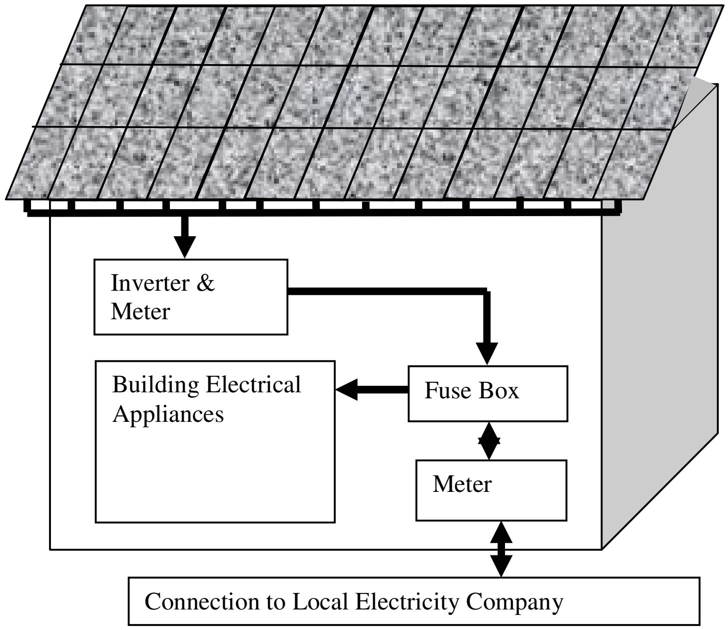


Figure 6.2 – schematic of grid connected renewables

PV systems can be mounted on supporting frames which can then be bolted to any structure from roofs to bus stop shelters. Alternatively they can be integrated into roof structures either by using roof integrated systems such as the one shown on the garage above or by using PV tiles and slates as seen below in Figure 6.3. This system has been used successfully on Grade II listed buildings and in National Parks.

Systems are typically sized to meet all, or a proportion of the annual electricity demand of a house. This will depend on the available roof area and orientation, financing and grid connection. The systems are mostly grid linked to allow for the disparity between production, which is much higher in the summer, and consumption which can vary across the year. In this way, the grid becomes the battery system for the generation to even out supply. It is necessary to have an agreement with an electricity supply company to buy this electricity from you, and sell back any excess you require. Different schemes for the sale and trading of electricity are given in Chapter 6.5.

Figure 6.3 – Carnyorth Outdoor Education Centre – 4.96kWp Sunslate PV installation in Cornwall AONB and Heritage Coastline. Photo courtesy of Plug into the Sun

6.1.1. Array Siting

PV's can be mounted in virtually any unshaded site. However there are clear benefits in orientating PV collectors well. Ideally a PV should point any where between southeast through south to south west, at an angle of 10-40^{O} to the horizontal.

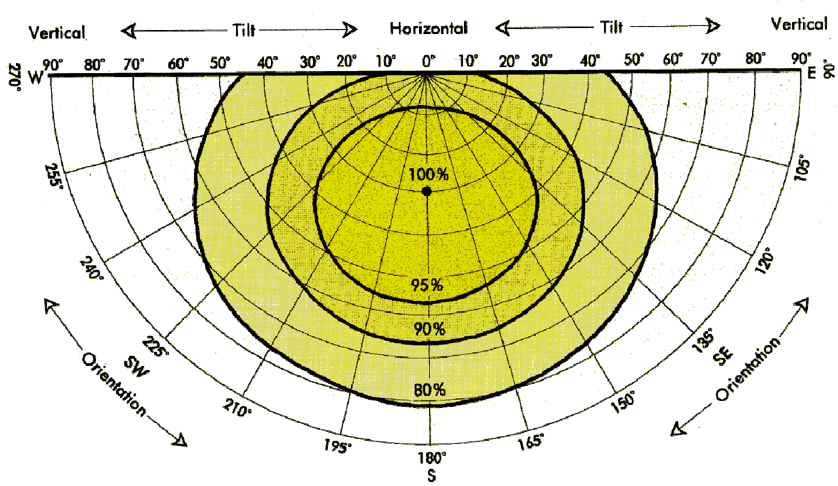


Figure 6.4 – orientation losses for a PV system

The figure above shows the losses associated with mounting PV's at different orientations and angles to the horizontal at a latitude equivalent to Malhamdale. Fortunately this requirement fits well with our general rule of orientating buildings to face south. On existing buildings, this is harder to achieve, so this diagram can be used to show the changes in efficiency for systems on existing roofs.

The other key consideration on a solar system is any shading. This should be avoided as much as possible by choosing locations with little annual shading from trees and nearby buildings. The levels of shading will change throughout the year, and therefore a site that is partially shaded in winter may still be viable, whereas one shaded in summer or all year probably will not. Each site must be assessed on a case by case basis to check its suitability.

6.1.2. Solar PV costs

PV systems are the simplest to operate and have the least maintenance of any renewable energy generation system. They have the advantage of producing a very predictable annual output for a system, and can work in most locations and at almost any scale. They are also typically the most expensive system to install. A typical 1kWp PV system can be expected to cost at least £6000 installed, with only a small reduction in price for scale of system. The grants available for individual domestic systems are now capped under Low Carbon Buildings Programme to £2000 per kWp and a total of £2500 for a system.

6.1.3. Feasibility

An initial analysis of the potential solar resource available in each of the villages was undertaken. Due to their proximity, there is very little difference between them (approx 1% variance between villages). An example of an idealized PV installation for a south facing roof in Malham is given on the next page. The following conditions are assumed:

- Inclination of modules: 35.0°
- Orientation (azimuth) of modules: 0.0°
- Estimated losses due to temperature: 6.2% (using local ambient temperature)
- Estimated loss due to angular reflectance effects: 3.1%

- Other losses (cables, inverter etc.): 14.0%
- Combined PV system losses: 23.3%

PV electricity generation for Malham: Nominal power=1.0 kW, System losses=14.0%		
	Inclin.=35 deg., Orient.=0 deg.	
Month	**Production per month (kWh)**	**Production per day (kWh)**
Jan	27	0.9
Feb	43	1.5
Mar	68	2.2
Apr	92	3.1
May	116	3.8
Jun	107	3.6
Jul	112	3.6
Aug	97	3.1
Sep	78	2.6
Oct	53	1.7
Nov	30	1.0
Dec	19	0.6
Yearly average	**70**	**2.3**
Total yearly production (kWh)	**841**	

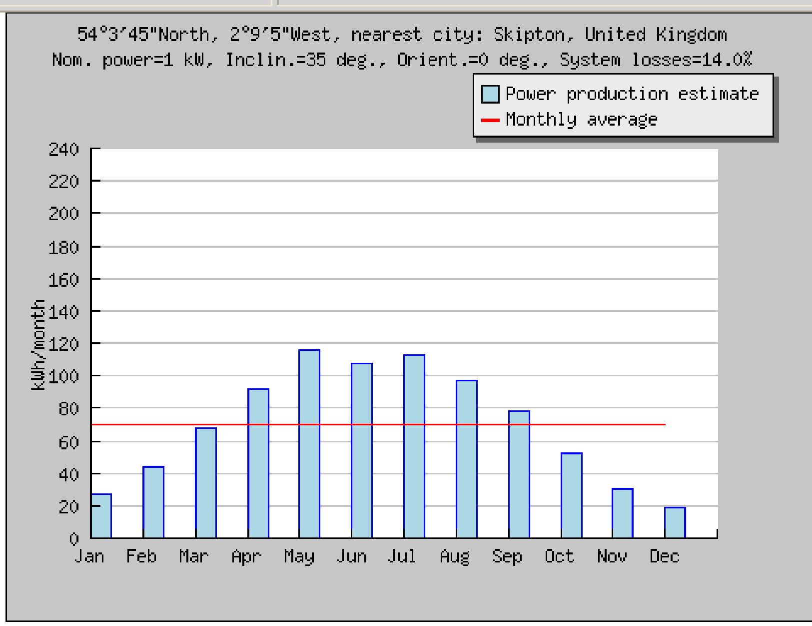


Figure 6.5 – idealized PV generation for Malham

This means that for an average house in Malhamdale, which uses an estimated 4769kWh/year[8], it would require around 6kWp of PV panels to produce this for each household across the course of the year. However if the electricity consumption is reduced through energy saving measures, awareness and efficiency then the required electricity, and resulting size of PV array required drops significantly. Energy efficient houses typically have annual electricity consumption figures of 1-2000 kWh/year, requiring 2-3kWp of PV array.

To offset the entire emissions of the Malhamdale area with PV generated electricity would require over 7000kWp worth of PV installation. Although there are PV installations of this size globally, nothing of that scale exists in the UK due to the unfavorable price for exporting electricity to the National Grid. However, small domestic installations are capable of offsetting their domestic electrical consumption with moderately small scale arrays.

[8] The UK average is 3300kWh/year. The figure used here is calculated from survey data, which only provides a rough gauge of the electricity consumption.

6.2. Wind Electric

6.2.1. Wind Speed Assessment

The performance of a wind turbine is dictated by the wind speed. The only truly accurate means of assessing wind speed is to erect an anemometry mast and monitor the site for a minimum of 6 months (a year or more is preferable). The data is then collected and compared with data from a weather station and a prediction of long term mean annual wind speed is made. This is a fairly costly process. To assist potential wind power users the Energy Technology Support Unit (ETSU) have developed a computer program called NOABL which predicts the average wind speed over a 1km square of the ordinance survey grid[9].

During the desk study, a matrix showing the average wind speed given by the NOABL database for the area surrounding Malhamdale.

Av wind speed (10m above ground level (agl))

Lat/Long	82	83	84	85	86	87	88	89	90	91	92
71	4.8	5.9	5.4	6.3	8.3	8.2	5.2	5.1	5.4	3.9	2.7
70	4.9	5.7	5.1	6.2	8.9	7.8	4.3	3.5	3.9	4.2	4.9
69	5.2	4.9	4.3	6.2	8.9	7.4	6.3	4.5	5.3	5.9	6.4
68	4.4	4.1	4.1	6.3	8.5	6.9	4.8	5.5	6.5	7.3	7.3
67	3.4	4	4.6	6.4	8.1	6.9	5.2	5.6	6.4	6.7	7
66	3.5	4.8	5.5	6.6	7.7	6.8	5.5	5.5	5.8	5.8	6
65	3.6	5.8	6.8	7.2	8.7	8.4	7.5	5.7	5.7	5.7	5.8
64	3.8	5.8	6.7	7.5	9.0	8.7	7.5	4.7	4.7	5.4	5.8
63	4.2	5.9	5.7	6.5	9.3	8.7	6.6	3.1	2.9	4.1	6.1
62	4.4	5.3	5.6	7.7	8.2	6.2	4.4	2.8	2.5	4.2	6.3
61	5.3	5.9	6.6	7.8	7.2	5.9	4.5	3.3	3.6	5.3	6
60	5.7	5.9	6.2	6.9	6.4	5.4	4.7	3.9	4.3	5.4	5.4
59	5.3	5.4	5.6	6.3	5.9	4.8	4.7	4.4	4.3	4.7	4.7
58	4.4	4.4	4.8	5.8	5.8	5.1	4.6	4.4	4.0	4.0	4.1
57	4.4	4.2	4.4	5.1	5.7	5.3	4.4	4.2	4.2	4.2	4.1

Key
8+ m/s
7-8 m/s
6-7 m/s
5-6 m/s
4-5 m/s
Under 4m/s

Figure 6.6 – Wind speed assessment of the Malhamdale area at 10m agl

The co-ordinates given are the Landranger codes for each 1km^2. These can be found in the format SD 90 62 (e.g. for Malham village). Each square can be located by

[9] Follow http://www.bwea.com/noabl/ for instructions and access

putting the prefix SD in front of the longitude, then the latitude. The table above (figure 6.6) shows the average wind speed at 10m above ground level.

