Esk Valley – A low carbon future

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Contents

1 Executive Summary

CO2Sense has been commissioned by Danby Village Hall and Esk Valley Community Energy Group (EVCEG) to develop a 10 year low carbon action plan – 'Esk Valley – A low carbon future'.

This action plan has been funded by the Department of Energy and Climate Change through their 'Local Energy Action Fund (LEAF)' program. Through this funding, CO2Sense have also completed a feasibility study for the Esk Valley, assessing the potential for renewable energy installations. It is recommended that this is read and considered in conjunction with the findings of this document.

Members of the Esk Valley community have an ambition to make the Esk Valley a more sustainable area and this action plan is a template from which their vision of a low carbon community can be realised. This is not a prescription of how this should be done, but a tool kit which outlines the different options of how this ambition can be achieved. It also proposes targets which could enable the community to realise its ambition of becoming more sustainable. It is not an exhaustive list of measures, but rather a springboard for further discussion, research and action.

For a community to become 'low carbon' they must be an active stakeholder in the process. For this reason, the emphasis within this low carbon action plan is placed on local people investing in energy efficiency measures and potential renewable energy installations. It is also an opportunity for local business, council or other public bodies to co-invest alongside the community - forging stronger ties between the corporate and local public spheres.

The document is broken down into four main sections:

1. Energy benchmarking – How much energy does the community use now?
2. Energy reduction – Can this energy demand by reduced and by how much?
3. Renewable energy generation – What potential is there to develop renewable energy generation?
4. How can this be achieved – What needs to be done to enable these changes?

It is crucial for those involved to appreciate that there are no easy wins that can lead to a low carbon society. There are many steps that need to be taken and changes that are required. This report helps to define those steps and sets out an action plan towards a low carbon Esk Valley.

1.1 Energy benchmarking

For the local community to be able to assess their progress towards a low carbon area, an energy demand benchmark must first be determined. CO2Sense have completed this baseline of current electrical and heat energy demand for the Esk Valley using published government figures. These can be seen in Table 1. Going forward, the community can use these annually published DECC figures to monitor and evaluate their change and progress.

Table 1 – Baseline summary

	Electrical	Heat
Current annual domestic demand	20,320 MWh	55,000 MWh
Potential annual domestic demand (With 30% energy reduction)	12,192 MWh	33,000 MWh
Estimated existing renewable energy generation	518 MWh	1,390 MWh
Potential Renewable Energy generation (as recommended in feasibility study)	933.85 MWh	4,161 MWh
Existing percentage demand met by local renewables	2.6%	2.5%
Potential percentage demand met by local renewables, with 30% demand reduction)	7.7%	12.6%

The total annual domestic electrical consumption has been found to be around 20,320 MWh and heat consumption is 55,000 MWh.

1.2 Energy reduction

This low carbon action plan scrutinises how the current energy demand can be effectively reduced. This includes measures of upgrading the building fabric of the housing stock in the Esk Valley, alongside draught reduction, glazing upgrades and the installation of smart meters.

This report has found that if 67% of the Esk Valley housing stock was improved to meet the 'super' insulated scenario as described in Section 5, then a reduction of current heat demand of 30% could be achieved. For electricity usage, a large number of reduction measures have been outlined and it is proposed that these could lead to a similar 30% reduction in electrical energy consumption.

By reducing the energy demand required by the community, through the energy efficiency measures suggested, the percentage of energy demand which could be met by renewable sources becomes much greater.

1.3 Renewable energy generation

The current estimated installed renewable energy generation in the Esk Valley is 2.6% for electricity and 2.5% for heat.

The corresponding report completed by CO2Sense, 'The Esk Valley Renewable Energy Feasibility Study' proposes that these figures could be increased through additional medium scale installations to approximately 7.7% for electricity and 12.6% for heat generation (this assumes that energy reduction measures have been implemented decreasing demand by 30%).

A further scenario in this report looked at larger scale projects including a large scale roll out of ground mounted PV installations, further Hydro development, greater uptake of heat pump technologies and large scale implementation of domestic biomass for dwellings off the gas-grid.

This resulted in an additional uplift of energy demand met by renewables of nearly 16% for electricity and 25% of heat. This scenario has been put forward as an ambitious target that the community of the Esk Valley should aim for.

It has also been highlighted that if the 27 wind hotspots defined in the feasibility study were developed for 50kW turbines instead of the 5kW turbines only currently accepted by planning, then the Esk Valley could meet 44% of its electrical energy demand from renewable energy.

Although these projects are more difficult to achieve than those outlined within the feasibility study and are likely to experience more difficulties with planning and public objection, by aiming high, the Esk Valley community is likely to deliver real change within the area.

This large scale deployment scenario (without the 50kW wind turbines) would see an installed capacity of 6,613kW, save 4,342 tonnes of CO_2e emissions each year, generate 15,161MWh of renewable energy and have a capital cost of £8.7 million. Depending on technology, this capital cost is likely to be paid back within 5 to 10 years.

These scenarios show that unless the large scale deployment scenario is achieved then potential levels of local renewable generation are relatively low compared to the levels of energy usage within the Esk Valley. This is due to a number of constraints, in particular those of planning and visual impact. The location within a National park also forms a barrier to large scale developments which could encroach into this protected area.

This highlights that whilst local generation can make a contribution, support for large-scale, national projects is essential in decarbonising the UK grid. However, local generation has a key part to play and the percentage contribution will increase as more energy efficiency measures are implemented.

1.4 How can this be achieved

Throughout the document, at the end of each appropriate section, there are recommendations and next steps to assist the community to meet the objectives of this report

This report has many key findings that can be implemented by the community to make the move towards becoming a low carbon valley. The area has many older buildings and it is difficult and expensive to make improvements and reduce the energy consumed to heat them. There are currently subsidised insulation and energy efficiency products available; however the main change will come with the implementations of the Government's 'Green Deal' which is currently being formulated. A key priority for members of the community is to keep up to date with the 'Green Deal' announcements and ensure that the local community is in a position to take advantage of these.

The Government is also currently subsidising renewable energy installations through the Feed in Tariff and the Renewable Heat Incentive. This makes renewable installations financially attractive for investors with projects offering short paybacks and good return on investments. It is recommended that the community takes advantage of the current financial incentives and progresses with projects while these subsidies are favourable.

Although this report has been structured as a 10 year action plan, it would be beneficial for the community to achieve these aims well before the end of the 10 year duration. With strong cooperation from the local council, businesses and other interested parties the community could enable these changes within a shorter timeframe.

Without community stakeholders onboard, creating a low carbon area will be a much more difficult task. Through programmes such as LEAF, the Government are helping communities to kick start engagement in the low carbon agenda. Members of the Esk Valley community, with the help of the work completed through LEAF, can start to drive this grass roots change forward and achieve a more sustainable future for the Esk valley.

2 Introduction

2.1 Background

To limit the effects of climate change and restrict global temperature rise to 2^0C there is currently an urgent need to reduce Greenhouse Gas (GHG) emissions. In 2008 the UK Climate Change Act set legally binding targets for the UK to reduce GHG emissions by at least 80% by 2050, set against a 1990 baseline.

It is now understood that our current lifestyle of high energy consumption is environmentally unsustainable. There is a drive both from the Government and local communities to re-evaluate and redress this balance. This gives an opportunity to reconsider some of the fundamental lifestyle choices we have previously made, and align these with a more environmentally sensitive path that will benefit us now and the generations to follow.

2.2 Danby Village Hall

Danby Village Hall, in conjunction with the North York Moors National Park, commissioned an energy audit for the hall. This acted as a catalyst for further action to be taken within the community. Danby Village Hall is managed by a committee which includes representatives from local organisations, including Esk Valley Community Energy Group (EVCEG). EVCEG have a vision to deliver a low carbon future for the Esk Valley. EVCEG is made up of local residents and has aspirations to achieve its 'vision' through four key deliverables:

- To reduce energy consumption,
- Investigate renewable energy options,
- Become an eco-friendly community and
- Produce low carbon ideas that benefit people within the community.

Danby Village Hall and EVCEG's vision for the area is based on the values of community, sustainability and enterprise. It brings together local residents, businesses, and community groups to develop a range of activities that will provide economic, social and environmental benefit to the community.

With EVCEG's support, the local community has already taken a pro-active role to ensure the area progresses with its low carbon ambitions. Esk Energy (Yorkshire) Ltd, a community organisation, are in the process of installing a 50kW Hydro-electric power plant on the River Esk, which will be another step towards their aim of becoming a low carbon exemplar area. EVCEG are committed to delivering the 'Esk Valley – A low carbon future' project and are already firmly engaged in existing community activities.

2.3 Aim of the report

This low carbon action plan outlines a 10 year strategy to support delivery of the EVCEG vision. It has been formulated by CO2Sense with close involvement from the EVCEG and is designed to guide them through the transition to a sustainable, low carbon future. The key aim of this report is to provide the following advice and direction to the EVCEG:

1. Energy benchmarking – How much energy does the community use now?
2. Energy reduction – Can this demand by reduced and by how much?
3. Renewable energy generation – What potential is there to develop renewable energy generation?
4. How can this be achieved – What needs to be done to enable these changes?

These aims fit within a low carbon process of change which engages and involves the local council and community throughout. An outline of the process put forward in this plan is shown in Figure 1.

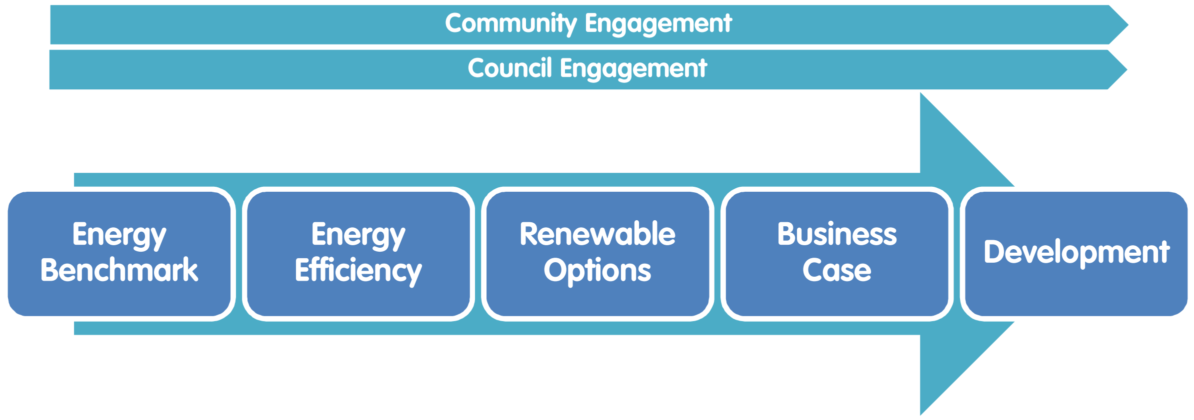


Figure 1 – Low carbon plan development process

2.4 Methodology

This low carbon action plan has been broken down into sections to help understand the current energy demand of the area, how this can be reduced and then evaluate what percentage of this unavoidable demand can be met by renewable energy. These points are highlighted below and follow the overall process in Figure 1:

Report Structure

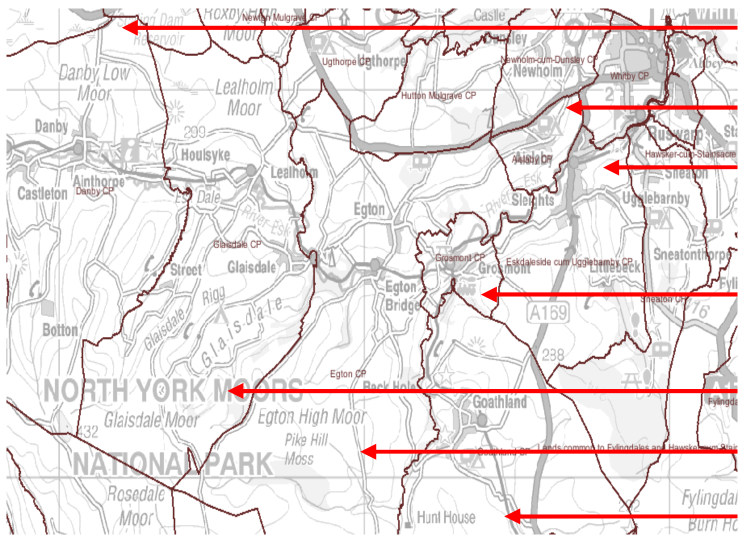
- Background
- Energy Benchmark
- Power down
- Power up
- Business case
- Timeline for action
- Community empowerment
- Conclusion and action plan

At the end of each relevant section there are conclusions and recommendations for next steps. The suggestions made in this low carbon plan should undergo further investigation and public consultation and are seen as a springboard for discussion, further research and action.

3 The Esk Valley

The Esk Valley, depicted in Figure 2 and Figure 3, is situated in the north of the North York Moors National Park. Geographically, the valley covers the area from Westerdale to Whitby. The River Esk flows along the valley and the community are set to harness the River's energy with a 50kW Archimedes turbine currently being installed at Ruswarp Weir. There are few major settlements within the National Park and the villages in the Esk Valley are thriving local communities, within which a determination to improve the sustainability of local energy consumption has developed. Many areas in the Esk Valley are in designated conservation areas and some buildings are listed.

Figure 2 – Satellite view of the Esk Valley (Bring maps images)



Danby
Aisleby
Eskdaleside-cum-
Ugglebarnby
Grosmont
Glaisdale
Egton
Goathland

Figure 3 –Parishes of the Esk Valley (neighbourhood statistics)

The valley is predominantly off the gas network and t he majority of space heating needs are met by bottled gas, oil and coal. Electricity supply is reasonably good, although there are only two entry points at each end of the valley which may constrain renewable electricity installations connecting to the National Grid. The Esk Valley is located within the North York Moors National Park and this constrains some developments of larger scale renewable energy technologies.

The Esk Ward has a small population of just over 4,200, as seen in Table 2. Ward data is used for identifying types of houses in area (see Section 3 and 4). However the majority of energy data is drawn from Parish level data as this offers a good breakdown for further analysis. It should be noted in Table 2 that there are less households than dwelling stock; this discrepancy is likely to be due to the holiday cottages in the area.

Table 2 – Census output data for the Esk Valley ward

	Esk Valley ward
Hectares	16,861
Total population	4,217
Households	2,085
Total dwelling stock	2,179

The local demographic is of an aging population with 42% of the residents over 50. Unemployment is higher than the national average, with a greater proportion of people employed in skilled trade and elementary occupations. The population of the Esk Valley area is approximately 4,217 and with an approximate area of 16,861 hectares. This gives a very low population density with small pockets of housing that make up the villages dotted around the Valley.

84% of homes are privately owned and a large portion of these are considered 'hard-to-treat'. With an average Environmental Performance Certificate grade E, there is a clear need for supporting home owners to reduce the energy demand of their homes and help to reduce fuel bills.

4 Esk Valley area energy assessment

Prior to assessing the potential renewable energy that can be generated in the area, a detailed estimate of the current electrical and heat demand must be considered. This report has broken down the energy use of the Esk Valley area to build up a picture of what proportion of this demand can be reduced through energy efficiency measures and what percentage of this reduced demand could then be met by installing renewable energy technologies.

This base line of existing energy use should also be used to assess the progress of the Esk Valley in becoming a low carbon area.

4.1 Energy consumption data

The current energy demand in the Esk Valley has been determined using the electricity and gas consumption data obtained from the Department of Energy and Climate Change (DECC). This is published for both domestic and non-domestic consumption of electricity and gas. In this report only the domestic data has been evaluated. The data is classified into different spatial areas according to census geographies.

- Census output area (COA) - A census output area is a grouping of approximately 115 dwellings
- Lower layer super output area (LLSOA) – are grouping of five to seven COAs
- Middle layer output area (MLSOA) – are groupings of four to six LLSOAs.

Data for domestic MLSOA level is available from 2005; however the more detailed LLSOA data is only available for domestic gas and electricity usage for 2008 and 2009.

Figure 4 depicts the MLSOAs, there are two MLSOAs in the Esk Valley – Scarborough 002 and 004

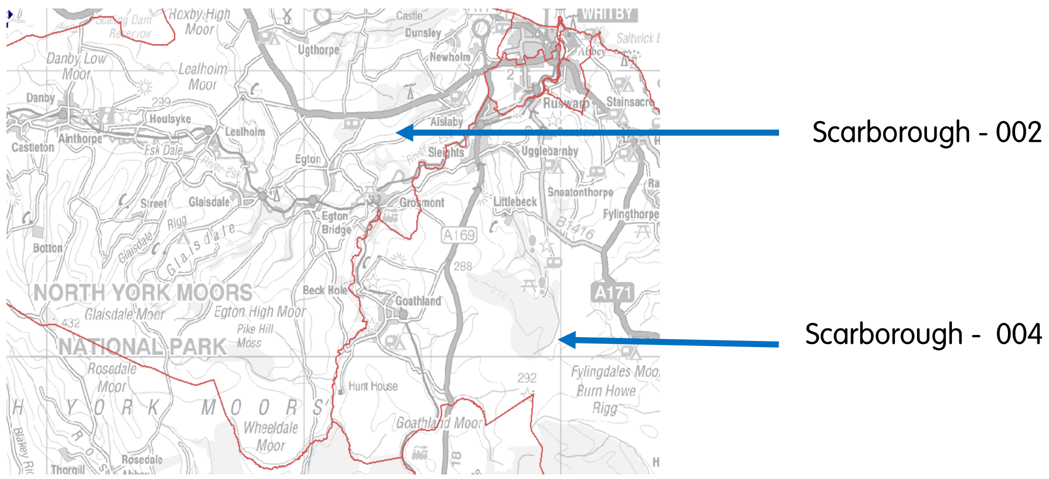


Figure 4 –Map depicting MLSOA for the Esk Valley (neighbourhood statistics)

Figure 5 depicts the LLSOAs for the Esk Valley. There are five LLSOAs in the Esk Valley – 002A, 002B, 002B, 004A and 004B.

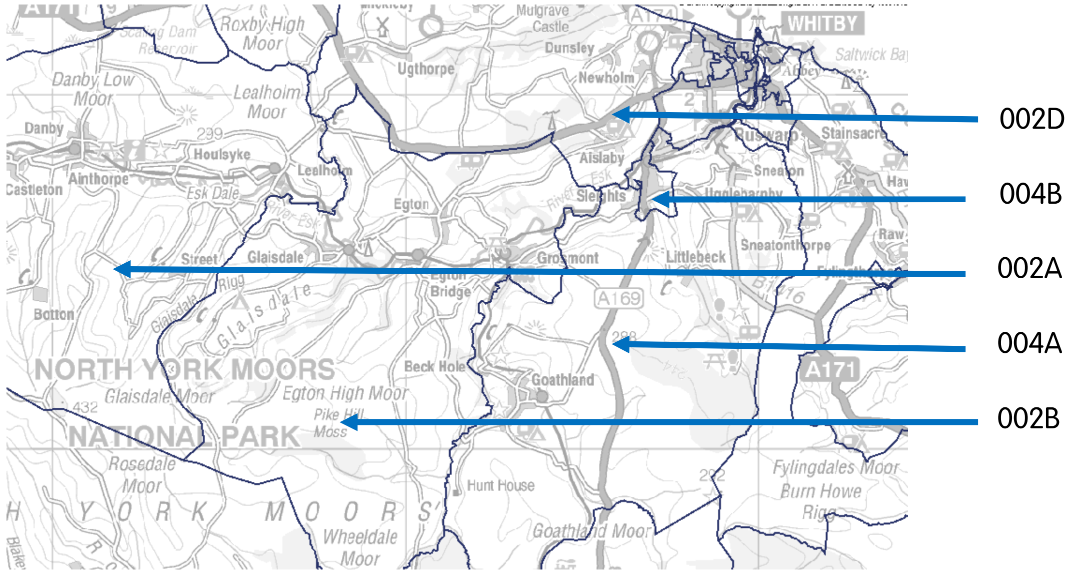


Figure 5 –Map depicting LLSOA for the Esk Valley (neighbourhood statistics)

Table 3 gives the populations and the number of households for each of the LLSOA designated areas. It can be noted that the combined area has a larger population than the Esk Valley ward data, however, as the data is collected in the areas defined by LLSOA groupings, these areas have been used for the energy benchmarking process.

Table 3 – Population data for the Parishes within the Esk Valley

LLSOA Name	LLSOA code	Population	Households
Danby	Scarborough 002A	2,219	784
Goathland	Scarborough 004A	1,413	627
Glaisdale/ Egton/ Grosmont	Scarborough 002B	1,368	584
Eskdale Cum Ugglebarnby	Scarborough 004B	1,436	641
Aislaby	Scarborough 002D	1,481	599
Total for the above areas		7,917	3,235

4.1.1 Electrical consumption within the Esk valley area

The total electrical consumption of the LLSOA areas for 2009 can be reviewed in Table 4. This shows a total consumption of over 20,000MWh. The data provides EVCEG with a baseline from which they can evaluate their annual electricity demand to assess if the energy efficiency measures implemented are effective at reducing their overall energy demand.

Table 4 – Esk Valley area electrical energy consumption data, 2009 (DECC)

LLSOA	Domestic electrical consumption (kWh)
Danby	5,152,360
Goathland	4,077,835
Glaisdale/ Egton/ Grosmont	4,131,576
Eskdale Cum Ugglebarnby	3,954,807
Aislaby	3,003,500
Total	20,320,077

Figure 6 shows the reported electrical consumption for the areas defined in both 2008 and 2009. It can be seen that the electrical consumption remains largely the same in both years for each area.

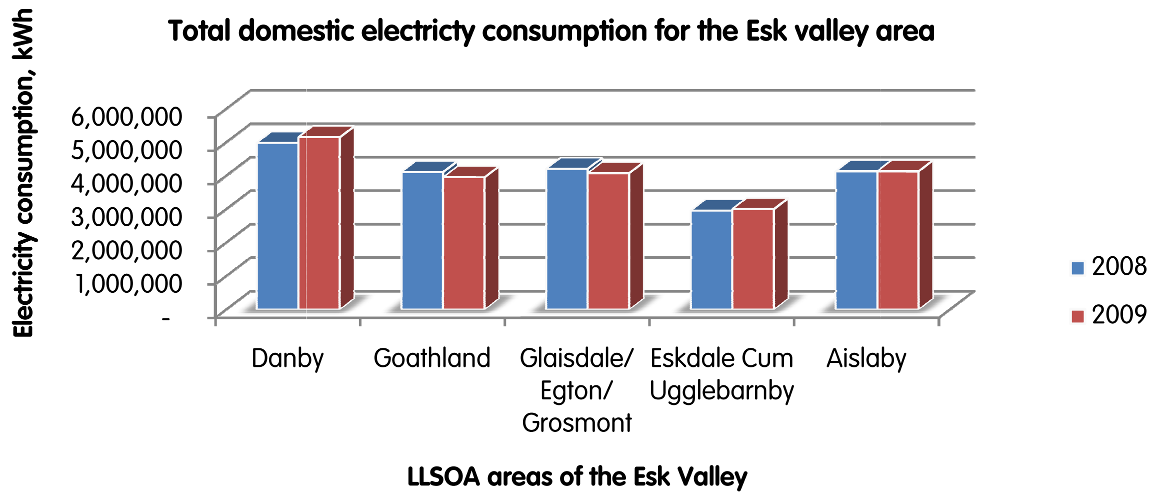


Figure 6 – Total domestic electrical consumption for the Esk Valley area

Figure 7 reflects the number of electricity meters recorded for the area, alongside the total number of households. It can be seen that there are a considerable number of households with economy 7 meters. This represents households that use electric storage heaters to meet their heating needs. This figure also shows that the total number of meters in the area is higher than the total number of households. This could be due to the number of holiday cottages or properties with outbuildings in the area.

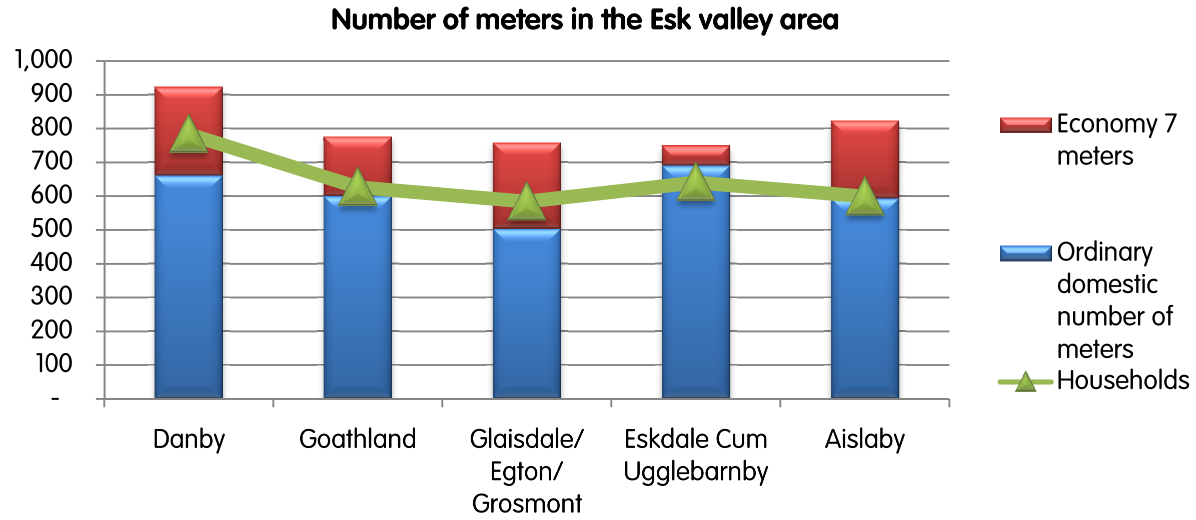


Figure 7 – Number of electricity meters in the Esk area, 2009

Figure 8 depicts the average annual electrical consumption per household for the Esk Valley area and the UK. It can be seen that the households that use economy 7 for heating have a much greater average consumption than those on ordinary meters. The Esk Valley residents that have ordinary meters have a similar consumption to the UK average. Heating homes using electricity can be ineffective, expensive and carbon intensive. A great effort should be made to replace existing electric heating systems with a lower carbon alternative.

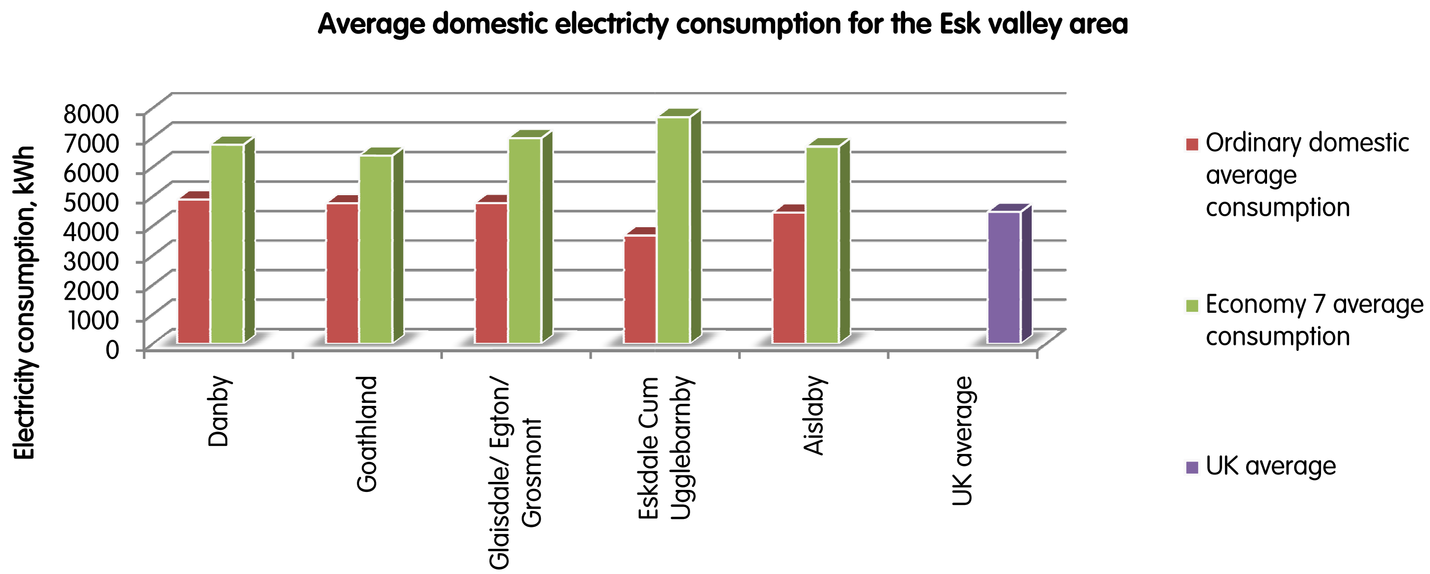


Figure 8 – Average electrical consumption per meter for the Esk Valley area

4.1.2 Gas consumption within the Esk Valley area

The total gas consumption in 2009 was nearly 22,000MWh and can be reviewed in Table 5. As with the electrical consumption data, these figures can be used to benchmark progress of energy reduction achieved through the implementation of energy efficiency measures.

Table 5 – Census output data for the Esk Valley area

LLSOA	Gas consumption, (kWh)
Danby Glaisdale/ Egton/ Grosmont Aislaby	4,062,898
Goathland	5,593,621
Eskdale Cum Ugglebarnby	12,245,194
Total	21,901,713

The total gas consumption for the Esk Valley areas is depicted in Figure 9 for 2008 and 2009. It can be seen that there is a reduction in consumption from 2008 to 2009. This decrease in consumption may be due to increased uptake of energy efficiency measures, or this could also be due to weather patterns.

It should be noted that the winter of 2009 was more severe than the previous year so milder temperatures may not be the reason for this drop in energy use. Nevertheless if 2009 had a milder autumn and spring compared to 2008 this would lead to less demand for space heating at the beginning and end of winter.

