Sustainable Consulting

EVALUATION OF RENEWABLE ENERGY PROJECTS FUNDED THROUGH THE FOREST OF BOWLAND SDF

Executive Summary

The Forest of Bowland Sustainable Development Fund (SDF) supported 10 renewable energy projects across the Area of Outstanding Natural Beauty (AONB) in the first three years it was operational. These projects covered a cross section of technologies installed in various types of buildings, from new build through to large refurbishment projects. The projects were spread across different sectors, from business through to community buildings. Elizabeth Bruce Associates were commissioned to look at these projects and assess them against their ability to generate renewable heat and/or power, offer carbon savings and value for money. The work involved a visit to each of the sites compiling detailed information on each. The following report pulls together this information, offering conclusions and recommendations for future support of such projects by the SDF.

All projects excluding 1 were operational at the time of the visit; however despite this direct comparisons between projects, and exact calculations for costs and savings have been difficult to quantify. None of the projects (Except Barley Village hall) have monitored energy consumption or generation on a regular basis making it hard to get accurate and conclusive readings.

Many of the projects were installed with little independent support, which has led in some cases to technologies being installed in less than optimum conditions. This means that on paper not all of the projects look as if they offer good value for money. However it should be remembered that the criteria above are only part of the reason for installing on site renewable energy technologies at the current time. These projects have a role to play in increasing acceptance and uptake of renewable technologies and in education and awareness raising on the issues of climate Change. These projects lead the way in demonstrating the role that small scale renewable energy technologies can play in the development of a low carbon economy even in areas of high landscape value, such as the Forest of Bowland AONB, and despite not always offering high levels of return financially have been key in the wider uptake of renewable across Lancashire that you are now beginning to see.

Funding is currently available for installing renewable energy technologies and because of this the SDF has taken a step back from supporting further projects of this type at the current time. In the future grant funding for renewable energy technologies is likely to become harder to access. There are plans to put Feed in Tariffs (See Appendix 1) in place to help stimulate uptake of small scale renewable, which would replace the existing government grant schemes. There are concerns that this will not be an effective mechanism for aiding uptake in community and voluntary sectors, therefore grant schemes like the SDF may become increasingly important as a source of funding for future projects.
In addition, as the sector develops and costs begin to come down some technologies are stacking up on their own financially without grants or incentives if installed in optimum locations.

Should the SDF choose to fund renewable energy technologies in the future it is recommended that the following be considered:

- That all renewable energy technologies have been investigated so that the most appropriate technologies for that site are installed.
- Evidence should be provided on what additional work is being done to improve the energy efficiency of the site alongside installing the renewable technologies. There is little value in installing capitally expensive renewable if basic low cost energy efficiency measures are not being installed alongside.
- All projects should be required as part of the funding agreement to monitor the system and provide the SDF with data on output and savings. (The SDF could develop a template for monitoring to help simplify this process).
- Projects should not be funded if they are not technically viable unless they offer significant additional benefits in the form of education, research and development, reaching new audiences etc.
- Consideration should be given to whether the project can stand up in its own right and therefore is eligible for grant funding. For example some woodfuel projects installed in the 'right location' e.g. off grid, large energy user although up front are capitally expensive can have a payback of as little as 3 years. In cases such as this the SDF could offer loans if the project is not able to access the existing interest free Carbon Trust Loans.

In conclusion, although the 10 projects have been extremely successful in raising the profile of small scale renewable in the Forest of Bowland in some cases the technologies installed have offered minimal financial and carbon savings when looked at in relation to the level of finance put into the project. In the future it is recommended that the SDF assess projects against not only wider benefits but also suitability for the site, to ensure technologies are only installed where they can maximise on the benefits they offer. This is also important in ensuring the sector continues to develop in a positive manner as bad projects tend to get far more publicity than good projects!

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1 BACKGROUND

Over the past four years the Forest of Bowland Sustainable Development Fund (SDF) has awarded grant support to 10 renewable energy projects within the AONB. These have often been used as examples of good practice yet to date no analysis or follow up has been carried out to find out if they are delivering the energy generation and carbon savings predicted prior to installation. As many of these systems have now been installed and operating for over a year it is possible to evaluate these projects and look at their ability to deliver renewable energy generation and carbon savings; and assess whether they offer value for money in the fight against climate change. Elizabeth Bruce Associates have been commissioned by the Forest of Bowland SDF to evaluate the projects and summarise them against their ability to:

- Generate heat and Power
- Offer carbon Savings
- Offer value for money

The work has included site visits to all 10 installations. Information has been compiled on each of the technologies evaluating them against the criteria detailed above taking into account both lessons learnt and issues raised which would be of value to future installations. The report pulls together the findings under the different headings with individual case studies for each of the projects.