It must be stressed that if a grid square has a high or low value, this does not directly indicate that every point in the square will be the same. It is designed to demonstrate the general distribution of wind across the study area, and to highlight areas more likely to be suitable. This does not consider aesthetic or environmental considerations in the calculation, only the potential for wind speed.

For grid connected domestic wind turbine systems to be viable, the minimum recommended wind speed will be 5m/s, and 6.7m/s is a preferred lower value in larger commercial wind sites. If the site is off-grid, then the system can operate with a lower average wind speed, but it is still preferable to choose the location with the highest clear air wind speed.

6.2.2. Energy output for different turbine sizes

There are a wide variety of wind turbines available, from small battery charging turbines to larger grid connected turbines through to community scale machines. The choice of turbine size will depend upon the demand, level of grid connection and height of tower acceptable. The energy output will then vary according to average wind speed, as detailed in the previous chapter. For comparative purposes, the energy outputs for a cross section of turbine types are given at three different wind speeds. These figures are calculated using a Raleigh distribution statistical system for estimating the spread of wind speeds based on the mean. Therefore, these figures are designed to provide comparative estimates, not guaranteed energy generation performance data. All assume a nominal site altitude of 100m above sea level (asl).

Input parameters			
Ave. Wind (m/s) =	4		
Site Altitude (m) =	100		
Anem. Height (m) =	10		
Estimated output	**Diameter**	**Daily**	**Annual**
	m	kWh	kWh
Marlec WG913 - **100W**	0.9	0.1	49
Marlec FM1803 - **450W**	1.9	0.7	251
Bergey XL **1kW**	2.5	2.1	758
AWP 3.6 - **1kW**	3.6	2.2	802
Proven 600 - **600W**	2.3	1.3	469
Proven 2500 - **2.5kW**	3.5	5.2	1,899
Proven 6000 - **6kW**	5.5	15.8	5,780
Vestas V17 **75kW**	17	236.2	86,212
Estimated **750kW** turbine	42	2362.0	862,120

This shows outputs for a 4m/s site. This is typical for about 1/3rd of Malhamdale. It is the lowest wind speed viable and is possible for standalone applications.

Input parameters			
Ave. Wind (m/s) =	5		
Site Altitude (m) =	100		
Anem. Height (m) =	10		
Estimated output	**Diameter**	**Daily**	**Annual**
	m	kWh	kWh
Marlec WG913 - **100W**	0.9	0.3	97
Marlec FM1803 - **450W**	1.9	1.3	486
Bergey XL **1kW**	2.5	3.9	1,432
AWP 3.6 - **1kW**	3.6	3.8	1,377
Proven 600 - **600W**	2.3	2.2	814
Proven 2500 - **2.5kW**	3.5	9.1	3,320
Proven 6000 - **6kW**	5.5	27.1	9,906
Vestas V17 **75kW**	17	399.8	145,932
Estimated **750kW** turbine	42	3998.1	1,459,322

This shows outputs for a 5m/s site. The energy output is twice that for the 4m/s table. It is the starting point for most small domestic turbines

Input parameters			
Ave. Wind (m/s) =	6.7		
Site Altitude (m) =	100		
Anem. Height (m) =	10		
Estimated output	**Diameter**	**Daily**	**Annual**
	m	kWh	kWh
Marlec WG913 - **100W**	0.9	0.6	217
Marlec FM1803 - **450W**	1.9	2.8	1,028
Bergey XL **1kW**	2.5	7.8	2,835
AWP 3.6 - **1kW**	3.6	6.7	2,443
Proven 600 - **600W**	2.3	4.2	1,524
Proven 2500 - **2.5kW**	3.5	17.0	6,206
Proven 6000 - **6kW**	5.5	48.2	17,609
Vestas V17 **75kW**	17	667.6	243,689
Estimated **750kW** turbine	42	6676.4	2,436,887

This is for a 6.7m/s site. This is about 4 times the 4m/s site, and the preferred minimum for a commercial wind site.

The previous tables show that the size of turbine necessary for generating a fixed annual energy supply will get bigger with lower wind speed, or put another way, the same sized wind turbine could produce twice or four times as much on a site with 1 or 2 m/s extra average wind speed. Bear in mind that the average annual electricity consumption is about 3,300kWh for an average house, and 4769kWh for properties in Malhamdale. In terms of turbine scale, this would require a 2.5kW turbine at 6.7m/s or a 6kW turbine at 4m/s to cover the annual electricity consumption.

As a general rule, if a site is viable for a wind turbine, then the larger turbine the better. This means only a slight increase in the size of the rotor diameter, but a massive increase in output. It also means the total number of wind turbines to produce a regulated amount of renewable electricity form the Malhamdale area would be smaller.

6.2.3. Viability of Wind power in Malhamdale

There are many locations in the Malhamdale area which are potentially viable for wind generation. The initial assessment of technical feasibility is shown in figure 6.6. This is not, however, a definitive guide to suitable locations as there are many further considerations.

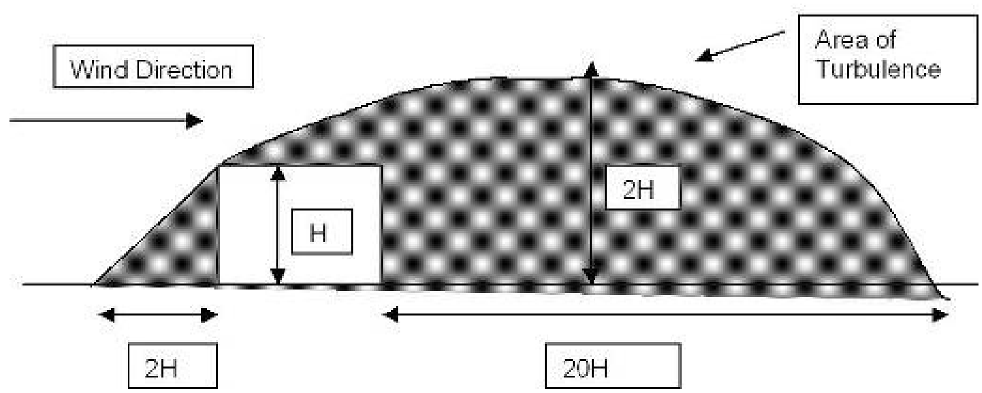


Figure 6.7 – Area of turbulence caused by object

Within each 1km square, the wind speed can vary dramatically and is affected by topography, as well as trees, buildings and other structures which slow the wind and cause turbulence. The effect of an object to the wind path behind it can be seen in a decrease in wind speed measurable for at least 20 times the height of that object, as shown in figure 6.7. The quantifiable effects of this are shown for an average site in figure 6.8 below.

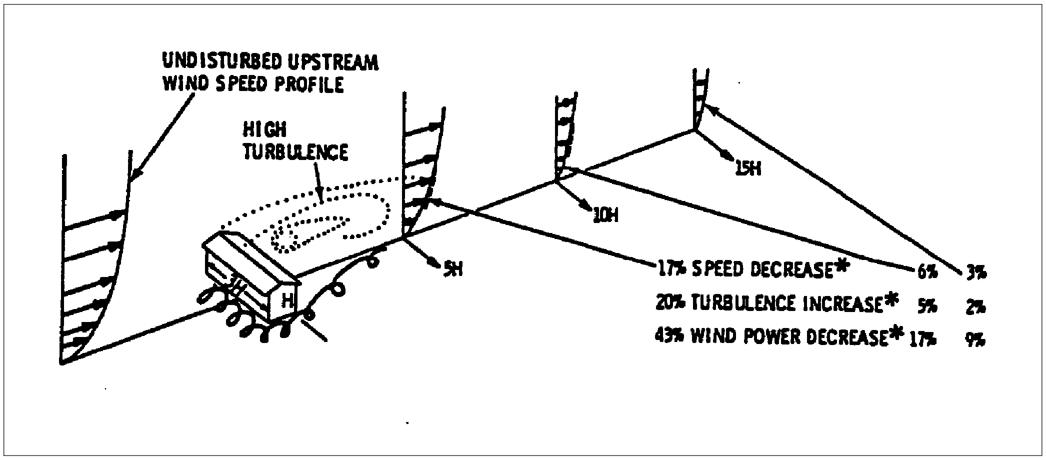


Figure 6.8 - Effect of turbulence on wind power, from Wegley

That decrease in wind speed can be highly detrimental to the effectiveness of any wind power system. Its power output is a cube law relationship with wind speed, which means that double the wind speed means 8 times the power; half the wind speed means a 1/8th of the power. It is therefore essential to choose sites with the best wind speed and lowest amounts of sheltering and resulting turbulence.

The number of locations is further reduced by the type of connection. As mentioned earlier, lower wind speed sites are more viable with off-grid sites, as they are utilizing battery storage and all energy generated helps to maintain charge in the battery. With grid connected sites, the inverter has a 3 minute cut-in under G83/1 regulations, meaning that the first 3 minutes of each generation cycle are not producing electricity which can be used or exported. In turbulent locations, this can be a significant issue causing much lower than expected production. Therefore grid connected wind turbines must have good quality locations.

From a planning point of view, the visual intrusion into the landscape is the greatest barrier to the inclusion of wind turbines in Malhamdale. In order to be acceptable, they must be placed with care and be sympathetic to the landscape. It does not mean that they cannot be included, but that their inclusion must be balanced against the aesthetic, the needs of the property and the alternatives in terms of electrical supply. Figure 6.9 shows a photomontage of a prospective wind turbine in the YDNPA which has been granted planning permission. As this is for a standalone system, there has been the caveat included preventing the erection of overhead power lines. See Appendix 10 for full information.

Figure 6.9 – Photomontage of Wind Turbine at Cosh Farm, Foxup, Littondale

6.2.4. Community Wind Power schemes

There is benefit in most situations to operate a community scale turbine instead of many smaller turbines, both in terms of cost of installation and total energy production. Basically, one big turbine in a good location is worth much more than several small turbines in slightly worse locations. This is the basis behind many of the community energy projects listed in Appendix 6. Given in the table below is a quick comparison of the equivalent number of small turbines necessary to produce the same energy as one of the larger turbines. All figures are for a nominal 5m/s site.