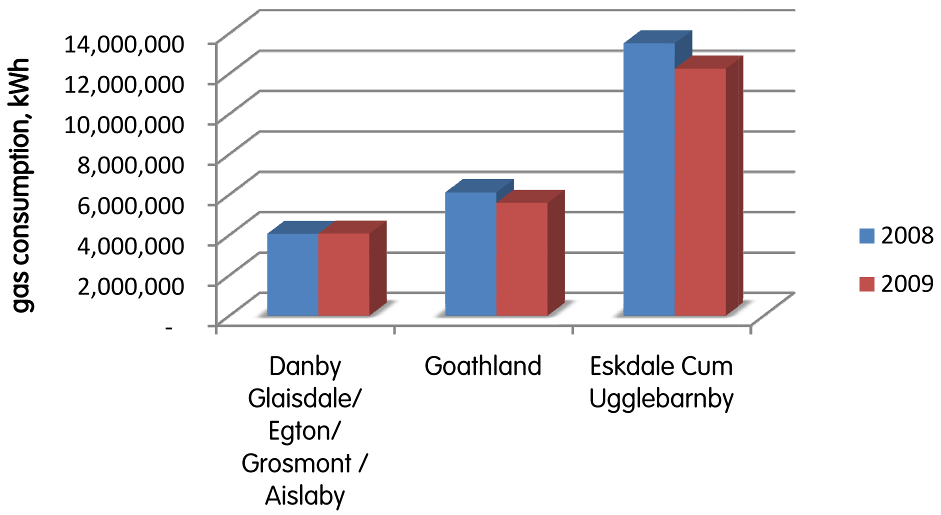


Figure 9 – Total domestic gas consumption for the Esk Valley area

The average UK house consumes approximately 16,500 – 20,000kWh of energy for heating and hot water each year. Figure 10 shows that the average gas consumption for all the areas falls within the average band.

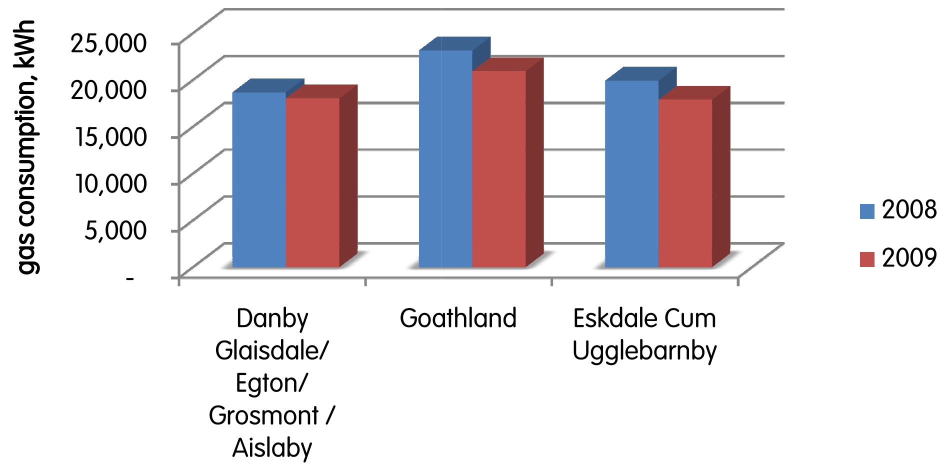


Figure 10 – Average gas consumption per meter for the Esk Valley area

4.1.3 Households off the gas grid

The data in Table 6 can be used to make a calculation of the numbers of households off the gas-grid and build a profile of energy use in the Esk Valley area. It has been assumed that the number of gas and economy 7 meters subtracted from the number of households will give an indication of the number of households off the gas-grid. This shows that there are at least 1,076 households off the gas-grid, which is approximately 33% of the households in the Esk Valley area.

Table 6 – Census output and DECC data for the Esk Valley area

LLSOA Name	Households	Economy 7 meters	Gas meters	Households off gas grid
Danby	784	263	225	994
Glaisdale/ Egton/ Grosmont	584	255		
Aislaby	599	230		
Goathland	627	176	267	184
Eskdale Cum Ugglebarnby	641	59	684	-102
Total for the above areas	3,235	983	1,176	1,076

Table 7 shows the approximate number of households off the gas grid multiplied by the average gas consumption for the Esk Valley area. This gives an approximate estimate of the heat consumption of houses off the gas grid.

Table 7 – Total heat energy demand for the Esk Valley parishes

Total heat energy demand for the Esk valley parishes	
Households off the gas grid	1,076
Average energy consumption per household (accounting for less efficient heating method than gas boilers) - kWh	24,659
Households off the gas grid heat energy consumption - kWh	26,533,084

An estimate of the total heat energy demand for the Esk Valley parishes has been calculated in Table 8 using the overall average consumption of gas figures. This gives a total head demand for the area of over 55,000MWh. Assumptions have been used to determine which fuels properties off the gas grid use. For example the percentages of LPG, Oil and coal that are utilised for space heating dwellings. These can be reviewed in Table 8. Key to this is the assumption that oil is used in the majority of properties off the gas grid.

Table 8 – Total energy demand broken down into energy source and CO_2e emissions

Type of energy consumed in the parish	Percentage of demand	Energy consumed within the Parishes	CO_2e emissions, tonnes
Electricity	12.1%	6,672,539	3503
Gas	39.7%	21,901,713	4,424
LPG	7.3%	4,022,836	17,491
Oil	33.5%	18,487,413	4,955
Solid fuel	7.3%	4,022,836	1,287
Total	100%	55,107,336	31,660

The assumed energy demand by fuel type can be seen in Figure 11. When compared with the UK national average it can be seen that Esk has much lower usage of gas, 40% compared to 83.4%. Meeting heating demand with coal, oil and electricity is expensive and carbon intensive. Upgrading those dwellings that are not on the gas grid onto a lower carbon heating plant, such as small biomass installations, would reduce house-holders fuel bills and CO_2e emissions.

A more definitive assessment of fuel used in those areas off the gas-grid could be undertaken through EVCEG to build up a more detailed profile of energy consumption in the area.

The energy consumed for space heating, by fuel type, is demonstrated in Figure 11. It can be seen that the Esk Valley area has a much larger percentage of people using non-gas heating than the national average. As gas heating is the lowest carbon intensive method of heating when compared to these other fuel sources, it can be assumed that the Esk Valley area will have greater CO_2e emissions to meet its space heating requirements than the national average.

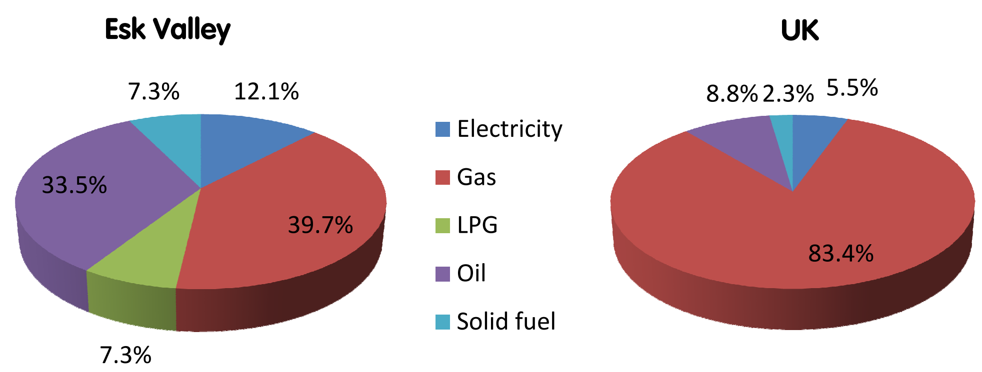


Figure 11 - Percentage domestic heat consumption by end use

4.1.4 Domestic energy use

The overall energy demand of each dwelling includes energy consumption for space heating, hot water and cooking. Figure 12 shows the percentage of domestic energy consumption by end use. This highlights the large consumption of energy for hot water, but the relatively small share used for cooking. This highlights the importance of also targeting hot water consumption in the home and initiating energy saving measures to reduce this demand.

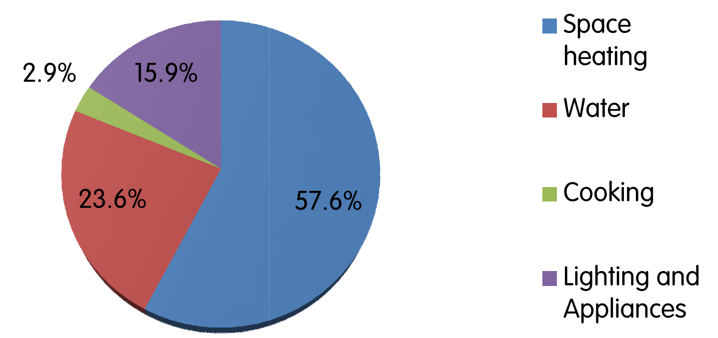


Figure 12 - Percentage domestic energy consumption by end use, 2008.

4.1.5 Historic energy trends

MLSOA data from the larger regions of Scarborough 002 and Scarborough 004 have been used to provide a historic evidence baseline for energy consumption in the Esk Valley. This historic data is not available for the more refined areas for the LLSOAs. Table 9 shows the total energy consumption for the two areas. This data is broken down into the separate areas of Scarborough 002 and Scarborough 004 in Figure 13 and Figure 14. Using these figures we can see there is an overall decrease in electrical consumption of 12% and gas consumption of 17% from 2005 to 2009, although the area of Scarborough 002 saw a spike in consumption in 2009. This could be due to the unusually low external temperatures during that winter period. However this is not mirrored in the Scarborough 004 area.

Table 9 –Total energy consumptions for Scarborough areas 002 and 004

Year	Total electrical consumption, kWh	Total gas consumption, kWh
2005	45,768,484	83,821,577
2006	43,868,780	70,886,258
2007	42,825,833	68,621,738
2008	40,851,677	65,334,627
2009	40,467,268	69,551,163
Percentage decrease	12%	17%

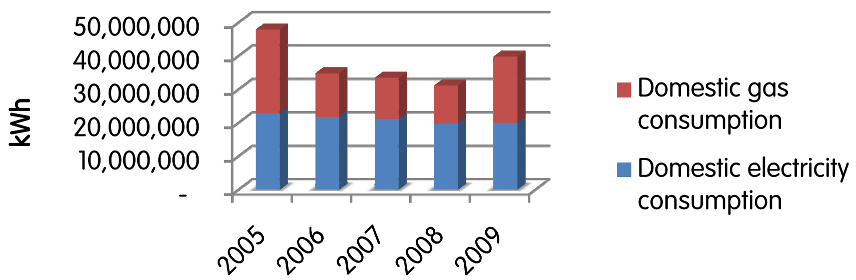


Figure 13 - –Historical domestic energy consumption in area – Scarborough 002

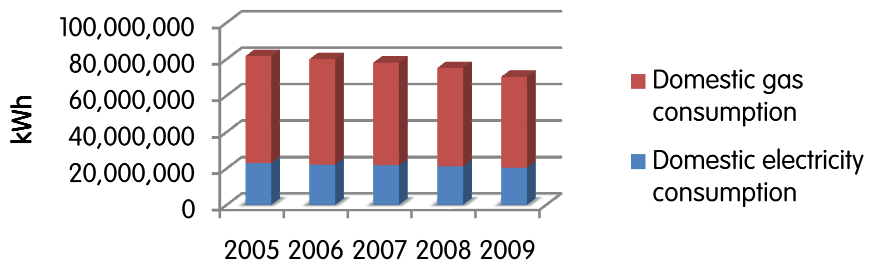


Figure 14 - Historical domestic energy consumption in area – Scarborough 004

4.1.5.1 Heat demand by sector

DECC has a tool to analyse the heat load of specific areas in the UK. This tool breaks down the demand for heat use according to different sectors. CO2Sense has used this tool to analyse the Scarborough 002 MLSOA area. Figure 15 demonstrates the breakdown of heat load described by the DECC tool. It can be seen that the largest user of heat is the domestic market, with a demand of 27MW. This emphasises the huge dominance of energy consumption in the Esk Valley used for domestic heating (98%). This shows the importance of targeting this sector for energy efficiency measures.

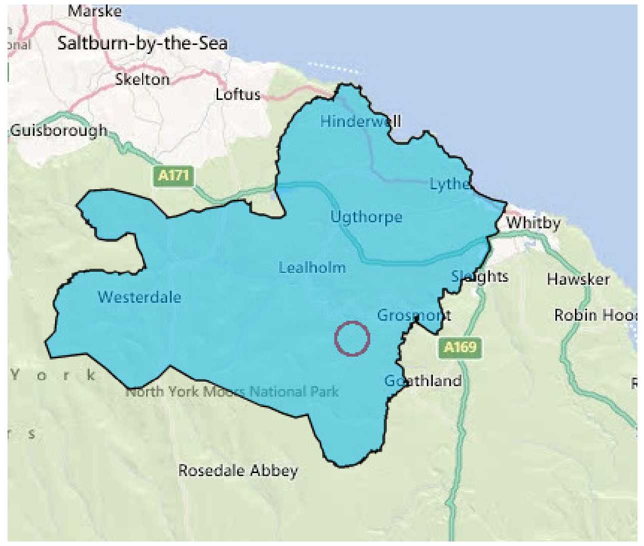


Figure 15 – Area defined by the DECC heat load tool

Table 10– Heat demand by sector for area Scarborough 002

Sector name	Total, kW
Communications and Transport	1
Commercial offices	35
Domestic	27,506
Education	137
Government Buildings	23
Hotels	211
Health	10
Other	63
Small Industrial	9
Retail	47
Sports and Leisure	18
Warehouses	52
Total	28,112

4.1.6 Conclusion – energy benchmarking

This section builds up a picture of the energy usage of the area. CO2Sense have found that the total domestic electricity consumption in the Esk Valley is 20,320,077kWh (20,320MWh) and the total domestic heat demand is 55,107,336kWh (55,107MWh). This data includes the wards of Danby, Glaisdale (including Egton and Grosmont), Aislaby, Goathland and Eskdale Cum Ugglebarnby. To meet the heat demand requires a heating load of 28MW.

The data used in this report is collated by DECC and can be used in the future to monitor the progress of energy reduction measures and the achievement of goals and targets set by the community. This benchmark can be used as a starting to point to evaluate successive year's energy demand. It has already been seen that there is a downward trend in gas and electrical consumption over the last 5 years, this trend should be monitored and measured to assess progress.

The energy benchmarking for the different LLSOA areas could be separated and evaluated in isolation, with renewable energy targets for smaller areas.

The average energy consumption of households within the Esk Valley mostly falls in line with the national average, however this is not a good way to benchmark energy consumption as the nation's average is too broad an indicator to be used for comparison with such a small area. Therefore it is advised that the total energy consumption for the area and a year on year target decrease of this total will be a better indicator of successful energy efficiency measures uptake.

It has been approximated that 33% of the households heat their homes with fuels other than gas. Solid fuel, oil and electricity are vey carbon intensive methods of meeting space heating requirements. It should be a priority to identify homes that are off the gas-grid and inform those householders on how they can upgrade their heating systems to a less carbon intensive method of heating.

Nearly 98% of the heat demand required for the area is for domestic use. The responsibility to reduce this energy consumption falls to the hands of the heat users; the householders themselves. If individuals address their own heat demand and reduced their energy consumption then the heat demand and the CO_2e emissions created from heating the homes in the Esk Valley area will be greatly reduced. The methods to effectively reduce heat demand are discussed in the 'Power down' chapter.

The recommended next steps on this energy benchmarking section are highlighted in the blue box.

Next steps

1. Continue to evaluate the baseline demand of the area to understand the current energy demand and how the consumption of energy is changing.
2. Annually reassess the energy demand for the area. This should be undertaken by the energy champions each year using the websites and resources provided in this report, to determine if any energy reduction measures implemented are making an impact.
3. Annually revise methods for encouraging people to uptake energy reduction measures if the impact has not been as expected.
4. Publish any changes, findings or progress on the EVCEG website to facilitate understanding and knowledge sharing.
5. Promote the website and further studies to encourage the community to take action and make changes to their buildings and behavior.

4.2 Energy audits of buildings in the Esk Valley

Five typical domestic buildings in the Esk Valley have been audited by Energy Champions from EVCEG to understand energy use and identify opportunities for energy saving measures which could be rolled out across the area. In addition, CO2Sense has audited two further community buildings. This section outlines the results from these studies to determine typical energy demand and building construction type and relate this to typical properties in the Esk Valley.

4.2.1 Typical properties in the Esk Valley

An assessment of the building stock in Esk has been taken from the Esk Ward profile data which gives an indication of the dwelling types in the Valley. This can be reviewed in Table 11. Determining the type of dwellings is important in order to further assess the potential insulation measures which may be suitable for the buildings and the potential financial and energy savings which could be achieved by upgrading the building fabric.

Table 11 - Number of households by dwelling type in the Esk Ward

Dwelling type	Quantity
House or bungalow	2029
Detached	1082
Semi-detached	577
Terraced (including end-terrace)	370
Flat, maisonette or apartment	48
Purpose built block of flats	12
Converted or shared house	22
Commercial building	14
Caravan or mobile structure	8

CO2Sense visited the Esk Valley and undertook a visual inspection of the properties in the villages of Danby, Castleton, Lealholm, Egton, Sleights and Glaisdale. The majority of buildings in the Esk Valley were found to be historic (early 20th Century), detached or semi detached stone wall properties. It was not confirmed if the stone walls were cavity or solid walls, however given the age of the majority of properties, CO2Sense estimate that the majority of buildings were solid wall. There are some concentrations of new build cavity stone semi-detached properties (e.g. Danby) and older solid stone terraced housing (Egton).

A preliminary questionnaire has been undertaken by EVCEG to gather data with regards to the type of properties and what energy efficiency measures they have implemented. At present there have been only 14 responses to this questionnaire and therefore the results are not statistically reliable. It is hoped that over time more of these questionnaires can be collected to build up a useful profile of the building stock which can help the community identify where energy efficiency measures can be targeted. Out of the survey participants, 71% reported that they have a solid stone wall building and 21% had brick walls. The majority of participants were residents of Danby.

CO2Sense undertook energy audits of two of the community buildings located in the Esk Valley:

- Danby Village Hall
- Castleton Village Hall.

Danby Village Hall is a stone cavity building with pitched roof and loft area. Castleton Village Hall is a mixed stone cavity and brickwork/stud wall.

4.2.2 Hard-to-treat buildings

A ‘hard-to-treat’ dwelling is a building of a construction type that can’t be easily modified to improve the building fabric and therefore reduce its heat loss. The buildings in the Esk Valley fall into this category and many buildings have the additional complexity of being located in a conservation area and National Park.

4.2.3 EVCEG audits

EVCEG has undertaken five audits within the Esk Valley and will be undertaking several more through the Energy Champions. These buildings were identified on the basis of:

- Representing “typical” building sizes and construction; and
- Availability of buildings.

EVCEG was constrained by willing participants and time as to their choice of buildings to audit. However the buildings audited were:

- 2 storey 1930’s brick cavity (filled) semi detached
- 2 storey 1990’s sandstone cavity (filled)
- 2 storey 1840’s solid brick
- 1 storey 1700’s solid stone
- 2 storey 19th Century solid brick

4.2.4 Energy demands of the buildings

EVCEG has undertaken energy audits of five typical domestic properties in the Esk Valley. No data has been captured on actual energy demand of these buildings. However the building structure has been detailed to enable comparison with similar buildings. This has been summarised in Table 12.

Table 12 - Summary of domestic energy consumption: EVCEG (2012)

Property	Type of building	Windows	Doors	Roof	Floor	Walls
1	1700's solid stone with 1970s extension	wood frame double glazed	wood	insulated pitched roof - high level	concrete floor, no insulation	no insulation in main building, extension includes cavity insulation
2	1991 sandstone insulated cavity	wood frame double glazed	wood	insulated pitched roof - moderate level	insulated	cavity insulation during construction
3	19th century solid brick	wood frame double glazed	wood	insulated pitched roof - moderate level	concrete floor, no insulation	no insulation
4	1849 solid brick	wood frame double glazed	wood	insulated pitched roof - high level	no insulation	no insulation
5	1930's cavity brick	UPVC double glazed	UPVC	no loft area	no insulation	retrofitted insulation

The Esk Valley properties are likely to have a varied heat demand due to a mix of ages and construction types. However, the majority of buildings audited and inspected visually were 'hard to treat' properties and therefore are likely to have a higher heat demand than the national average.

Table 13 shows the energy demand for typical dwellings according to the Building Research Establishment (BRE). These give average space heating demands of buildings with 150mm of loft insulation and where appropriate, cavity wall insulation.

Table 13 – BRE Space heating demand

House type	Floor area, m^2	Space Heating demand		
		Cavity wall, kWh	Solid Wall, kWh	Per kWh/ m^2
Mid-terrace	63	-	7961	123.3
Semi-detached	89	9674	-	108.6
Bungalow	67	7786	-	116.2
Detached	120	16944	-	141.2

Table 14 shows the results of energy audits for various buildings undertaken by Bradford Environmental Action Trust. The buildings audited spent between £728/yr and £1,354/yr on energy, dependent on building type and size. A calculation has been done to show the energy consumption per m^2 of floor area of the dwelling. This is a good way to look at energy demand as it means different buildings can be compared and an achievable benchmark can be set for residents to work towards. It is recommended that the buildings audited by the EVCEG in Table 12 should use their annual energy bills and floor area to calculate their heat energy consumption in kWh/m^2.

Table 14 - Summary of domestic energy consumption: BEAT (2012)

Type of buildings	Floor area, m^2	Energy use	Consumption	Cost	Carbon	Consumption
			kWh	£	Kg/CO2	kWh/m^2
1896 solid stone/brick: 4 bed 3 storey semi detached	140	Total Gas	17,893	781	3,317	128
		Total Electricity	2,587	425	1,393	18
1907 solid stone/brick 2 bed 2 storey mid terrace	60	Total Gas	10,063	438	1,862	168
		Total Electricity	2,174	290	1,167	36
19th century solid stone/rubble cavity 3 bed 3 storey semi detached	120	Total Gas	30,065	1,032	5,562	251
		Total Electricity	1,984	240	1,065	17
19th century solid stone/rubble cavity 3 bed 2 storey detached	100	Total Gas	25,660	846	4,747	257
		Total Electricity	3,762	508	2,020	38

Table 15 further demonstrates the energy consumption of dwellings with varied degrees of energy efficiency measures. The example of a semi-detached home pre and post improvements shows the significant reductions in energy consumption that can be achieved by upgrading the building fabric.

Table 15 – Space heating demand of typical dwellings

Type of dwelling	kWh/m^2
Pre-improvements semi-detached residence	160
Post-improvements semi-detached residence	54
A typical retrofitted building	30
A German Passive house	15

(Mackay (2008), ZCB (2011))

The heat demand for buildings in the Esk Valley will vary according to building type and size. However, an easy assessment can be made by dividing the annual heat consumption by the floor area to give the kWh/m^2 and the building can be compared to the benchmarks provided in Table 13 and Table 15.

The difference in energy usage between a building with energy reduction measures and a building that has not been upgraded is very large and the benefits of evaluating and improving the building fabric are enormous. Using the example in Table 15 of a semi-detached dwelling, the energy demand, post building fabric upgrades, is reduced by two thirds with corresponding CO_2e emission savings.

4.2.5 Community buildings

A summary of the community buildings energy consumption can be reviewed in Table 16. As Castleton Village Hall is electrically heated, CO2Sense has estimated the electricity used for heating compared to lighting and equipment, in order that this can be compared and assessed with other buildings.

The halls are broadly similar in energy use, however Table 16 demonstrates that Castleton Village Hall uses more energy on heating and has a greater energy and carbon cost associated with this. This is largely due to:

- the electric heating used at Castleton (this is detailed further in the next section) and also explains the higher energy costs per year of £1732; and
- The greater use of the building by the local community – the building is used almost every day in comparison to Danby Village Hall which is used slightly less frequently.

In summary the energy use for each hall is similar and this could therefore be used to compare and assess other community buildings across the Esk Valley. Recommendations made within the energy audit could also be appropriate for other community buildings and further investigation into their energy consumption, which could be undertaken by the energy champions trained under the LEAF remit, is advised.

Table 16 - Summary of Community Buildings Energy Use

Type of buildings	Energy use	Consumption	Cost	Carbon
		kWh	£	Kg/CO_2
Danby Village Hall	Total LPG (heating only)	6423	420	1,379
	Total Electricity	3680	640	1,931
Castleton Village Hall	Electricity (estimated heating only)	10499	1,350	5,512
	Electricity (estimated lighting/equipment)	2972	382	1,560

4.2.6 Conclusion – energy audits of typical dwellings in the Esk Valley

It has been evaluated that many of the dwellings in the Esk Valley fall into the 'Hard-to-treat' category. This means that reducing their energy demand is more of a challenge comparatively to a modern building. No energy consumption data is available from audits undertaken by EVCEG, however similar work undertaken in other areas suggests that an average detached domestic property may have a heat demand as high as 257m^2/kWh whereas the national average heat demand for a detached domestic property is 141m^2/kWh.

A key target needs to be those properties identified as off the gas grid and in particular those on Economy 7. Converting these properties to renewable sources of energy such as heat pumps or biomass will lead to large energy reductions.

Whilst reducing the heat demand of the housing stock in the Esk Valley may be a challenge, this means that there are potentially large energy savings to be made if improvements can be implemented. Reductions in energy usage will give a direct reduction in household fuel bills and costs.

Next steps can be evaluated in the blue box.

Next steps

1) The community could be encouraged to use the data from their bills and the floor area of their home to determine their energy consumption/m^2. This could then be compared to the recommended targets given by BRE.
2) The community could then assess what energy efficiency measures could be implemented and undergo upgrades.
3) These upgrades could be evaluated by rechecking the bill data and calculating the new annual energy consumption per m^2.
4) This is an effective way of the community monitoring their own energy consumption and comparing it to achievable targets.
5) EVCEG could encourage people to upload this type of data onto the website, to encourage other people to assess their energy demand and also to show people of the achievable changes that can be made.
6) Build a more complete profile of the housing stock in the Esk Valley and the wider community. The energy champions and other residents could identify many details which could give an effective overview of what energy reduction measures could be implemented and the effect this would have on reducing energy demand. Key questions to ask are:
   a) How many houses have solid walls
   b) How many houses have cavity walls
   c) How many cavity walls are un-insulated
   d) How many houses have single glazed windows
   e) How much loft insulation do the houses have
   f) Are the houses draft proofed
   g) What type of heating systems do the houses have
   h) How old are the heating systems
7) The energy champions, or volunteers, should assess community buildings and canvass local businesses to evaluate improvements that they could make.
8) Collection information gathered by doing simple door-to-door surveys, or a simple questionnaire which could be posted on the website.

5 "Power Down" - Potential energy reduction measures

In this section, CO2Sense offers assistance to EVCEG and the local community by giving guidance on how domestic energy use can be reduced. Further information can be obtained from the Energy Saving Trust (http://www.energysavingtrust.org.uk/).

5.1 Domestic energy consumption

Figure 16 show a breakdown of UK CO_2 emissions, by sector, between 1990 and 2010. The residential sector currently has an overall share of approximately 17% of total UK emissions and it can be seen that residential emissions have remained relatively steady over the last 10 years whilst other sectors have begun to reduce.

This reduction is largely due to the other sectors trying to reduce their costs, along with meeting regulatory requirements. This regulation has been largely absent from the residential sector and whilst there have been national schemes aimed at reducing energy usage, these have had limited impact on the overall figures.

Even though the residential sector is not the largest emission producer, it does present the best opportunity for local communities groups to make an impact on emission levels whilst also reducing fuel bills. As the emission levels of other sectors decrease, the % contribution of the domestic sector to total emissions increases. This can begin to be readdressed using some simple measures outlined in this section.

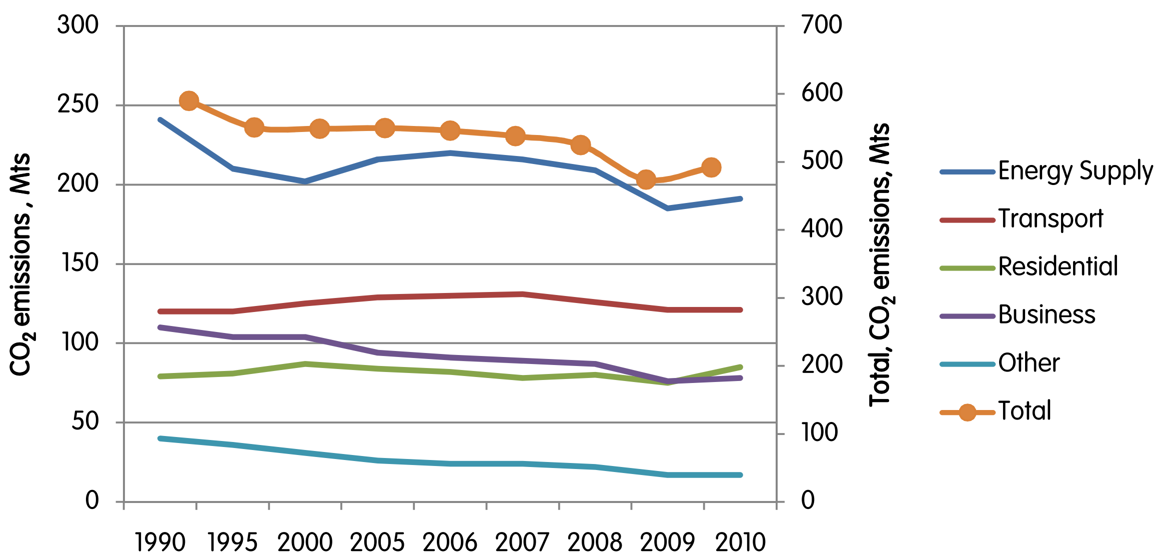


Figure 16 – Sources of carbon dioxide emissions, 1990-2010. (DECC)

5.1.1 Fuel Poverty

"*A household is said to be in fuel poverty if it needs to spend more than 10% of its income on fuel to maintain an adequate level of warmth (usually defined as 21°C for the main living area and 18°C for other occupied rooms)*" DECC, 2009.