1.1 STRATEGIC BACKGROUND

The debate about Climate Change and whether it is happening has passed leaving the question of how we tackle it. This needs to be dealt with at global and national levels but also at a regional and local level to ensure practical steps are taken to minimise future impacts.

The UK has committed to reducing carbon emissions by 80 per cent by 2050, and will shortly set binding 'carbon budgets' for the UK as a whole. A target of at least 30 per cent reduction by 2020 is likely to be set. While some of this reduction will be achieved through EU and national policy measures (the EU Emissions Trading Scheme, the Renewables Obligation, building regulations, fuel and vehicle taxation, and so on), further savings must be found at regional and local levels.

Lancashire's response is within the context of the **North West Climate Change Action Plan**, which states the region's ambition to lead the way on responses to climate change and sets a framework for regional action.

Action in Lancashire is co-ordinated by the **Lancashire Strategic Partnership**, who has developed a **Climate Change Strategy for Lancashire**. This commits all members of the Strategic partnership including all district councils to take action.

The Lancashire Strategic Partnership has also signed up to a carbon reduction target as part of its local area agreement (LAA). Under a new arrangement with central government, Local Authorities can now choose from a suite of targets against which their performance will be measured. Lancashire has signed up to two targets, which relate directly to climate change:

- NI 186, to reduce per capita CO2 emissions across Lancashire as a whole (excluding emissions from large industry, motorways and airports).
- NI 188, Climate Change Adaptation. Recognising that climate change is happening and putting measures in place to prepare for the impacts it will have.

In addition to these local authorities will soon be part of the Carbon Reduction Commitment – a carbon trading scheme – which will mean that larger LAs will be rewarded financially for good performance on carbon, and penalised if they don't meet targets (small LA's will have the option to opt out).

If a low carbon economy is to be successfully implemented this needs to be managed and implemented not only at a strategic level but also through practical projects on the ground. There is the potential for small-scale renewable energy systems (typically up to a maximum generating capacity of 50kW) to play a significant role in tackling climate change alongside energy efficiency improvements and larger scale electricity and heat installations. These technologies have a particular role to play in areas of high landscape value where large installations are less appropriate.

However these benefits are further reaching than just the carbon savings they offer. They play a key role in education and wider dissemination on the issues of Climate Change and where small-scale renewable energy projects have been installed they have been shown to influence the behaviour of the wider community offering additional downstream benefits. In addition there are downstream benefits of job creation as the industry continues to expand and develop.

1.2 RENEWABLE ENERGY TECHNOLOGIES

The appropriate package of technologies is very site specific depending on the building, site, occupancy rates, and natural resources available. Renewable energy technologies should always be installed in partnership with improved energy efficiency measures to maximise on both financial and carbon savings. The main low carbon renewable energy technologies include:

a. Wind Power

Wind turbines capture the winds energy typically with two or three propeller like blades, mounted on a rotor, to generate electricity. Systems can be both on and off grid connected. There are two potential options for wind energy, which can provide small-scale on-site electricity generation; small ground mounted turbines and roof-mounted turbines.

b. Solar Photovoltaics (PV)

This is the generation of electricity from the suns energy. Panels can either be bolted on to the south facing aspect or integrated into the roof as either panels or tiles. Alternatively panels can be mounted on to flat roofs or mounted on the ground. Systems can be both on and off grid connected.

c. Hydro Power

Hydropower uses moving water to generate electricity. The energy of the flowing water turns a turbine, which is connected to an electricity generator. The level of power is dependent on the rate of water flow (which is dependent on how far the water falls over a given distance, this is known as the head), the volume of water available and the efficiency of power conversion.

d. Solar Thermal

Solar water heating harnesses the suns energy to directly heat water, which is pumped round the panels. This is then used to heat the water in a cylinder via a heat exchanger. The water becomes preheated in the tank therefore less energy is used to bring the water up to temperature.

e. Woodfuel

The use of woodfuel (this could be a chip, log or pellet boiler) is carbon neutral; for every tonne of CO_2 released into the atmosphere the equivalent is absorbed by growing trees (assuming the timber has been sourced from sustainably managed woodlands of which the majority in the UK is). Combustion of woodfuel is the easiest way to release energy, which in turn provides heating and DHW.

f. Heat Pumps

Heat pumps utilise thermal energy taking low temperature heat from its surrounding. This could be the ground, surrounding air or a local water resource. This low-grade heat is then upgraded to a higher, more useful temperature. These are classed as low carbon as energy is used to operate the pump. However for every unit of energy used to run the pump typically 3-4 units of heat to be produced. There are three main types of heat pump systems that could be considered, air source (ASHP), ground source (GSHP) and water source (WSHP).