	600w	2.5kw	6kw
Proven 2500 - 2.5kW	4.1	1.0	0.3
Proven 6000 - 6kW	12.2	3.0	1.0
Vestas V17 75kW	179.3	44.0	14.7
Estimated 750kW turbine	1792.9	439.5	147.3

Figure 6.10 – turbine size comparison

In terms of cost, a 6kW wind turbine might cost in the region of £18,000 installed, whereas the V17 cost about £80,000, and a 750kW turbine (second hand) might cost £120-£150,000. Therefore there are obvious benefits to the larger system.

This is fine from a technical point of view, but has not yet addressed the issues of aesthetic and planning within a protected landscape. Within the Local plan for YNDPA, there is a maximum hub height for single wind turbines of 25m. This would effectively rule out most community scheme wind turbines, as these are usually between 40m and 100m hub height. The V17 turbine listed in the wind energy charts is the smallest community turbine (shown left), with a hub height of 23m, which could potentially fall within the local plan guidance. It could produce electrical energy equivalent to 30-40 houses on a good site.

However, it is unlikely that this could go ahead without extensive feasibility studies and community discussions. There is one example, Appleton and Spaunton in the North Yorkshire Moors NP, where the community is strongly in support of renewable energy generation, and undertook feasibility studies for 2 x 225kW turbines to offset the entire village CO_2 emissions through electrical generation[10]. These would exceed the 25m hub height limit, and therefore fall into untrodden ground in terms of

[10] http://www.appletonlemoors.co.uk/docs/wind_feasibility.PDF

community group and NPA activities. In order to check the level of community support, a postal ballot was undertaken to see if the entire community supported the project. If so, it would go forward to the NPA to be assessed. At the time of writing, this ballot is still underway, but if successful could set a new precedent in terms of community project in a protected landscape.

This does raise an interesting point, because if the community was in favour of offsetting its entire energy consumption / CO_2 emissions, then this would come down to a few practical options. The cheapest and probably most effective would be a single large wind turbine, a 2 or 3MW turbine would suffice if located correctly, but this is very unlikely to acceptable within a protected landscape unless there is a major reassessment of the NP priorities. It is, however one of the least intrusive methods of generating this amount of electricity. To put in perspective, to generate the same quantity of electricity as a 2MW turbine would require:

- 3 x 750kW wind turbines
- 9 x 100kW hydro turbine installations, or
- 7100kWp of solar photovoltaic

6.2.5. Summary

Malhamdale has the technical potential to harness large amounts of energy from the wind, either in small domestic schemes, or in large community projects. Practically given the constraints of the landscape and planning restrictions, small wind turbines are much more favorable, and should be employed where they serve the best purpose. Examples of these would be:

- Situations of off-grid properties to supply their standalone power requirements – often in exchange for agreeing not to have overhead power lines connected;
- Locations with grid connections and high average wind speeds where the turbines can be located sympathetically with the landscape, such as where they are viewed in front of trees, hillsides, etc. from the view points or walkers trails;
- Farms where the high visual impact of agricultural buildings already detract from the landscape aesthetic;

6.3. Hydroelectric

The generation of electricity from the power in a flow of water via a water turbine is called hydroelectricity. The amount of power that a water turbine produces is dependent on the flow of water through the turbine and the vertical fall or head that drives that flow.

Figure 6.8 – 9kW Francis turbine at Gibson Mill – low head site

6.3.1. Flow

The flow of water available is determined by the area of land that captures the rain (known as the catchment), the amount of rainfall, the geology and the evaporation from the catchment area.

The only truly accurate way to determine the flow is to carry out daily monitoring over a long period of time (several years) and then scale the data against long term rainfall predictions. A faster, less expensive, yet less reliable method is to use a computer modelling system such as HydrA, set up by the Centre for Ecology and Hydrology, which will give estimated flow data when appropriate catchments are determined and entered using OS coordinates.

6.3.2. Head

The head describes the vertical distance between the intake and the turbine. The greater the head, the more power will be available from the flow. However, the longer the pipe run, the greater will be the losses (see Section 5) and the cost of the system. So a balance must be found between optimising the output and keeping the cost at a reasonable level.

Very broadly, we can split head into three bands: low head (1-5m); medium head (5-15m) and high head (15m and above). The ideal situation for a hydro installation is high head – high flow, to have the maximum potential to generate power. This is comparably rare. In micro-hydro installations, the next best situation is high head – low flow. These are cheaper to install and run reliably using Pelton or Turgo turbine systems. Most common is situations of low head – high flow, where there is the potential to generate power, but the turbines for this type of situation (Francis or Kaplan) are considerably more expensive than the same sized Pelton turbine. There is an intermediary used for medium head sites called a Crossflow turbine and is comparable in cost to a Pelton or Turgo.

All of these can be used to charge batteries on a pico-hydro scale (500W- 1.5kW), such as the existing Tennants Gill site in Malhamdale, and can be grid connected generally if larger than that. Turbines over 5kW tend to be three-phase machines and this adds complexity to the grid connection, but allows the generation and export of more energy.

Recently there has been a lot of interest in an Archimedes screw system for low head sites that could be more cost effective. It has currently only been installed at one location in the UK, on the River Dart in Devon. It is shown in figure 6.9 over the page. These could have great potential, and two other National Parks (Exmoor and North Yorkshire) have commissioned hydro potential surveys, and have included them as possible technologies. However, there is only one installed system so far, and we will know in time how reliable and effective it is.

Figure 6.9 – Archimedes screw hydro turbine on the River Dart

6.3.3. Locations

There are two types of site that are going to be viable in Malhamdale:

- Farms or rural buildings where suitable stream and head exist – Tennant Gill Farm is an example. These could be grid connected or standalone battery systems.
- Run of river schemes with low head – high flow regimes. Old mill sites on the River Aire – Scalegill Mill and Airton Mill are examples where existing leat and mill pond could be restored and hydro potential exploited.

Farms and rural systems

Locations for small scale systems have been suggested at:

- Gordale SD9163, utilising flow from catchment around Weets Top,
- Accraplatts SD8862 Kirkby Fell catchment into Tranlands Beck, and
- Kirkby Malham SD8861 into Kirkby Beck.

All of these have numbers of small seasonal streams that could possibly be connected via a single channel into an intake similar to the one at Tennant Gill, providing sufficient head for a relatively small flow to produce a significant amount of electricity for a single dwelling or farmstead. None have been investigated in detail. There may be many more such sites around upper Malhamdale that could be used to supply electric power to individual field barns if required for alternative use, such as bunk barns, without having to install transmission lines to connect to the grid.

Run-of-river schemes

Potential Run-of-river sites occur at former mills on the River Aire at Scalegill SD899617 and Airton SD903593. Scalegill has been used in the past to generate hydro power and has a likely potential of around 20kW.

At Scalegill the original weir, intake, leat and a large millpond exist and would need cleaning out, although the basic structure seems sound. At Airton the hydraulic structures are in a more advanced state of decay and would take more work to bring them back into service, including the construction of a new weir. Both of these would need a new building to house a generator as the existing plant rooms have been converted into accommodation.

These schemes offer the best potential due to the existing (or previously present) water control structures, but they still require greater investment in terms of turbine and control equipment. Typically, a low head scheme will only be viable if it is at least 10kW, and ideally much more. This necessitated a three phase connection, and this can rule out many sites.

There are also sites that do not have existing infrastructure, but do have the potential to generate power. Some have previous history as water control systems for flooding or mills, where as others are untapped locations. One example of the former is Malham Mill at SD898633 on Malham Beck. The mill no longer exists but just upstream of the site is a steep gorge ending in a waterfall and above that there used to be a low dam with a sluice gate which presumably controlled the flow of water to the mill.

Figure 6.10 –Malham Cove, as painted by Turner, 1810

Figure 6.10 is a reproduction of Malham Cove painted by Turner in 1810, showing a dam and sluice. Remains of the dam can still be found on the site. Restoration of the dam could provide an off take for a supply to a small hydro plant downstream, possibly at the mill site. The dam could also act as a useful regulator to attenuate peak flows in Malham Beck when it is in spate, if an automatic control gate was fitted. Although flooding in Malham is not, at present a serious threat, there are some properties in the village that are at risk when exceptionally high flows occur, and clapper bridges across Malham Beck are regularly submerged during high flows. This is obviously a highly sensitive site but it could be argued that recreating the small lake that existed in Turner's day might provide a much enhanced view of the Cove.

6.3.4. Viability for Malhamdale area

There is the potential for the inclusion of hydro power systems in the Malhamdale area, but no one location stands out as a guaranteed viable site. Hydro systems usually go through several stages of survey and calculation before going ahead, typically involving:

- Pre-feasibility study – to determine technical potential (head, flow, location, turbine type, etc.)
- Feasibility study – Calculation of practicalities such as costs, licenses, planning and abstraction license information, grid connection, etc)
- Application to planning authority and EA for permissions and licenses.
- Finalisation of system design
- Installation
- Commissioning

This increases the initial cost of a hydro installation, but ensures that they are correctly designed and installed in appropriate locations. Once operating, a good hydro installation will return on its investment in only a few years if selling to the grid, and be cost effective immediately on off-grid locations, when compared to connection costs.

It is suggested that a Feasibility study is undertaken for the River Aire to determine if a hydro installation is viable, and small domestic schemes be encouraged to consider a Pre-feasibility study if conditions appear to be suitable, such as those listed before.

As mentioned previously, it would be possible to offset all of the emissions from the energy consumption of the Malhamdale area with the use of large hydro turbines. It would take between 8-9 100kW turbines along the river in order to match the emissions of the community. It is unlikely to be possible within the river resource of Malhamdale, but some proportion of this could be met.

There is also scope for several small domestic systems throughout the Malhamdale area, and these should be explored to assess the viability.

6.4. Biogas

All organic matter breaks down over time. Under certain circumstances, organic matter decays releasing methane gas, which is a greenhouse gas and can be polluting. The process is called Anaerobic Digestion (AD) and is a proven, well-tried and tested technology that converts organic matter to biogas in the absence of oxygen. In temperate environments the microbiological process of digestion is normally accelerated by heating to either mesophillic (20-40^{0}C) or thermophillic (50-60^{0}C) temperatures. Products of AD are biogas [mixture of methane (60-80%), carbon dioxide (20-40%) plus low levels of hydrogen sulphide (0-3%), ammonia and nitrogen (0-5%)] and digestate (liquid). Digestate is typically spread on agricultural land and is a source of plant nutrients. Typically 40-60% of organic matter is converted to biogas with a typical calorific value of 17-25 MJ/m^3 (20 MJ/m^3 at 70% methane content). Biogas can be utilised by combustion in modified gas boilers to produce heat or in a combined heat and power unit to produce electricity and heat.

In agricultural terms, the nearest comparable situation is a dairy farm, where vast quantities of manure are produced, often in the location of a paddock or milking shed, where they can be easily collected and stored. Under these circumstances, there is the potential for the generation of methane gas, to burn as a fuel. The system has been used successfully in Nepal on a domestic scale using as few as 1-2 buffalo per household to generate enough gas for cooking, and in China and parts of Europe on a larger scale for electricity generation.

This process is also common on old landfill sites as a method of controlling emissions from the site, while generating an income from the sale of electricity to help finance the remedial work and monitoring at the site. Around 30% of our national renewable energy generation comes from this process of landfill gas incineration for electricity.