In 2007 the number of fuel poor households was 4 million. By 2009 this had risen by 27% to 5.1 million (DECC 2009). Energy prices are continually rising at unprecedented rates and as income stagnates the issue of fuel poverty grows year on year. The causes of fuel-poverty are highlighted in Figure 17.

Ensuring that people can meet the basic need of maintaining an adequately heated home affordably is an increasingly urgent priority. Ensuring that dwellings reduce their energy consumption reduces one of the causes of fuel-poverty.

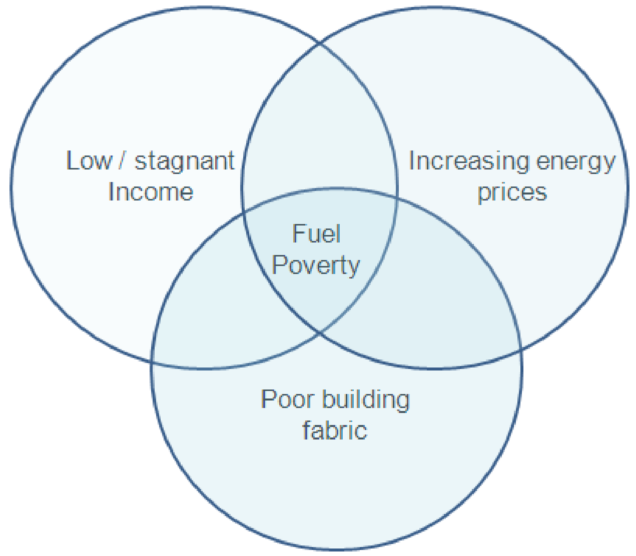


Figure 17 – Causes of fuel-poverty

5.1.2 Tackling the building stock problem

Whilst there is increased regulation on the energy efficiency of new build properties there is no legal requirement to improve existing buildings. Refurbishing the existing housing stock of the UK is an important consideration as 75% of the current housing stock is expected to still be in use in 2050. The UK is made up of many draughty, un-insulated and poorly maintained dwellings that give us amongst the worst housing stock energy performance in Europe. However, with a successful retro-fit programme the average home's energy demand could be reduced by up to 60% vastly reducing the CO_2e emissions this sector produces.

As many of the dwellings in the Esk Valley area are in designated conservation areas, listed or categorised as 'hard-to-treat' this poses significant issues when considering remedial measures to reduce their energy demand. Consultation with conservation officers should be sought throughout the process of improvements. A 'hard-to-treat' dwelling is a building of a construction type that can't be easily modified to improve the building fabric and therefore reduce the heat loss from the building. The valley has an abundance of stone buildings, some are solid wall and some are stone clad. There are small pockets of new build properties, but these tend to be more towards the bottom of the valley nearing Whitby.

5.1.3 Space Heating

Figure 18 indicates that 57.6% of domestic energy is utilised for space heating (SH). This means that reducing this large energy demand, through achievable energy efficiency measures, could not only have a dramatic impact on lowering CO_2e emissions for the area, but also reduce the risk of households falling into fuel poverty.

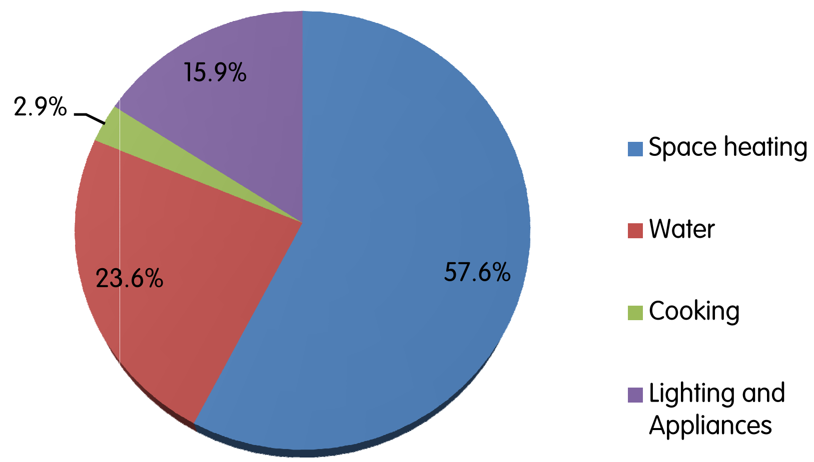


Figure 18 - Percentage domestic energy consumption by end use, 2008 (DECC)

5.2 Reducing space heating demand in the home

Heat escapes from our homes in two main ways; fabric heat loss and ventilation heat loss.

5.2.1 Fabric Heat loss

Fabric heat loss is when heat is lost through any part of the house structure which is either exposed to outside air or to an area of unheated space. The heat lost is:

- Dependent on building material
- Dependent on the temperature difference between the external air and internal air.

The areas that typically experience heat loss are: walls, roof, windows and floors.
A standardised method is used to indicate the different rate of heat transfer through different building materials. This is known as the U-value and puts a value on the rate at which the heat passes through a particular material. The lower the U-value the slower the heat will transfer through a material. By upgrading the building fabric of a dwelling the U value is lowered and the building is able to retain more of the heat within, requiring less consumption of fuel to maintain the comfort temperature required.

DECC suggest that in order to improve the overall average heat loss coefficient (HLC) of the existing housing stock, the measures in Table 17 should be undertaken with the resulting drops in U-value.

Table 17 - Impact of insulation measures for domestic buildings

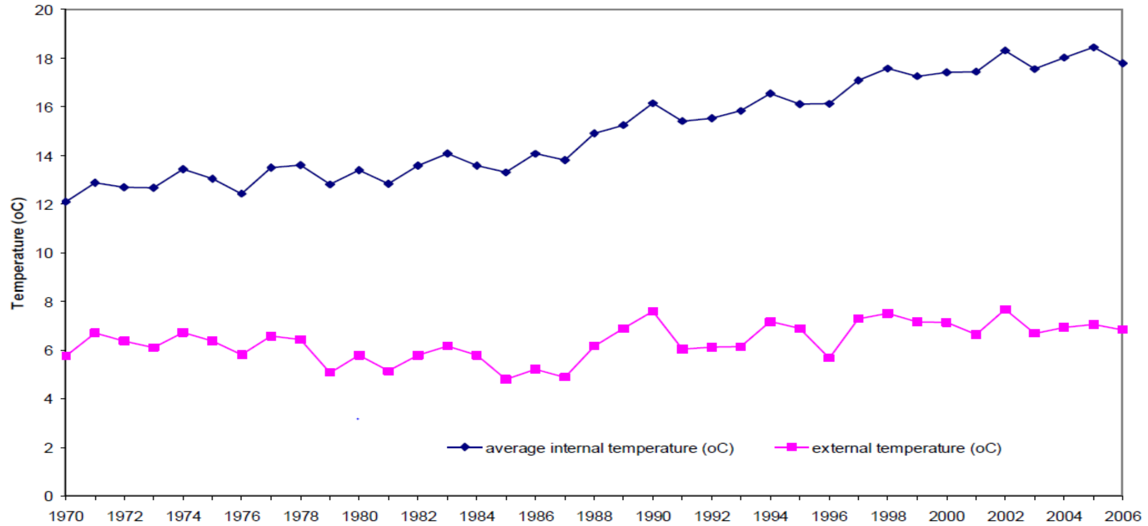
Element	Assumed average U-value (W/m²K)	
	Pre- insulation	Post- insulation
Solid wall	2.20	0.35
Cavity wall	1.60	0.35
Floor	0.60	0.16
Glazing (single-triple)	2.20	1.00
Loft increasing mineral wool insulation	0.29 (125mm)	0.16 (270mm)

5.2.2 Ventilation heat loss:

Ventilation heat loss is when heat escapes as a result of airflow in and out of a building. This occurs through both controlled ventilation such as windows and doors and uncontrolled ventilation. Uncontrolled ventilation is a result of air infiltration through cracks and gaps that naturally exist within a building such as letter boxes, gaps in floorboards and open unused chimneys. Uncontrolled ventilation is often more of a problem for older style buildings. Ventilation heat loss is usually measured in Air Changes per Hour (ACH) which denotes how long it takes for the air in a room to be replaced without aiding ventilation.

5.2.3 Behaviour change

Behaviour change is an important tool for reducing the energy our buildings consume. Understanding the building, its fabric and the heating system is important in ensuring that it is heated in the most fuel efficient way possible. Our move away from heating our homes with coal fires towards convenient and clean gas has made us less energy conscious. Only one or two generations ago there would only be one fire that would heat the living area of a house. It would have been unimaginable to have had each room burning a coal fire every evening. However, with our modern heating systems, the boiler fires up and heats the entire house even if the majority of the rooms are unoccupied. Our expectations of internal comfort temperatures have risen over the years and can be seen in Figure 19. The steady rise in internal temperatures corresponds to increases in space heating needed to meet these increased temperatures.



(Shorrock, 2008, p45)

Figure 19 – Mean internal and average winter external temperature

According to Mackay (2008) by only heating the spaces we use, a decrease of 40% in heat demand can be achieved. Turning down the thermostat by 1^{0}C can cut more than 10% from the average central heating bill. Therefore before energy efficiency measures are implemented evaluation needs to be made of how the heating system is used:

- Which rooms are heated?
- When are they heated?
- For how long are they heated?
- What temperature are they heated to?

5.3 Building fabric improvements

As the majority of dwellings in the Esk Valley are solid Yorkshire stone or similar construction and off the gas network they can be classified as "hard to treat" with regards to building fabric improvements. In addition the many buildings are in a National Park and/or conservation areas and therefore face additional potential restrictions from planning as to what measures can be implemented. Consultation with conservation officers should be sought throughout the process of improvements.

The refurbishment of dwellings should take a holistic approach, whereby the remedial measures are considered as a long term improvement to reduce the energy demand for the current occupants and the occupants over the course of the dwellings future.

Consideration should also be taken as to the embodied energy of the materials used for the retro-fit. Embodied energy denotes the energy consumed to extract, manufacture and transport the product. Therefore using a natural product such as locally sourced wood, which locks in or sequesters carbon into the building fabric, should be considered over a plastic product which has been manufactured using large amounts of fossil fuels. Therefore, a wooden floor instead of man-made carpets or natural products for insulation rather than carbon intensive insulations will give added carbon savings when the dwellings are upgraded.

The logistics of implementing a large scale programme of retro-fitting is an enormous challenge. Completing this process using a systematic village by village approach will dramatically reduce the overall costs than a piece meal method of individual households upgrading.

5.3.1 Walls

35% of heat within a home can be lost through the walls making this is an important area to remedy, if feasible. Three options exist to reduce heat loss for domestic properties.

5.3.1.1 Cavity wall insulation

Cavity walls are usually found in properties built after the 1920's and 1930's. This new method of constructing external walls was to reduce the spread of damp through to internal walls. These cavities can be insulated to reduce the heat loss through the walls. The most common method is where a series of holes are drilled through the outside wall and the cavity is filled with insulation material. This insulation material will be moisture-repellent to prevent damp. Cavity wall insulation will not be possible for many of the properties within the Esk Valley due to their solid wall construction. Other options that can be implemented on buildings constructed with solid walls include external and internal wall insulation. This type of insulation works by creating another wall or dry lining and insulating the cavity created.

5.3.1.2 Internal wall insulation

Internal wall insulation is a method of insulating the internal walls of a property. This is done through two main methods; plasterboard laminate and wooden batten in-filled with insulation. Plasterboard laminates are ready made boards that are fixed directly to the wall whereas the 'wooden battens' method fixes wooden battens to a wall with plasterboard built on top. The cavity is then filled with insulation. This type of insulation can reduce the U-value from 2.1 to 0.45. However, payback on internal wall insulation can be lengthy at 30 years due to the initial high capital cost. It will also reduce the usable area of internal rooms which may be unacceptably inhibitive in small premises. In some cases, due to the extensive civil works carried out, the residents may have to vacate the property whilst the work is being completed.

5.3.1.3 External wall insulation

External wall insulation is a method of insulating an outside wall which is finished with a protective weatherproofing material. This process is also knows as thermal cladding and there are several methods available. This type on insulation will not be possible on properties within the majority of buildings in the Esk Valley due to planning restrictions. In addition, the average payback for external wall insulation is 40 years often making this measure an unfeasible option.

5.3.2 Windows and doors

Homes in the Esk Valley may have restrictions on the types of windows which can be installed. Many dwellings in the valley have inefficient single glazed windows. These can be replaced with double or tripled glazed windows which will reduce the U-value and therefore the heat loss from the dwelling. A window can be double glazed by fitting a single pane of glass or plastic to an existing window (know as secondary glazing) or by replacing the window with a sealed double glazed window.

If specific homes face prohibitive restrictions on windows due to the conservation restrictions, secondary glazing can be installed at lower cost (and lower effectiveness).

5.3.3 Roofs and floors

Other internal improvements can be made without the worry of infringing the appearance of the buildings. Loft insulation can be maximised, either between the rafters or between the joists. A minimum between the joists should be laid of 270mm to help give a reduced U-value and heat loss. 'Do it yourself' loft insulation of 270mm should pay back between three and four years. After loft insulation is installed any cold water tanks in the roof area should also be insulated as the roof area will be cooler. Any connecting piping should also be insulated to avoid the risk of freezing and bursting in cold weather.

Ground floors can lose up to 15% of the heat in a home. There are two main types of floor insulation depending on the type of floor a home has; suspended timber floors and solid floors. However floor insulation will mean removing the existing floor and therefore should ideally be carried out whilst other works are being completed. Suspended timber floors can be insulated under the floor boards between the joists. Solid floors can be insulated by fitting a 'floating floor' with an insulating layer.

5.3.4 More efficient heating system

Old boilers are less efficient than the modern condensing boilers. Condensing boilers are more efficient as they are more effective at recovering heat lost through the flue. Replacing an old gas boiler with an A-rated high-efficiency condensing boiler and improving the heating controls can reduce the homes fuel bill by around £300 a year[1].

Upgrading the insulation on a hot water cylinder is an inexpensive and easy measure with a quick payback of around six months to one year. Un-insulated or poorly insulated cylinders lose a lot of heat and should be priority measure in the home if this has not already been done.

5.3.5 Draught stripping

Windows and doors can lose heat through controlled ventilation heat loss, when they are opened and uncontrolled heat loss, through gaps around the edges. Measures to reduce heat loss through windows and doors include draught proofing and insulation. A wide variety of materials are available to close gaps around windows and doors including seals and liquid sealants. Draught proofing will result in short payback periods (between two and three years) as these measures can usually be carried out by the home owner. Therefore this should be a priority measure particularly as uncontrolled ventilation loss is more of a problem for older properties.

There are various methods of insulting windows to reduce heat loss. Simple measures include fitting curtains (thermal lined) and blinds. Placing a layer of material in front of a window or door will create an insulating barrier therefore reducing heat loss. Most rooms in a home will require curtains so it is worthwhile getting the maximum insulation from them. If there is no radiator below the window then curtains should be floor length with additional fabric covering the floor. This will trap colder air behind the curtain and reduce draughts. Well fitted blinds can also reduce heat loss through windows. If there are unused fire places, ensure the chimney has a damper fitted to reduce the ventilation.

5.3.6 Preparing houses for the effects of climate change

It is uncertain what effect climate change may have on the UK local climate. The two coldest winters on record have been felt as recently as 2009 and 2010 and have been held responsible for the reported increase in CO_2e emissions in the UK. This highlights the whimsical nature of previous emissions savings and how fragile those gains can be in the face of dramatically colder winters.

Various measures can help protect the home from unavoidable changes in the weather. Insulating the home will not only keep the dwelling warm in winter but will also keep the dwelling cooler in the summer. Rather than using air conditioning which will cost money and increase energy use, make use of natural ventilation in the home by opening the windows at the highest and lowest points in the house or on opposite sides to assist natural ventilation. Closing curtains and blinds in the day time during hot spells will help keep the heat out.

Many homes are now at increased risk of flooding due to changes in weather patterns and increased rainfall. The Environment Agency's map below indicates areas at risk of flooding:

- www.environment-agency.gov.uk/homeandleisure/floods/31650.aspx

As the Esk valley has the River Esk running through, those houses near the river should check the flood status of their area. The UK is likely to experience more droughts in summer months, therefore saving water will become even more important. Simple measures such as fitting a water butt in the garden can help reduce dependence on mains water supply.

[1] Energy Saving Trust

5.4 Reducing heat demand in the Esk Valley building stock

Table 18 shows the modelled results of two typical dwellings with increased insulation measures and draft proofing. The improvements and calculations, using the Chartered Institute of Building Services Engineers (CIBSE), can be reviewed in Appendix 1. The super insulation levels show the dramatic reduction in energy that can be achieved, with corresponding CO_2e savings, with these increases in energy efficiency measures.

Table 18– Calculated energy demand of a 1930's semi-detached and Victorian terrace house

Type of house	Level of insulation	Total energy demand per year, kWh	Percentage reduction in energy from standard insulation	Annual energy demand per m^2, kWh/m^2
1930's Semi-detached house	Standard	12162.8	-	95.3
	Extra	8557.6	29.64	67.0
	Super	4845.2	60.16	37.9
Victorian terrace	Standard	20209.2	-	146.3
	Extra	14726.0	27.13	106.6
	Super	9597.1	52.51	69.4

Taking the number of house types in the Esk Valley that are terraced and semi-detached a rough approximation can be calculated as to the energy and CO_2e emission savings that could be achieved with a roll-out of super insulation measures. This makes the very broad assumption that the house types 'terrace and semi-detached' are all the same as those modelled, which although will not be the case, gives a rough indication of the area wide savings that can be made. The 1930's semi-detached house that was modelled had a standard level of insulation, including cavity wall insulation, which many of the homes may not have. Therefore this is thought to be a conservatively considered broad assumption. The results can be seen in Table 19.

Table 19– Calculated energy demand of a 1930's semi-detached and Victorian terrace house

Type of house	1930's Semi-detached house	Victorian terrace
Number of houses in the Esk valley	577	307
Annual energy saving per house if insulation level is increased from standard to super, kWh	7317.6	10612.1
Annual energy saving for house type in Esk Valley, kWh	4,222,255	3,257,915
Annual CO_2e emissions savings per house, tonnes	1.96	2.84
Annual CO_2e emissions savings for house type in Esk Valley, tonnes	1131.5	873.1

It can be seen that if these two houses types underwent these improvements then the heat demand for the area would be reduced by approximately 14%. The CO_2e savings have been calculated according to the savings being made where a property has oil fired system. Table 20 offers a broad assumption of the heat demand reduction that could be achieved if all properties in the Esk Ward were super insulated. These approximate calculations suggest that a total heat reduction of 44.7% could be achieved.

Table 20– Estimation of potential heat demand savings with dwellings super insulated

Type of house	Total number of terrace and semi-detached properties	Total in Esk Ward
Number of dwellings	884	2029
Approximate head demand for Esk Valley area, kWh	55,107,336	
Percentage heat demand reduction	14.0%	31.1%
Energy savings/year with super insulation, kWh	7,480,170	17,168,851
Heat demand with all houses super insulated, kWh	30,458,314	
Percentage reduction in head demand	44.7%	

5.4.1 Conclusion – domestic heat demand

It can be seen that domestic energy use gives rise to a large percentage of the UK's total CO_2e emissions. Of this demand; the largest share of energy is used for space heating. There are also a growing number of households living in fuel poverty who struggle to maintain their properties at an adequate level of warmth throughout the year.

This energy consumption, and its costs, can be greatly reduced by improving the building fabric of the existing housing stock, which is largely made up of old and poorly insulated buildings. This section has looked at a number of measures that can be implemented which can make a large impact on the heating requirements of a property. The key measure highlighted is the improvement of draught proofing and insulation levels to prevent heat being wasted.

If these improvement measures were made across the entire building stock of the Esk Valley area then the domestic energy consumption for space heating could be reduced by 45%. This would correspond to a reduction in heating bill of approximately 25% for each household.

If only 67% of the Esk Valley householders upgraded their insulation to the 'Super' levels suggested, then the energy consumption for space heating demand would be reduced by 30%.

Recommendations on how this can be achieved are highlighted in the blue box overleaf.

Next Steps

1) Encourage all residents to assess their heating patterns and discuss changes that can be made and the results of these changes on the website forum.
2) Have a list of 'easy win' implementation measures on the website:
    1) Assess heating patterns;
    2) Fit room thermostats;
    3) Fit radiator thermostats;
    4) reduce the thermostat temperatures from 23°C to 20°C;
    5) only heat rooms that are in use;
    6) Don't turn the heat up, put a jumper on.
    7) Keep windows and doors shut when the heating is on;
    8) If it's too hot with the heating on, turn it down, don't open a window.
3) Recommendations should be highlighted on the website to show the benefits of:
    a) Draft stripping;
    b) Cavity wall insulation;
    c) Solid wall insulation;
    d) Double glazing;
    e) Loft insulations;
    f) Under-floor insulation;
    g) Upgrading to a more efficient heating system;
    h) The carbon and cost reductions when converting to Biomass heating;
4) Lists of installers should be given on the websites, with a possible 'recommend a tradesman' so the community can get in touch for quotes and check with others whether they are reasonable. This has the additional benefit of creating and encouraging local suppliers and jobs.
5) EVCEG could look at a bulk purchase scheme where it can negotiate larger discounts based households grouping together to buy products.

5.5 Reducing electrical consumption

There are some simple measures that can be introduced into the home to reduce electrical consumption.

5.5.1 Heating and hot water

Using electricity for heating and hot water is expensive and carbon intensive. A large numbers of households in the Esk Valley area are on economy 7 and use electricity to produce heat.

Replacing storage and immersion heaters with a gas boiler, or preferably a renewable technology such as domestic biomass or a heat pump, is the best option to reduce this inefficient use of electricity. However if this is not possible, improved controls and more modern insulated storage heaters may make a large difference to energy usage.

For hot water, fitting a timer control will ensure water is only heated when it is required. Also, ensuring that the hot water cylinder thermostat is set to no more than 60 degrees will mean that energy isn't wasted heating the water up to a higher than necessary temperature.

5.5.2 Lighting

Traditionally, incandescent bulbs have been used in homes but these are inefficient compared to the modern replacements and are currently being phased out. The most common type of light fittings found in the home are standard fittings and halogen spotlights. There are now low-energy alternatives for both of these:

- Compact fluorescents are a more energy efficient light bulb and have replaced the traditional incandescent bulbs. Compact fluorescent bulbs of the same brightness and will typically save around £3 per year, or £55 over the life of the bulb[2].
- LED's are even more efficient than compact fluorescents and are the ideal replacement for halogen spotlights. They are more expensive than compact fluorescents but will have a shorter payback. If a 50W halogen spotlight is replaced with a 6W LED savings of around £4 per year are possible, or £70 by the time the bulb is replaced2.

5.5.3 Appliances

One third of a household's energy bills, and over a quarter of household's carbon dioxide emissions, comes from electrical appliances[2].

When choosing new appliances attention should be taken for energy efficiency labelling and the Energy Saving Trusts Recommended label. Energy efficiency labels rate an appliance from grades A^{+++} to G with A^{+++} being the most efficient and are found on goods such as fridges, freezers, ovens, dishwashers and washing machines. This allows the consumer to choose a more energy efficiency appliance. The Energy Saving Trust's recommended label is found on goods that are very efficient and have been tested by the Energy Saving Trust.

5.5.4 Smart meters and energy monitors

The Government have plans to introduce smart meters into every home in the UK. Smart meters will allow an energy company to receive regular information on the properties energy use. This will result in more accurate bills and allow the home owner to monitor how much energy is being used through an in-home easy to use display. Smart meters are planned to be fitted between 2014 and 2019.

Energy monitors are small wireless electronic devices that hook up to the electricity supply and show how much electricity is being used, the cost per hour and the equivalent CO_2 emissions. This information will help the community to understand their own electricity usage. People who fit home energy monitors often find their energy use drops by five to 15 per cent in the first year of using them.[2]

There are various websites that collect information about people's energy use, which enables comparisons to be made with similar homes. They work by using data which can be obtained from bills, meters or energy monitor. Information is also available on the measures other people have implemented in similar types of properties.

Imeasure and EnergyAverage are two examples of energy comparison websites. Imeasure is run by the University of Oxford's Environmental Change Institute. It uses the data that it collects to help its research into reducing emissions from houses and offices.

5.5.5 Conclusion – domestic electrical demand

By making small changes the electrical energy demand of a home can be reduced significantly. If all homes make these changes than a large energy reduction in electricity demand could be achieved across the Esk Valley. Some recommendations on how to achieve this change can be reviewed in the blue box below.

Next Steps

Simple measures can be implemented in the home to help reduce out electrical demand:

- Switching off appliances such as radios, TV's and lights when you leave a room. It is always cheaper to switch off lights however short the period.
- Don't leaving items such as TV's, DVD players and computers on standby.
- Don't turn the air conditioning on if it's too hot in summer, use through ventilation where possible.
- Always put on a full load when using a washing machine or dishwasher.
- Turn you washing machine thermostat down. A 40°C washing machine cycle uses a third less electricity than 60°C cycle.
- Put on dishwasher/washing machines and tumble driers at night time when there's less demand on the Gird.
- Only fill up the kettle with required amount. Using a cup to fill it with water is an easy method to ensure you only boil enough for the number of cups you are making.

For community buildings, it is recommended that posters, stickers and other behavioural change techniques are used to promote energy saving opportunities.

Homes on Economy 7 should be a priority target and moving these householders onto alternative heating technologies is likely to make the biggest impact on electricity usage.

[2] Direct Gov Website

6 "Power Up" - Renewable energy generation

CO2Sense undertook a renewable energy feasibility study of the Esk Valley. The assessment was not an exhaustive list of potential renewable technologies, but provides an overview of the possibilities.

This section looks at the impact that these technologies could have on the energy profile of the Esk valley.

6.1 Rationale for renewable energy in the Esk valley

The key drivers for renewable energy generation are listed in Figure 20.

Key drivers for renewable energy
• Reduction of energy costs
• Carbon reduction
• Security of energy supply
• Community becoming a stakeholder
• Reduction of fuel poverty

Figure 20 – Drivers for renewable energy installations

Gas and electricity prices have increased dramatically in recent years and are likely to remain volatile in the future. UK average gas and electricity bills can be reviewed in Figure 21.

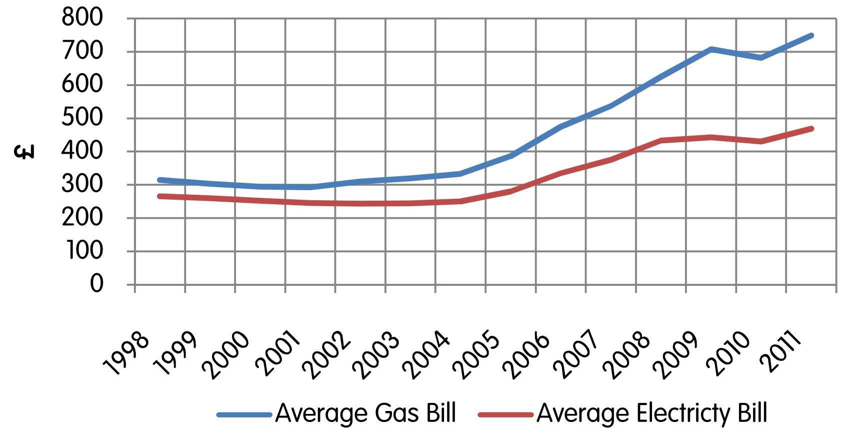


Figure 21 - Average Standard Energy Bills (None Inflation Adjusted)

This clearly shows that the energy prices have increased dramatically since 2004 / 2005. Gas bills in particular are now approximately twice the level in 2005. This increasing energy cost and issues regarding security of supply offer a powerful argument to invest in renewable energy technologies. The feasibility report highlighted potential renewable energy installations within the Esk Valley area and gave an overview of their costs, paybacks and carbon savings.

The Government is currently supporting subsidies for renewable electricity and heat generation with the Feed in Tariff (FIT) and the Renewable Heat Incentive (RHI). Details of these generation tariffs can be found in Appendix 3. This support means that renewable energy projects such as those in the report now generally make commercial sense as well as environmental sense.

Table 21 (overleaf) shows the technologies that were considered viable for further investigation within the area. This highlights that anaerobic digestion, biomass district heating and combined heat and power were not investigated further. Hydro was excluded due to the significant work already undertaken in the valley by Esk energy.

Table 21 – Technologies considered in feasibility study

Energy Generated	Technology	Further Analysis	Rationale
Renewable Electricity	Wind	Yes	Limited due to the location within a National Park and likely visual impact, however the wind resource is high. There is therefore likely to be opportunities for small, domestic size wind turbines.
	Solar PV	Yes	Many un-shaded southerly facing roof spaces offering opportunities for Solar PV installations. Also likely to be less visually intrusive than wind and more likely to receive planning permission.
	Anaerobic Digestion	No	Population density considered too low to give sufficient feedstock for AD plant. Location within national park may mean planning permission would be difficult to achieve. Feasibility study already carried out as part of previous National Park work.
	Hydro	No	Feasibility studies along the River Esk have already been completed and it is felt no further work is required at his level.
Renewable Heat	Biomass	Yes	There are significant areas in the valley off the gas grid utilising oil and coal for space heating requirements. This offers an opportunity for biomass heating.
	Biomass District Heating	No	Villages have low population density and are considered too widely spread to make District Heating a viable option.
	Solar thermal	Yes	Many un-shaded southerly facing roof spaces offering opportunities for Solar thermal installations.
	Water Source Heat Pump	Yes	The River Esk could be utilised for heating requirements for buildings located in close proximity to the river
	Ground Source Heating	Yes	There are areas with sufficient land for either vertical or horizontal ground loops with close proximity to suitable buildings.
	Air Source heat Pump	Yes	This system is most effect if utilising low temperature heating system, such as under-floor heating, in a well insulated and airtight building. It is therefore most suitable for new build properties. However if replacing a carbon intensive heating system such as oil, it could give carbon savings. a
Renewable Electricity and Heat	Combined Heat and Power	No	There are no sufficient heat loads that would warrant the technology which has a large capital costs.