More detailed information on the different renewable and low carbon technologies their suitability for different sites and typical costs is included in Appendix 1. In addition to these key technologies there are other methods of reducing the energy load of the building for example passive solar design, maximising on natural daylight, and passive ventilation systems. Many of these features are only possible at new build stage and should be integrated into any design to minimise on the energy load of the building. This sustainable design concept can then be integrated alongside high levels of energy efficiency and renewable energy technologies to have a building with a minimal electricity demand and heat load.

1.3 BACKGROUND TO THE FOREST OF BOWLAND SDF

The Forest of Bowland SDF Fund is provided by DEFRA and seeks to support projects which indentify and test out more sustainable ways of living and working within the AONB. National and local criteria are set, and in the forest of Bowland positive encouragement was given to renewable energy projects in the first three years (2005-2007), as alternative funding was limited at that time. 10 projects were supported during this period covering a range of different technologies.

2 PROJECT EVALUATION

2.1 ABOUT THE PROJECTS

The projects supported through the Forest of Bowland SDF cover a diversity of technologies and end users. They range across new build and retrofit for both business and community projects highlighting the difficulties that exist when trying to compare projects against each other or quantify exact savings offered by the renewable energy technologies.

A site visit was carried out to each of the sites and a meeting took place with one of the key people involved in the development of the project. Detailed project information is available in Appendix 2. The projects included:

1. ***Barley Village Hall –*** Part of a large refurbishment project, which includes 14kW Air Source Heat Pump System (ASHP) to replace a large oil boiler and 3kW$_p$ solar PV system alongside improved energy efficiency measures.
2. ***Quernmore Church of England School –*** 5kW Wind turbine installed in the school grounds
3. ***Lower Gill Cottages –*** 150kW$_{th}$ Biomass district heating scheme installed at a small holiday let business replacing 8 individual lpg boilers.
4. ***Slaidburn Village Hall –*** New build village hall built to high levels of energy efficiency incorporating 50kW$_{th}$ biomass boiler
5. ***Bleasdale Parish Hall –*** Part of a large refurbishment and extension project which includes improved energy efficiency measures, 25kW$_{th}$ pellet boiler and 6kW wind turbine.
6. ***Bleasdale Cottages –*** Farm diversification project offering self-catering cottages. 2 60kw$_{th}$ pellet boilers were installed instead of individual oil boilers.
7. ***Bowland Wild Boar Park –*** The site has no access to mains electric with power provided onsite via a diesel generator. A 6kW wind turbine and 2 ground mounted 2kW$_p$ solar PV arrays were installed at the park to generate a percentage of the energy demands of the site.
8. ***Dalehead Church –*** Small rural off grid church. The 2.5kW wind turbine was installed as part of a major refurbishment project. The energy is stored in batteries and provides power for lighting and heating in the church.
9. ***Dove Syke Nursery –*** Commercial business that runs a Christmas tree nursery and arboricultural business. The business relocated to a new site and has installed a 46kW$_{th}$ biomass boiler and 4.5kW$_{th}$ solar thermal system to meeting on site heating and hotwater needs for the offices and staff room.
10. ***Over Wyresdale Parish Hall –*** New build project which incorporated high levels of energy efficiency, 13.4kW Ground Source Heat Pump (GSHP) System and 3kW$_{th}$ Solar Thermal System

Each project accessed varying levels of support when assessing which technologies were most appropriate for the site. In some cases little research into alternative technologies was carried out. Energy Efficiency technologies were not always installed alongside the renewable energy technologies. All projects were installed and operational except for the biomass boiler and solar thermal system installed at Dove Syke Nursery.

In summary the Forest of Bowland SDF has supported 10 renewable energy projects to a total installed capacity of 26.5kW of renewable electricity generation and 440kW_{th} of renewable heat across the Forest of Bowland AONB. These projects demonstrate that renewable energy can be appropriate even in high value landscape areas. In addition to the carbon and financial savings these system offer is the far-reaching, wider benefits. This is in the form of education; dissemination of information; making renewable energy more 'acceptable' and stimulating change within communities towards a low carbon economy. These benefits are less tangible to quantify than financial or carbon outputs but offer significant benefits, which it is hard to place a value on. In addition these projects also help stimulate investment in the sector leading to further advancements in development and job creation as the sector continues to expand.