In 1995, there were 30 biogas plants operating in the UK, but many of these smaller schemes have since stopped operating, either due to technical and maintenance issues or a move away from dairy farming towards other farming activities.
There are also biogas plants that operate on the principles of composting of domestic organic food waste. These have been operated successfully in some parts of the UK.

There have been examples such as the Burford and Ludlow projects[11] which have successfully demonstrated small to large scale (restaurant to 1200 houses). These typically require large volumes of household waste to be viable. For example, the plant below is designed to process 5000 tonnes of food waste a year.

Figure 6.11 – Biogas food processing plant, courtesy of Greenfinch

The viability of any biogas schemes in the Malhamdale area will depend on the amount of organic material available. This is primarily food waste from domestic properties, which would require a centralised collection system, or large dairy farms with existing septic systems for manure. The food waste community scheme is unlikely to be viable, as the households in Malhamdale are ¼ of the number for the above plant, and the dispersed nature of the houses would make collection uneconomic.

The viability of the farm systems will depend on the level of existing dairy farming and the current infrastructure. At the time of writing, it is thought that there are no large scale dairy farms remaining in Malhamdale, making this non-viable.

[11] http://www.greenfinch.co.uk/burford.html

6.5. Electricity sale mechanisms

The amount of income per kWh of generated electricity will depend on the end-use of the electricity. If it is used directly at the location of the RE system, then a saving of around 10p/kWh (depending on the current expenditure) is made as the electricity has not been bought from the energy company. This is the first option as it provides a direct cost saving. ROC's can still be claimed on this, creating an additional income. In theory it could mean offsetting all electricity bills, and the cost benefit of the turbine would be the savings in purchasing electricity.

The second option is called net-metering. Under this scheme, an agreement is made with an electricity company and the electricity is used in the house if needed, or sold to the grid if there is excess. Under situations where not enough electricity is produced, the electricity is bought back from the grid at the same price it is sold for. It requires two meters to be installed to monitor the flow of electricity. These schemes are common in other countries, but not here. There is only one company known in this country to offer such a scheme (details given in the appendix). It is the next best option.

The third is import-export metering, where a different price is offered for the sale and the purchase of electricity. This is the most common system for small scale embedded generators in this country at the moment. The price for this varies, but is typically in the range given in section 6. The bulk of the revenue comes from the collection of ROC's and LEC's, and proportionally less from the sale of the electricity itself. The details of a potential purchaser of green electricity is given in the appendix, although this arrangement can be made with any electricity company.

Currently, there is only one company offering net-metering. Due to the increase in demand for Green Electricity, other companies will offer prices that can be as high as 9p/kWh for each kWh generated at the site, as they are interested in buying the ROC's more than the electricity. This can drop to around 4.5p/kWh from other suppliers.

6.6. Green electricity tariff

The alternative to generating your own power is to buy 'green' electricity from a larger provider. This can either be in the form of a green tariff, or as a more direct arrangement where a wind farm developer erects capacity on your behalf in return for a long-term power purchase agreement. Some contact details are given in the appendix.

Green tariffs are not without controversy at present. The central issue is that of 'double accounting', whereby the carbon dioxide emissions reductions are claimed more than once. The market model used by the generators is that their customers are buying the carbon dioxide allowance. However, the figure for the average CO_2 emissions from UK electricity generation takes into account the proportion of renewables in the generation mix and so also includes the same CO_2 allowance.

If the UK had an overall carbon trading scheme in place then the issue would be easy to resolve: whoever bought the carbon credits would be able to claim the emissions reduction. No such scheme is in place. The Renewables Obligation is often regarded as a proxy for carbon trading, and the carbon credit is therefore often associated with the Renewables Obligation Certificates (ROC's). This is in formal terms incorrect, although if carbon trading did come into play, something very like the ROC would represent the carbon credit for each unit of renewably generated electricity.

These points aside, it is still a better idea to get your electricity from a Green electricity supplier than to not. The important points are to choose suppliers who provide 100% green electricity tariffs, and to be aware that they are not a panacea for entirely removing the emissions related to electricity consumption; they merely reduce the emissions, and as the level of demand for green tariffs rise, provide incentives to increase the proportion of renewable electricity generation on the grid as a whole.

Estimated emissions for electricity bought from different electricity companies can be found at http://www.electricityinfo.org/supplierdataall.php?year=latest and good information on different green tariffs at http://www.greenelectricity.org/tariffs.php

7. Planning and Other regulatory Issues

7.1. Introduction

In line with the rest of the UK the Yorkshire Dales National Park Authority (YDNPA) is requested to consider PPS22 (the current renewable energy guidance to planners) with respect to all planning applications regarding renewable energy systems. To this effect, the YDNPA has published, as part of its April 06 Local Plan, guidance relating to large and small scale renewable energy. At present this is the most up to date advice, but this is expected to change in some way if the draft Climate Change bill is passed, making energy reduction and carbon reduction measures more widespread and mainstream. How this effects the regulations within the confines of the National Park, with its primary considerations of aesthetic and landscape cannot be said at this time.

Of course here it can be very difficult to balance these often opposing forces. It is true to say that all forms of energy conversion have their environmental impacts. Whether it is oil disasters off the Pembrokeshire coast or acid rain dissolving ancient buildings, someone somewhere pays the price. With renewable energy the price is usually a change in the way our environment looks, whether it is solar panels on a roof looking different from the red pan tiles, or slates that people are used to, or wind turbines changing the skyline. Some planning authorities in national parks[12] have made sustainability and renewable energy an integral part of their development strategy and have a high success rate for inclusion of small scale renewables into the area. It is hoped that many of these aspects can be transferred across to the revised YDNPA local plan

7.2. Planning Issues relating to Wind power

The first reaction of many people to the proposal of a wind turbine in a landscape such as Malhamdale may be negative. This is largely because there are many misconceptions surrounding wind power which would need to be carefully allayed. The usual principal objections are:

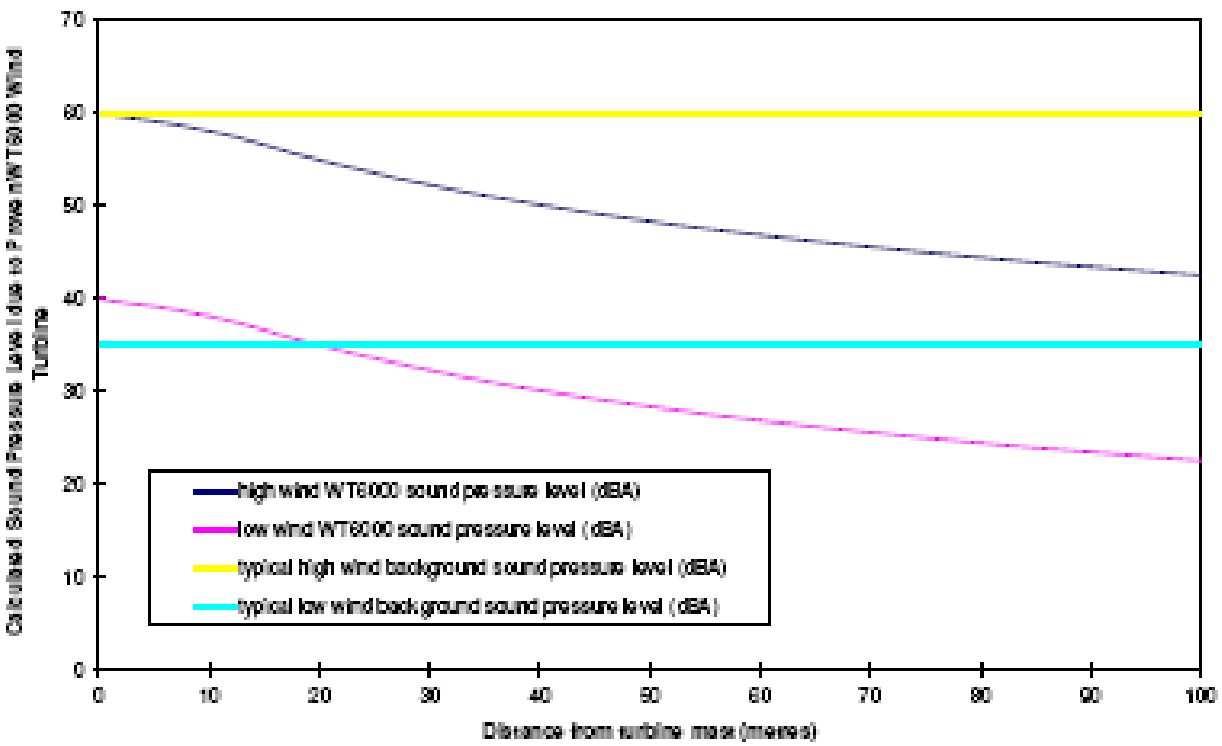
[12] See the Lake District National Park website – http://www.lake-district.gov.uk/index/living_in/sustainableliving.htm

- Noise
- Effects on birds
- Visual intrusion and flicker

Noise

Modern wind turbines are much quieter than the machines of ten or fifteen years ago. The Proven 6kW turbine produces 60dBa of noise at the tower base in high wind speed and 40dbA in low wind speeds. As we move further away from the turbine the noise will decrease by 6dbA each time the distance is doubled (see graph below).

WT6000 & Background Individual Sound Pressure Levels



As can be seen the turbine noise quickly becomes less than the background noise. As other habitation is more than 250m away we can expect noise levels from the turbine to be 34dbA in high wind speeds. To put this into some perspective the table overleaf gives typical noise levels for different situations.

	Sound Level dbA
Threshold of Hearing	0
Whisper	30
Talking	60
City Traffic	90
Rock Concert	120

Whilst it is not possible to say that nearby residents will never be able to hear the turbine under all conditions, there will be many other noises in the environment that will be noisier.

Effects on Birds

There have been many reports of the detrimental effects of wind turbines on birds in the media. However despite many surveys of birds around wind farms the effects have to date been extremely small when compared with other environmental factors which affect birds. So much so that the RSPB supports well-sited wind farms because they consider the effects of climate change to be far more detrimental to bird populations than wind farms ever will be (see www.rspb.org.uk/policy/windfarms/index.asp). They have even erected wind turbines of the scale we are proposing here at their Old Moor Reserve near Wath upon Dearne.

Visual intrusion

The erection of a wind turbine at this site would be visible for some distance however these machines are relatively small and are of a comparable scale or smaller than other obstructions such as the high voltage power lines.

Due to the relatively low height of most domestic turbines and the high rotational speed, flicker of sunlight is unlikely to be a problem

Community Ownership

The people of an area are much more likely to support renewable energy initiatives if they feel that they have ownership of the project. Consideration should be given to local groups owning and operating the renewable energy equipment proposed in this report. This would have a number of advantages:

- Community groups are much better placed to access grants than many private companies.
- Community ownership ensures that more energy pounds stay in the local economy for longer.
- Community owned schemes are more likely to have the support of the local people
- Community ownership gives a tangible demonstration of a local groups commitment to low carbon energy systems

In the Appendix is given the Yorkshire Dales Local Plan planning notes for small and large scale renewables within the national park. It specifically mentions wind turbines, and states that any application for more than one turbine, or a turbine with a hub height greater than 25m will not be permitted. Applications for smaller turbines will be taken on a case by case basis, stating that '*small-scale individual wind turbines will require careful siting and colouring to ensure minimal impact on the landscape*'[13].