A summary of the installed capacity recommended in the corresponding feasibility study highlighting energy generation, paybacks, carbon savings and approximate capital costs are shown in Table 22.

Table 22 – Potential renewable installation figures derived in the feasibility study

Installation type	Installed capacity, kW	Energy generation, kWh/yr	Capital cost, £	Payback, years	CO_2e savings, tonnes/year
Wind turbine x 27	135	356,022	810,000	6.6	186.8
PV array – all sites highlighted	48.14	36,163	69,245	7	19.708
20 domestic PV arrays	30	23,000	62,920	9	12.53
Biomass – 50 residences	500	1,314,000	475,000	await RHI	399.46*
Biomass – Esk Moor care home	150	400,000	93,106	5.1	95*
GSHP – 10 residences	100	262,800	125,000	5.1	24
ASHP – 20 residences, low flow temperatures	170	300,000	90,000	6	43.2

6.2 Renewable energy in the Esk Valley

The feasibility report highlighted potential renewable energy installations within the Esk Valley area. A key outcome of the feasibility work was the concentration on small scale, domestic projects (particularly biomass). There is relatively limited scope for large projects within the Esk Valley, mainly due to planning constraints.

The following section outlines the current installed renewable capacity in the region and three scenarios for future renewable generation based on varying levels of uptake:

1. Business as usual with gradual increase in installations;
2. Recommended projects from the feasibility study;
3. Large scale deployment of renewable energy;

6.2.1 Current Installed Capacity

There are already a number of renewable technologies installed within the Esk valley. Table 25 shows a breakdown of the current installed capacity of local renewable generation facilities. There is currently 830kW of installed renewable energy in the Esk Valley generating 1908MWh of energy. This data has been compiled utilising local knowledge, surveys, the FIT register and UK averages. There is currently no central database of micro generation installations and this means that the figures provided are estimates based on the best available sources. Where there is no accessible data for an individual technology, UK averages have been taken from a report commissioned in 2008 by BERR :*Numbers of micro generation units installed in England, Wales, Scotland, and Northern Ireland*. These have been scaled to take into account the intervening years and then referenced to the Esk Valley as a percentage of the UK population.

Table 23 – Estimated total installed capacity, March 2012

Technology	Installed Capacity (kW)	Annual Energy Generation (kWh/yr)	Total CO_2e savings tonnes/yr
Hydro	0	0.00	0.00
PV	250	438,000	238.27
Wind	28	80,942	44.03
Solar Thermal	70	122,640	32.87
Biomass	420	1,103,760	295.81
GSHP	35	91,980	12.14
ASHP	23	60,444	3.05
WSHO	4	10,512	0.91
Total	**830**	**1,908,278**	**627.08**

6.2.2 Scenario 1: Business as Usual

Table 24 gives a prediction for the level of generation in the Esk valley if no pro-active work is done to support renewable development. This assumes all currently planned and prospective projects are realised, along with a general increase of 5% per annum for all technologies except hydro. This is because hydro can only be installed in limited locations.

Table 24 - Increase in renewable energy: Scenario 1 - 'Business as usual'

Technology	Installed Capacity (kW)	Annual Energy Generation (kWh/yr)	Total CO_2e savings tonnes/yr
Hydro	50	175,200	95.31
PV	402	352,701	191.87
Wind	45	130,358	70.92
Solar Thermal	112	197,512	52.93
Biomass	676	1,777,616	476.40
GSHP	56	148,134	19.55
ASHP	37	97,345	4.91
WSHP	6	16,929	1.47
Total	**1,386**	**2,895,500**	**913.36**

6.2.3 Scenario 2: Recommended Projects

Table 25 gives a prediction for the level of generation in the Esk valley if all the renewable energy installations recommended in the feasibility study are developed alongside the current installed capacity. If this development profile is met it would almost double the installed renewable electrical capacity and increase renewable heat installations by nearly 70% over the next 10 years.

Table 25 - Increase in renewable energy: Scenario 2 - 'Recommended projects

Technology	Installed capacity (kW)	Annual Energy Generation (kWh/yr)	Total CO_2e savings tonnes/yr
Hydro	50	175,200	95.31
PV	328	287,450	156.37
Wind	163	471,200	256.33
Solar Thermal	70	122,640	32.87
Biomass	1,070	2,811,960	753.61
GSHP	135	354,780	46.83
ASHP	193	507,204	25.56
WSHP	139	365,292	31.66
Total	**2,148**	**5,095,177**	**1,398.54**

6.2.4 Scenario 3: Large Scale Deployment

This scenario evaluates the projected installed capacity that could be developed if a large scale deployment of renewable installations was realised. However, this estimate still takes into account the local factors and constraints of renewable projects within the National Park and the recommendations are based on achievable levels, which should have little visual impact. All the technologies recommended are small scale and generally linked to domestic or community properties. There is further scope to increase this if heat pump technologies are also developed.

The total potential installed capacity of renewable energy is shown in Table 26. This is based on a large roll out of technologies over the next 10 years. It includes the installed capacity recommended in the feasibility study, the installed capacity of four of the Hydro schemes deemed feasible along the river Esk, a roll out of domestic biomass to 25% of properties currently off the gas-grid and using oil or coal and a large uptake in PV which could include 9 100kW ground mounted installations. This shows that under this scenario renewable electricity would be increased by 83% against current installation rates, and by 90% for renewable heat.

Table 26 - Increase in renewable energy: Scenario 3 - 'Large scale deployment'

Technology	Installed capacity (kW)	Annual Energy Generation (kWh/yr)	Total CO_2e savings tonnes/yr
Hydro	200	700,800	381.24
PV	1,200	1,051,200	571.85
Wind	163	471,200	256.33
Solar Thermal	380	665,760	178.42
Biomass	3,950	10,380,600	2,782.00
GSHP	270	709,560	93.66
ASHP	250	657,000	33.11
WSHP	200	525,600	45.55
Total	**6,613**	**15,161,920**	**4,342.17**

6.3 Renewable generation levels

This subsection looks at the renewable capacity scenarios put forward and identifies how these contribute to the energy demand within the local area. An assessment is performed with and without the potential energy saving measures identified in Section 5.

6.3.1 Without energy efficiency measures

Figure 22 and Figure 23 shows the progress the different scenarios make towards meeting an increasing percentage of the current energy demand with renewable energy. These figures assume that energy usage within the valley stays the same and that no energy efficiency measures are implemented.

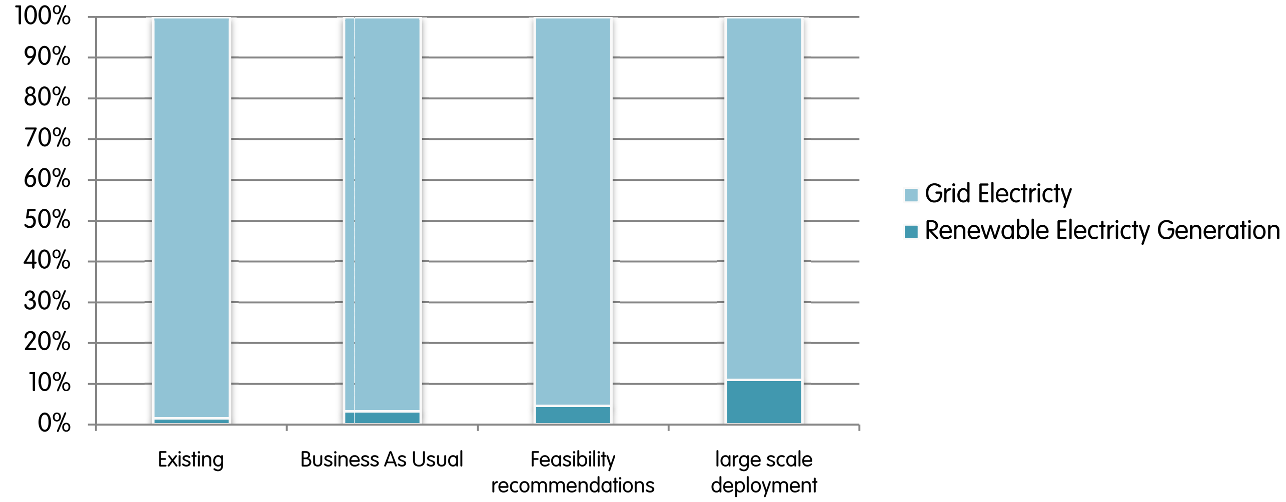


Figure 22 - Percentage of electrical energy demand met by renewables for each scenario

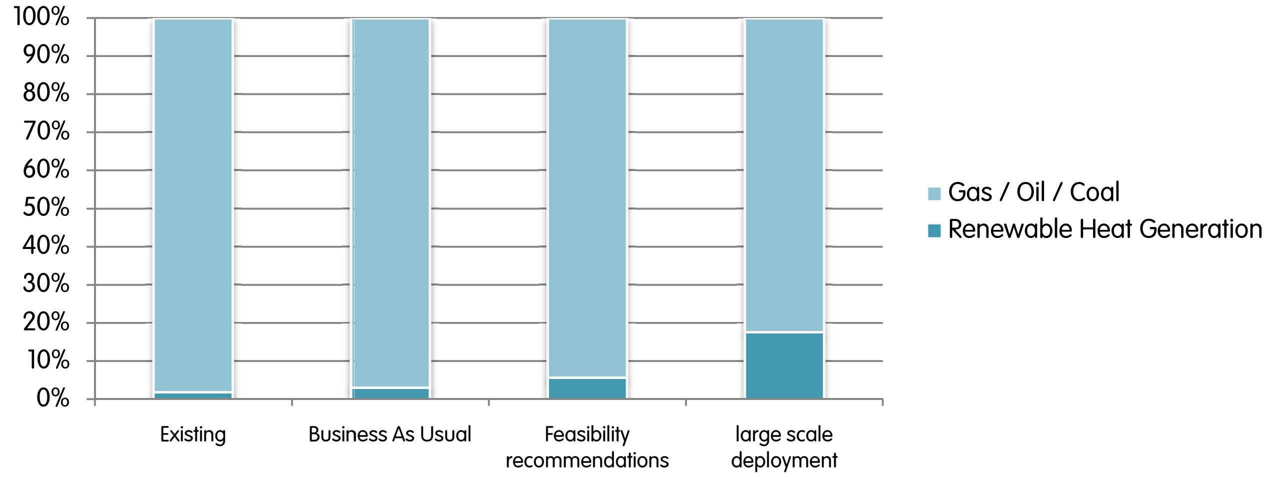


Figure 23 - Percentage of heat demand met by renewables for each scenario

It can be seen that with the business as usual and the feasibility recommendations deployed a very small percentage of the current energy demand is met by renewable energy generation. With large scale deployment of renewable electrical generation plant, 10.94% of the current electrical demand and 17.55% of heat demand of the Esk Valley can be met.

This shows the level of the change needed in order to produce a significant amount of energy from renewable sources. This will be very difficult and expensive to achieve unless current overall energy usage is not reduced to more sustainable levels.

6.3.2 With energy efficiency measures

If energy efficiency measures are implemented, this will change the proportion of energy demand able to be met from renewable sources. A reduction in increments of 10% in energy demand for each of the scenarios in the graphs has been assumed.

This correlates with the time required to implement both energy efficiency measures and the renewable installations. Reducing the heat demand by this amount is considered to be feasible if 67% of the housing stock in the Esk Valley upgraded their insulation and draft proofing to meet the levels indicated in the super insulation scenario discussed in Section 4 over the next 10 years.

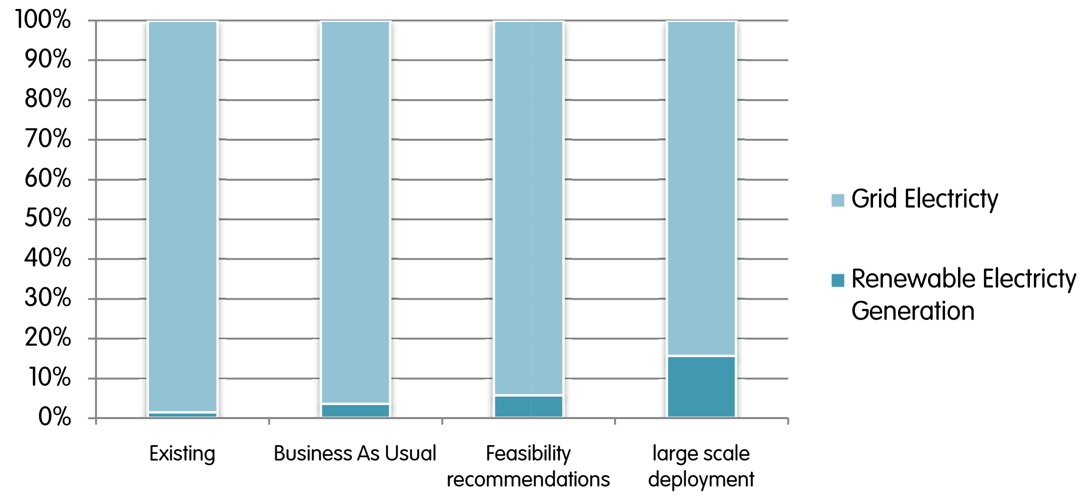


Figure 24 - Percentage of electrical energy demand met by renewable with energy efficiency measures

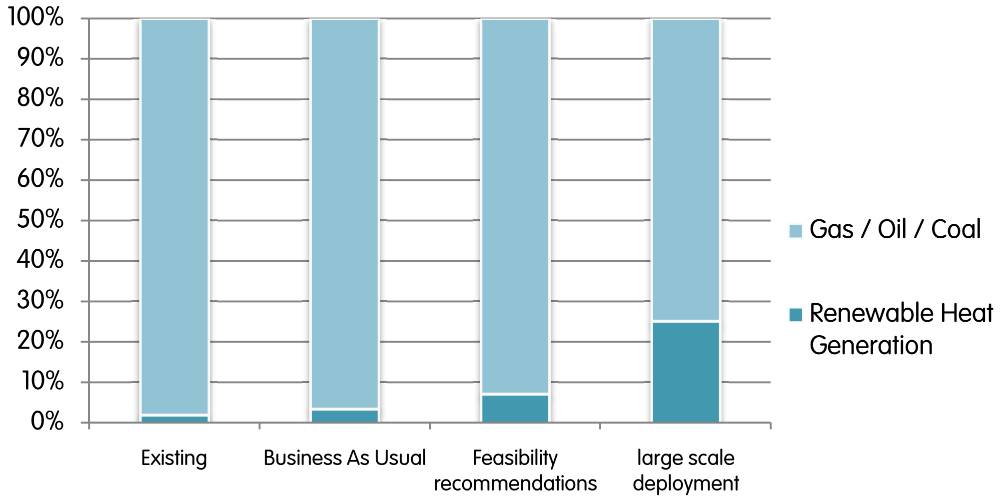


Figure 25 - Percentage of heat demand met by renewable with energy efficiency measures

This could be considered ambitious as any new build housing developments in the area could increase the overall energy consumption. Also it is predicted that electrical energy consumption in the home to increase as people acquire increasing amounts of electronic goods.

Reviewing Figure 24 and Figure 25 it can be seen that with the energy demand reduction, the feasibility recommendations achieve nearly 6% of the current electrical demand and the large scale deployment achieves nearly 16%. Nearly 7% of the heat demand could be met if the renewable feasibility recommendations are implemented, however if large scale deployment of renewable energy went ahead then nearly 25% of the heat demand of the Esk Valley area could be met by renewable energy generation.

These scenarios show that the potential levels of local renewable generation are relatively low compared to the levels of energy usage within the Esk Valley area. This is due to a number of constraints, in particular those of planning and visual impact. The proximity of the National park forms a barrier to large scale developments which could encroach into this protected area.

This highlights that whilst local generation can make a contribution, support for large-scale, national projects is essential in decarbonising the UK grid. However, local generation has a key part to play and the percentage contribution will increase as more energy efficiency measures are implemented.

It is important to be aware of these difficulties in order to see the scale of our energy use and the large projects needed to reduce our dependence on fossil fuels.

6.3.3 Scenario 4: Development of wind hot spots

In the corresponding renewable energy feasibility study to this report, CO2Sense considered how wind energy could be implemented across the Esk Valley. CO2Sense identified 27 wind hot spots in the area with annual mean wind speeds of over 6m/s at 10m above ground level. These sites were considered feasible for development of wind turbine installations. The summary wind hot spot map is reproduced in Figure 26. This map demonstrates specific concentrations of wind opportunity in the central Valley area (North of Sleights) and Southern areas (near Goathland and Botton). Planning permission is severely restrictive in this location for wind installation, and turbines above 5kW.will face significant planning pressure.

CO2Sense recommended that these sites should be installed with 5kW turbines in-line with planning guidance. However, if these sites had 50kW wind turbines installed (rather than the 5kW turbines) then this would result in a far greater renewable energy generation. This is shown in Table 27. An example of a 50kW wind turbine is the Endurance, which has a rotor diameter of 19.2m and a hub height of 23m.

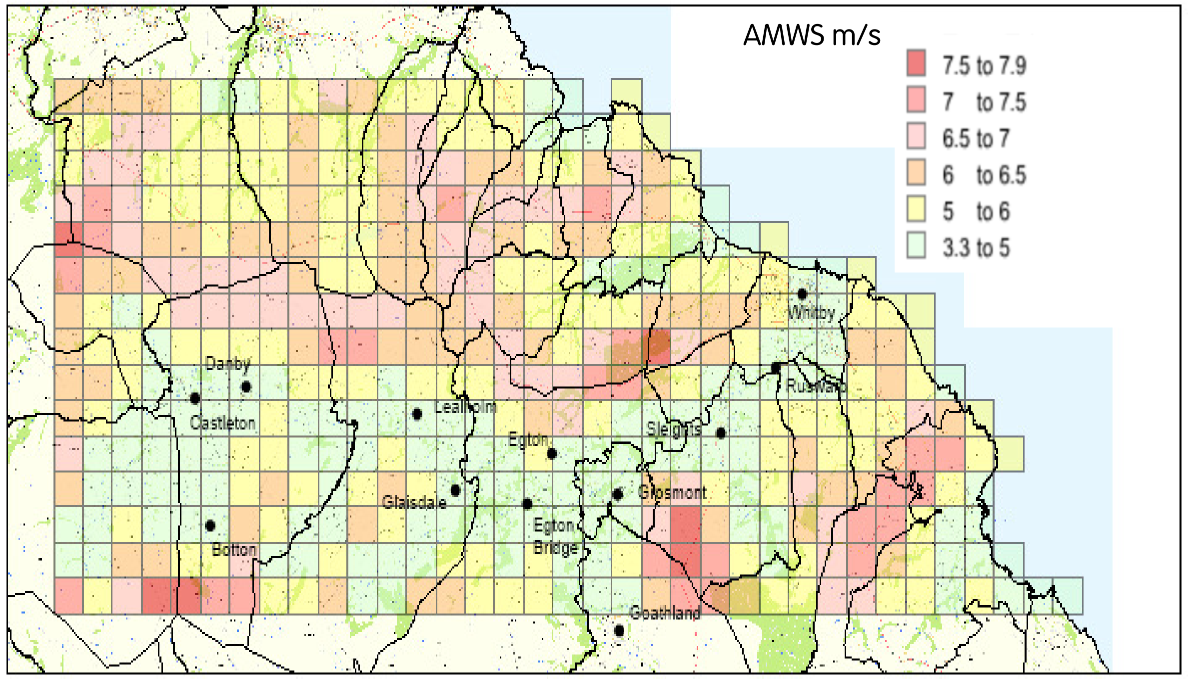


Figure 26 – Wind hotspots identified by CO2Sense (10m, above ground level)

Table 27 - Large scale deployment Installed Capacity with 50kW wind turbines

Technology	Installed capacity (kW)	Annual energy generation (kWh/yr)	Total CO_2e savings tonnes/yr
Hydro	200	700,800	381.24
PV	1,200	1,051,200	1,143.71
Wind (currently installed)	28	80,942	44.03
27 installations of 50kW	**1,350**	**4,455,000**	**2,423.52**
Solar Thermal	380	665,760	178.42
Biomass	3,950	10,380,600	2,782.00
GSHP	270	709,560	93.66
ASHP	250	657,000	33.11
WSHP	200	525,600	45.55
Total	**7,828**	**19,226,462**	**7,125.24**

CO2Sense has included the larger wind installations to the "large scale deployment" scenario to calculate how much energy demand could be met in the Esk Valley. Without a reduction in demand through energy efficiency measures, 30% of the current electrical energy demand could be met by renewable energy generation. If energy efficiency measures are taken in to account then 44% of current electrical energy demand could be met from renewable energy sources. This is demonstrated in Figure 27.

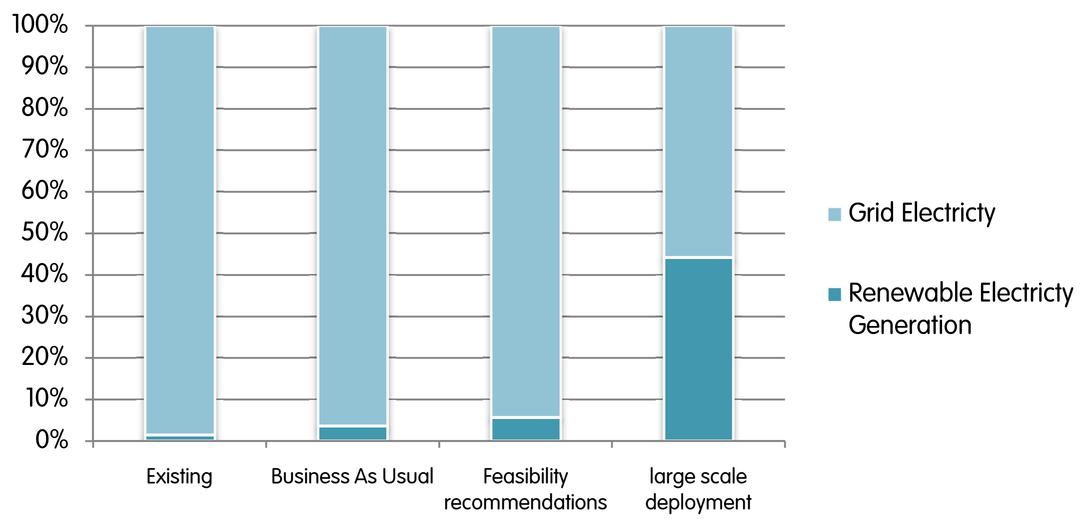


Figure 27 - Percentage of electrical energy demand met by renewable energy, with energy efficiency measures if 50kW turbines are considered.

At present 50kW wind turbines are not considered feasible in the Esk Valley due to planning restrictions. Therefore the next section of the report does not include this option in the larger scale deployment scenario. However, CO2Sense recommends that the planning authority are approached to discuss this restriction in more detail as if this restriction can be altered to reflect larger wind turbines in appropriate locations, then this will allow a more significant renewable option for the Esk Valley.

6.4 Renewable energy generation mix

Figure 28 shows a breakdown of the energy mix for the Esk valley in the scenarios discussed above. It can clearly be seen that a large adoption of domestic biomass along with solar PV is key to the future energy mix that ordinary householders can implement. Developing the identified hydro projects alongside the river Esk will also provide further opportunity for development as community projects.

Figure 28 highlights the large increase in renewable energy generation if the 'large scale deployment' path is followed. Even with this huge upsurge in renewable energy generation this will still only meet 16% of electrical energy demand and 25% of heat demand with inclusion of current demand reduction through energy efficiency measures. This emphasises the huge domestic energy demand of the UK and the great strides that need to be taken to become a more sustainable nation.

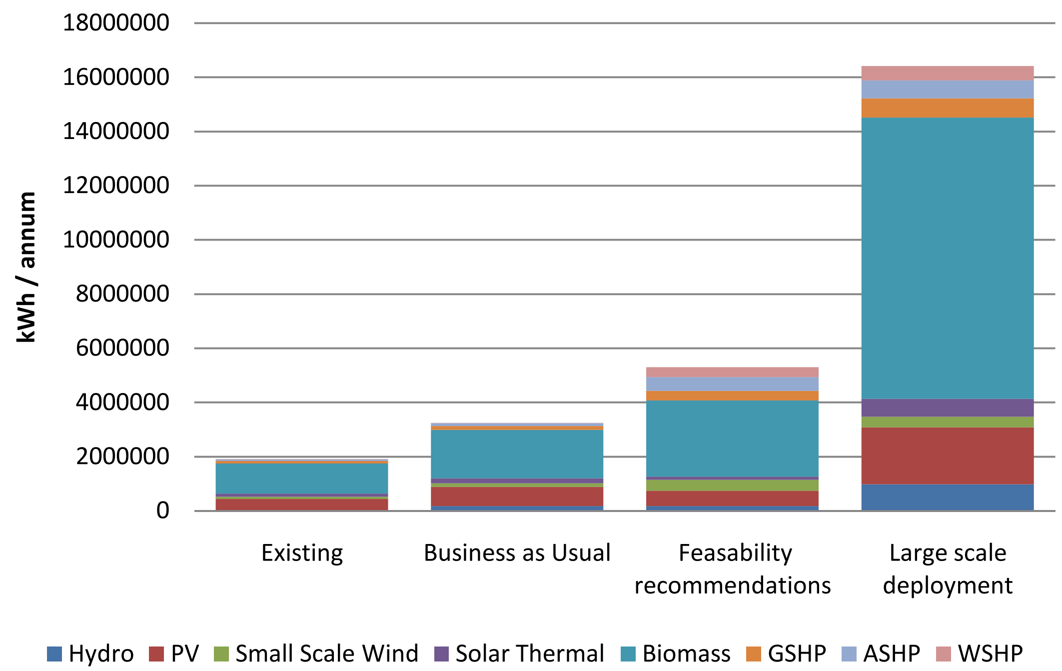


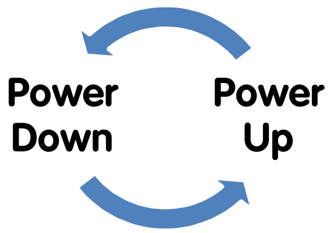
Figure 28 - Renewable Generation Mix showing total contribution in kWh.

6.4.1 Conclusions – Renewable energy targets and energy mix

A baseline of the current installed capacity of renewable energy in the valley has been evaluated at 830kW. Three scenarios have been modelled based on varying levels of renewable uptake in the valley. A business as usual scenario estimates future generation at 1,386kW. The findings from the corresponding renewable energy feasibility study undertaken by CO2Sense have been added to the current installed capacity to give a potential installed capacity of 2,148kW if recommendations are undertaken. The total generation from this

installed capacity was still small in comparison with the current energy demand, therefore a scenario of 'large scale deployment' has been considered. This gives a total installed capacity of 6,613kW.

This section has evaluated that a larger percentage of energy demand can be met by renewable energy generation when energy efficiency measures are implemented and the reduction in energy demand is achieved. This highlights that the Power down approach is just as important as the Power up approach. If both are achieved than the Esk Valley will be able to meet an increasing percentage of its energy demand from renewable energy generation.



Only with the 'large scale deployment' scenario can significant percentages of the Esk Valleys energy demand be achieved through renewable energy generation. With this scenario 16% of electrical demand and 25% of heat demand can be achieved from renewable energy generation (when including energy efficiency measures).

This section highlights that the 'large scale deployment' scenario should be pursued if the Esk Valley is to have a low carbon future. However, due to the constraints of the local environment, single large installations are not a viable option. Therefore the uptake of renewable must be at an individual or co-operative level for individual dwellings. The greatest proportion of renewable energy generation would be from biomass and large scale ground mounted PV arrays. CO2Sense has also highlighted that if 50kW or slightly larger wind turbines were permitted, then this would greatly increase the percentage of demand met by renewable energy generation in the Esk Valley.

Recommendations for next steps can be reviewed in the blue box below.

Next steps

1) Discussion and community engagement highlighting that only with large scale deployment of renewable energy and the installation of energy efficiency measures can the valley meet a significant proportion of energy demand from renewable energy.
2) Dialogue with the community, local council, local business and other stakeholders to engage and consolidate local commitment to a lower carbon future.
3) This may raise awareness as to how much energy is consumed and how big steps need to be made to achieve only a small percentage of this demand by renewable sources.
4) Discussion around the technologies that will give the greatest energy generation potential as priorities for development

7 Business case for a low carbon future

7.1 "Power Down" business case

7.1.1 The Green Deal

Within the Energy Act 2011, launched last year by the Government, was the legal framework for the Green Deal and Energy Company Obligation (ECO).This is a mechanism whereby people can improve the energy efficiency of their home through upgrading the fabric of the building. This not only conserves energy, but reduces their utility costs and carbon emissions. Accessing these improvement measures will follow a process depicted in Figure 29.