2.2 HOW THE PROJECTS WERE ASSESSED

All projects except Dove Syke Nursery have been installed, commissioned and generating either renewable heat or power for over 1 year at the time of the site visit. Each of the projects was looked at in relation to its ability to:

1. ***Generate heat and/or power –***Actual generation was looked at in relation to both expectation and estimates provided by the installers prior to installation.
2. ***Offer carbon savings -*** These have been calculated using figures taken from the Carbon Trust publication 'Energy & Carbon Conversions 2008 Update' (Factsheet CTL018). These were calculated against the alternative fossil fuel that would have been used had renewable technologies not been installed. E.g. oil boiler, imported electricity from national grid derived from fossil fuels.
3. ***Offer value for money –*** This is far harder to quantify than points 1 or 2. Small-scale renewable technologies remain capitally expensive to install predominantly due to economies of scale. All projects supported through the SDF were leading the way in demonstrating practical low carbon solutions and therefore all received some if not 100% grant funding to enable the project to get off the ground. At the time when the projects were developing and pulling together funding packages there was little legislative support in place to help the development of such projects and specific government funding was not yet in place E.g. Clear Skies. Because of this grant funding was available through the SDF to help stimulate the uptake of such technologies. As policy continues to develop to support our move to a low carbon economy new mechanisms are being put in place to help stimulate the uptake of projects of this type (e.g. Feed in Tariffs) over time it is hoped these will replace the need for grant funding. In addition as the sector continues to grow further investment will take place and prices will continue to come down. Therefore there is little to be gained by looking at payback in relation to actual costs versus income or even actual cost to the installer (including grant funding) versus income. Therefore for the purposes of the report value for money is being looked at in relation to the projects ability to reduce running costs and has been assessed against cost per tonne of carbon saved. This method of financial evaluation has been adopted by BRE who administer both the Government Funded 'Low Carbon Building Programme' and the Big Lottery 'Community Sustainable energy Programme'. Appendix 3 has a list of benchmark figures for all the main renewable energy projects which all grant applications are assessed against.

In addition the assessment aims to draw attention to the wider benefits offered by the projects which are less tangible to quantify but believed to be of equal importance.

2.3 EVALUATION

The projects were evaluated against the criteria as laid out by the SDF. In addition the report tries to recognise the wider role that each project has in the dissemination and acceptance of small-scale renewables in the community. When looking at small-scale renewable energy generation the following points should be considered:

Electricity Generation

When looking at carbon savings in relation to electricity generation it is easy to calculate displaced kg or tonnes of CO_2 as the energy generated is either used on site or exported thus reducing demand for imported energy. Electricity has a high carbon content when produced via traditional fossil fuel methods therefore replacing electricity offers higher carbon savings per kwh than alternative fossil fuels such as gas and oil. However due to the technical requirements of these systems e.g. large south facing roof, grounds to accommodate turbine, scale of development within the environment and the typically more intrusive nature of these systems they generally displace a smaller percentage of the sites electricity consumption as compared to the potential for a low carbon heating system therefore making costs per tonne of CO_2 saved higher. Few sites have the potential to generate 100% of their electricity demands from on site renewable technologies due to the confines of their site.

Thermal energy

The opportunity exists with heating and hotwater systems to replace the existing system with a low carbon alternative offering high carbon savings as up to 100% of the fossil fuel consumption for space heating and hotwater can be replaced. However it is much harder to make a direct comparison against the equivalent litres of oil or gas that may have been consumed as they generally replace inefficient boilers or may run as a dual system for example. This issue is further compounded as many of these systems are only installed as part of a new build or major refurbishment project making direct comparisons impossible. Where refurbishment has taken place this often leads to increased occupancy of the building due to improved comfort levels and improved energy efficiency levels of the building. However for the purposes of this report some form of direct comparison has been looked at using some simple assumptions. These figures should therefore be used with caution; but give an indication of potential savings that the different systems offer. Where assumptions have been made these are highlighted in the case studies.