7.3. Planning Issues relating to Photovoltaics

The Local Plan states that '*Solar energy schemes will only be appropriate where the design is acceptable to the character of the building and surrounding area. The design of solar power panels mean that such schemes may not always be suitable, particularly on Listed Buildings or in prominent locations in Conservation Areas*'. There are systems such as solar slates that have been approved for use on grade 2 listed buildings in Snowdon National Park and may be more appropriate for some buildings.

7.4. Planning Issues relating to Hydro Power

Hydro Power schemes always require some form of planning consent, and are also subject to restrictions from the Environment Agency about volume of abstraction of water from the river and an impoundment licence if an in-river structure is required. The Local Plan states '*Hydroelectric generators will be carefully assessed for their effects on the flow of watercourses and their impact on nature conservation. It will*

[13] See Appendix 1 – U6 Yorkshire Dales Local Plan

normally be advantageous to seek the advice of a planning officer before submitting an application'. This is common practice and provides no different restrictions to that of hydro schemes anywhere else in the country. Any powerhouse for the turbine should be in the traditional local style of building.

7.5. Planning Issues relating to Solar Water Heating

Although not specified in the Local Plan, it is expected that Solar Hot Water schemes would have similar restrictions to those for Photovoltaics. Solar Thermal systems can be integrated into the roof, or perhaps mounted on outbuildings or ground mounted to reduce visual impact which may be more acceptable.

7.6. Planning Issues relating to Biomass Heating

Biomass heating systems are not covered in the Local Plan, and none of the National Park is registered as a Smoke Control Area. This means that the use of Biomass Heating systems is restricted only by the planning required for any additional flues or buildings for the equipment.

7.7. Regulation and Structural Issues

The connection of the wind and solar electric systems will be governed by engineering recommendation G83 and or G59. The installer of the equipment should ensure that only equipment that complies with these requirements is installed. The distribution network operator will need to be contacted by the installer to ensure these regulations are met.

The mounting of wind or solar equipment will have an impact on the structure of the buildings. However the sub-structure of a roof is usually constructed with sufficient strength to support solar systems. When the architect and structural engineers are appointed they should work closely with the solar and wind equipment installers to ensure that any additional structural support and cable ducts required are installed during the roof design.

To gain the maximum financial benefit from the solar and wind generators, meters should be fitted to the output of each system. This will enable Renewable Obligation Certificates (ROC) to be claimed from OFGEM once the site has been registered with them. ROC's can then be sold for the equivalent of 3-4p/kwh of generation achieved.

8. Overall Summary

The aim of this feasibility study has been to identify a renewable energy approach for the Malhamdale area of the Yorkshire Dales National Park. The report analyses a range of renewable technologies, describing the practicalities and further research that should be undertaken in each area, with contacts given in the Appendix for organisations to approach. This information has been compiled using desk and site surveys and a representative sample of information taken from a questionnaire, and also via case studies and examples of existing installations, as well as drawing on the wide renewable energy knowledge-base built up at CAT over the past 30 years.

The overall conclusion is that there are many technologies which could, and should, be applied throughout the Malhamdale area. The technologies suitable vary throughout the different areas and types of houses, but some general conclusions are reached below:

- High levels of insulation and draught-proofing should be incorporated throughout the existing housing, working to improve the existing measures undertaken. Ideally, any new builds should be constructed as low or zero-heating homes.

- The local assessors trained in energy efficiency in households should be utilized wherever possible to ensure the best choice and return on investment in terms of energy efficiency, followed by renewable energy system

- All homes should have solar thermal panels fitted wherever possible, or at the least, be serviced in such a way as to make retrofitting a solar thermal system as straightforward as possible.

- Biomass heating systems are currently viable for many of the properties, and there is potential for the development and integration of district heating systems using biomass in the future, if a local biomass production scheme can be put in place.

- PV and wind electricity installations are the most feasible of the electricity generation options. PV could certainly be incorporated into the housing design. Both options are practically feasible and the decision will be an important part of the further housing development design process.

- A feasibility study should be undertaken along the River Aire and tributaries to assess the possibility of installing small or community scale hydro schemes.

All of these options are technically feasible, and are limited only by financial constraints and planning issues within the National Park Authority. Grant funding is available to assist with the financial aspects (see appendix), but an agreed framework is required with the National Park Authority with regards to Renewable Energy systems and their integration into the park. This will become increasingly important as a means to meet environmental targets for emissions and climate change over the coming years.

The information within this report will enable the reader to come to an informed decision about the best way to proceed on all aspects of renewable energy implementation within Malhamdale.

9. Appendix 1

Malhamdale Energy Survey February 2007

Global warming, the need to limit emissions of greenhouse gases and the rising cost of energy are problems that concern us all.

Please help us to make Malhamdale "green" by making the most of local renewable energy resources for the benefit of everyone in the community. The benefits of clean energy production have to be balanced against harm to the visual amenity of the National Park which is why the Yorkshire Dales National Park Authority is supporting this Initiative by funding it through the Yorkshire Dales Millennium Trust.

What we have to do:

First we have to find out our energy consumption and what types of fuel we use in the Dale. This is the aim of this survey and it will enable us to calculate our **carbon footprint**.

Next we have to identify sources of **renewable energy** in the Dale and **finally** we will prepare a report identifying potential **projects**.

The questionnaire can be accessed at http://www.beckhallmalham.com/energy_survey.htm **Please help by completing as much of the questionnaire as you can, then hit the "submit query" button to return to Malhamdale Initiative**.

Questions on the current level of **insulation** and **occupancy** of your home or business are included to give us an idea of how much energy might be saved by **passive measures** such as reducing heat loss through windows, roofs, etc by double glazing or loft insulation and by using more economic appliances. Some questions repeat parts of the Malhamdale Plan survey you may have completed in 2004; apologies for this but we need to relate energy used to the size of house and occupancy. Information will be kept strictly confidential. We have not asked you for your address, however if you would like a detailed energy efficiency audit of your home please call the undersigned.

This Initiative is being carried out in association with the **Centre for Alternative Technology (CAT)**, Machynlleth, North Wales www.cat.org.uk

If you are planning to install a renewable energy device, or already have one, we would like to know. Also if you **know of a site** which might support a **renewable energy project** please let us know. Any project identified by this Initiative will, of course, be subject to the usual process of planning consultation and approval.

THE AIM OF THIS INITIATIVE IS TO MAKE MALHAMDALE CARBON NEUTRAL.

Thank you for your co-operation. If you have any questions please contact me, Sandy Tod, at jamestod@btinternet.com or phone 01729 83069

Appendix 2 - Planning Restrictions and Guidance

Yorkshire Dales Local Plan – April 2006

Excerpts taken from Local Plan highlighting sections on Renewable Energy developments:

Policy U5 Large-Scale Renewable Energy Developments

Large scale renewable energy developments of more than local importance will not be permitted unless it can be demonstrated that the objectives of the designation of the National Park area will not be compromised by the development, and any significant adverse effect on the qualities for which the area has been designated are clearly outweighed by the environmental, social and economic benefits.
In the case of wind energy, development of more than one turbine or a single turbine with a ground to hub height of 25m or more will not be permitted.

Justification

8.19 The aim of the policy is to resist large-scale renewable energy developments in the National Park, particularly large-scale wind turbines, because of their unacceptable visual impact on the quality of the landscape.

8.20 Notwithstanding the National Park Authority's support for the development of clean, renewable alternatives to fossil fuel, it is concerned at the potential visual impact of large wind turbine masts on the landscape of the National Park. Planning Policy Guidance Note No. 22 (Renewable Energy) advises that the Government's policy of stimulating the development of renewable energy sources must be weighed carefully with its continuing commitment to protection of the environment, and in National Parks the need to take full account of the special qualities that justified designation. In relation to Policy GP5 (Major Development) major energy schemes would have to demonstrate a national need why they could only be located in a National Park.

8.21 Major wind power developments inevitably have to be sited in prominent exposed positions. By reason of their form and scale, they are especially intrusive in open upland landscapes and are, therefore, particularly inappropriate in the Yorkshire Dales. Environmental damage during the erection of wind turbines and as a result of ancillary developments, such as access roads and power lines, is also likely. It is therefore considered that neither large-scale renewable energy schemes nor large-scale wind turbine developments should be permitted in the National Park.

Policy U6 Small-Scale Renewable Energy Developments

Small-scale renewable energy developments to meet local energy needs will be permitted if all the following criteria are met:
i) It will not adversely affect the character of the landscape, settlements or buildings either individually or as a consequence of a cumulative impact,
ii) It does not adversely affect the nature conservation value, the archaeological interest, residential or recreational amenity of the surrounding area. The National Park Authority would welcome small scale renewable energy schemes that result in local environmental benefits through, for instance, the removal or avoidance of the use of overhead wires.

Justification

8.22 The aim of this policy is to support appropriate small-scale renewable energy schemes that are compatible with the special qualities of the National Park.

8.23 Although the National Park Authority supports the principle of renewable energy, a careful balance is required between the benefits of clean energy production against the harm to the National Park. A wide variety of renewable energy generators are now available including individual wind turbines, solar heating, ground source heat pumps, photovoltaics, hydro-generators, wood fuel. Others may be become more available in the future.

8.24 Small-scale renewable energy schemes can benefit rural and isolated local communities and can provide a suitable alternative to overhead electricity supply lines. 'Small scale' is defined in this context as domestic or community power schemes of a scale that can be carried out within the capacity of the local environment, without causing lasting damage or eroding the special qualities of an area. This will include its cumulative contribution to any existing schemes in the locality.

Nevertheless great care must be taken in the detailed design of any proposal to minimise their impact, especially on the landscape. The impacts will vary according to the type of scheme proposed. Small-scale individual wind turbines will require careful siting and colouring to ensure minimal impact on the landscape. Solar energy schemes will only be appropriate where the design is acceptable to the character of the building and surrounding area. The design of solar power panels mean that such schemes may not always be suitable, particularly on Listed Buildings or in prominent locations in Conservation Areas. Hydroelectric generators will be carefully assessed for their effects on the flow of watercourses and their impact on nature conservation. It will normally be advantageous to seek the advice of a planning officer before submitting an application.

Appendix 3

PPS22 – Renewable Energy

PPS22 is the National planning guidance to planners on Renewable Energy across England. It was issues in August 2004. It is currently only planning guidance, but is due to be reviewed under upcoming legislation, with the hope of becoming statutory.

KEY PRINCIPLES – Taken directly from PPS22

1. Regional planning bodies and local planning authorities should adhere to the following key principles in their approach to planning for renewable energy:

(i) Renewable energy developments should be capable of being accommodated throughout England in locations where the technology is viable and environmental, economic, and social impacts can be addressed satisfactorily.