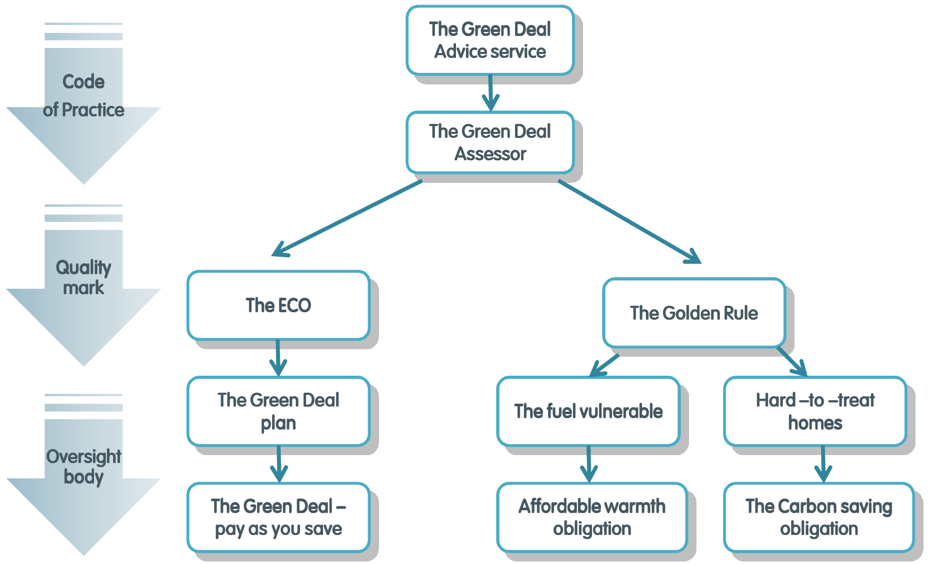


Figure 29 – The Green Deal process chart

7.1.2 The Green Deal steps

The key steps of the green deal are:

1. The domestic dwelling occupier will request a free of charge Green Deal assessment.
2. An accredited Green deal assessor will audit the home, looking at the building fabric and energy usage.
3. The assessor will be required to act impartially, but to suggest a package of measures of improvements which will improve the energy performance of the dwelling.
4. The results will be given to the dwelling occupier along with details of whether the building improvements fit with the 'Golden Rule'.

> **'Golden Rule'**
> The predicted savings from the energy efficiency improvements to the property must equal or exceed the cost of the installation.

If the dwelling falls within the 'Golden Rule' then the occupier can seek a Green Deal provider and a Green Deal Plan can be negotiated.

a. The Green Deal Provider –
   - Only authorised companies will be able to identify themselves as Green Deal Providers through a Green Deal Quality Mark.
   - They will set out the costs of the works to be carried out.
   - They will raise the finance and liaise with the utility company for the repayments to be collected through the utility bill.
b. Once these terms have been negotiated and agreed they area set out in 'The Green Deal Plan'
   - This is attached to the property, not the customer.
   - The customer can meet some of the costs upfront if desired.
c. The work is then completed on the property by Green Deal Provider, who will inform the utility company so installments can start to be collected through the utility bills, which are paid in the same way as before.
d. The Green Deal has been designed so that the estimated energy bill saving will not be less than the Green Deal Plan installments, or 'Pay-as-you-save'.

> **'Pay-as-you-save'**
> This requires no upfront payments, but rather the charge is added to the utility bill, which will have been reduced by the energy efficiency measures installed

7.1.3 The Energy Company Obligation

> **'The Energy Company Obligation - ECO'**
> Large energy companies, in partnership with local authorities and other organisations, will fund improvements, via grants, to eligible dwellings.

If dwellings do not meet the 'Golden Rule' then they will be eligible for Energy Company Obligation (ECO) grant funding. This will apply to two main groups:

- Those on low incomes or those who are in, or at risk, of fuel poverty – **The Affordable Warmth Obligation.**
  - 25% of the ECO funding will be directed to this initiative.
  - Eligibility is for all thermal improvement measures for those living in private rented or owner occupied dwellings who receive:
    - Pension credit
    - Child tax credit
    - Income support
- Occupiers of 'Hard-to-treat' homes, where energy efficiency upgrade costs do not meet the 'Golden Rule' – **The Carbon Saving Obligation.**
  - 75% of the ECO funding will be directed to this initiative.
  - Eligibility will be determined if the dwelling fails to meet the 'Golden Rule' in the Green Deal assessment.

It is hoped that by autumn 2012 the Green Deal program will begin its roll-out. All the providers and installers will be required to adhere to best practice and be quality marked.

7.1.4 Esk dwellings – remedial works case study

In the Esk Valley, as many of the buildings are considered 'hard–to–treat' it is likely they would fall under the ECO scheme. This means that the capital costs of works could be funded by the scheme, however as this scheme is still being developed by the Government and is hoped to be implemented in Autumn 2012 it is recommended that the community keep up to date with news via the EVCEG website.

The energy audits that were undertaken by then EVCEG Energy Champions involved assessing buildings using a thermal imaging camera which detailed specific areas of heat loss in the properties audited. The day of the audit was warm and sunny; therefore this may have affected the imaging camera.

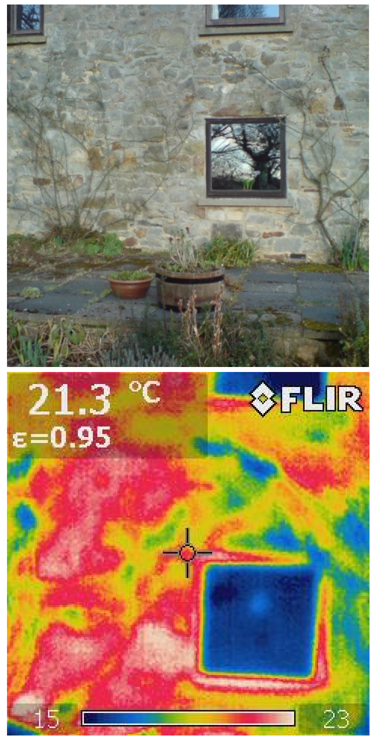


Figure 30 – thermal Image of property 1

Case study: Property 1

The EVCEG undertook an audit of a 1700's stone property (with 1970's extension). There was found to be a high level of insulation in the roof, and the building has been double glazing throughout. However the walls are solid stone (except for the extension which is of cavity construction) and several areas of wall were found to have a high level of heat loss during the audit. This was demonstrated by the thermal imaging camera (bottom picture). Not all wall areas showed a high heat loss and therefore this could help future prioritisation of rooms and areas for solid wall insulation.

Figure 31 - thermal Image of property 2

Case study: Property 2

The EVCEG undertook an audit of a 1991 sandstone / block cavity property with insulation (installed during construction). The building has double glazing throughout and a moderate level of insulation in the roof (approx 200mm). The walls, particularly above the garage, were found to demonstrate a high level of heat loss. This may be due to the sun radiating off the property but may also reflect that the insulation installed during construction was only partial or is inadequate. Where warm areas are demonstrated on insulated spaces, it is recommended that further investigation is undertaken to confirm that insulation is sufficient.

7.1.5 Domestic energy saving

Energy audits undertaken by Bradford Energy Action Trust (BEAT) for a selection of 'hard-to-treat' homes with solid walls in North Yorkshire are summarised in Table 28. These savings demonstrate that the most significant cost reductions can be met through solid wall internal insulation. Additional savings can be achieved from new boilers and improvements to boiler efficiency and operation. Substantial savings could also be achieved through installing new fridge-freezers in the properties.

Table 28 - Summary of main domestic savings (BEAT domestic audits: total for all buildings surveyed)

Action	Total Saving	Cost saving	Carbon	Proportion of heat saved
	kWh	£	Kg/CO2	%
Install new boiler	16,098	604	3284	19%
Install internal solid wall insulation	15,061	555	3072	18%
Install under floor insulation	1,690	55	345	2%
Install loft insulation	636	35	130	1%
Install double glazing	350	12	71	0.4%

The energy savings identified that relate to heat and building fabric are linked to the total heat demand of the property – e.g. the insulation measures identified represent percentage savings of total heat demand. Table 28 summarises the percentage savings for each type of measure for the properties surveyed. The percentage savings are lower than if considered on a property specific level, as the percentage calculation reflects that not every property is suitable for every measure.

The largest identified saving, representing 19% of the total heat demand of the buildings audited, was replacing an old boiler that was operating at a low efficiency with a new condensing boiler which can achieve 92% operational efficiency. Solid wall internal insulation can give a further 18% reduction of energy consumption.

7.1.6 Typical dwelling savings

Table 29 shows the approximate annual fuel bill savings, if the levels of insulation previously evaluated were implemented. This assumes that the dwellings are heated by oil at a cost of 6p/kWh and boiler efficiency has not been evaluated.

Table 29– Calculated cost of energy demand of modelled typical dwellings

Type of house	Level of insulation	Total energy demand per year, kWh	Cost of heating demand, £	Savings on the oil bill, £
1930's Semi-detached house	Standard	12162.8	729.76	-
	Extra	8557.6	513.45	216.31
	Super	4845.2	290.71	439.05
Victorian terrace	Standard	20209.2	1212.55	-
	Extra	14726.0	883.56	328.99
	Super	9597.1	575.82	636.72

If the energy demand is reduced, with the increases in insulation measures and draft proofing, a smaller boiler size can meet the space heating demand of the house. Table 30 shows the reduced space heating plant size required for the reduced energy demand on a cold winter's day with an outside temperature of -3°C. The super insulated dwelling requires nearly half the installed capacity of boiler and reduces the cost of heating a house on a cold day by 50%.

Table 30 – Load requirement of a Victorian terrace dwelling at -3°C

Insulation level	Size of heating plant required to meet load at -3°C	Energy consumption for 12 hours of heating at -3°C	Cost to heat the dwelling for 12 hours at -3°C
Standard insulation	11.1kW	133.2 kWh	£5.30
Extra insulation	8.2kW	98.4 kWh	£4.00
Superior insulation	5.6kW	67.2 kWh	£2.68

Approximate costs and savings for upgrading energy efficiency measures can be seen in Table 31.

Table 31 – Likely costs for improvements to a 1910 mid-terrace house

Potential measures	Capital cost (£)	Bill Saving (£)	Payback (years)
Loft insulation (top up)	120	19	6.3
Boiler and heating control upgrade for radiators	200	130	1.5
Solid wall insulation	1,500	190	7.9
Double glazing	2,800	48	58
Total	9,345	387	24
	Current	With Savings	
Bills (£)	1,310	923	

7.1.7 Community building – remedial works case study

The total savings identified by CO2Sense for the two community building audits undertaken in the Esk Valley are summarised in Table 32. These savings demonstrate that the most significant savings can be met through insulation measures, totalling 6,606kWh.

CO2Sense found that Castleton Village Hall is poorly heated (i.e. the heat demand is not currently being met) and therefore by installing a new heating system (dependent on system installed) actual energy use may increase. However this is a worthwhile investment due to lower operational costs (p/kWh energy cost) and lower carbon costs when comparing alternative fuels with electricity. In addition, Castleton Village Hall currently has very poor insulation, but because the heating is not currently thermostatically controlled, limited energy will be saved through installing insulation measures (although comfort will be greatly improved).

The buildings audited can be considered "hard to treat" and represent the challenge facing the Esk Valley: small community buildings may not have sufficient capital reserves to undertake the required refurbishment work and may have limited short term financial gain from installing efficiency measures. Therefore the following should be prioritised wherever possible for community buildings in the Esk Valley:

- Investing reserves in short-term "quick wins" such as heating controls and behavioral measures;
- Securing funding for longer term refurbishment projects from local and national grant funding bodies (for example BIG lottery);
- Considering the wider benefits of investing in longer term measures (such as comfort and reduced condensation / improved building fabric) when undertaking investment decisions.

The total energy demand of the buildings was relatively small and therefore savings identified were also small. If the occupancy and/or total energy use increases the total savings will also increase proportionally.

Table 32 - Summary of Main Community Savings (CO2Sense community audits)

Type of saving	**Total Saving**	**Cost saving**	**Carbon**
	kWh	£	Kg/CO2
Insulation	6,606	411	1,418
Heating	-2,333	77	1,832
Lighting	1511	219	792.5
Total	**5,784**	**707**	**4,042**
Specific actions			
Roof insulation (Danby Village Hall)	1,479	92	318
Solid wall insulation (Castleton Village Hall)	1,676	104	360
LPG heating system (Castleton Village Hall)	-2,333	77	1,832
Under-floor heating system (Castleton Village Hall)	326	242	2,403

Case study: Castleton Village Hall

CO2Sense is working with Castleton Village Hall to identify how energy consumption can be minimised in the hall. The Hall used LEAF funding to commission CO2Sense to undertake an energy saving review of their historic building. The review highlighted some low and no cost measures that could save up to 10% of the Hall's annual energy bill and increase comfort of the building's occupants; these included more efficient lighting and improved heating controls. Further savings were identified from installing solid wall insulation and loft insulation with a longer payback period, totalling 3155kWh or £196. The hall would also benefit from a new heating system to replace the expensive and carbon intensive electric storage heating. A new heating system may actually increase energy use, but would greatly improve building comfort and reduce overall costs. Therefore CO2Sense recommended a major refurbishment scheme for the hall to include new heating system and significant insulation measures.

7.1.8 Conclusion – Power down business case

There are a number of energy reduction measures highlighted which can give savings on electrical and gas bills. Measures such as loft and cavity wall insulation can produce savings which payback within around 6 – 10 years. This is at a level that some householders may decide to take up without additional financial incentives or grants. Further price reductions could be negotiated by implementing a collective purchase scheme which would further improve the payback period.

Other upgrades such as secondary glazing and boiler upgrades may be more expensive and have a longer pay back period. This may especially be the case for many of the homes in the Esk Valley area which fall into the 'hard-to-treat' category. In these instances the costs of any upgrade to the building fabric to reduce energy demands could prove inhibitive to many householders.

Currently the Government are finalising the details around the 'Green Deal', this will assist householders of all homes to meet the costs to upgrading their insulation, draught proofing, glazing and building fabric to reduce their energy demand and bills. The Green Deal is expected to be launched in October 2012. Once the Green Deal is in place the financial business case for these improvements is likely to be stronger.

In the meantime, organisations such as the Energy savings Trust and the Yorkshire Energy Partnership (http://www.yorkshireenergypartnership.org.uk/) can provide advice and details on other locally available grants.

Next steps

1) The biggest changes will come about through the community uptake of 'the Green Deal'. Therefore keeping the community up to date and informed regarding these Government incentives will be paramount to the uptake of the measures suggested. This could be through:
   - Local community meetings;
   - Parish magazines;
   - Web-site;
   - Posters in village shops;
   - Leaflets through doors.
2) In preparation of the Green Deal, people who would like their homes assessed could be enlisted, so when the scheme becomes operational in autumn 2012, there is no delay in getting the improvements underway.
3) Further to the energy audits that have been recommended in a previous blue box, details of houses and what upgrades they may be suitable for should be highlighted.

7.2 "Power Up" – business case

Taking the conclusions from Section 5 a business case for individual installations of renewable energy is considered with further analysis. This chapter considers methods of finance that the community can secure to procure their renewable energy installation. This looks at the financial viability of the schemes and how the community could benefit, not only in terms of revenue, but in the wider context of local jobs created, increased energy awareness of the community and resolved aspiration of local residents to further increase the renewable energy generation within the area.

7.2.1 Capital costs of renewable energy installations

Calculating the £/kW for renewable technologies, is a guide to the overall capital costs of different installations. The higher the £/kW, the higher the costs of implementing the technology. To understand how effective a renewable energy installation is in providing energy and CO_2e emission savings, it is more appropriate to evaluate the emissions saved and energy generated by £/kW, £/tonne CO_2e and £/kWh. Table 33 shows these three measures for each technology.

Table 33 – Approximate costs of potential renewable installations

Approximate Capex estimates	£/kW	£/tonne CO_2e	£/kWh
Hydro (average high and low head)	4,000	2,098	1.14
Solar PV domestic	2,700	2,832	1.54
Small wind	4,750	3,020	1.64
Medium wind	1,500	835	0.45
Solar thermal	1,600	3,407	0.91
Biomass domestic	640	908	0.24
GSHP domestic	1,250	3,603	0.48
ASHP domestic	650	4,907	0.25
WSHP	1,250	5,488	0.48

To understand how effective a renewable energy installation is in providing energy and CO_2e emission savings, it is more appropriate to evaluate the emissions saved and energy generated by £ spent. This can be reviewed in Table 33.

This shows that single biomass installations give the best energy generation for money spent, but medium wind installations give the best emissions savings than the other technologies. ASHPs give good energy generation for £s spent; however, there are minimal CO_2e savings at present when replacing oil consumption (although this will change if the carbon intensity of grid electricity falls in the future).

To assess which of the technologies are the most appropriate to implement, other variables need to be considered in a wider evaluation. For example should technologies that produce heat over electricity be favoured? Should schemes that have minimal disruption for example PV arrays be targeted first? Which of these schemes will give the best financial returns to the community and are important to the community? These questions should be considered at a local level during community engagement and dialogue.

7.2.2 Overall project ratings

Using the values in Table 33 along with an assessment of local constraints and the potential for community investment, a summary of the suggested renewable energy projects has been rated in Table 35. The information has been collated using a rating system devised by CO2Sense using the following method:

- The 'value for money' column is the projects £/kWh calculated in Table 33 multiplied by a weighting factor of 2.
- The community investments column has been determined by the ability for a project to become a community project, drawing investment from the community and providing a financial return
- The constraints column has been rated according to previous knowledge with renewable energy projects as to the number of constraints that are common for that type of renewable installation. For example, planning and opposition for wind turbines offers that technology many more constraints than a PV installation, which in non-designated areas, is a permitted development
- The payback rating is taken from the renewable energy feasibility and other industry data collated by CO2Sense and rated according to Table 34.
- The best carbon savers column is rated according to the £/CO_2e in Table 33 and is based on technologies either replacing grid electricity or oil.

Table 34 – Payback period rating score

Payback rating	
Payback period	Score rating
<3	1
>3<5	2
>5<7	3
>7<9	4
>9<11	5
>11<14	6
>14<20	7
>20	8

Table 35 – Potential renewable energy installations rated according to feasibility

Installation type	Value for money, £/kWh x 2	Community investment opportunity strong =1, weak = 5	Constraints few = 1 , many = 5	Payback rating	Best carbon savers,£/tonne strong =1, weak = 5	Overall project rating	Order of best projects
Biomass, domestic	0.48	5	1	Await RHI (assume 2)	0.9	9.38	1
Medium wind	0.9	2	4	2	0.8	9.7	2
Hydro	2.28	1	3	5	2	13.28	3
Solar PV	3.08	3	1	4	2.8	13.88	4
GSHP	0.96	3	3	5	3.6	15.56	5
Small wind	3.28	5	3	3	3	17.28	6
Solar thermal	1.82	5	2	5	3.47	17.29	7
WSHP	0.96	3	3	5	5.4	17.36	8
ASHP	0.5	5	2	5	4.9	17.4	9

It can be observed in Table 35 that a payback rating has been assumed for the single Biomass installations. This is because the domestic RHI has not been announced, if it is in line with the commercial RHI then this subsidy should favour domestic biomass installations making it the most financially viable.

Table 35 rates the projects according to many variables including value for money, opportunity for the community to invest, constraints that the project may face, the payback rating and the best CO_2e emission savers. All these factors should be considered when looking at the overall attractiveness of a project; however, as seen in the renewable targets section, large scale deployment of installations is needed to meet a sufficient percentage of the energy demand. Therefore all these projects should be viewed as potential developments and the question should be around in which order should the developments progress.

Although a further Hydro project is unlikely at this time, an evaluation of Hydro has been included in Table 35 to allow for comparison with other technologies.

Figure 32 shows a graph showing all of the technologies discussed. The width of the box represents the potential of the technology to deliver renewable energy in the Esk valley and the height represents capital cost per kWh/annum installed. Long, flat boxes show that a technology has the potential to deliver large levels of generation, whilst being low cost. Tall thin boxes show that the technology is relatively high cost with little potential to deliver large energy production. This figure is useful when deciding on what technologies to concentrate on and indicates clearly that small scale biomass has the potential to produce the most energy at the lowest upfront cost.

Whilst this doesn't give us a rating it does provide a visual guide to assist in technology choice. Long, flat boxes show that a technology has the potential to deliver large levels of generation, whilst being low cost. Tall thin boxes show that the technology is relatively high cost with little potential to deliver large energy production. This figure is useful when deciding on what technologies to concentrate on and indicates clearly that biomass has the potential to produce the most energy at the lowest upfront cost. PV is shown as a relatively high cost technology however it does have the potential to produce the most electrical energy of any renewable technology investigated.

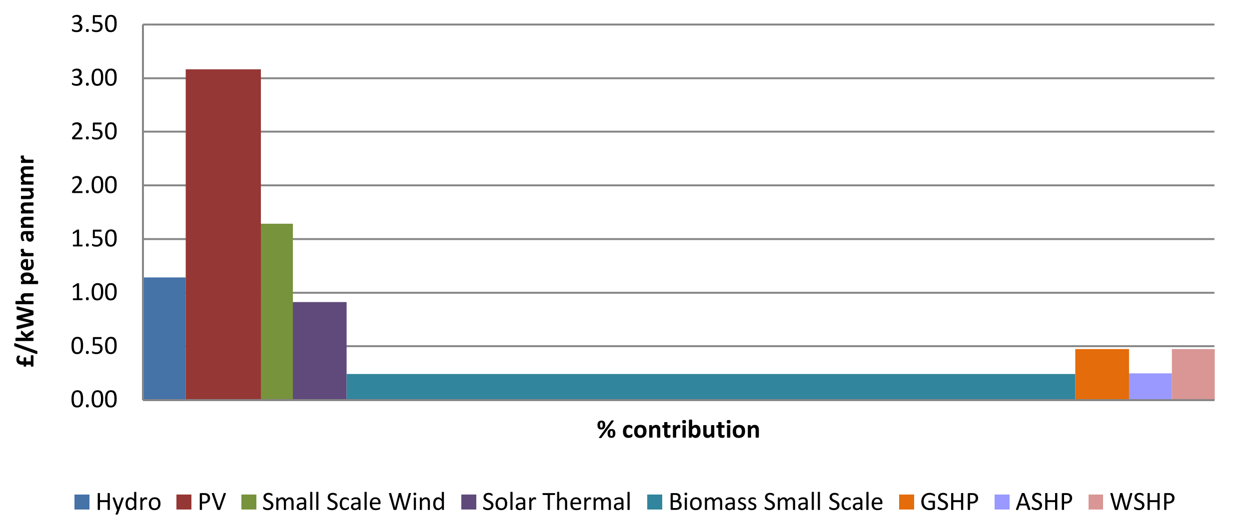


Figure 32 - Renewable Energy Comparison

The figure clearly shows that Biomass has the largest potential to deliver a large proportion of energy and the lowest cost. Wind is identified as having a larger cost compared to its potential generation.

A priority list for the Esk Valley is shown in Table 36. This is based on the assessment by CO2Sense and EVCEG may choose to prioritise these technologies differently after further community engagement.

Table 36 - Priority list for the Esk Valley

Priority List	
1	Biomass, domestic
2	Medium wind
3	Solar PV
4	GSHP
5	Small wind
6	Solar thermal
7	WSHP

7.2.3 Conclusion – power-up business case

The ratings table and comparison graph give an overview of which technologies offer the best projects for the community to concentrate on.

This is useful when prioritising; however a key consideration should always be in obtaining an energy mix. By utilising a number of different technologies, large peaks in generation can be avoided and more energy can be generated when it is needed. In this instance developing a range of technologies will be more beneficial than simply developing the rated 'best' technology

The highest priority is biomass which whilst being the most suitable technology also has the potential to deliver the largest contribution to generation within the Esk Valley area. PV is also highlighted, as although it is the most expensive technology, it does have the potential to contribute a large portion of local renewable energy. It also has very few development constraints which mean it can be quickly implemented.

Although Heat pump technologies do not rate very highly in the assessment, in certain situations they may be still be the best technology. This would be particularly the case in instances where a property is off the gas grid but has no space for a biomass system. Being able to pick from a range of technologies ensures that there is a solution for the majority of situations.

Whilst the Government are offering renewable energy subsidies for the installation of renewable energy technologies, this should be taken advantage of. Once an installation is accredited the subsidy is guaranteed and index linked for 20 years, 25 years for PV. However, these subsidies could be reduced or withdrawn over the coming years, so the business case for installing may become less favourable.

Next steps

1) Gather interest from the community, local businesses, local council and other stakeholders.
2) Advertise the benefits that these local carbon installations could have for the community, highlighting the business case and the community benefit.
3) Run a community event and play 'Renewable Pursuits – The Esk Valley Edition' a CO2Sense game which explores the development of Renewable Energy.

8 Methods of financing

Renewable energy projects can have high development and construction costs. This section outlines the main methods of financing available for renewable energy projects. To secure finance, a project must balance risks against potential return. The most common and significant considerations for investing in renewable projects are:

- Inputs:
  - Total project cost and size;
  - A proven and reliable technology and supplier;
  - Planning permission, licensing and permitting;
  - Additional capital finance to share financial risks;
  - Long term feedstock or fuel supply contracts;
- Outputs:
  - Long term tariff guarantee (for example the FIT, RHI or ROCs);
  - Power purchase agreement and/or heat sale contracts;
  - Destination and method of waste/by-product removal (e.g. digestate, ash, etc);
- Operation:
  - Operational and maintenance contracts;
  - Exit route (the ability to get an investment out of a project); and
  - Performance guarantees on equipment.

A project which reduces the risks associated with the considerations above is more likely to negotiate investment on better terms. The strongest projects and best investments are those with low risk and high financial returns. However, some investors will only consider projects with a minimum level of financial return (regardless of risk) or perceive risks in different ways (e.g. some investors may be more comfortable with certain types of project/technology than others).

There are two main forms of financing – debt finance or equity finance. These are now discussed in further detail in the following sections.

8.1.1 Debt Finance

Debt finance for renewable energy projects is when money is borrowed on the basis of a loan. A creditor agrees to provide capital investment on the basis of securing the original investment back over a period of time with additional interest. There are three key elements to traditional debt finance in renewable energy projects:

1. Investment sum – the total value of investment made by the creditor.
2. Duration of investment – the amount of time the investment is made over. Some repayments may allow early or staggered capital repayment.
3. Interest payable – the level of interest associated with the investment sum. This may fluctuate according to market conditions or be fixed in value.

Debt finance generally offers the least risk to the investor and greatest risk to the project developer but conversely offers the greatest potential reward to the developer. This is because the debt is repaid regardless of the profit/loss of the project and is usually "secured" against assets owned by the creditor (e.g. the renewable project or land). The most common form of debt finance for renewable projects is project finance (or "senior" debt). Senior debt is debt that takes priority over other unsecured or "junior" debt and must be repaid before any other creditors receive payment if the project becomes bankrupt or is liquidised.

The UK is soon to set up the world's first bank dedicated to investing in green technologies and projects; the Green Investment Bank (GIB). The projects recommended throughout this low carbon plan are likely to be too small in scale for GIB investment. However there could be potential for joint ventures at a wider regional level to finance larger projects in partnership with other organisations, or to work with other investors managing smaller funds in conjunction with the GIB. The GIB will have an initial fund of £3billion and is set to start formally in 2013 following state aid approval.

8.1.2 Equity Finance

An equity investment involves sharing ownership of the project including sharing the profits and risks associated with this. Money is invested into the stock or shares of a project, with the capital returned during when the shares are sold to another party or the assets of a company are liquidated. Dividends can be paid during the project to shareholders. Equity finance offers the most risk to the investor and lowest risk to the project developer, but conversely offers the lowest potential reward to the developer as profits will be shared with the investor.

The projects identified in this report are unlikely to be of interest to traditional forms of equity due to the low returns and long payback periods. However equity shares bought by the local community could be possible and are explored in more detail in later sections of this report.

8.1.3 Asset Finance

Asset finance is increasingly used as a third opportunity to fund renewable energy projects. Asset finance is partly debt finance and partly equity finance. Asset finance describes the types of finance packages provided by banks and specialist companies which can be used by a customer to purchase or lease assets. The most common kinds of asset finance are hire purchase and leasing.

- Hire purchase asset finance: an investor will pay for and own a specific asset as part of a wider renewable project (e.g. a CHP generator in an anaerobic digestion plant) in return for repayment of the cost of the equipment, plus interest, over time.
- Lease asset finance: an investor will pay for and own an asset and simply rent the asset out (usually there is an option to purchase the asset at the end of the period).

The benefit of asset finance in a renewable energy project is that it can significantly reduce capital cost and even maintenance costs if the equipment is maintained as part of the asset finance agreement. However as a result of this, the total running costs of the project will increase and therefore potential profitability may be

reduced. Asset finance is more common for projects with specific component parts which may be best serviced by a specialist company for example anaerobic digestion or biomass.

8.1.4 Community Share

Several renewable energy projects are now including a community share as part of the mix of investment alongside traditional debt and equity. A community share approach is a form of equity investment; individuals purchase shares in the project and receive benefits as a result. These benefits can be direct (for example a financial dividend) or indirect (for example carbon savings and improved local environment). Most community share offers include some form of financial incentive. The Esk community is well aware of this type of finance after having its own community share issue to raise finance for Ruswarp Weir Community hydro scheme.
Community shares have legal restrictions on financial returns. These shares also cannot increase in value; they can only remain the same or decrease in value. However a community share allows a person a vote or say in how a project is run. The "community shares programme" is a government funded project working across England to support community investment projects. The programme has a large amount of information on how to invest in local community projects. This has been used to produce Table 37.

Table 37: Comparison of standard company shares / equity investment with community shares

Factor	Community share (cooperative and community benefit society)	Company share
Share limit	£20,000 limit on individual shares	No limit to shares which can be owned
Voting	One vote per shareholder	One vote per share
Interest	Limited interest on shares	No legal limits to dividends payable
Tax	Interest is paid gross of tax, investors need to declare income	Tax credit of 10% of deducted from all dividend payments
Exit	Shares can be cashed in / withdrawn	Shares must be sold to other investors
Increase	Share cannot increase in value	Shares can increase or decrease
End profit	If there is any profit after the closure of the organisation, money will be given to another similar organisation	Money left on closure of organisation will be distributed between shareholders

8.1.5 CO2Sense Revenue Share

CO2Sense provides investment into renewable energy projects. CO2Sense investment is on commercial terms in return for an agreed share of a specified revenue stream (e.g. Feed in Tariff) which is expected to increase as a result of CO2Sense's investment. The revenue share investment commonly covers a fixed term, usually three or five years, with a small increase each year to encourage the business to repay the investment sooner if possible. At the end of the term the capital is repaid plus a premium payment. There is no single fixed revenue share model, but rather a degree of flexibility around a core approach, the exact approach being negotiated on a project by project basis. At any point companies who have a revenue share agreement with CO2Sense can choose to refinance the project through their bank or other investors. This may be possible after projects have demonstrated tangible results which enable lower cost finance to be secured. CO2Sense investment in various projects and could consider investing in a community co-operative Biomass scheme for the Esk Valley area.