	Total installed capacity (kW)	Alternative energy replaced	Estimated % of energy replaced	Cost of renewable energy technology (£)	Annual carbon saving (Tonnes)	£/tonnes of CO_2 saved over the estimated lifetime of the system	CSEP Benchmark Figure (£/tonne CO_2)[1]
Barley Village Hall							
Solar PV	2.9kW_p	Electricity	UNKNOWN	£21,000	1.29	£651.77 tonne of CO_2 saved	£990
ASHP	28kW_{th}	Oil	UNKNOWN	£9,500	2.98	£71.15 per tonne of CO_2 saved	£225
Quernmore School							
Wind Power	5kW	Electricity	33%	£22,500	2.79	£402.96 per tonne of CO_2 saved	£531
Lower Gill Cottages							
Woodfuel	150kW_{th}	Lpg gas	100%	£45,000	83.46	£26.96 per tonne of CO_2 saved	£185
Slaidburn Village Hall							
Woodfuel	50kW_{th}	Oil	100%	£50,000	30.00	£83.33 per tonne of CO_2 saved	£83
Bleasdale Parish Hall							
Wind Power	6kW	Electricity	75%	£24,000	3.28	£366.33 per tonne of CO_2 saved	£419
Woodfuel	25kW_{th}	Oil	100%	£35,000	10.56	£204.08 per tonne of CO_2 saved	£83
Bleasdale Cottages							
Woodfuel	120kWth	Oil	100%	£55,000	36.96	£66.81 per tonne of CO_2 saved	£83
Bowland Wild Boar Park							
Wind Power	6kW	Electricity	3% for both	£25,000	1.125	£1,111 per tonne of CO_2 saved	£419
Solar PV	4kW_{th}	Electricity	As Above	£45,000	0.75	£2,400 per tonne of CO_2 saved	£990
Dalehead Church							
Wind Power	2.5kW	Electricity	95%	£13,000	1.07	£605.21 per tonne of CO_2 saved	£531[2]
Dovesyke Nursery							
Solar Thermal	4.5kW_{th}	Oil	100%	£1,500[3]	NDA	NDA	£489
Woodfuel	46kW_{th}	Oil	100%	£6,800	NDA	NDA	£83
Over Wyresdale Parish Hall							
Solar Thermal & GSHP system as a combined system[4]	16.4kW_{th}	Oil	60%	£15,000	3.72	£201.40 per tonne of CO_2 saved	N/A

Table 1: Carbon savings (tonnes) and cost (£ per tonne of CO_2) for each of the installed technologies

[1] Figure depends on the type of fossil fuel it is replacing
[2] This figure includes the costs of batteries, which the grant scheme would not fund. Therefore in reality this is likely to be in line with the benchmark figures
[3] Plus the costs of installation and commissioning which are currently unknown
[4] No data available to calculate cost and savings for standalone systems

Table 1 summarises the outputs and savings of each of the projects against the criteria as laid out by the SDF. In addition it looks at costs per technology and compares these with benchmark figures where possible as set out in the CSEP capital grant scheme. Theses benchmarks have been developed based on applications received for funding through the last two government funded grant schemes 'Clear Skies and the 'Low carbon Building Programme'[5].

It highlights the range of both potential carbon savings and the costs between the same technologies on different sites demonstrating again that some technologies are far better suited to the site than others. For example if a wind project is installed at a site with a less than optimum wind speed the costs for installation will remain the same but the potential carbon savings over the lifetime of the turbine will be less. Of particular note when looking at projects in isolation against the wider benefits both the wind turbine and solar PV system at the Bowland Wild Boar Park were very capitally expensive to install in relation to the actual energy they generate. The ground mounted solar PV systems were expensive and the wind turbine has been installed in an area of less than optimum wind speeds with some issues of turbulence. On the opposite end of the spectrum Lower Gill Cottages offers both high economic and carbon savings for the site. The woodfuel boiler has replaced 100% consumption of lpg gas on the site and offers high annual savings. Projects such as these can stand up as a legitimate business investment in their own right without the need for public funding.

Points of Note

- *Deciding on which technology*: There is a clear need for projects to receive independent advice to enable them to opt for the right package of technologies. Some projects received support from either CLAREN (Cumbria and Lancashire Community renewable Project), Lancashire Rural Futures or Lancashire Community Futures none of which are still operating in the same capacity to provide this free independent advice. This lack of support means that either little research is done or the installers who cannot provide an unbiased view decide on choice in technologies. In the case of some projects they had an idea for the technology they wanted to install and opted for this regardless of whether there may have been more effective alternatives. In some cases only one installer was spoken to. This can lead in some cases to technologies being installed in less than optimum conditions.
- *Monitoring:* None of the projects have carried out any formal monitoring. This makes it difficult to get accurate results to calculate both carbon savings and make direct comparisons. This was felt to be surprising as it was expected that people would be keen to find out if the systems were performing as estimated by the installers.
- *Cost of installed Systems:* It is difficult to get an exact cost of installation for the renewable energy technologies as different people associate different elements with the cost. Where possible we have tried to get the costs for only the generating technology e.g. turbine, boiler, fuel store etc and the infrastructure required to link it to the building. For example it would not include the cost of radiators, which are required whatever wet system is installed. In some cases it was not possible to accurately break down costs in this way, as the costs were part of a bigger contract. In these cases cost had been estimated.