(ii) Regional spatial strategies and local development documents should contain policies designed to promote and encourage, rather than restrict, the development of renewable energy resources. Regional planning bodies and local planning authorities should recognise the full range of renewable energy sources, their differing characteristics, locational requirements and the potential for exploiting them subject to appropriate environmental safeguards.

(iii) At the local level, planning authorities should set out the criteria that will be applied in assessing applications for planning permission for renewable energy projects. Planning policies that rule out or place constraints on the development of all, or specific types of, renewable energy technologies should not be included in regional spatial strategies or local development documents without sufficient reasoned justification. The Government may intervene in the plan making process where it considers that the constraints being proposed by local authorities are too great or have been poorly justified.

(iv) The wider environmental and economic benefits of all proposals for renewable energy projects, whatever their scale, are material considerations that should be given significant weight in determining whether proposals should be granted planning permission.

(v) Regional planning bodies and local planning authorities should not make assumptions about the technical and commercial feasibility of renewable energy projects (e.g. identifying generalised locations for development based on mean wind speeds). Technological change can mean that sites currently excluded as locations for particular types of renewable energy development may in future be suitable.

National Designations

11. In sites with nationally recognised designations (Sites of Special Scientific Interest, National Nature Reserves, National Parks, Areas of Outstanding Natural Beauty, Heritage Coasts, Scheduled Monuments, Conservation Areas, Listed Buildings, Registered Historic Battlefields and Registered Parks and Gardens) planning permission for renewable energy projects should only be granted where it can be demonstrated that the objectives of designation of the area will not be compromised by the development, and any significant adverse effects on the qualities for which the area has been designated are clearly outweighed by the environmental, social and economic benefits.

12. Regional planning bodies and local planning authorities should set out in regional spatial strategies and local development documents the criteria based policies which set out the circumstances in which particular types and sizes of renewable energy developments will be acceptable in nationally designated areas. Care should be taken to identify the scale of renewable energy developments that may be acceptable in particular areas. Small-scale developments should be permitted within areas such as National Parks, Areas of Outstanding Natural Beauty and Heritage Coasts provided that there is no significant environmental detriment to the area concerned.

Appendix 4 – given as a demonstration of advice from other NPA's on Solar Panels. In YDNPA, no fixed figure is given for heights and distances. Taken from: http://www.exmoor-nationalpark.gov.uk/re_advice_note_for_household_solar_panels.doc

Advice note for household solar panels.

Panels on dwelling houses (excluding flats and maisonettes and listed buildings).

Most households in Wales enjoy certain permitted development rights, detailed in the General Permitted Development Order (1995). This means there are specific works to a dwelling which are granted planning permission by the Order, subject to certain provisions, conditions and limitations. Under these rights, any alterations to a roof are permitted, so long as they do not enlarge the roof space or alter the shape of the roof. **The National Park Authority takes the view, that as long as a solar panel does not project more than 10cm above the plane of the existing roof or break the ridge line of the roof when viewed from the ground, the submission of a planning application will not be required.** This advice does not apply to houses created from barn conversions, where permitted development rights have been removed in order to preserve the character of the barn. If in doubt whether this applies to your property, please call for clarification.

If the panel projects further than 10cm, breaks the ridge line or is for a barn conversion, the planning department at the National Park, must take a decision on whether permission is required. In this case please send as much information on the proposal as possible to the address given at the top of this leaflet. Information should include: a map identifying your house, a photo of the house, specification of the proposed panel and an indication of where on the roof you wish to place the panel.

Pipework for panels is generally less than a finger width or 2cm, in diameter and normally runs directly from the panel into the roof space. If pipework has a larger diameter than this, or needs to be run extensively across the plane of the roof, please contact the planning department for advice.

Listed dwellings

If your house is a listed building, any works, which are likely to affect the character of the house, will require listed building consent. Always contact the planning department before installing panels on a listed building.

Other buildings

This advice only relates to dwellings (other than flats and maisonettes). For advice relating to any other building, please contact the planning department at the National Park.

Freestanding panels

There is no direct national planning advice for the erection of solar panels in the curtilage of a dwelling house. The National Park Authority take the view that if the panels are to be placed nearer to the highway than the original house, and are then within 20m of that highway, or if the final height would be over 4 metres, then a planning application may be required and you should contact your planning adviser. If the panels are to be placed within the curtilage of a listed building, a planning application will be required and if within the curtilage of a barn conversion, where permitted development rights have been specifically removed, the proposal must first be approved by your planning adviser.

If you have any doubts as to whether permission is required, please telephone 01874 624437 and ask for your area planning adviser.

Appendix 5

JOHN WILLOUGHBY'S			DOMESTIC FUEL PRICE GUIDE No 32					May-07
FUEL	**PRICE**		**p/kWh**	**£/GJ**	**Quarterly Stand. Chg**	**Relative to Gas**	**Rank**	**kg CO2 / kWh**
GAS	4.02	p/kWh $	4.02	11.18				
	2.05	p/kWh $$	2.05	5.70	£ 21.57++	1.00		0.19
ELECTRICITY	15.03	p/kWh**	15.03	41.78		7.33		
(on-peak)	11.11	p/kWh***	11.11	30.89	£ 7.13++	5.42		0.42
ELECTRICITY	20.98	p/kWh**	20.98	58.32		10.23		
(Economy 7)	11.55	p/kWh***	11.55	32.11	£ 17.16++	5.63		0.42
night rate	4.41	p/kWh	4.41	12.26		2.15		0.42
OIL (35 sec)	36.50	p/litre*	3.47	9.64		1.69		0.27
OIL (28 sec)	31.18	p/litre*	3.24	9.01		1.58		0.27
COAL	£ 175.00	/tonne +	2.10	5.84		1.02		0.29
ANTHRACITE	£ 201.00	/tonne +	2.21	6.15		1.08		0.32
LPG	35.34	p/litre*	4.95	13.75	£ 13.65	2.41		0.23
Wood Pellets	£ 220.50	/tonne@	4.17	11.61		2.04		0.03
Wood Pellets	£ 147.86	/tonne	2.80	7.78		1.37		0.03
Logs (B'leaf)	tba	/load@@	1.97	5.47		0.96		0.03

$ based on B Gas DD price for first 12 kWh/day
$$ based on B Gas DD price for over 12 kWh/day
** based on nPower first 182 kWh/q
*** based on nPower for over 182 kWh/q (£**20**/yr discount available for DD)
* based on 1000 litre delivery
+ based on 1 tonne delivery
@ 15 kg bags. 1 tonne + delivery (£49+VAT)
bulk delivery (10 tonne 80 miles)
@@ cost in Lydney. Stacking ratio 0.56, 9 GJ/m^3
All prices include VAT at **5%**
CO_2 figures from SAP 2005

Prices obtained from nPower, B Gas, Welsh
Biofuels, RHP and 'best price' from local
suppliers. Thanks to Alan Clarke for logs' co

Price relative to gas now distorted by
two tier tariffs and no standing charges.
Second tier used for relative prices.
++If consumption over first tier you can
use 2nd tier price plus equivalent stdg chg.

COMMENTS Since Apr 06 - Electricity up 5% E7 up 5%
Gas % dwn 8%
OIL 35s dwn 12%, 28s dwn 15%
Coal up nc, Anthracite down nc
LPG Previous prices turn out to be 'intrductory offer'
This is a more realistic price from Salkent
Wood Pellet - dwn 9%
Logs - %

Appendix 6

The process for setting up a Commuinty RE scheme
(Developed by Mid Wales Energy Agency)

Lead individual/group/body
One of the keys to a successful community renewables scheme is a strong social network with a critical actor, a leader who can drive the project forward and inspire others to get involved. The social networks that are needed for community schemes to thrive are strengthened by strong relationships, common goals, frequent interactions and long-term relationships. This is embodied by Cymni Gwynt Teg, which was set up by three farmers after they shared their frustrations over the impact of foot and mouth disease on the rural economy.

Communities with strong social networks are also likely to have trust in one another. This in turn enables the community to feel comfortable taking on large-scale projects such as a local renewable energy scheme.

A strong group has:

- A core group to plan, coordinate, lead, inspire and make decisions (5 - 10 people)
- People to volunteer (15 - 20 people)
- Investors and supporters to come to public events when you need them (dozens)
- The general public to support you with money or a vote (the majority of the public)

It is fine for people to become involved at different levels. Not everyone is going to (or want to) become part of the core group (although obviously the more the better for spreading the work load).

Accessing expertise
Some of the necessary skills for developing a scheme will already be available in the community, there will also be people who are willing to undertake training to enable them to take on areas of the project. However, some skills will need to come from outside the community. Your local Energy Agency or Advice Centre should be able to signpost you to organisations and other communities with the skills you require.

You have a choice as to whether to employ individuals or organisations to manage specific fields, (effectively creating a management organisation specific to the project), or to delegate the entire management process to an organisation with previous experience in renewable energy projects. The first option creates additional costs through professional fees and requires the community to be able to control the activities of those employed. The second option involves finding a commercial developer sensitive to community issues.

Is it feasible?
At the feasibility stage you need to shortlist the best options and assess these for:

- Resource
- Costs

- Capability
- Outcomes

This information will enable you to develop your project proposal. Firstly, outline the main tasks and identify the barriers and measures required. Next estimate the rough costs and sketch out your project plan, incorporating a timeline.

Community consultation
Once the core group has a solid project proposal it is critical that it consults with the wider community about the project. An open and accessible community consultation will vastly improve the possibility of success at the planning stage.

There are many avenues open for community consultation and these can also serve as a vehicle for recruiting new blood into the project's core group:

- Events (information meeting, public hearing)
- Door-to-door/telephoning
- Press work
- Direct mailing
- Flyers
- Posters
- Friend to friend
- Paid advertising
- Emails/internet
- Talking to local groups (WI, parent groups etc)

Planning for planning
In order to achieve statutory planning permission for your project, you will need to produce a technical summary and an impact assessment. The planning process will involve significant time and cost. You will need to consult with the Environment Agency regarding abstraction, Building Control and Environmental health.

Tender development and procedure, negotiations
At this stage you must consider the legal implications of the project, these may include:

- Landowners (of the site and access)
- Incorporation
- Contracts for construction, operation and maintenance, power purchase, network access

All of these aspects necessitate time, cost (for professional advice) and more time.

Raising funds
There may be funding available for: time spent working on the project, accessing expertise (such as feasibility studies), community consultations, planning, tender development and procedure, hire and purchase of plant, installation and your launch event.

You will need to estimate and refine your costs and then choose your funding approach.

There is a range of potential funding sources available. When applying for grant funds, there are some basic considerations:

- How much money you are looking for?
- What do you hope to achieve?
- Are you eligible to apply?
- What is the project's Unique Selling Point?
- Do your's and the funder's deadlines match?

Non-energy-specific support can come from organisations such as the Councils for Voluntary Action and the Big Lottery Fund.

For energy specific funds you can begin by contacting your local Energy Agency or Advice Centre or by joining CAfE. They will be able to advise you about the various funding options, including:

- Community Renewables initiative (England only)
- Utilities, such as Scottish Power's Green Energy Trust Fund
- European Funding
- Wood Energy Business Scheme (Wales only)
- Local authorities

Some community schemes have been funded through a share issue. The Renewable Energy investment Club (REIC) is a useful organisation for information about this option.