8.1.6 Grants

A grant is a contribution or sum of money bestowed for a specific purpose. There are no repayment requirements on a standard grant (unless the conditions of the grant are broken), but most grants are paid for very specific purposes and are restricted in their scope. At present there are no government grants available for the installation of renewable energy technologies as grants have been replaced by the feed-in-tariff and renewable heat incentive. If any government grants become available for renewable energy it is likely that they would make the project ineligible for FIT/RHI financing.

CO2Sense are currently aware of the following non-government grants offering (restricted) renewable energy finance:

- Community Energy Challenge (project development funding) -
  http://www.cse.org.uk/projects/view/1178
- Energyshare (project development funding)
- http://www.energyshare.com/community-fund/
- National Lottery (community buildings)
- http://www.biglotteryfund.org.uk/

There are occasionally grants available from other sources and it is recommended that the following organisations are checked regularly to confirm if any new funds have been announced:

- CSEP - http://www.communitysustainable.org.uk/
- British Gas - http://www.britishgas.co.uk/community-energy/funding.html
- EON - http://www.eon-uk.com/about/sustainableenergyfund.aspx

Further support on grant funding is available from the EST
http://www.energysavingtrust.org.uk/Take-action/Community-projects/Find-funding

8.1.7 Conclusion - Investment

Table 38 summarises the different investment opportunities available. A mixture of traditional project finance and community investment is recommended for any community project undertaken as suggested by this low carbon plan, as this will enable ownership to be retained within a community while maximising the potential financial risks/returns of the project. The exact mix of investment will vary by project, dependent upon available investors and project specific conditions. CO2Sense can potentially offer a revenue share investment for projects in the region which can also provide reassurance for other investors.

Table 38: Comparison of investment opportunities

Investment	Positive	Negative
Senior debt or project finance	• Several available funds and straightforward applications • Can cover a significant portion of capital cost	• Long term repayments required • High risk for project developer (in case revenue falls or project fails)
Equity finance	• Low risk for project developer • Can cover a significant portion of capital cost	• Part of the project is owned by a third party with long term profits significantly reduced • High rate of return required • Often favour high capital cost projects
Asset finance	• Low risk for project developer • Can cover a significant portion of capital cost	• Part of the project is owned by a third party with long term profits significantly reduced • Long term repayments required
Community share finance	• Involves the local community and develops enthusiasm in project • Low rates of return required • Allows profit to be spent on community projects	• Can be difficult to secure a large portion of community share • Requires a strong management team / organisation to coordinate investment and profit
Revenue share finance	• Can incentivise other sources of finance by reducing overall risk • Low risk for project developer • Short term only with ability to buy out the investor (CO2Sense)	• Potentially higher rate of return required than debt finance • Only larger projects over 50kW, and up to 25% of investment are possible
Grant finance	• No finance repayment means high profit margin for the project	• Limited available grants • Competitive

8.2 Methods of governance

There are several different ways in which energy projects can be governed. To a certain extent these methods are related to investment as investors will require a clear governance structure that can provide accountability for funds spent and income generated. Any investor taking equity in a project (e.g. through community shares) is likely to require voting privileges or similar governance rights in order to protect their investment. The following section details different methods of governance for energy projects.

8.2.1 Existing organisations

8.2.1.1 EVCEG

EVCEG could manage the consenting, financing, construction and operation of any potential renewable project with their existing constitution and structure. This approach would carry significant financial and reputational risk for EVCEG. EVCEG could alternatively take a leading role in enabling projects including the financial and governance structure, rather than taking full responsibility for the project itself.

8.2.1.2 Local community organisations

CO2Sense are not aware of any other local community organisation which is suitable (in its capabilities or aims) to manage and operate a renewable energy project on behalf of the local community.

Several examples exist where renewable energy projects are undertaken by an organisation and a separate pre-existing organisation (usually a community and/or charitable organisation) is chosen to manage a new grant fund arising from revenue generated by a project. Therefore one organisation manages the installation and ongoing operation and finance of the project, and a separate organisation manages the funds generated.

Funds managed by an organisation already established and skilled in doing similar work would bring associated cost savings and the ability to draw on existing skills and partnerships. However, unless very strong guarantees are in place within the organisation to ensure a local focus, it may also dilute the work away from the local area and reduce the immediate impact to the local community.

8.2.1.3 Local authority

The local council could potentially install and manage a renewable energy project on behalf of the local people of The Esk Valley. This is not likely as on a strategic level, councils are not undertaking this type of activity any more.

However, councils (in particular parish councils or community councils in Scotland) are one of the most common forms of administrative body in the UK for managing community funds generated by renewable energy projects. This model is particularly common in Scotland.

It is recommended that a partnership approach is used with the local authority to allow sharing of resources and knowledge, while retaining local independence and involvement. Local authorities are increasingly taking the role of "enablers" and are likely to provide funding and/or governance support in any future energy projects.

8.2.2 New Organisations

A special purpose vehicle (SPV) is the term for legal entity which has been created to fulfil a specific objective. They are usually created to separate another company or organisation from financial risk. An SPV is often used in a renewable energy project as a discrete business enterprise which then manages the financing and operation of the renewable project. Different organisations see different benefits from SPVs:

- If several organisations form a joint venture and use an SPV, this is a new and clean legal structure for the enterprise to work;
- If a bank invests in an SPV, this can ensure there uncontested rights over assets (as pre-existing organisations may have existing debtors);
- If an equity investor invests in an SPV, this can limit its obligations to the SPV and distance itself from the activities of other organisations in the project.

It is recommended that some form of SPV is established for any medium to large scale community renewable project, as this will form the basis of a management structure. An SPV can come in several different constitutional structures.

8.2.2.1 Energy Services Company (ESCo)

Capital investment in large low carbon and renewable energy projects is often financed either wholly or in part with funds contributed by third parties into an energy delivery company, usually called an Energy Services Company (ESCo). This would be a particularly useful mechanism for a district heating network where multiple properties would be supplied with heat.

An ESCo is a specific form of SPV. The precise role and responsibilities of an Energy Services Company (ESCo) are tailored to meet the needs of the specific project or initiative. In general, ESCo's are used to deliver the following objectives:

- Supplying heat, power and cooling
- Renewable energy projects
- Energy savings
- Energy efficiency services
- Energy advice
- Tackling fuel poverty

Usually an ESCo is a company limited by shares or by guarantee, but in some cases it may instead be an industrial and provident society or a trust (these options are discussed in more detail in the sections below). ESCo's may be used to oversee the financing, construction, operation and maintenance of the system.
An ESCo will not make an unviable project viable, but it may take a different view on acceptable rates of return and risk than other facility management companies. They typically take a long term view, 15 years or more, and contracts are structured to reflect this. The structure of an ESCo will depend on the specific details of the

project or purpose, and be influenced by the attitudes of their partners towards funding and risk. As with most businesses, the organisation's structure can also be influenced by the degree of experience and knowledge within the ESCo's ownership or by the scope of the project or service delivered. An ESCo may be 100% privately owned or 100% publicly owned, or a public/private partnership where shared funding, risk and expertise come together to present the best solution for all parties.

8.2.2.2 Charity

One of the more common methods for managing and distributing finance from a renewable project is establishing a charitable trust. There are three main types of charity:

- Unincorporated organisation – these are the most common form of charity, but are not legal entities and cannot therefore borrow money, enter contracts etc. Therefore this is not suitable for a renewable community project.
- Trust – a trust is a relationship between a donor, trustees and beneficiaries of assets. A trust also has no legal status and is not recommended.
- Limited company – a charity can be a private limited company which does not have share capital but members (who generally pay a nominal sum, for example £1). The company has a legal status and can undertake community projects. Until recently, a charity could not issue share capital – as charity law forbid charities distributing profits to non-charities. However, from January 2012 exempt charities can offer a limited return on community share issues while retaining charitable status.

Charities secure a host of benefits, including tax breaks and numerous other financial benefits. However, any charity which starts distributing a large amount of money will find itself under close scrutiny from the charities commission (despite recent rulings) and therefore caution is recommended if this is chosen as an SPV.

8.2.2.3 Industrial and provident society / cooperatives

An industrial and provident society (IPS) is a legal entity for trading. An IPS can be separated into two categories; cooperatives, or societies for the benefit of the community. A cooperative works to benefit the members of the cooperative, while a society works for the benefit of the community. Legal issues for cooperatives are assessed according to cooperative principles (which have a very small amount of case law to back them up) while legal issues for societies are assessed according to charity law. A maximum shareholding in an IPS is £20,000 and shares typically allow a vote on the basis of one member, one vote.

A useful case study is Energy4All. Energy4All was created from the Baywind Cooperative in 2002 to expand the number of renewable energy co-operatives in the UK. The Baywind Cooperative is a successful community owned wind farm in Cumbria. Energy4All now establishes cooperatives across the UK for wind projects using a consistent delivery model. It is suggested that an IPS or Cooperative is explored in greater detail by EVCEG.

8.2.3 Example ESCO - Biomass boiler

The ESCo model presented below for a biomass boiler is a common arrangement as many customers do not want responsibility for the boiler and fuel arrangements. The ESCo generates returns from the sale of heat and from any market incentives, such as the RHI, whilst taking all responsibility for the operation and maintenance of the boiler. The customer receives low carbon heat which should be at a lower cost than they could purchase from a utility, without the complication of fuel ordering and boiler maintenance.

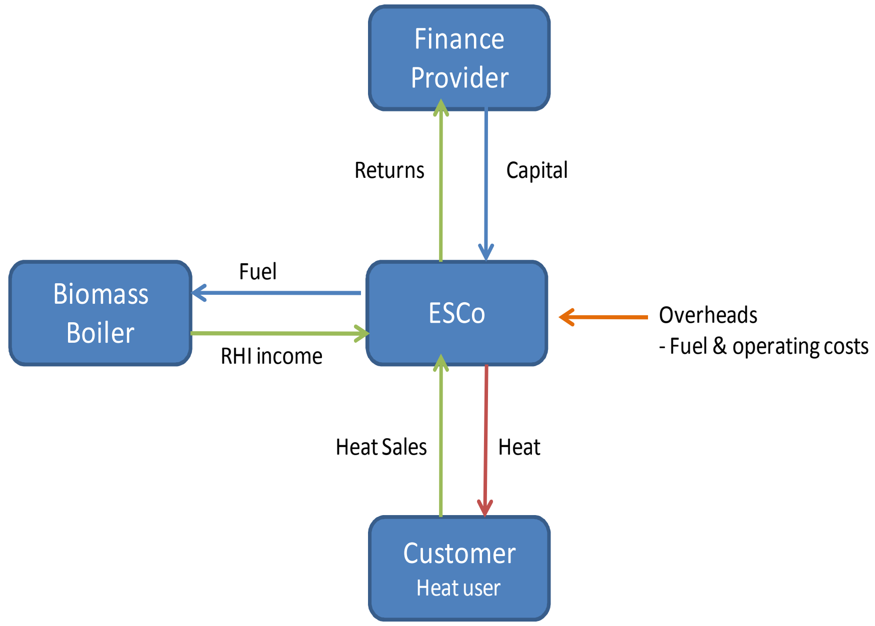


Figure 33 - Biomass ESCo model

8.2.4 Community decision making

Any organisation created will need to make decisions on how to manage finances arising from the project. Some finances will be legally contracted (e.g. repayment to creditors) but some decisions will need to be made on how money is reinvested into the local community. There are several options for decision making:

- Small group of appointed decision makers:
  - Board. A board could determine how to use the money arising from the project with no input from the community aside from an annual election to determine Board members. This would be a rapid and simple but could be incompatible with certain forms of legal governance.
  - Subgroup. A board could determine the size of any fund available for the local community, and a subgroup could determine what projects to fund. A subgroup could consist of representatives from the local community and allow separation internally from administrative or project based activities away from more financial or regulatory issues.
- Decisions made by all community members:
  - Every funding decision could be decided upon through community consultation and voting. This could be online, a postal vote, or through regular community meetings. This would allow

everyone a fair say but could be very time consuming to manage. This may be required if an IPS is chosen as the delivery body.
  - A full vote could be required only when the funds allocated or requested exceeded a certain value. This would allow funds to be distributed without as much administration as a full vote.

The community members on the board of the organisation, or any other subgroup chosen to manage finances arising from the project should be elected by the local community. These members could be elected on different grounds. Members of the board could be chosen based on demonstrated commitment and involvement or skills which they have to bring to the management of the SPV, for example experience in managing a charity or business. They could be chosen to represent specific interest groups within the local community to ensure fair representation of different stakeholders, for example; council, businesses, schools, religious groups and landowners.

8.2.5 Conclusion - Governance

CO2Sense recommend that prior to any governance structure being chosen, legal advice is sought as there are significant tax, legal and operational differences between all types of structure. However, if the chosen project is likely to make a limited return on investment and/or benefit a local community in other, non-financial means a charity is likely to be the best option. For the majority of projects, an IPS is likely to be the preferred choice. For a project of considerable size it is suggested that ESCos are also considered.

8.3 Community benefit opportunities

A key benefit of developing renewable projects is that profits can be re-invested into the local community. Prior to determining projects to invest in and potential uses of the community fund, a clear mission aims and objectives should be established. This needs to be identified and agreed by the local community. It is recommended that the community determine any specific needs that the local area has. It is important that the community benefit fund does not duplicate the work of any other organisation or project and that a project addresses a real need.

8.3.1 Project types

Projects financed by a community fund could be aimed at environmental, economic or social objectives. Several example projects are demonstrated below:

- Environmental projects:
  - Energy efficiency, e.g. insulation or boiler replacement
  - Renewable energy, e.g. subsidised solar PV installations
  - Conservation, e.g. local habitat protection or tree planting initiatives
  - Transport, e.g. free bikes or investment in better transport facilities
- Social projects:
  - Health and wellbeing, e.g. local allotments
  - Sport, e.g. investment in local clubs
  - Culture, e.g. community art projects
  - Crime, e.g. local youth offenders projects
  - Education and training, e.g. bursaries or education grants
  - Business and industry, e.g. start up business grants

8.3.2 Project beneficiaries

Funding could be allocated for individuals in the community, for individual people, households or members of the organisation (e.g. through share dividends). Allocating funds to individual people or households will ensure that members of the community directly benefit from the community benefit fund either financially or through other services. However, unless funding was allocated in a flexible manner it would be hard to ensure that all individuals benefit equally as it could be difficult to find products which every person needs.

Funds could be used to support schemes that would provide shared benefit for local people, with less focus on individual benefit. Allocating funds to the community will potentially generate a longer term benefit and enable the entire community to benefit. However, it may be more difficult to get consensus on projects to fund, and it may be difficult to measure tangible success of the projects. There are also wider international, national or regional projects and organisations which could be funded or established using the community benefit fund.

8.3.3 Conclusion - Opportunities

Any project undertaken by the community will have outputs and outcomes; for renewable energy projects these will largely be financial outputs. Any finance generated by a project will need careful management to ensure that the end use of this finance is equitable and has been agreed by the project stakeholders – chief amongst these being the local community. Identifying aims and objectives early will help refine the potential opportunities for the funds generated and ensure that the community is in agreement on how finance can be spent. These opportunities can be broken down into social/economic and environmental, and according to scale of project or beneficiary. CO2Sense recommends that the options are reviewed carefully and considered early in the formation of any community project.

9 Timeline for action

This low carbon plan has been written to be completed over a timescale of ten years. The recommendations that have been made could be achieved within this time; however a strong community network must be built upon to enable these changes.

The timeline shown in Figure 35 shows the possible stages for engaging and organising the community into action to enable the renewable energy projects. This is a shortened version of a more detailed chart which can be reviewed in Appendix 5. Developing this 'power-down' and 'power up' approach in the 'Esk Valley' could lead to the area becoming a low carbon hub. The timeline evaluates each renewable energy installation defined in the feasibility study alongside the energy reduction measures discussed in this report.

A ten year plan is fraught with bumps in the road and the impact of this on morale of the community should not be underestimated. A constant review and refresh approach should be taken to keep the momentum going and to address and redress issues as they crop up. The continual momentum diagram in Figure 34 highlights this process of progress.

- **Idea** - Ideas are suggested by community and group members. These are discussed in the forums available, in particular at meetings, events and on the website forum. CO2Sense reports can be used as a starting point.
- **Research –** Research is carried out as to the validity of the idea and the process by which the idea can be followed through. The results of the research should be analysed by other group members or interested parties.
- **Implementation** – This is the stage whereby the idea is mapped out into a chart of actions that will lead to the implementation of the idea.
- **Operation** – The idea comes to fruition and the process can be reviewed, assessed, revised and re-started

There are many "measure and monitor" breaks in the 'Power up' and 'Power down' timeline. These are crucial annual review breaks to check the progress of the low carbon action plan.

The idea of continual momentum enables multiple projects to be ongoing at any time, with continual assessment to progress always being monitored.

Public consultation should be an ongoing requirement throughout any project, the more the community are involved and are informed of the benefits of any schemes in a well balanced proposal; the more likely they are to be amendable to the ideas put forward.

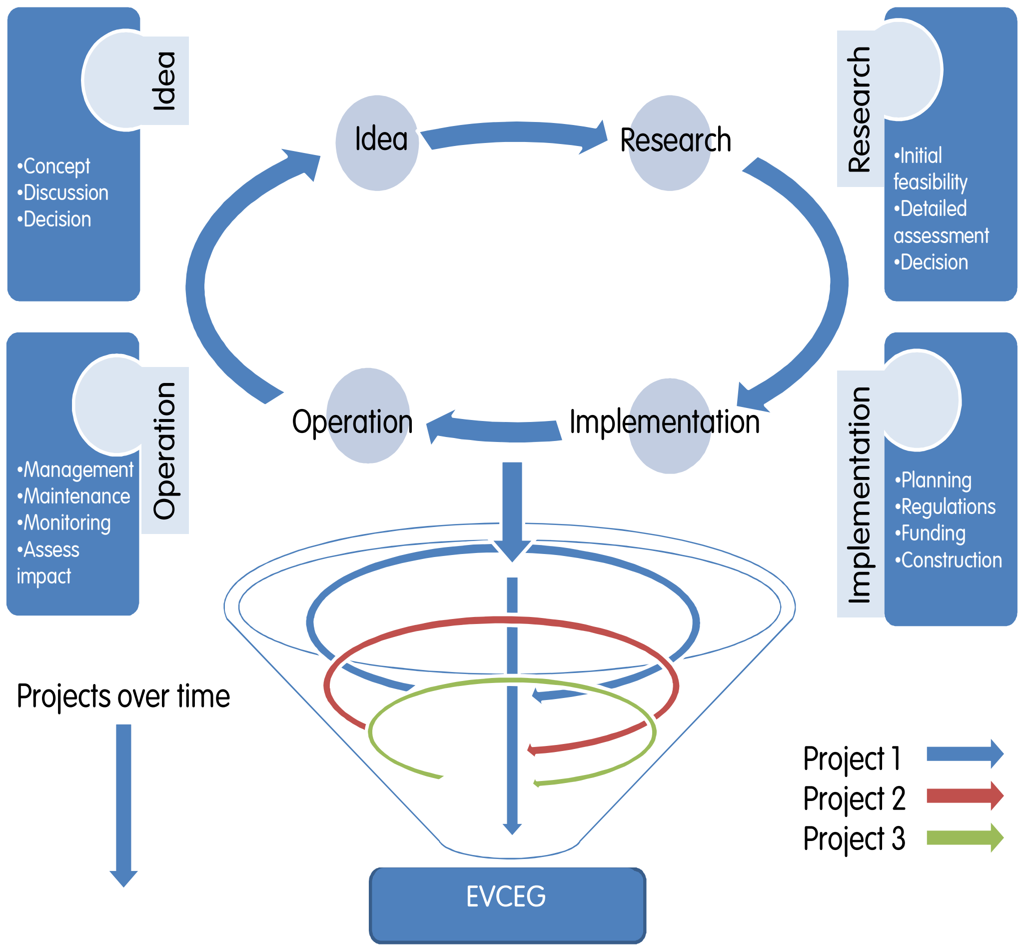


Figure 34 – Continual momentum diagram

9.1.1 Conclusion – timeline for action

Developing this 'power-down' and 'power up' approach in the Esk Valley could lead to the area becoming a low carbon hub. The timeline stretches over the ten year period of the Esk low carbon plan and evaluates each renewable energy installation defined in the feasibility study alongside the energy reduction measures discussed in this report. It is merely a suggestion of how the gradual stages of change can be implemented, however, if actions could be progressed faster than the timeline, this would be beneficial to the community.

Next Steps

1) Set achievable targets
2) Continually monitor and measure progress
3) Check that targets are being reached and if not why not?

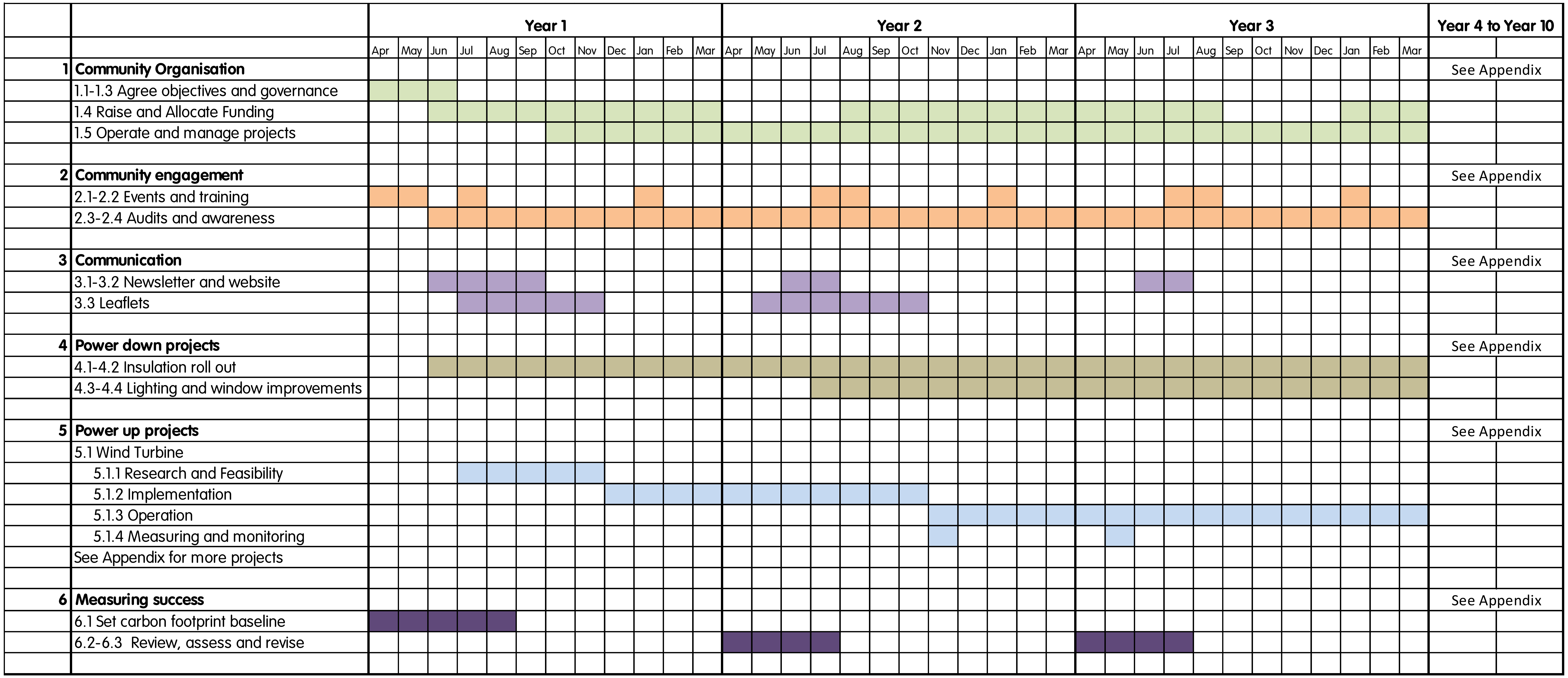


Figure 35 – Timeline for community action (full time line provided in Appendix 5)

10 Results

10.1 Power down – energy efficiency

This report has shown that the community can go a long way to achieve their ambition of becoming a lower carbon, more sustainable community. The priority in the Esk Valley must be to reduce current energy demand. This can be addressed with the Government's new 'Green Deal' which is expected to be rolled out in autumn 2012. It is hoped that this will assist householders to meet the capital costs of upgrading the building fabric of their dwellings to minimise heat loss and reduce energy consumption.

This report has shown that this could have dramatic effects on the current energy demand, potentially reducing the demand by almost 45%. The energy reduction measures are all achievable, but can be capitally expensive, inhibiting most householders in their efforts. However, if the 'Green Deal' can assist with this obstacle, then householders should be informed, encouraged and guided through this process to maximise on this opportunity. The energy efficiency measures will not only reduce their bills, improve their thermal comfort within the home and save energy, but it will do all these things for many years and generations to come.

Figure 36 depicts graphically the progress that the Esk Valley could achieve if the energy efficiency measures suggested in the timeline were implemented. The heat (blue) and electrical (red) demand lines) can be seen to decrease by 30% over the period of 10 years as the energy demand is reduced year on year by energy efficiency measures.

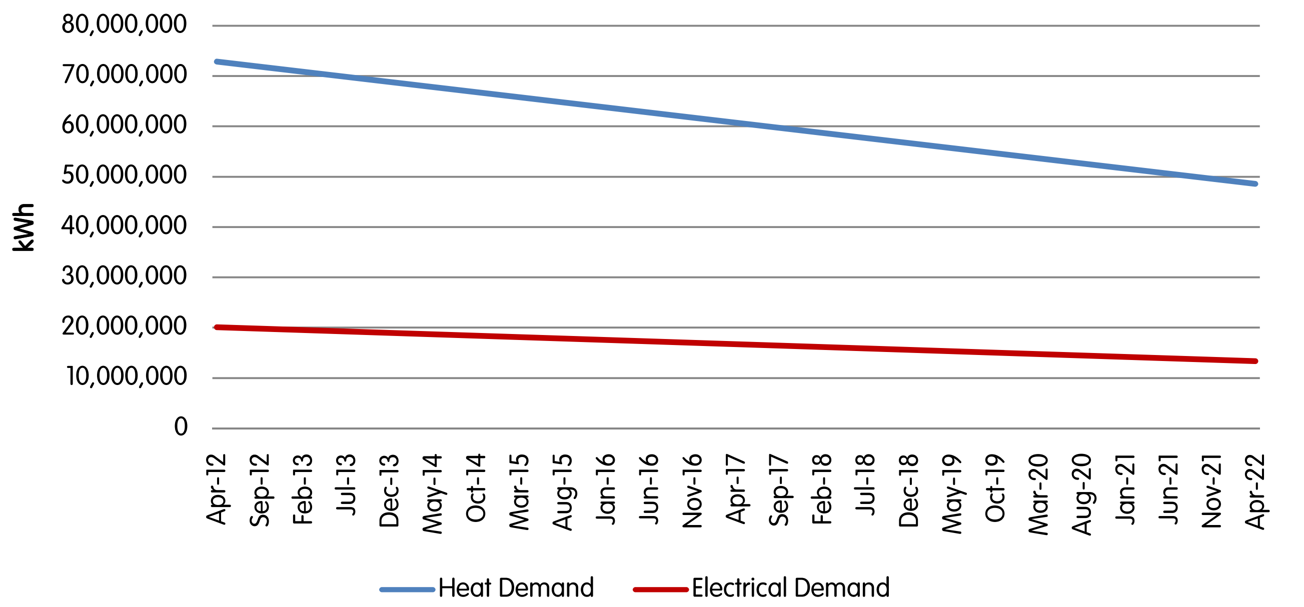


Figure 36 – Graph showing energy demand over 10 years

10.2 Power up - renewable energy generation

Figure 37 shows the predicted percentage contribution of renewable generation (large scale deployment scenario) of the local demand for the next 10 years. The stepping up of the lines can be seen as the increased capacity comes on line. These step-ups mirror the renewable energy generated by the renewable energy installations that are charted in the 10 year timeline discussed in Figure 35.

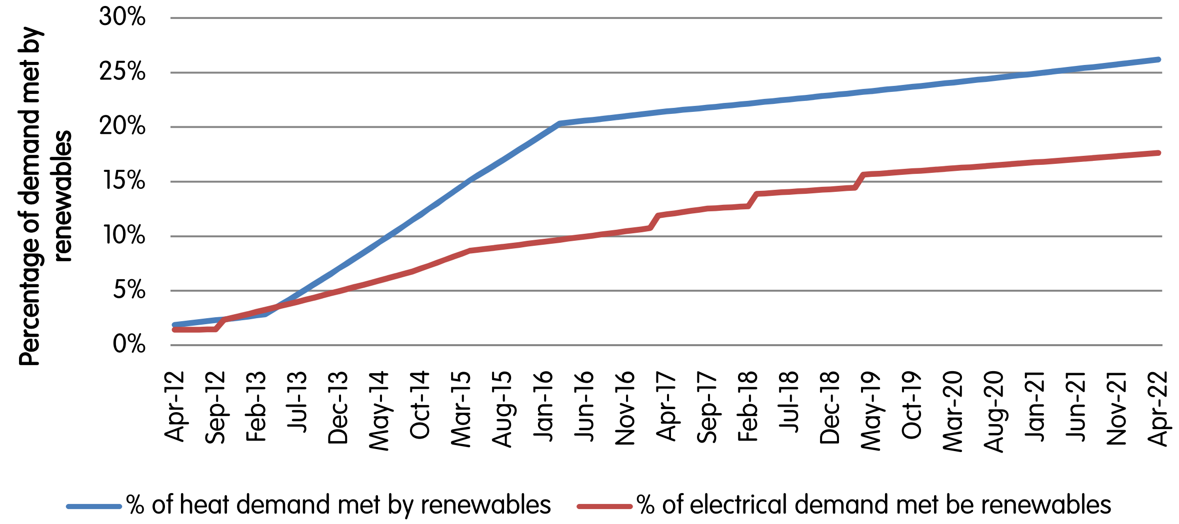


Figure 37 – Graph showing percentage of energy demand met by renewable energy generation, large scale deployment scenario, over 10 year

10.2.1 Power up - Renewable electricity

Reviewing the renewable electricity generation line in Figure 38 it can be seen that the generation rises in a number of steps as the suggested installations recommended in the feasibility study are completed. By 2016 the majority of these are implemented and the increasing % contribution rises seen in Figure 37 are mainly due to the energy efficiency measures being rolled out.