[5] For Comparison Benchmark Figures used for financial evaluation under the CSEP Funding Programme – See appendix 3

- *Off Grid Sites*: For sites such as Dalehead Church and Bowland Wild Boar Park the cost of the installation also has to be looked at in relation to the capital cost of bringing mains electricity onto the site. In both cases tens of thousands was quoted making the economic viability of the renewable technologies more appealing.
- *Wind Turbines:* None of the wind turbines installed have been installed on optimum sites with high wind speeds. In addition some are also prone to turbulence from surrounding trees and buildings. If a project is to maximise on value for money and carbon savings offered by small scale renewable energy projects then optimum site conditions should be targeted. If considering wind projects in the future the SDF may look at wind speed as criteria for funding before making a decision about whether to support a project. As an example a double in wind speed leads to 8 times more energy generation and hence carbon savings. In addition it should be remembered that the weather is variable from year to year. Some of the wind turbines may have generated below expectation in the first year however this may be accounted for in part as the last 12 months has been a poor year for wind generation. Output will vary from year to year based on current weather conditions.
- *Solar PV*: Both solar PV systems have performed in line or above the installer's estimates. In both cases the solar PV systems are well sited on a south facing aspect with no shading. Variation in output will then be dependent on local weather conditions.

Every site is different with unique energy requirements and resource availability. Because of this it is difficult to make comparisons between different technologies. In addition not all sites have installed renewable energy technologies purely for the financial and carbon savings they offer. For most there are a range of reasons that offer additional benefits over and above the criteria that these projects have been assessed against. This should be remembered when looking at the conclusions. These may include:

- Lack of mains electric and the large cost associated with bringing it on site e.g. Bowland Wild boar Park, Dalehead Church
- The role of the project for educational purposes and demonstration e.g. Quernmore School
- Minimising long term running costs - The costs of generating both renewable heat and electricity is expected to remain fairly constant where as traditional energy prices are expected to continue to rise e.g. Barley Village Hall, Over Wyresdale Parish Hall, Slaidburn Village Hall, Dove Syke Nursery
- The role the installed technologies can play in marketing of businesses e.g. Bowland Wild boar Park, Bleasdale Cottages, Lower Gill Cottages
- Helping to access and draw down additional funding e.g. Bleasdale Parish Hall
- Linking in with local resources and networks e.g. Lower Gill Cottages

3 CONCLUSIONS

All projects installed have been a success in demonstrating the generation of both renewable heat and or electricity (this also includes Dove Syke Nursery which it assumes will be operational in due course). They have all offered the installer to varying levels reduced running costs through reduced dependence on imported fossil fuels and have made a contribution to reduced carbon emissions of the site. Where these technologies have been installed alongside improved energy efficiency measures these carbon savings can be further enhanced. Table 2 summarises each of the project in relation to the technical viability of the project and the wider benefits they offer:

Project	Conclusions
Barley Village Hall	This is an effective package of measures, which includes energy efficiency, renewable heat and renewable electricity. The project offers an estimated saving of around 4 tonnes of carbon per annum and offers good value for money over the lifetime of the system in relation of cost per tonnes of CO_2 saved. They have maximised on the potential electricity they could generate on site through the use of solar PV and the committee have worked hard to ensure they maximise potential savings from the heat pump system. This has lead to stable energy costs at a time when energy prices are increasing despite higher occupancy levels. As a community building it is accessed by a cross section of the community increasing the understanding of on site renewable technologies.
Quernmore School	Despite the wind speed being fairly low at the school the installer has maximised potential generation by putting the turbine on a high mast to reduce the risk of turbulence. This means that the project offers good savings in relation to cost and saves an estimated 2.8 tonnes of CO_2 per annum. The school is an Eco School and this turbine is part of a package of energy saving measures, which has varied educational value linking into the curriculum and raising awareness and understanding about the issues of climate change. However the school did not look at other renewable energy technologies, as they were keen to have a technology that made a visible statement about the schools commitment to reducing its carbon footprint.
Lower Gill Cottages	The woodfuel boiler at Lower gill is an excellent example of the benefits that a woodfuel system can offer when installed in the 'right location'. The owner received support and advice throughout the process from Lancashire Rural Futures, which made the project possible. It brings together the use of woodchip at an off grid high-energy use site, linking in local supply of woodchip and on site processing. The system offers significant savings to the installers. The system saves an estimated 83.5 tonnes of CO_2 per annum with a low cost per tonne of CO_2 saved over the lifetime of the boiler.