You will also need to consider insurance such things as: construction period, operation, loss of revenue, third party liability and employer liability.

Installation

Project management is a full time job that should not be underestimated. The project manager needs to keep a clear overview, be able to delegate tasks, ensure compliance with CDM Regulations 2007 and Health and Safety.

The installation phase consists of construction, grid connection, metering and sales and, finally, commissioning.

Operation & maintenance

Once the scheme is commissioned, it will need constant attention. Operation and maintenance arrangements need to be considered at the feasibility stage of your project.

Official launch

This is an opportunity to thank the funders and partners, attract media attention and announce the completion of your scheme.

Evaluation, responding to queries

You will have learned many lessons, so now is the time for reflection and evaluation. You are likely to be contacted by other communities and developers, inspired by your project and keen for advice.

Appendix 7

Community Renewable Energy contact list

AWEL AMAN TAWE, Awel Aman Tawe, Ysgol Gynradd Gymraeg, Gwaun-Cae-Gurwen, gwaun-cae-gurwen, Rhydamen, Heol Newydd, Neath Port Talbot SA18 1UN.
Tel: 01269 822 954; Fax: 01269 825 628.; Email: awelat@freenetname.co.uk Website: www.awelamantawe.org.uk
Planning community owned wind farm on Mynydd Uchaf, Neath Port Talbot County. Funds generated will be used to assist in the regeneration of the Upper Amman and Upper Swansea valley areas, supporting the implementation of Agenda 21 objectives. Also developing other renewable energy projects and give home energy efficiency advice. Offer the 'EDUcan' (Energy Demonstration Unit) for workshops or to power musical events. Supported a school in installing PV panels. Also offering up to 50% grants for the installation of Thermafleece in Welsh homes until March 2007.

BAYWIND ENERGY COOPERATIVE, Unit 22, Trinity Enterprise Centre, Furness Business Park, Barrow-in-Furness, Cumbria LA14 2PN.
Tel: 01229 821 028; Fax: same.; Email: info@baywind.co.uk Website: www.baywind.co.uk
UK's first co-operative to own wind turbines (at Harlock Hill & Haverigg II). Promotes development of renewable energy and set up the Energy Conservation Trust and Energy4All (see entry), which gives advice on the development of community owned renewable energy schemes.
COMMUNITY ACTION FOR ENERGY (ENERGY SAVING TRUST),
Tel: 0870 1261 444; Email: online form Website: www.est.org.uk/cafe
Energy Saving Trust programme designed to promote and facilitate local community-based energy projects. Can offer advice on sources of funding, useful contacts, training, events, and information about other projects.

COMMUNITY POWER (POWERGEN), Westwood Way, Westwood Business Park, Coventry, CV4 8LG.
Tel: 024 7642 5218; Fax: 024 7642 5443.; Email: community.power@powergen.co.uk Website: www.community-power.co.uk
Scheme to help local communities and/or local authorities develop small-scale wind schemes in partnership with Powergen. The company will fund development and construction.

COMMUNITY RENEWABLES INITIATIVE, The Countryside Agency, John Dower House, Crescent Place, Cheltenham, Glos GL50 3RA.
Tel: 01242 533 260; Fax: 01242 584 270.; Email: cri@countryside.org.uk Website: www.countryside.gov.uk/communityrenewables
Helps local people and organisations devise and implement renewable energy developments. Local Support Teams around the country.

COMMUNITY WIND POWER NETWORK,
Website: www.freewebs.com/communitywindpowernetwork
Independent not-for-profit initiative offering advice on planning and financing a community wind power scheme.

CWMNI GWYNT TEG CYF / AIL WYNT, Pennant, Melin-y-coed, Llanrwst, Conwy LL26 0TR

Tel: 01492 640529; Fax: 01429 650760.; Email: gwenan@rheinaltw.freeserve.co.uk Website: www.ailwynt.co.uk
A co-operative of three hill farming families from near Llanrwst who set up three turbines at Moel Maelogen in North Wales. Planning a new project ('Ail Wynt') to install more turbines on the site. Approval was gained for the extension in November 2004, and local people are able to invest in the project through a bond issue.

ECODYFI (DYFI ECO VALLEY PARTNERSHIP), Ty Bro Ddyfi, 52 Heol Maengwyn, Machynlleth, Powys SY20 8DT.
Tel: 01654 703965; Fax: same.; Email: info@ecodyfi.org.uk Website: www.ecodyfi.org.uk
Local group working for community regeneration and sustainable development. Aims to create an exemplary model of a more sustainable community. It includes a wide range of appropriate energy generation schemes (including community based hydro & wind schemes), and related businesses, all working for the benefit of the local community, economy and environment. Other areas include Tourism and Waste Minimisation.

ENERGY4ALL Ltd, Unit 22, Trinity Enterprise Centre, Furness Business Park, Barrow-in-Furness, Cumbria LA14 2PN.
Tel: 01229 821 028; Fax: same.; Email: info@energy4all.co.uk Website: www.energy4all.co.uk
Set up by the Baywind Cooperative to give advice on the development of community owned renewable energy schemes. Offers viability assessments, project development (including securing planning consent), establishment of co-ops or share issues, and site monitoring and management of finished projects. Developed Westmill Wind Farm Project in Watchfield, Oxfordshire.

ORKNEY RENEWABLE ENERGY Ltd, Commercial Union House, Castle Street, Kirkwall, Orkney KW15 1WQ.
Tel: 01856 876810; Fax: none.; Email: macleodork@aol.com
Company financed by Orkney residents, which has installed an 850kW Vestas wind turbine at Northfield, Burray. They aim to re-invest profits from this community scheme into similar developments elsewhere in Scotland.

RENEWABLE ENERGY AT LOCAL LEVEL (REALL), Earth Balance West Sleekburn Farm Bomersund Bedlington Northumberland NE22 7AD
Tel: 01670 823706; Fax: 01670 511400.; Email: REALL@ccn.org.uk melaniegreenwood@ccn.org.uk Website: www.countryside.gov.uk/communityrenewables
North East Community Renewables Initiative which helps communities develop systems using solar power, wind power and biofuels. Offers advice, feasibility studies and funding support. Projects supported include: a woodchip district heating scheme in Kielder, solar panels in a Ferryhill Community Centre, conversion of a Northumberland corn mill waterwheel into a power generator, and the building of a wind turbine at Catchgate Primary School in County Durham.

RENEWABLE ENERGY INVESTMENT CLUB, Unit 1, Dyfi Eco Park, Machynlleth, Powys SY20 8AX.
Tel: 01654 705000; Fax: 01654 703000.; Email: andy.warrington@dulas.org.uk Website: www.reic.co.uk
Initiative enabling local people to have a stake in sustainable energy initiatives by linking them with renewable energy developers and providing a mechanism for investment in approved projects. Provides individuals, community groups and

businesses with opportunities to invest directly in sustainable energy projects in their locality.

SWANSEA BAY ENERGY Ltd, 1 High Street, Clydach, Swansea, SA6 52G.
Tel: 01792 846000; Fax: 01792 849000.; Email: info@swanseaenergy.org.uk
Website: www.swanseaenergy.co.uk
Community wind power scheme based around the installation of a 250kW wind turbine in Swansea Docks. Profits will be put into an energy fund, and used to fund a range of local energy projects.

Contact List for Merchant Wind Power.

ECOTRICITY, Axiom House, Station Road, Stroud, Gloucestershire GL5 3AP.
Tel: 0800 0326 100; Fax: 01453 756 222.; Email: info@ecotricity.co.uk Website: www.ecotricity.co.uk
Commercial and domestic supplier for England and Wales, at the same price as 'conventional supply', and will buy electricity from grid-connected houses (e.g. solar roofs). Installed 600kW Enercon turbine at Sainsbury's depot in East Kilbride, through Merchant Wind Power scheme - Ecotricity finance and build wind turbines and provide ongoing servicing in return for a 12 year power purchase commitment. Erected the UK's tallest wind turbine (85m, 1.8MW) at Swaffham, Norfolk. Recently built London's first wind project - two 1.8MW wind turbines to power Ford's new Dagenham Diesel Centre.

WIND DIRECT LTD, The Gatehouse White Cross Business Centre South Road LANCASTER LA1 4XQ
Tel: 01524 33689; Website: www.wind-direct.co.uk
Merchant Wind Power provider. Develops wind farms at their risk but on the customer's land.

Appendix 8 - Pellet quotes

Renewable Fuels Ltd

The Hackings

The Menagerie

Escrick

York, YO19 6ET

Sales Enquiries / Quotations

Andrea Moulton

Tel: 01904 720575

Email: **sales@renewablefuels.co.uk**

Technical Enquiries
Tel: 01904 720575

Email: info@renewablefuels.co.uk

Email to Renewables Fuels

Hello,

I am assessing the feasibility of biomass heating for the Malhamdale area.

I am interested in quotes for both bulk delivery and blown pellet supply, including delivery costs. Volumes of between 1-10 tonnes are to be considered, potentially for multiple drop-offs within the same local area.

Please confirm the quality standard of your pellets, with details of last testing (durability, m/c and calorific value if available)

Thank you

David Hood

Good Morning Mr Hood

Many thanks for your enquiry

We can supply wood pellets in both 6mm and 8mm and have plenty of supply readily available. I have attached for you our company profile and also our logistics pack which explains the bulk deliveries and also includes our fuel analysis report.

650kg bags £97.80 + VAT (5% domestic / 17.5% trade) per bag plus delivery of £35.00 + 17.5% VAT. Each 650 kg bag is delivered on an individual pallet.

Bulk deliveries (pneumatic) the price per tonne ex works is £132.00 + VAT (5% domestic / 17.5% trade). The delivery cost is £ this is based on an 18 tonne delivery vehicle to BD23 4DB, if multiple drops were to take place we would need all the relevant postcodes involved to pass on to the transport company so that they can then give us a revised price to the one already quoted to you.

I hope this information is of help to you, if there is anything else I can help you with please do not hesitate to contact me.

Kind Regards

Andrea Moulton
Sales Co-ordinator
Renewable Fuels Ltd

Hello Mr Hood

I have just got the cost from our transport company. The cost is £250.00 + VAT for whether it is 1 tonne delivered or 18 tonnes delivered. As I mentioned before if there are other drops to take place if you can let me have these postcodes, the transport company will then give a revised price.
If for instance it was a delivery of 5 tonnes to be delivered it would then work out at £50.00 per tonne for the delivery, the more ordered the more cost effective it becomes for our customers.

Kind Regards

Pellet analysis

All analysis **As Received basis**	**SS187120**
Size	Max 4ø[1]
% Moisture Content (Total)	< = 10%
% Ash	< = 0.5%
% Total Sulphur	< = 0.08%
% Chlorine	< = 0.03%
Net Calorific Value MJ/kg	> = 17.0MJ/kg
Fines in % < 3mm	< = 0.8%[1]
Bulk Density	> = 600kg/m[1]

This equates to 4.72 kWh/kg. The prices per kWh are given in the following table fro different delivery systems.