With these energy efficiency measures reducing demand by 30% by 2022, it can be seen that the large scale deployment of renewable will contribute to 16% of the total electricity demand.

10.2.2 Power up -Renewable heat

Renewable heat can only be developed at local levels and can't be distributed via a national grid like electricity and gas. Therefore developing local and low carbon alternative forms of heating is essential to meet National renewable energy targets. Furthermore, the Esk Valley has many households off the gas grid requiring coal, oil, LPG and electricity to provide their heating. This is a very expensive and carbon intensive way for people to meet their space heating needs. Therefore producing heat locally and upgrading people's heating systems to less carbon intensive fuel should be considered a priority for communities.

In Figure 38 the maximum percentage of heat demand that can be met with the recommendations from this report and the accompanying feasibility study is over 25%. The main opportunities for developing renewable heat options were identified as biomass and to lesser extent heat pumps. Investigation into forming a co-operative for individual biomass installations should be undertaken to reduce costs of both installation and supply of fuel. This may be a viable option if people uptake the renewable premium payments which area available until summer 2013 when the domestic Renewable Heat Incentive is hoped to be introduced. (Further details are in Appendix 3).

10.3 Conclusion - Results

Great inroads can be made towards securing a lower carbon future if energy efficiency measures are rolled out and renewable energy installations are deployed. However, to reduce demand by 30%, 67% of dwellings in Esk must upgrade their homes to the 'Super' insulation scenario discussed. This is a great challenge, but it is achievable with community engagement. Large scale deployment of renewable energy installations will be needed to achieve 25% of heat demand and 16% of electrical demand. If the community could have a share of ownership in some of these projects then this could provide a useful income stream to the community and re-circulate wealth within rural communities.

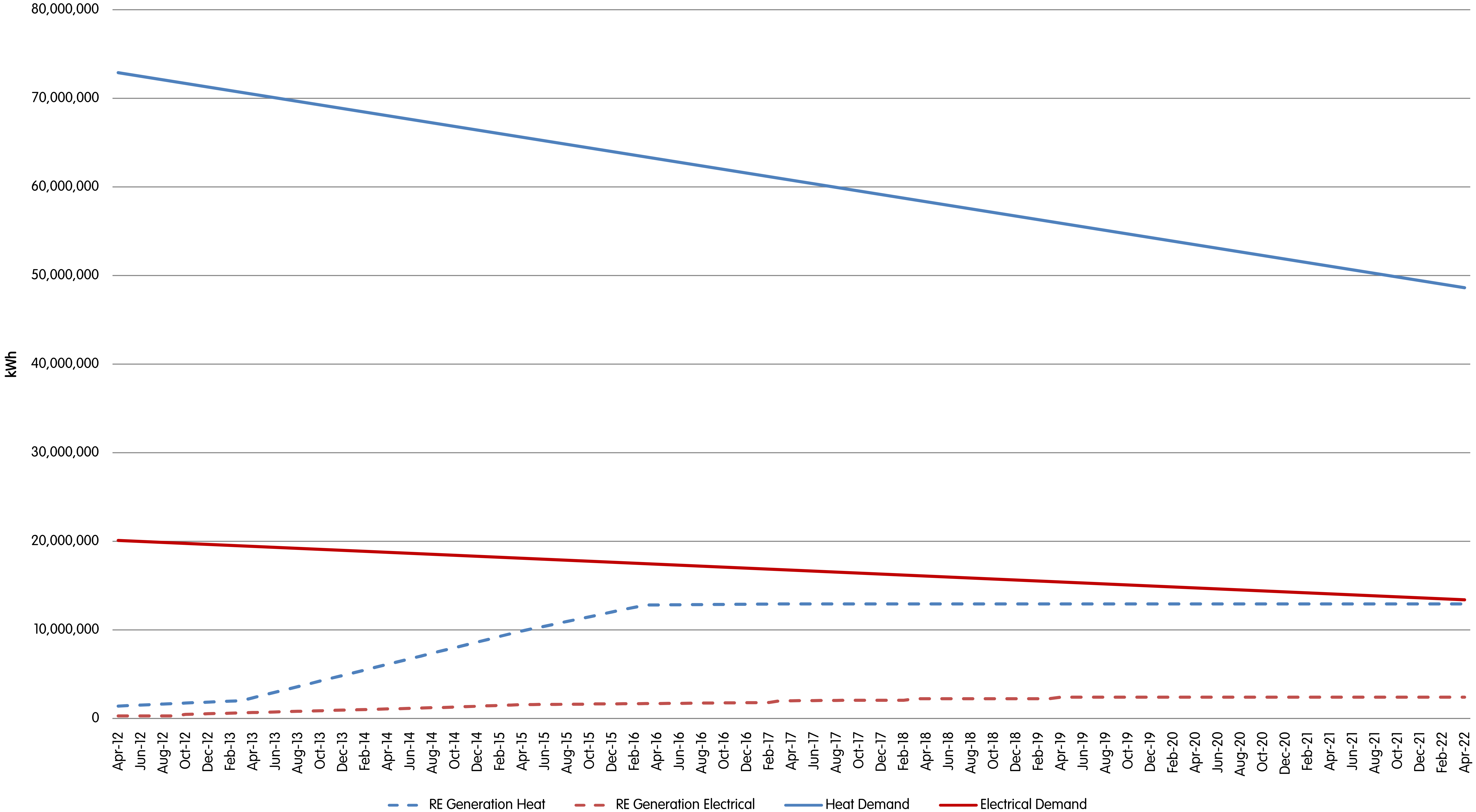


Figure 38 – Graph showing percentage of energy demand met by renewable energy generation, suggested by the feasibility study, over 10 year

11 Community engagement

Community engagement is the epicentre of change. The impetuses for all the recommendations concluded in this low carbon plan are ineffective without the passion and commitment of an engaged community striving to become a stakeholder in the future of their area. CO2Sense has worked with many community groups and has an understanding of the immense capacity of people motivated to improve their communities.

The Esk Energy Hydro project has brought together the whole community including householders, businesses and community organisations. It is hoped that this impetus can be utilised in the continuation of further low carbon installation. By having a range of people involved, these projects are encouraging participants to share examples of good practice and to challenge each other to make greater changes to the way they behave environmentally at home, in the work place, when out shopping and enjoying the local area.

Each individual in the Esk Valley is being challenged to consider how their lives have an impact on the environment and how they can make small changes to reduce this. The collective outcome across the Esk Valley will be significant as all the small actions are joined together. It is hoped that the actions of those involved in these projects will inspire others in the area and further afield to get involved in this movement.

The community is being empowered to act by gaining knowledge of how their actions affect the environment. Everybody can be involved in the decision making of the project through the website and public meetings. This involvement gives the community ownership so the benefits will continue long after the initial phase of the project.

11.1 Conserve and reduce network

This will be a website based network that has a two way exchange of information between the community and EVCEG.

1. The community can upload information about their energy use in the forms of:
    - energy bills;
    - energy saving tips;
    - energy efficiency measures that householders have undertaken and the costs and savings that they given;
    - Feed back on installers;
    - Good energy deals;
    - Co-operatives that residents are forming to get the best cost saving deals;

2. EVCEG can upload information about:
    - The Green Deal and other Government incentives;
    - Local installers that are offering home improvement discounts;
    - Energy benchmark data for the area;
    - Information on up and coming events;
    - Information on progress of renewable energy installation projects;
    - Energy saving tips and advice;
    - Useful web links;
    - Templates for remedial works that have been approved by the conservation officer;
    - Advice on how to cope with the disruption when works are being undertaken.
    - Case studies that will assess the:
        - Impact on the energy reduction and efficiency of the building.
        - Impact on the appearance of the building.
        - The cost to benefit ratio of the works.

11.2 Energy Champions

The energy champions who have been trained as part of the LEAF scope of work will be able to advise and train other community members on energy efficiency.
A team of energy champions could be trained to go into homes and advise on how to save energy and cut costs, or offer door to door advice.
Energy reduction workshops could be run, not only highlighting energy that can be saved in the home, but broader energy saving advice, for example:

- Eating Locally grown food;
- grow your own;
- keeping chickens or bees;
- Reducing meat consumption or going vegetarian as meat production is highly carbon intensive;
- Buying natural products such as wooden toys rather than highly carbon intensive plastic;
- Holiday in this Country rather than fly abroad;
- Leave the car and take public transport;
- Use an energy meter.

11.3 Community involvement

As changes and visible improvements are made, public enthusiasm will grow encouraging further improvements and change. Collaboration with local schools and other organisations such as the Women's Institute should be encouraged to help gather momentum and get a wider cross section of the area involved and onboard.
Through community action, the objectives in Table 39 could be achieved and lead to a more sustainable area being realised.

Table 39 – Community action forging change

Objective	Deliverable	Rationale
Empowering the community	Reduction in fuel costs	Protect against rising fuel costs and risk of fuel poverty
	Community income	Community becomes a stakeholder in their own decentralised energy generation
	Energy resilience	Bringing energy resilience to the community to protect against volatility in the energy market.
Carbon reduction	CO_2 savings	Mitigate against climate change
	Renewable targets	Assist the council to meet their renewable energy targets
	Renewable Electricity/heat delivered	Progress new low carbon energy generation installations
Bringing growth to the region	Infrastructure improvements	Long lasting change to benefit the community
	Sustainable neighbourhood	Enhance quality of life and promote further change
	Utilising natural resources	Reducing dependence on fossil fuels and harvesting local resources
	Green jobs	Increasing employment and diversifying the skill base for the area

11.4 Community dialogue in renewable energy generation

As the price of fossil-fuel derived energy increasingly soars, decentralised energy generation, owned by the communities they serve, becomes an increasingly attractive proposition for neighbourhoods. This gives the local people security of energy prices and reduces the monopoly of the 'big six' energy providers, increasing competition and offering a new model of shared resources. Income from energy sold on to other users can be reinvested into the community for further renewable energy installations or other projects, but either way keeping money within the local community.

Consultation with the community should be initiated and a dialogue opened as to how they want to invest and what owning their own renewable energy generation plant would achieve for them. Suggestions for key questions to ask during consultation are shown below.

Consultation questions

1. Which renewable energy technology should be prioritised?
2. What should be the priority for the first 12 months?
3. What should be avoided?
4. How important are targets?
5. Should sub groups be set up to manage different priorities?
6. How should we assess and re-evaluate progress?

11.5 Consultation response

Danby village Hall hosted an event run by Summations to advertise the current work being undertaken for the LEAF project. The event was held in two parts; an afternoon drop-in session for the community to ask questions about how to save energy and an evening event where CO2Sense presented the findings from the Renewable energy study and asked for feedback on how the community felt the big issue of energy use could be tackled.

The questions in the box above were considered by the 30 attendees in round table discussion and then the group members fed back their opinions. The following section is a summary of the feed-back received.

There was general concern about a large scale deployment of individual Biomass boilers for households. The main concerns were based around:

- Emissions around Biomass;
- A large scale uptake of Biomass would lead to a shortage of wood;
- A shortage of wood would increase the price of the wood available;
- If more wood was planted for fuel, would that encroach on land used for food growing;

These questions can be answered:

- Biomass boilers have to comply with strict emissions standards;
- The up-take of Biomass boilers should be targeted at those homes that are off the gas grid. This is a small proportion of the population and shortage of wood supply should not be an issue;
- The price of wood is likely to remain below the price of fossil-fuels which are following a trend of becoming increasingly expensive.
- There are many unmanaged woodlands and old coppiced woods that are now redundant. Restoration of these should be an objective rather than utilizing food crop land which is likely to remain more valuable retained as land for food crops.

Suggestions made by the community with regards to Biomass:

- Encourage the community to buy and manage their own woodland;
- Incentivise the creation of a local pellet mill to supply the increased local demand;
- The North York Moors National Park is the most wooded National Park and this asset should be utilized;
- Burning locally grown wood in modern boilers is a very efficient way to produce heat.

The community highlighted their priorities for action as:

1. Reducing demand through:
   a. Draft proofing;
   b. Education on how to combat heat loss;
   c. Double glazing;
   d. Loft insulation;
   e. Local school action – children informing parents;

f. Energy meters;
g. Parish councils updating parishioners;
h. Car clubs;
i. Better public transport

2. Monitoring energy demand and setting targets for reduction;
3. Looking at community renewable energy schemes;
    a. Setting up multi-functional groups for specific projects;
4. Developing new channels of communication to spread the action:
    a. The Women's Institute;
    b. Parish councils – church magazines;
    c. Local schools and fetes;
    d. Meet up groups with speakers.

It is hoped that his low carbon plan will be circulated throughout the community and be food for discussion and further action.

11.6 Conclusion – community engagement

Without the community onboard, creating a low carbon hub will be an impossible task. This report was funded by the Department of Energy and Climate Change through their 'Local Energy Action Fund (LEAF)' program. This fund was set up, as the Government realise that a grass roots up approach is an effective way to drive change. There is huge passion, motivation and commitment within most communities that want to instigate a more sustainable way of life, that is more in-tune with the limited resources of this finite plant. Through the LEAF work, the community will access, via upgraded websites, to this report and the others carried out for LEAF. They will have further tools to evaluate their community's energy consumption, how to reduce it and how to meet it with feasible renewable energy installations. Next steps are recommended in the blue box at the end of this section.

Next steps

1) Advertise the website and post –LEAF follow up meetings;
2) Engage people while LEAF reports are current and fresh;
3) Encourage the energy champions to train-up other willing volunteers in small groups;
4) Encourage the 'reduce and conserve' network to gain strength with key corner stone people to act as enablers;
5) Draw up an energy and building audit questionnaire which can go on the website or people can use to assess the area;
6) Begin to structure the area into sections that people can survey, either door-to-door or external visual inspection;
7) Have local meetings and invite speakers to come and enthuse the community about various low carbon activities and topics, for example 'how to keep chickens' – bicycle maintenance'
8) Encourage a forum on the website where people can get involved, ask questions or installers can advertise;
9) Advertise courses that maybe run on relevant topics, i.e., DIY insulation;
10) Keep the community updated on the Government incentives, such as the 'Green Deal', the domestic RHI.

12 Summary of recommendations and next steps

This section summarises the main recommendations and next steps drawn from throughout this document and the accompanying renewable energy feasibility study. Further detail is provided in each study on the recommendations as appropriate.

12.1 Energy baseline

Section 3 assessed the energy demand within the Esk Valley to determine the current energy baseline and project future growth in energy demand and generation.

- **Recommendations** – CO2Sense recommends that EVCEG undertakes a wider and longer term assessment of domestic energy use. This should link with the community engagement work (outlined in more detail in Section 10.4) and include the following next steps.
- **Next steps** –
  - Continue to evaluate the baseline demand of the area to understand the current energy demand and how the consumption of energy is changing.
  - Annually reassess the energy demand for the area. This should be undertaken by the energy champions each year using the websites and resources provided in this report, to determine if any energy reduction measures implemented are making an impact.
  - Annually revise methods for encouraging people to uptake energy reduction measures if the impact has not been as expected.
  - Publish any changes, findings or progress on the EVCEG website to facilitate understanding and knowledge sharing.
  - Promote the website and further studies to encourage the community to take action and make changes to their buildings and behavior.

12.2 Power down

Sections 4-8 assessed how powering down energy consumption within the Esk Valley may be possible through implementing energy efficiency measures.

- **Recommendations** – There are several recommendations on energy saving opportunities made for both domestic and community buildings. These include:
  - Behavioral measures; including reviewing heating/cooling patterns, switching off appliances and using appliances in the most efficient way possible;
  - Identifying and listing "easy win" implementation measures;
  - Identify who can undertake energy efficiency work across the Esk Valley, and what this work is;
  - Sharing assessment and quotes undertaken to share wider learning.
- **Next steps** –
  - Roll out a wider campaign of energy assessments using the network of energy champions;
  - Create case studies of successful projects and provide these on the website;
  - Create a list of local/trusted suppliers of efficiency technologies - provide this on the website;
  - Discuss regional projects with the local authority for insulation and improvements in line with the Green Deal.

12.3 Power up

Sections 5-8 assessed the opportunities available in the Esk Valley to power up energy production from renewable sources. The major recommendation from these sections was that a large scale renewable energy project is unlikely to be feasible and therefore the major opportunities stem from domestic sized installations; particularly biomass and solar PV. The next steps in driving change are further studies and assessments to determine the exact location and extent of these domestic installations.

The following section scrutinises the different types of potential renewable energy installations to understand the possible hurdles and constraints that must be overcome and the next steps which need to be taken to achieve a successful project (on either a project specific or wider scale). This section is taken from the accompanying renewable energy feasibility study. One of the biggest constraints to an area such as the Esk Valley is projects gaining planning permissions. An overview of planning permissions for the area can be reviewed in Appendix 4.

12.3.1 PV

- **Constraints** – There are not many constraints when installing a PV array. However the following should be considered:
  - Appropriately orientated and pitched roof space;
  - Adequate structural load of designated roof;
  - Planning permission for commercial buildings;
  - Permitted development for domestic buildings;
  - For large arrays, sufficient grid connection with appropriate permissions will be required;
- **Recommendations** – Further scrutiny of capital costs and payback periods.
- **Next steps –** Investigation of financial structure whereby a community group can invest in large scale array on private or council owned buildings or land, as an ESCo model.
- **Comments** – Once the capital costs have been agreed with an installer and the payback period is ascertained, PV becomes a low risk, low maintenance green energy generator for at least 25 years and possibly beyond.

12.3.2 Biomass

- **Constraints** – There the following constraints when considering the installation of a biomass boiler.
  - Exhaust emissions from the Biomass plant;
  - Increased traffic for wood fuel delivery, estimated at 1 truck per month;
  - Engagement and training of the facilities manager;
  - Storage space for fuel and space for a larger boiler.

- **Recommendations –**
    - Ensure the building has energy efficiency recommendations made and implemented; Confirm heat demand / output of the boilers:
    - Ensure sufficient space is left within newly designed plant rooms to allow for the installation of a biomass boiler:
    - Work with CO2Sense to secure quotations and designs from trusted suppliers for a) boiler and b) civil works;
    - Review case studies of biomass projects to learn lessons from similar projects, particularly with regards to financing and governance methods (see Appendix 5);
    - Negotiate long term contracts with suitable fuel suppliers;
    - Undertake detailed financial modelling for the lifetime of the equipment using real costs and site specific data; and
    - Undertake consultation with National park authority to determine any additional planning concerns. In particular it is recommended that information is requested on local air quality zones.
- **Next steps –**
    - Detailed feasibility/design and planning support –further detailed assessment will be required in addition to planning applications and related studies;
    - Investigation of financial structure whereby a community group can invest in the installations alongside the council as an ESCo model
    - Installer/supplier selection - review experienced qualified suppliers to secure the best value for money. This would include equipment, installers and fuel suppliers;

12.3.3 Heat pumps

- **Constraints** – There a few constraints around this type of technology, which once installed has a low visible impact on the environment and minimal maintenance requirement:
    - Appropriate heating distribution system;
    - Adequate insulation and air tightness to ensure there isn't excessive electrical usage from the compressor;
        - GSHP
            - Adequate space for ground loops;
            - Adequate ground conditions for vertical bore hole;
            - No utilities buried on the land earmarked for the ground loops or boreholes.
        - ASHP
            - Sufficient outdoor space to house unit with good air flow;
        - WSHP
            - Permission from the Environment agency to sink loops into a river ;
            - The river isn't too far from the building to be heated;
            - The power demand for the pump for the WSHP does not out-way the benefits of the system.
- **Recommendations** – Further scrutiny of energy demand of building, capital costs and payback periods.
- **Next steps –**
    - A detailed calculation of the heating demand of the building in order to more accurately size the heat pump;
    - Energy reductions measures need to be assessed and implemented to ensure that energy costs are minimised.
    - If a GSHP is considered then a detailed assessment to determine the feasibility of a ground loop or vertical borehole collector.
    - If a GSHP vertical borehole is to be considered then an assessment of the ground conditions would need to be made.
    - Assessment of feasibility of installing under floor heating or oversized radiators.

12.3.4 Wind

- **Constraints –** There can be many constraints to wind installations
- **Recommendations – Consultation** about the role wind energy can have in reducing the CO_2e emissions in the Esk Valley.
- **Next steps –**
    - Identify sites;
    - Wind data collection /modeling;
    - Talk to landowners;
    - Discussions with MCS Wind Turbine Installers, site specific surveys and three quotes per site;
    - Initial consultation with LPA concerning permissibility of turbine installation;
    - Preliminary EIA and consultations with relevant local bodies;
    - Grid Connection Application;
    - Local Consultation.
- **Comments –** Wind installations can be divisive and many people have polarised opinions. They are however a good long term way of generating green energy and bringing in an extra revenue stream for land owners. They are not long-term fixed structures, but can be removed after their operational life with ease. Embedding decentralised generation within the area will also lead to less requirements for grid strengthening and the works and costs that these measures will incur.

12.4 Stakeholder engagement

Community engagement is essential throughout each of the previous three stages (energy baseline, power down and power up) and is discussed in detail in Section 9. In addition, other stakeholders and potential investors or partners in the project should also be engaged with; several existing organisations (e.g. the Local Authority) exist that can provide excellent support to facilitate future change in the Esk Valley.

- **Recommendations –**

    - The profile and awareness of EVCEG and the Esk Valley low carbon future need to be raised across the Esk Valley and associated people and organizations in these villages;
    - Dialogue and partnerships should be undertaken with suitable local organizations to enable wider change (e.g. Local Authority, schools, NHS, major employers, other community groups);
    - An ESCo (or other SPV) should be established to undertake any future investment projects, and involve the local community with decision making in a fair and transparent manner.
- **Next steps** –
    - Train additional energy champions and run events to promote action in the community;
    - Organize a meeting with the Local Authority to outline the results of this study and determine a joint way forward for the region;
    - Develop and maintain the EVCEG website to disseminate information.

13 Conclusion and action plan

The aim of this report is to give members of the Esk Valley community a template from which their vision for a low carbon area can be realised. This low carbon plan is not a prescription of how this should be done, but a toolkit towards a sustainable community.

13.1.1 Energy benchmark

The first step in this process is producing a benchmark of current energy use. It is impossible to accurately assess progress if there is no defined start point. Section 4 of this report provided an assessment of current energy use within the Esk Valley area which can be used as this benchmark for future comparisons. This will not only allow effective evaluation of energy reduction measures but will add to community awareness of the true levels of energy consumption and associated CO_2 emissions.

The headline figures from this section are that the Esk Valley area has a total annual domestic electrical consumption of 20,320 MWh and a total annual domestic heat consumption of 55,00MWh. A total heat capacity of 28MW is required to meet this demand.

The section has also identified that approximately 33% of local households heat their homes with fuels other than gas, and it should be a priority to upgrade these heating systems to a less carbon intensive method of heating.

This plan has been undertaken for the Esk Valley. The Esk Valley covers a wide geographic area in North Yorkshire and has no defined political boundary. This plan has used the parishes within the Esk Valley for the purposes of analysing energy data as a high quality amount of information is available at this level. The parishes specifically include: Danby, Glaisdale, Egton, Grosmont, Aislaby, Goathland and Eskdale Cum Ugglebarnby. Additional data has been used where appropriate from regional or national datasets to supplement this work.

The total domestic energy consumption in the Esk Valley has been estimated at 20,320MWh for electricity and 55,107MWh for heat. CO2Sense has estimated that 60% of heat demand is met by fuels other than gas – mainly using high carbon and high cost alternatives such as electricity and coal.

13.1.2 Power down

Section 5 highlighted that the primary action for the area is the reduction of energy demand through a systematic and phased approach of building improvements. This will require strong support from EVCEG and the local authority to ensure it progresses as efficiently as possible.

The government is currently finalising details of the Green Deal which should provide a mechanism to fund these improvements once it is rolled out in October. EVCEG should begin work now to identify specific opportunities and ensure it is prepared when this funding framework is released.

As an indication of the level of energy reductions that can be made, the report has produced a series of calculations on the effects of insulation and draft proofing measures. A "super insulation" scenario has been suggested which includes the maximum practical insulation measures possible for the buildings. If these upgrades were made across the entire building stock in the Esk Valley area then the domestic energy consumption for space heating could be reduced by 45%.

It may be slightly ambitious to assume that every household can be improved, however If only 67% of the Esk Valley householders upgraded their insulation to the 'super insulation' levels suggested, then the energy consumption for space heating would be reduced by 30%.

CO2Sense have found that many of the dwellings in the Esk Valley fall into the 'Hard-to-treat' category. This means that reducing their energy demand is more of a challenge comparatively to a more modern building. More work is recommended to confirm actual building energy use and costs. This is an element of work which can be efficiently undertaken by community energy champions.

13.1.3 Power up

CO2Sense have found that the installed capacity of renewable energy in the valley is approximately 830kW. Three scenarios have been developed in this plan based on varying levels of renewable uptake in the valley

- A business as usual scenario estimates future generation at 1,386kW.
- A recommended renewable installation scenario estimates generation at 2,148kW
- A large-scale renewable scenario estimates generation at 6,613kW

A larger percentage of energy demand can be met by renewable energy generation when energy efficiency measures are implemented and the reduction in energy demand is achieved. This highlights that the Power down approach is just as important as the Power up approach. If both are achieved than the Esk Valley will be able to meet an increasing percentage of its energy demand from renewable energy generation. Only with the 'large scale deployment' scenario can significant percentages of the Esk Valleys energy demand be achieved through renewable energy generation. With this scenario 16% of electrical demand and 25% of heat demand can be achieved from renewable energy generation (when including energy efficiency measures).

The total generation from the installed capacity recommended in the feasibility study was relatively small in comparison with the current energy demand, therefore a further scenario of 'large scale deployment' was proposed. All the potential renewable energy installations that make up this scenario are achievable and incorporate the specific constraints within the Esk Valley area. However this scenario is more challenging than other scenarios and will require a greater amount of work by EVCEG and the local community to achieve projected levels.

Currently the Government are offering incentives for the uptake of renewable energy installations. Once the renewable energy plant is installed and accredited these incentives are guaranteed for 20 years or in the case of Solar PV, 25 years. These incentives make renewable energy development a financial attractive option. This offers developers an opportunity to bring new, long term income streams into local area. These subsidies could be reduced or withdrawn at over the coming years, so the business case for installing may become less favourable. However, with increasing energy prices from fossil-fuel generation, energy generated from renewable sources is likely to move towards parity

Encouraging communities to become the owners of their own decentralised energy generation not only gives them this additional income, but also improves their resilience to energy price volatility. It has a further benefit of encouraging energy awareness which could lead to more energy efficient behaviour change. A grass roots approach to energy efficiency and generation will help the UK to change the way we think of energy and consume it.

13.1.4 Community engagement

The task and challenge of encouraging the local community to become a low carbon hub will be a complex one. It is hoped that this report highlights that there is no one easy solution to the problem of CO_2e emissions, but rather a host of changes that are needed to bring about carbon emission reductions. EVCEG can follow the suggestions outlined in this document to ensure the community is kept up to date with changes and supported along the path to sustainability.

The Local Energy Assessment Funding was set up by the Government as a seed fund for change. This low carbon plan is the seed which can be cultivated by EVCEG and the community of the Esk Valley and grow to bring real change at a time where change is paramount. By harnessing the energy and commitment of the community the Government hopes motivated neighbourhoods will drive this change at a grass roots level that will spread beyond the boundaries of one community into the next.

It is recommended that the progress of 'Esk Valley – a Low Carbon Future' is evaluated on a regular basis and refreshed with new ideas and initiatives gathered from other community groups.

13.2 Action Plan

This report has outlined a large number of 'next steps' for EVCEG, the community and the local council to follow. A high level action plan based on these recommendations is shown in the following box. By following these steps, along with the appropriate detailed sections of this document, EVCEG can begin working towards the goals outlined in this strategy.

Action Plan

- **Step 1: Developing knowledge and awareness**
    - EVCEG should undertake further assessment of villages and houses in the Esk valley area to
      1) Identify what measures are possible (both renewable and efficiency) and
      2) Identify who is willing to undertake these measures (either with or without further financial support);
    - EVCEG should identify and train more volunteers to become energy champions and drive the work above across all villages in the valley;
    - Case studies should be created for any successful projects detailing what work was undertaken and any successes/failures of this;
    - Develop partnerships with the Local Authority and other local organisations.
    - EVCEG should produce advisory leaflets and run regular community events to keep the community informed.
- **Step 2: Implementing change**
    - Review the Green Deal and RHI (when details are released) and support widespread installation and refurbishment projects across the local community;
    - Decide on community energy projects and organise an ESCO or other SPV to manage future projects and ensure maximum community involvement and minimise financial risk;
- **Step 3 – Continually review and improve**
    - Monitor and measure energy demands and energy efficiency / renewable energy work undertaken in the valley;
    - Review successes and failures – identify lessons learned from all projects;
    - Keep the website and other networks informed about all the results;

Appendix 1 – Calculating heat loss

Typical Victorian terrace dwelling

A case study reviewing the energy demands of a typical Victorian mid-terrace house can be evaluated in this section. This highlights how changes in building fabric reduce the heat loss from a building.