Slaidburn Village Hall	Slaidburn Village Hall is an impressive new build project in a conservation area on the edge of the main village. It incorporates high levels of energy efficiency alongside a woodfuel boiler. The committee were keen to look at renewable energy and throughout the development process spoke with several different organisations. Although a suitable technology for the site the committee were poorly advised throughout and the system installed is less than adequate. The system has been running on pellets, which do not offer the financial savings of a woodchip system. The committee are now investigating alternative low carbon solutions to try and address the issue.
Bleasdale Parish Hall	The installation of renewable technologies was part of an expansion and refurbishment project, which included energy efficiency measures and renewable technologies. The project received a lot of support from external organisations and the renewable element was seen as a way to help draw down funding. The project has received a lot of publicity and has helped put 'Bleasdale' on the map, which has been beneficial to the community. The pellet boiler, which replaced an oil one, was expensive to install as compared with other woodfuel systems. The combined systems give an annual carbon saving of around 14 tonnes per annum.
Bleasdale Cottages	The owner took the experience he had gained from the Parish hall project and used this to implement a woodfuel project at Bleasdale cottages. He did not investigate any alternative technologies. This is a good reliable system although a woodchip system would have offered better financial savings; however the owner is happy with the installed system and is maximising on the potential marketing opportunities that the system offers. The system gives an annual carbon saving of around 47 tonnes per annum.
Bowland Wild Boar Park	The site is off grid with electricity provided via a diesel generator. The site has minimal space heating requirements. The owner approached a single company who proposed the mix of solar PV and wind. The system makes minimal impact to the electricity consumed on site and for the cost there are alternatives that would have offered better savings. However the systems are good marketing tools for the park and link in with the Eco Lodge on site as an educational facility for local schools. The systems save an estimated 2 tonnes of carbon per annum
Dalehead Church	The project achieves what it set out to do – namely keep the church with power and dry and has been a high profile project, which has received large amounts of publicity. However it is questionable the technical viability of the turbine on the site due to low wind seeds and the proximity of large coniferous trees. The turbine is not generating as much energy as originally anticipated which means the church is not kept warm which had been the original aim. The system saves an estimated 1 tonne of carbon per annum.
Dovesyke Nursery	Both the woodfuel boiler and solar thermal system although installed have yet to be operational. This package offers the opportunity to meet space heating and hot water requirements on site. However as a business it is likely to have limited educational value for wider dissemination.

Over Wyresdale Parish Hall	The new parish hall incorporates high levels of energy efficiency alongside a GSHP and solar thermal. The system is a good package to meet space heating and hot water requirements throughout the year and saves an estimated 3.7 tonnes of CO_2 per annum. The key issues here is the limited occupancy of the hall due to the remoteness of the site and whether this package was the most appropriate for the site. No external advice was given outside that of the architect and installers.

Table 2: Summaries for each project

However as highlighted above small scale renewable energy technologies are still capitally expensive to install upfront making it difficult to opt for these systems without some form of financial support. Therefore when looking at value for money this has been calculated against the cost (£) per tonne of CO_2 saved. It is at this level that the issues relating to some of the installations are highlighted. Some projects failed to look at the opportunities for all renewable technologies across the site and talked to only one company about one technology. This can lead to less than ideal installations, which do not offer the best value for money. However it should be remembered some technologies remain more expensive than others e.g. solar PV therefore it is important not to compare cost like for like but to look at it within the proposed technology. Here it is important that technologies should only be installed on a site if they are technically viable and offer good returns for that specific technology. Not all projects appear to offer significant savings as compared to installing the alternative fossil fuel despite all the projects being off mains gas where the best economic scenarios are found. This can be accounted for due to the following reasons:

- ***Wind Power*** – Ideally wind turbines should be installed at wind speeds of greater than 5m/s at 10m above ground level (as per the NOABL wind speed database www.bwea.com/noabl). In order to achieve good levels of return on an installation. All turbines have been installed on sites at with lower wind speeds than this although the turbine at Bleasdale went ahead as the installer was confident actual wind speed would be better than estimated. In addition there are issues of turbulence at some of the site, which further reduces the turbines ability to capture the wind. The wind turbine at the Bowland Wild Boar Park is located in a low wind speed with some turbulence and this is reflected in its low generation. The turbine at Dalehead Church is close to a large coniferous plantation, which creates turbulence around the turbine. As these trees continue to grow the issue of turbulence is likely to be enhanced.
- ***Solar PV*** – This remains the most capitally expensive technology against the level of energy it can generate; however it has a key role to play for onsite electricity generation. The systems at the Bowland Wild Boar Park were very expensive to install even compared with a roof mounted system yet generate the same amount of power with the contribution it makes to energy use on site being minimal. In this case the money would have been better spent on a second wind turbine despite lower wind speeds, as this would have offered better returns. However this system has a lot of educational value, which the park can link into.