16kg bag pallet	£	236.37	inc vat (5%)	£	236.37	
	£	-	inc vat (17.5)	£	-	
			total	**£**	**236.37**	
kWh per pallet	per pallet =		4023.33		kWh	
			£	0.059	per kWh	

650 kg Bag	£	97.80	inc vat (5%)	£	102.69	
delivery	£	35.00	inc vat (17.5)	£	41.13	
			total	**£**	**143.82**	
kWh per bag	650kg bag =		3069.44		kWh	
			£	0.047	per kWh	

Blown delivery	£	132.00	inc vat (5%)	£	138.60
number of tonnes delivered			4	£	554.40
delivery	£	250.00	inc vat (17.5)	£	293.75
			total	**£**	**848.15**
kWh per tonne	1000kg =		4722.22		kWh
			£	0.045	per kWh

Blown delivery	£	132.00	inc vat (5%)	£	138.60
number of tonnes delivered			10	£1,386.00	
delivery	£	250.00	inc vat (17.5)	£	293.75
			total	**£1,679.75**	
kWh per tonne	1000kg =		4722.22		kWh
			£	0.036	per kWh

Appendix 9 - Locations and PV generation results for Malhamdale villages

Grid Conversion Results - Malham

OS X	390190
OS Y	462985
Nearest Post Code	BD23 4DD
Lat (WGS84)	N54:03:46 (54.062714)
Long (WGS84)	W2:09:05 (-2.151371)
LR	SD901629

PV electricity generation for: Nominal power=1.0 kW, System losses=14.0%		
	Inclin.=35 deg., Orient.=0 deg.	
Month	**Production per month (kWh)**	**Production per day (kWh)**
Jan	27	0.9
Feb	43	1.5
Mar	68	2.2
Apr	92	3.1
May	116	3.8
Jun	107	3.6
Jul	112	3.6
Aug	97	3.1
Sep	78	2.6
Oct	53	1.7
Nov	30	1.0
Dec	19	0.6
Yearly average	**70**	**2.3**
Total yearly production (kWh)	**841**	

Grid Conversion Results - Hanlith

OS X	390135
OS Y	461275
Nearest Post Code	BD23 4BP
Lat (WGS84)	N54:02:50 (54.047345)
Long (WGS84)	W2:09:08 (-2.152155)
LR	SD901612

PV electricity generation for: Nominal power=1.0 kW, System losses=14.0%		
	Inclin.=35 deg., Orient.=0 deg.	
Month	**Production per month (kWh)**	**Production per day (kWh)**
Jan	27	0.9
Feb	43	1.5
Mar	68	2.2
Apr	92	3.1
May	116	3.7
Jun	107	3.6
Jul	112	3.6
Aug	97	3.1
Sep	78	2.6
Oct	52	1.7
Nov	29	1.0
Dec	18	0.6
Yearly average	**70**	**2.3**
Total yearly production (kWh)	**837**	

Grid Conversion Results – Kirkby Malham

OS X	389485
OS Y	461060
Nearest Post Code	BD23 4BT
Lat (WGS84)	N54:02:43 (54.045399)
Long (WGS84)	W2:09:43 (-2.162075)
LR	SD894610

Grid Conversion Results - Airton

OS X	390200
OS Y	459245
Nearest Post Code	BD23 4AS
Lat (WGS84)	N54:01:45 (54.029101)
Long (WGS84)	W2:09:04 (-2.151096)
LR	SD902592

PV electricity generation for: Nominal power=1.0 kW, System losses=14.0%

	Inclin.=35 deg., Orient.=0 deg.	
Month	**Production per month (kWh)**	**Production per day (kWh)**
Jan	28	0.9
Feb	43	1.6
Mar	68	2.2
Apr	92	3.1
May	116	3.7
Jun	107	3.6
Jul	112	3.6
Aug	96	3.1
Sep	78	2.6
Oct	53	1.7
Nov	30	1.0
Dec	19	0.6
Yearly average	**70**	**2.3**
Total yearly production (kWh)	**839**	

Grid Conversion Results - Calton

OS X	390905
OS Y	459255
Nearest Post Code	BD23 4AD
Lat (WGS84)	N54:01:45 (54.029204)
Long (WGS84)	W2:08:25 (-2.140334)
LR	SD909592

Grid Conversion Results - Otterburn

OS X	388315
OS Y	457830
Nearest Post Code	BD23 4DX
Lat (WGS84)	N54:00:59 (54.016344)
Long (WGS84)	W2:10:47 (-2.179817)
LR	SD883578

PV electricity generation for: Nominal power=1.0 kW, System losses=14.0%

	Inclin.=35 deg., Orient.=0 deg.	
Month	**Production per month (kWh)**	**Production per day (kWh)**
Jan	26	0.8
Feb	43	1.5
Mar	68	2.2
Apr	92	3.1
May	116	3.7
Jun	107	3.6
Jul	112	3.6
Aug	96	3.1
Sep	78	2.6
Oct	52	1.7
Nov	29	1.0
Dec	18	0.6
Yearly average	**70**	**2.3**
Total yearly production (kWh)	**835**	

Appendix 10

Solar slate pv installation - CARNYORTH OUTDOOR EDUCATION CENTRE

Carnyorth Outdoor Education Centre based near St Just In West Cornwall has just had a complete eco-rennovation! Work has included installing a solar thermal system, installing gas Central heating (rather than Electric) AND a state of the art PV installation.

The installation uses 372 Atlantis Sunslates wired in series to produce a total output of 4.96 kWpeak. The building is used by as a residential Centre by schools from throughout Cornwall and should produce all the Centre's Yearly electrical demand, saving over 2 Tonnes of Carbon Dioxide being produced every year.

The building is run by Alison Law from Cornwall Outdoors who has been very supportive of the whole installation. "We are visited by over 3000 pupils from throughout Cornwall every year - this installation will show the young people a glimpse of a more sustainable future and how we can all live a more sustainable life".

The Centre is owned by Cornwall county Council who have assisted in writing the specification for the installation and ensuring all the work is of the highest standards. This is the first PV installation on a Cornwall County Council building and has been a great success.

The Centre is in an Area of Outstanding Natural Beauty and Heritage Coast Line and is a very prominent building on the roadside so the local Planning Authority Penwith District Council requested that the sunslates were used to minimise any visual impact.

Funding for the installation has come from the Energy Saving Trust, SWEB Green Energy Fund and Cornwall County Council. The overall project was managed by RM Developments and the PV installation installed by PLUG INTO THE SUN.

Contact:

Plug Into The Sun
Trebehor Farm Cottage
St Levan
Penzance
TR19 6LX

By phone:

01736 871291

By email:

enquiries@plugintothesun.co.uk

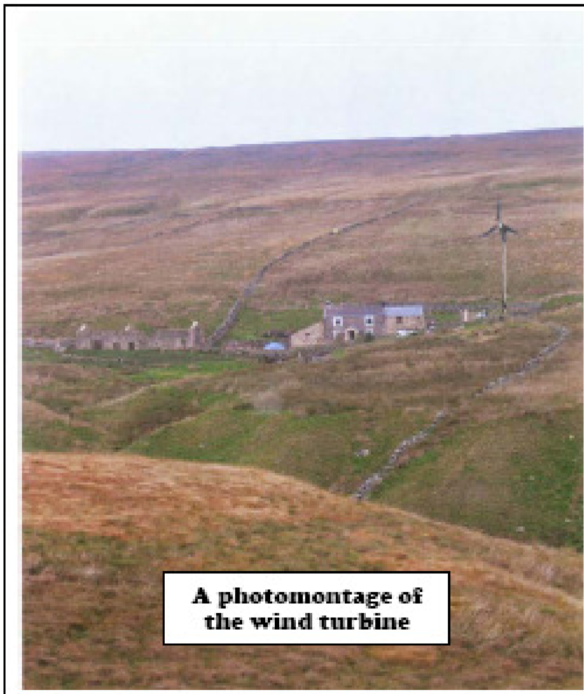
Appendix 11 – Cosh Farm wind turbine, YDNPA

YORKSHIRE DALES
National Park Authority

Wind Turbine at Cosh Farm, Foxup, Littondale

Cosh Farm is an extremely isolated house about 2 miles from the nearest settlement, Foxup, itself a remote place. Cosh Farm lies within Littondale Barns and Walls Conservation Area and open access land. The house has been redundant for many years, with only the occasional use by a youth hostel club. A young couple have recently bought the remote spot to create a family home – even after the sales details described it as a desirable spot for a recluse! The site has no connections to services and is currently served by a generator. Planning permission has already been granted for extensions to the building.

An application has been submitted for a wind turbine measuring just under 18m high to rotor tip. A justification for the scale and siting of the turbine was submitted with the proposal.


A photomontage of the wind turbine

The Yorkshire Dales Local Plan (Policy U6) supports small scale renewable energy developments where they will not adversely affect the character of the landscape, settlement or buildings and the development does not adversely affect nature conservation, archaeological, residential or recreational amenity.

The key issues with this proposal are the remoteness and nature of the site in a high quality landscape and, the scale of the turbine. Cosh Farm is positioned in a unique undeveloped landscape, the only structure other than barns and walls for several miles. The turbine will be significantly higher than the house and given the topography of the area there will be views of the turbine in isolation.

There are a number of factors in support of the turbine. The turbine will provide a source of renewable energy; remove or significantly reduce the need for the noisy generator in an otherwise quiet landscape; the backdrop of the turbine is the hillside rather than projecting above the skyline; the turbine would negate the need for the introduction of overhead lines which would otherwise significantly alter an uninterrupted 2 mile stretch of the dale.

The application was the subject of considerable officer debate. It was eventually decided that, whilst the turbine would interfere visually with the sweeping horizontality and 'wildness' of the moorland landscape against which it would be seen, the fact is that this is already impaired by the buildings at Cosh. As such the turbine would not be out of context with its immediate setting comprising those buildings. On this (arguable) basis the Yorkshire Dales National Park Authority has resolved to approve the application for the turbine, although the permission would be subject to a legal agreement to prevent overhead lines being erected as well.

Appendix 12

Llanwddyn District Heating Scheme, Powys

The 500kW Compte wood chip biomass boiler at Llanwddyn provides heating and hot water for the primary school, community centre and 31 houses. The total project cost was £366,000 (excluding wet heating systems in the houses) and was 100 % funded through European and local funding schemes. The wood chip boiler replaces oil boilers at the school and community centre, and solid fuel heating systems in the majority of the houses. The project was commissioned in October 2003.

The scheme is managed by Dulas Biomass Energy Supply Company (ESCo) which installed and maintains the boiler and supplies fuel, charging the Local Authority and individual households for heat used. Costs per kWh work out at less than the current price for oil, though of course as the project was grant funded investment costs do not have to be recouped. The boiler is owned by Powys County Council.

The main challenge when installing the project, apart from securing the funding, was the number of individuals and landowners involved. Because the heat main was being retrofitted to existing houses, the highways authority, local council, school, community centre local land owner and individual property owners all had to be consulted making the process very lengthy and costly. However the project has been very successful, with improved heating systems and comfort levels in the houses connected to the scheme, and reduced fuel bills for the school and community centre. However the school is threatened with closure, which would make the scheme unviable.