- ***Heat pump systems*** - These systems only deliver the financial savings if they are managed correctly. In many cases installers do not provide proper training and therefore the client continues to manage the heating system in the same way as they do an equivalent oil or gas system. This does not offer good efficiencies. Heat pumps systems should be operating fulltime at low temperatures and are then able to respond should increased temperature be required. They are not efficient at bringing a building up to temperature for cold. In the case of Barley Village Hall the committee have invested the time in learning about their system and because of this have got real financial savings. At Over Wyresdale the initial energy bills were higher than expected. This can be accounted for in part by one off energy use at the time of completion of the hall, however it is also felt that the committee are only now beginning to fully understand how to manage the system to optimise savings. It is hoped that savings will begin to be realised in the future.
- ***Woodfuel -*** woodfuel heating is one of the few renewable energy technologies that can stand up on its own economically when installed in the right location. However pellet systems do not offer the same savings as woodchip systems. This can be seen with both Bleasdale projects and the Slaidburn project as the cost of pellets is close to the cost of the equivalent volume of litres of oil. Pellet prices tend to be dictated by energy prices at the current time; however as the domestic manufacture of pellets continues to grow (there is a new pelletiser plant planned for Lockerbie in the next year to two years) then the market will become more competitive and prices are expected to begin to fall. It is at this time they may well be able to compete more effectively with fossil fuel alternatives. However woodchip systems offer real financial savings, which can clearly be demonstrated at Low Gill Farm. This is an ideal scenario for woodchip with a large heat load and access to low grade roundwood and the space to chip on site. However woodchip systems offer good savings even if buying in woodchip at a typical price of £70 per tonne as compared to oil or lpg and even increasingly in mains gas sites.

However it should be remembered that both Dalehead Church and Bowland wild Boar Park are off grid and have looked at renewable as an alternative to spending the large cost associated with getting mains services to the site.

Sale of Electricity: None of the projects generating electricity have yet signed up to selling the ROC's produced. Small-scale generators are eligible to claim ROC's or Renewable Obligation Certificates whether they use the electricity on site or export it. In the past this system has been extremely bureaucratic and time consuming which is the reasons cited by all projects for not maximising on the potential financial benefits these projects offer. However this system has been greatly improved and it is expected that all projects will sort this out over the next couple of months; particularly as the value of ROC's doubled in April 2009 improving the financial incentives significantly.

It is also worth bearing in mind that should Feed in Tariffs come in the financial income offered by such system will again be significantly improved.

England is still far from realising a low carbon economy and projects of this type although becoming more common are still a minority. There is much work still to be done to ensure that low carbon technologies are specified at new build or refurbishment stage (e.g. in schools when existing boilers are replaced, that the wider community is accepting of such projects and that bureaucratic systems are supportive of new development (e.g. planning permission). These projects are instrumental in driving this move towards a low carbon economy and therefore although they may not all offer the best value for money or be located in prime locations they have an important role to play in ongoing development of the sector and our move towards a low carbon economy.

4 LESSONS LEARNED AND RECOMMENDATIONS FOR THE AONB SDF IN THE FUTURE

The installed projects demonstrate the range of renewable energy technologies in lots of different applications. The projects evaluated have all been successful to varying degrees; however it is felt that in some cases the optimum technology, or package of technologies has not been installed therefore not offering best value for money in relation to the SDF funding invested in relation to carbon savings.

Recommendations when considering the funding of future renewable energy projects include:

1. That any projects funded can demonstrate they have carried out an options appraisal to identify which technologies are most suited to the site; and that any renewable energy technologies are installed alongside energy efficiency measures where appropriate. This may be their own research but they should demonstrate some understanding of the options
2. Evidence should be provided on what additional work is being done to improve the energy efficiency of the site alongside installing the renewable technologies. There is little value in installing capitally expensive renewable if basic low cost energy efficiency measures are not being installed alongside.
   That as part of the condition for funding the client is required to carry out regular monitoring of the systems and record the results. (The SDF could develop a template for monitoring to help simplify this process).
3. Consider developing a set of criteria against which to assess projects against. For example minimum windspeed. This will ensure that the systems installed offer maximum value for money and carbon savings achievable for such systems. [It is accepted that there will be some projects outside these criteria which offer benefits outside that of carbon savings and should be funded based on this]
4. Consideration should be given to whether the project can stand up in its own right and therefore is eligible for grant funding. For example some woodfuel projects installed in the 'right location' e.g. off grid, large energy user although up front are capitally expensive can have a payback of as little as 3 years. In cases such as this the SDF could offer loans if the project is not able to access the existing interest free Carbon Trust Loans.

Completed by Elizabeth Bruce
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Funded by The Forest of Bowland AONB For further information on their Sustainability Development Fund visit www.forestofbowland.com.

5 APPENDICES

5.1 APPENDIX 1 – RENEWABLE ENERGY TECHNOLOGIES

5.2 APPENDIX 2 – CASE STUDIES

5.3 APPENDIX 3 - BENCHMARK FIGURE TAKEN FROM CSEP CAPITAL FUNDING SCHEME