Building Characteristics for a typical Victorian mid-terrace dwelling

Floor area:- 138.1m^2

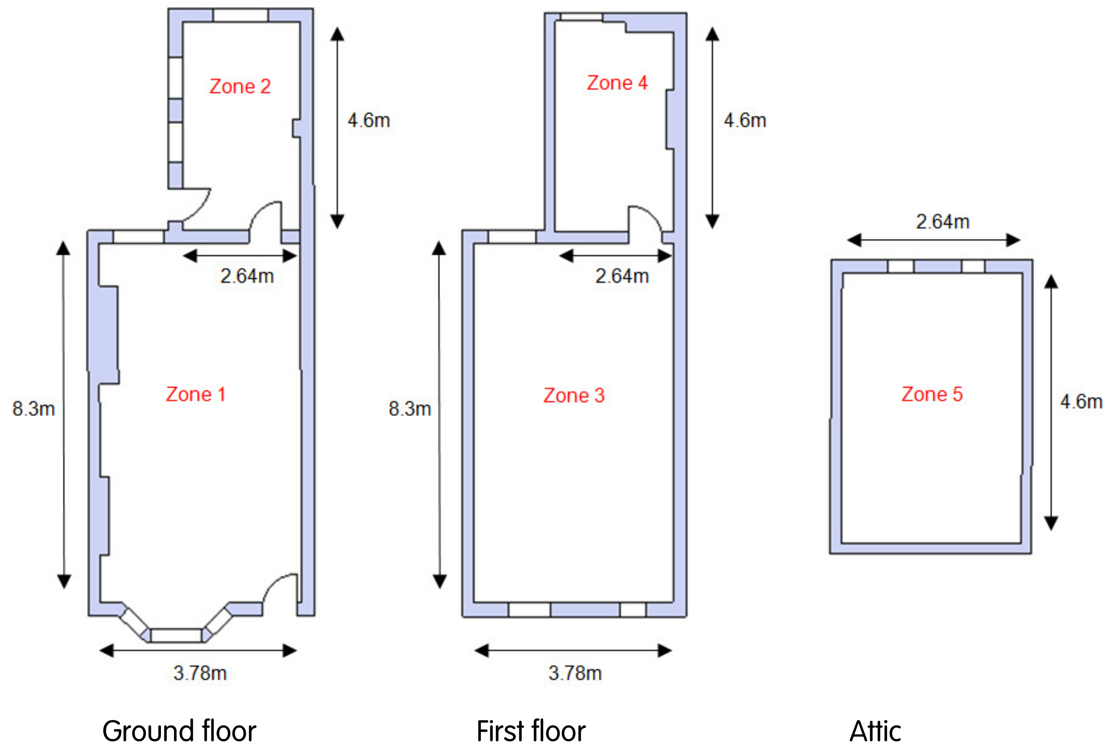


Figure 39 – Floor plan with dimensions of terrace dwelling

Table 40 highlights the U-Values of the building fabric with three differing levels of insulation:

a) Standard insulation
b) Extra insulation
c) Superior insulation

The calculations of heat loss from the building have followed the approved CIBSE methodology and have also considered improvements in the rate of air changes per hour seen in Table 41.

Table 40 - Terrace house building fabric and associated U values

Method of construction	Building Fabric	U- value, (W/m^2 K)
a & b)Solid brick (SB) walls	220mm SB, 13 mm dense plaster	2.09
c)Solid brick (SB) walls	220mm SB, 50mm airspace/battens, 12.5mm plaster board	1.41
Party wall	13mm dense plaster, 215mm brick, 13mm dense plaster	1.45
Floor between floors	Timber floor boards on 100mm joists, 12.5mm plasterboard ceiling	1.64
a)Roof (insulated rafter level)	12.5 mm plasterboard, 25 mm PU insulation between rafters, ventilated airspace, roofing felt, 25 mm ventilated airspace, clay tiles.	0.31
b)Roof (insulated rafter level)	12.5mm plasterboard, 150mm PU insulation between rafters, 25mm ventilated airspace, roofing felt, clay tiles	0.15
c)Roof (insulated rafter level)	12.5mm plasterboard, 300mm PU insulation between rafters, 25mm ventilated airspace, roofing felt, clay tiles	0.115
a)Ground floor	Un-insulated suspended timber floor over ventilated floor cavity (table 3.20 CIBSE A)	0.83
b) Ground floor	suspended timber floor with 100mm insulation between joists over ventilated floor cavity	0.21
c) Ground floor	Super-insulated suspended timber floor with 200mm insulation between joists over ventilated floor cavity	0.12
a&b)Glazing	Double glazed argon filled UPVC frame	2.9
c)Glazing	Triple glazed argon filled UPVC frame	1.4
a)Doors	Wood with single glazing	4.0
b&c)Doors	Double glazed argon filled UPVC frame	2.9

(CIBSE, A. 2006, table 3.54 & 3.48)

Table 41 - Internal design temperatures and ACH of Zones in terrace dwelling

	Window /door area (m^2)	Design temp (0C)	ACH Standard insulation		ACH Extra insulation		ACH Superior	
Zone 1	7.28/2.64	20	2	1 x fireplace 1 x gas fire	1.0	1 x dampened fireplace 1 x gas fire	0.5	Closed chimney, No fire
Zone 2	2.45/ 2.64	18	2	1 x kitchen extract	1.5	1 x kitchen extract	1.0	Minimum kitchen extract
Zone 3	4.84	18	0.75	-	0.5	-	0.5	
Zone 4	0.63	21	2	1 x bathroom extract	1.5	1 x bathroom extract	1.0	Minimum bathroom extract
Zone 5	2.36	18	0.75	-	0.5	-	0.5	

Reducing energy demand of a typical 1930's semi-detached dwelling

Building Characteristics for Semi-detached dwelling Floor area:- 127.5m^2

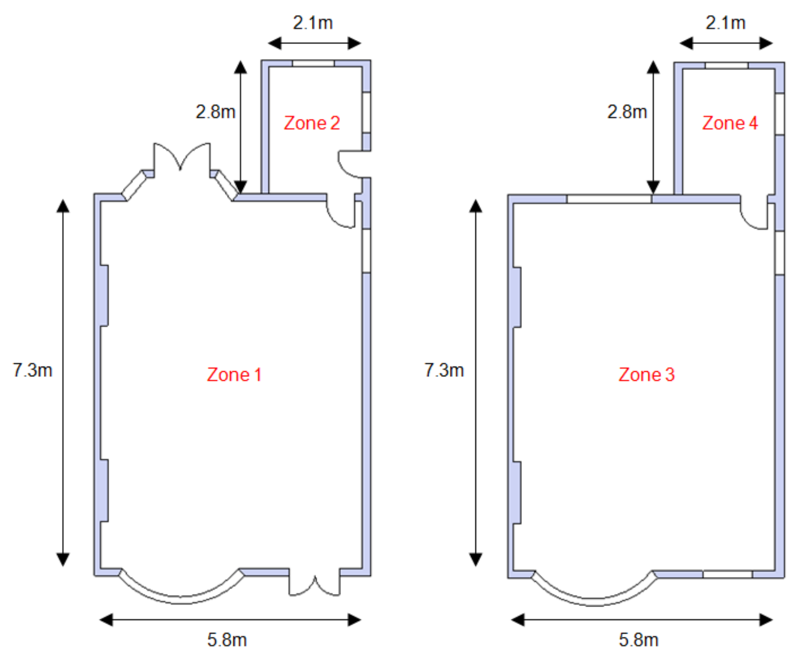


Figure 40 – Floor plan of semi-detached dwelling

Table 42 highlights the U-Values of the building fabric with three differing levels of insulation:

a) Standard insulation
b) Extra insulation
c) Superior insulation

Table 42 - Semi-detached house building fabric and associated U and Y values

Method of construction	Building fabric	U-value (W/m^2 K)
a, b &c)Brick/brick cavity walls	105mm brick, 50mm blown wool insulation, 105mm brick, 13mm dense plaster	0.55
Party wall	13mm dense plaster, 215mm brick, 13mm dense plaster	1.45
a)Roof	Felt and quarry tile, 125mm quilt insulation, ceiling level.	0.304
b) Roof	Felt and quarry tile, 250mm quilt insulation, ceiling level.	0.16
c)Roof	Felt and quarry tile, 350mm quilt insulation, ceiling level.	0.115
Floor between floors	Timber floor boards on 100mm joists, 12.5mm plasterboard ceiling	1.64
a)Ground floor	Un-insulated suspended timber floor (table 3.20 CIBSE A)	0.74
b) Ground floor	insulated suspended timber floor, 100 mm PU foam between joists	0.2
c) Ground floor	insulated suspended timber floor 200 mm PU foam between joists	0.12
a)Doors	Wooden door single glazed	4.0
b &c)Doors	Double glazed argon filled UPVC frame	2.9
a &b) Glazing	Double glazed argon filled UPVC frame	2.9
c) Glazing	Triple glazed argon filled UPVC frame	1.4

(CIBSE, A. 2006, table 3.48 & 3.5)

Table 43 - Internal design temperatures and ACH of semi-detached dwelling

	Glazed area window /door (m^2)	Design temp (^0C)	ACH Standard insulation		ACH extra insulation		ACH Superior insulation	
Zone 1	11.67/3.6	20	1.5	1 x working fireplace 1 x gas fire	1.0	1 x dampened fireplace 1 x gas fire	0.5	Blocked chimney No fires
Zone 2	2.98/1.58	18	2	1 x kitchen extract	1.5	1 x kitchen extract	1.0	Minimal extract
Zone 3	10.35	18	0.5		0.5		0.5	
Zone 4	1.25	21	2	1 x bathroom extract	1.5	1 x bathroom extract	1.0	Minimal extract

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Peak SH demand

The following is an example calculation for zone 1 of the standard insulated terrace house to give the peak space heating demand for the dwellings. This was achieved by firstly using the calculation of heat loss method described by CIBSE A (2006, 5-10).

Ventilation Conductance:- External walls

$$C_v = \frac{NV}{3} \quad (1)$$

C_v = Ventilation conductance (W/K)
N = air changes per hour
V = Volume of the room (m^3)

Ventilation rate correction

$$F_{1cu} = \frac{3(C_v + 6\sum A)}{\sum(AU) + 18\sum A + 1.5R\,(3C_v - \sum(AU))} \quad (2)$$

Edge offset correction

$$F_{2cu} = \frac{\sum(AU) + 18\sum A}{\sum(AU) + 18\sum A + 1.5R\,(3C_v - \sum(AU))} \quad (3)$$

R = radiant fraction of emitter (0.9 for radiators and 0.5 for under floor heating (CIBSE A. 2006, 5-11)

Total heat loss

$$Qt = (F_{1cu} \times \sum(AU) + F_{2cu}C_v) + (t_c - t_{ao}) \quad (4)$$

t_c = dry resultant temperature in room
t_{ao}= temperature on other side of the wall (external air temperature or opposing side of party wall)
An example calculation is shown in Table 44 to Table 46 for the standard insulated terrace house at an external design temperature of -4^{0}C. The calculation shows zone 1 (living room) with an internal design temperature of 20^{0}C and an ACH = 2 (unrestricted fireplace x 1). Q_t values for zones 2-4 were calculated using the same method seen in Table 45. Therefore the peak space heating demand, as seen in Table 46, at the design external temperature of -4^{0}C is 11.58kW.

Table 44 - Dimensions and U-values of Zone 1

	Length (m)	Room height (m)	Area window door (m^2)	External areas (m^2)	Internal Areas (m^2)	U-value (W/m^2K)	admittance Y-value (W/m^2K)	External area x U-value	Internal area x U-value
Wall									
Front	4.34	3	5.64	5.64	-	2.09	4.49	11.78	-
Left	9.54	3	28.63	-	28.64	1.45	4.61	-	41.53
Right	9.54	3	28.63	-	28.64	1.45	4.61	-	41.53
Back external	1.15	3	2.13	2.13	-	2.09	4.49	4.45	-
Back internal	3.19	3	9.01	-	9.01	1.45	4.61	-	13.06
Windows	-	-	-	6.56	-	2.9	2.9	19.024	-
Floor	-	-	-	41.49	-	0.83	1.97	34.44	-
Roof	-	-	-		41.49	1.64	0.86	-	68.04
Door 1	-	-	-	2.64	-	4	3.01	10.56	-
ΣA	-	-	-	58.46	107.78	-	-	-	-
ΣAU	-	-	-	80.254	164.16	-	-	-	-
ΣAY	-	-	-	-	-	-	486.1	-	-

Table 45 - Heat loss calculations for zone 1

Variable	Heat loss calculations for Zone 1
Cv	82.15
F_{1cu}	1.122
F_{2cu}	0.978
Q_t (W)	170.45 x ΔT
Q_t (W)	4090.83

Table 46 - Total peak space heating demand for all zones

Zone	Qt external walls (W)	Qt internal walls ΣUA x ΔT (W)	Qt total (W)
1	4090.8	577.7	4668.5
2	2076.2	-15.7	2060.4
3	1639.9	5.3	1645.3
4	1999.7	233.0	2232.7
5	863.3	110.4	973.7
All zones	-	-	11580.9

The plant ratio

The plant size ratio was calculated to determine the extra capacity needed to overcome the thermal inertia of the building. CIBSE A, (2006, 5.7.2.1) defines the rate at which the mass absorbs heat, or admittance Y (W/m^2K), as 'the rate of flow of heat between the internal surfaces of the structure and the environmental temperature in the space'.

According to CIBSE A, (2006, 5.7.2.1)

$$Response\ factor\ f_r = \frac{\sum(AY) + C_v}{\sum(AU) + C_v} \qquad (5)$$

$$Plant\ ratio. F = \frac{24 f_r}{H f_r + (24 - H)} \qquad (6)$$

- F = Plant factor
- f_r= Response factor
- H= number of hours heating is on including pre-heat period
- AY=Sum of all areas x admittance values of building fabric (W/m^2K)
- AU=Sum of all areas x U-value of building fabric(W/m^2K)
- C_v= Ventilation conductance (W/K)

Calculating the annual space heating demand

$$SH\ demand = fabric\ losses + ventilation\ losses - solar\ and\ passive\ gains \qquad (7)$$

(CIBSE A, 2006)

The SH demand, shown in Table 47, is calculated for each of the 1^0C external temperatures recorded and multiplied by the degree hours calculated from the external temperature data, according to the heating regime required. The solar and passive gains are subtracted from the total SH demand for each external temperature 1^0C bin, to give the total required SH demand at that 1^0C bin temperature. The sum of the SH demand for all bin temperatures gives the total SH demand for the heating season to meet the required internal design temperatures. It can be seen for a standard insulated terrace house that the total space heating demand is 20,204kWh.

Table 47 – Calculating the space heating demand of a standard insulated terrace dwelling

A	B	C	D	E	F	G
External air temperature, ^{0}C	Fabric and ventilation loss of dwelling, kW	Hours at external air temperature, measured at Machynlleth (Wales)	Heating loss over heating season, kWh D= BxC	Solar gains, kWh	Passive gains, kWh	Total SH demand over heating season, kWh G = D-E-F
-8	13.41	5	67.07	1.12	2.41	63.53
-7	12.95	5	64.78	1.12	2.41	61.23
-6	12.49	9	112.48	2.03	4.34	106.10
-5	12.03	9	108.35	2.03	4.34	101.97
-4	11.58	28	324.26	6.31	13.53	304.41
-3	11.12	31	344.79	6.99	14.98	322.81
-2	10.66	32	341.24	7.22	15.46	318.55
-1	10.20	58	591.89	13.08	28.03	550.78
0	9.74	68	662.76	15.34	32.86	614.55
1	9.28	130	1207.43	29.33	62.82	1115.27
2	8.82	202	1783.52	45.57	97.62	1640.32
3	8.37	244	2042.46	55.05	117.92	1869.48
4	7.91	269	2128.36	60.69	130.00	1937.66
5	7.45	246	1833.56	55.50	118.88	1659.17
6	6.99	242	1692.77	54.60	116.95	1521.21
7	6.53	237	1549.10	53.47	114.59	1381.09
8	6.07	221	1343.17	49.86	106.80	1186.50
9	5.61	249	1399.16	56.18	120.33	1222.64
10	5.16	294	1517.19	66.33	142.08	1308.77
11	4.70	225	1057.93	50.76	108.73	898.42
12	4.24	196	831.68	44.22	94.72	692.74
13	3.78	167	632.04	37.67	80.70	513.65
14	3.32	152	505.56	34.29	73.45	397.81
15	2.86	88	252.33	19.85	42.52	189.95
16	2.40	84	202.3	18.95	40.59	142.79
17	1.95	54	105.31	12.18	26.09	67.03
18	1.39	26	36.18	5.86	12.56	17.750
19	0.93	13	12.12	2.93	6.28	2.91
Total		3584	22749.98	810.00	1735.00	20204.98

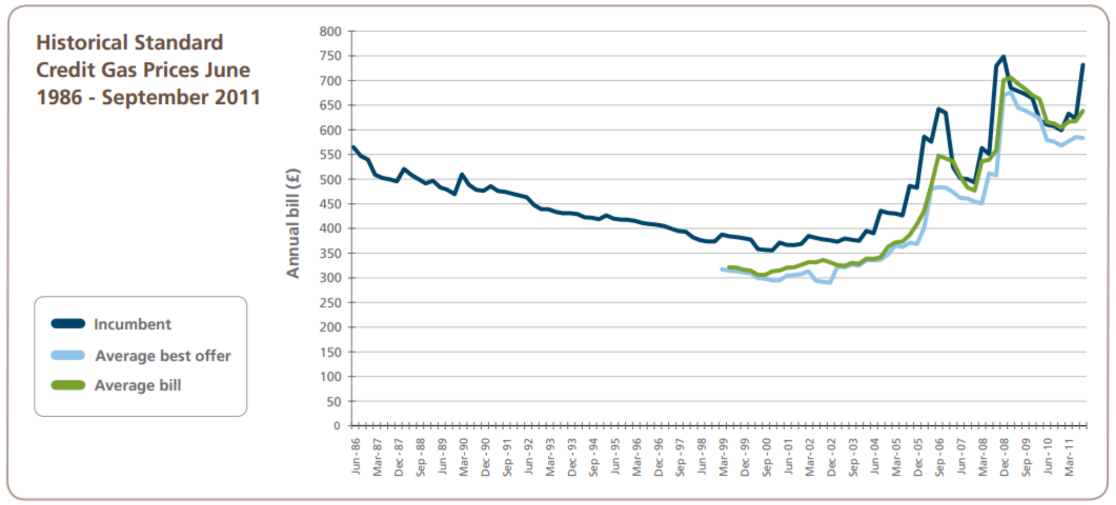
Appendix 2 - Assumptions made in calculations

Cost of domestic energy

Rising energy prices have been modelled in the overall payback calculations for PV arrays, however they have not been included within other financial modelling for other renewable energy technologies. However, the upward trend in energy prices is well documented and understood and can be reviewed in Figure 41. If this trend continues, which is highly likely, then this can only increase the financial viability of installing renewable energy technologies over fossil fuel consuming plant.

Table 48 – Cost of domestic energy

Cost of domestic energy	
Gas	4p/kWh
Electricity	10p/kWh
Oil	6p/kWh



Updated graph based on revised average consumption level of 16500 kWh per customer, per year for a standard tariff. Ofgem analysis on data from TheEnergyShop.com from 2003 – 2011, data prior to this date is owned by Ofgem.

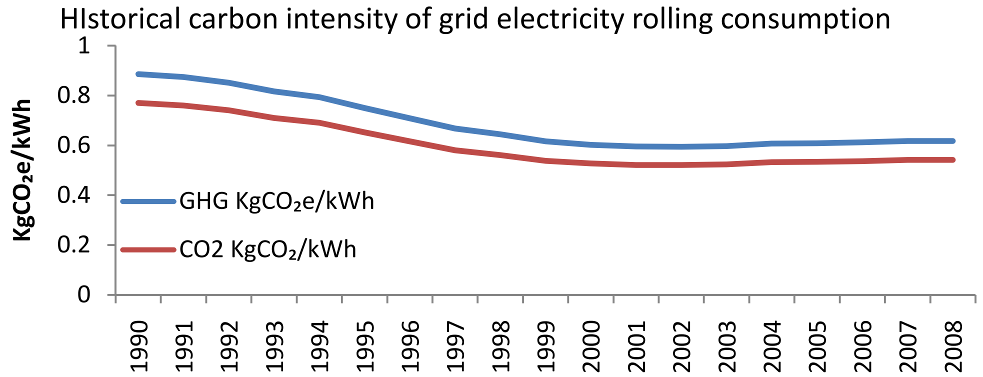
Figure 41 – Upward trend in energy prices

Carbon intensity of energy sources.

To compare the CO_2e emissions saved if renewable energy technologies are used over differing SH plant or grid electricity than an accurate evaluation must be made of their carbon intensities.

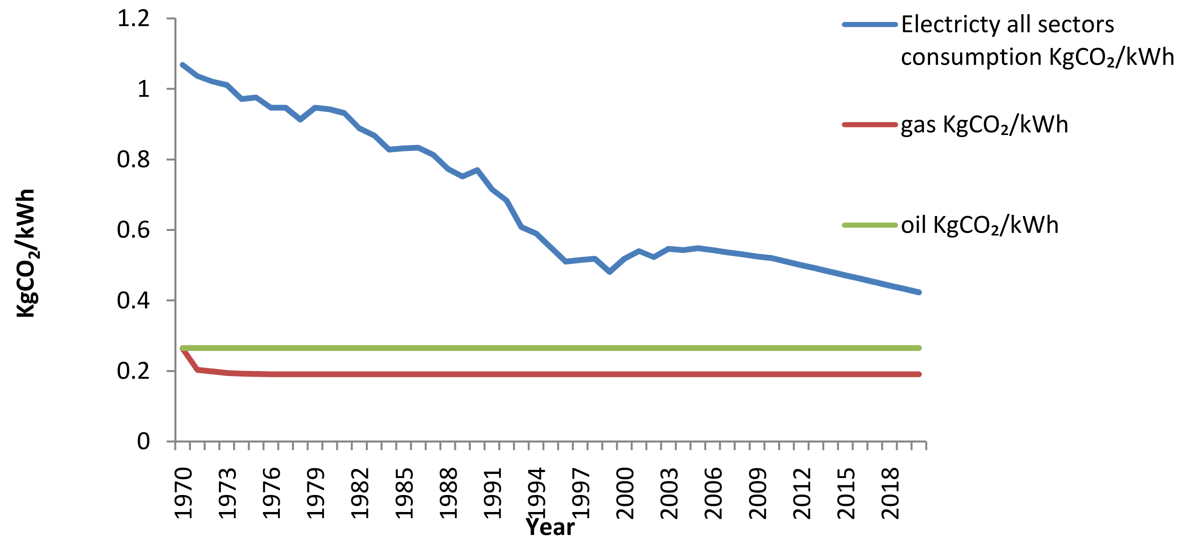
Carbon intensity of grid electricity

The carbon intensity of grid electricity fluctuates throughout the day and year as demand alters and different plant comes on and off line. However, for the purposes of this low carbon plan, a fixed annual carbon intensity has been used. Carbon intensity is expected to decline as the generation mix has increasing renewable plant online, however, it can be seen in Figure 42 that carbon intensity of grid electricity increased between the years of 2002 to 2008. The averaged out rolling carbon dioxide equivalent emission figures in Figure 42 include transmission, distribution and indirect losses, for example extraction and transport. However, these figures are considerably higher than those in Figure 43, which details $kgCO_2$/kWh of grid electricity consumption and were devised in 2003 and revised in 2009. Figure 43 does not show the same increase in carbon intensity between 2002 and 2008. This highlights the difficulty in assessing carbon intensity factors and the uncertainty in predicting future carbon intensity factors.



(Defra, 2010, annex 3, table 3c)

Figure 42 – Depiction of carbon intensity



(Defra, 2009, MTP)

Figure 43 – Historical and projected carbon intensity of grid electricity

The projected carbon intensities forecast by Defra in 2009, could be considered overly optimistic considering the actual calculated carbon intensity of CO_2 emissions of 0.541kgCO_2/kWh and total GHG emissions of 0.617 kgCO_2e/kWh for 2008 (Defra, 2010).

Table 49 – Projected carbon intensity of Grid Electricity

Year	Projected carbon intensity of grid electricity, kgCO_2e/kWh
Actual reported in 2011 and used in this low carbon plan	0.525
2012	0.500
2015	0.471
2020	0.423
2025	0.384
2030	0.341

(Defra, 2010, table 3c)& (Defra, 2009)

Boiler efficiencies

Boiler efficiency, shown in Table 50, is paramount to the calculation of GHG emissions if replacing an old boiler with a new boiler.

Table 50 – Fuel combustion efficiencies

Fuel combustion method	Efficiency
Gas condensing boiler	91%
Oil Boiler	83%
Pellet boiler	90%
Wood burning stove	65%*

(Sedbuk. 2009, Boiler efficiency database) *(H.M.Government, 2010, p.11)

Emissions factors

Calculations to estimate the CO_2e emission savings have used the conversion factors given in Table 51. For Biomass installations, emissions have been given for the displacement of fossil fuels and the emissions from the combustion of wood pellets or chips have been considered to be carbon neutral, as per the carbon reduction commitment guidelines.

Table 51 – carbon emission factors of energy sources

Carbon intensity of energy, CO_2e kg/kWh	
Gas	0.186kg/kWh
Grid Electricity	0.525kg/kWh
Oil	0.267kg/kWh
Wood pellet	0.04kg/kWh
Wood chip	0.02kg/kWh
Coal	0.357kg/kwh
LPG	0.258kg/kWh

Capacity factors

The capacity factors used in Table 52 have been drawn from industry knowledge.

Table 52 – Assumed capacity factors used for calculations

Technology	Capacity Factor
Hydro	**0.40**
PV	**0.20**
Small Scale Wind	**0.33**
medium wind	**0.30**
Solar Thermal	**0.20**
Biomass	**0.30**
GSHP	**0.30**
ASHP	**0.30**
WSHP	**0.30**

Appendix 3 - Government Subsidy

Through the use of the 'Feed-in-tariff' and the 'Renewable heat incentive' the Department for Energy and Climate Change (DECC) hope to encourage deployment of low carbon generation of electricity and heat. The schemes promote investment in eligible renewable installations below 5MW and award index linked guaranteed payment, for 20 years, or 25 years for PV.

The feed-in-tariff

The feed-in-tariff supports technologies that generate renewable electricity and offer payments for both the electricity they generate and export to the grid. The following 'generation' tariff rates, in pence per kWh, are applicable for eligible renewable energy technologies installed before 31st March 2012.

On 31st October 2011 DECC announced radical planned changes to the solar FIT which proposed halving the tariff and applying a new rate from 1 April 2012 to all new solar PV installations with an eligibility date on or after 12th December 2011. There has been widespread concern about the proposed change and accelerated timescale of change. Subsequently these changes were challenged in court and the High Court ruled that the proposed changes were unlawful. DECC appealed this decision but the High Court has denied a hearing for the appeal. Further appeals may be made by DECC.

As a result the original FiT rates will apply until 3rd March and thereafter fall to the lower rates proposed by DECC. Therefore installations made before 3rd March will be able to secure the original FiT rate, while those after this date will receive the lower rates.

From the 1st April all new building-connected PV installations will only be eligible to receive the FiT if they can demonstrate that the building they are attached to meets minimum energy efficiency criteria. This is currently proposed at EPC level C or equivalent (this is still in consultation).

A wider review of the FiT for other technologies is due to be released in February although this may be delayed. CO2Sense are aware of no major changes planned for the FiT for other technologies, however we cannot confirm any details until the "Phase 2" consultation is released. Further information is available on the DECC website.

Table 53 – Feed-in-tariff revenues

Technology	Scale	Tariff p/kWh to April		Tariff from October
Anaerobic digestion	≤250kW	14.0		14.7
	>250kW - ≤500kW	13.0		13.7
	>500kW	9.0		9.0
Hydro	≤15kW	20.9		21.0
	15kW -≤ 100kW	18.7		19.7
	>100kW - ≤2MW	11.5		12.1
	>2MW – 5MW	4.7		4.5
Wind	≤1kW	36.2		21.0
	>1.5kW - ≤15kW	28		21.0
	>15kW - ≤100kW	25.3		21.0
	>100kW - ≤500kW	19.7		17.5
	>500kW - ≤1.5MW	9.9		9.5
	>1.5MW - ≤5MW	4.7		4.5
Solar PV		*To 3/3/12*	*To 31/3/12*	*(From July)*
	≤ 4kW (new building)	37.8	21.0	13.6 to 16.5
	≤4kW (retro-fit)	43.3	21.0	13.6 to 16.5
	>4kW - ≤10kW	37.8	16.8	10.9 to 13.2
	>10kW - ≤50kW	32.9	15.2	9.9 to 11.9
	>50kW - ≤150kW	32.9	12.9	7.7 to 10.1
	>150kW - ≤250kW	30.7	12.9	5.8 to 10.1
	>250kW - ≤5MW	30.7	8.5	4.7 to 7.1
	Stand-alone	30.7	8.5	4.7 to 7.1
Export tariff		3.1	TBC	Export tariff

The Renewable Heat Incentive –commercial installations

The Renewable Heat Incentive has been constructed to assist commercial schemes that generate renewable heat. The tariff rates for large biomass and the other technologies are calculated according to meter readings. For smaller scale biomass the tariff is eligible for capacity (kWth) multiplied by 1,314 hours of peak load hours.

Table 54 – Renewable Heat Incentive revenues

Technology	Tariff name and size	Tariff tier and rate, p/kWh
Solid biomass; municipal solid waste (inc CHP)	Small biomass ≤ 200kWth	Tier 1:- 7.9
		Tier 2 :- 2.0
	Medium biomass 200kWth – 1MWth	Tier 1:- 4.9
		Tier 2:- 2.0
	Large biomass >1MWth	1.0
Ground source heat pumps Water source heat pumps Deep geothermal	Small ground source <100kWth	4.5
	Large ground source >100kWth	3.2
Solar thermal	<200kWth	8.5
Bio-methane Injection or combustion excluding landfill gas	<200kWth	6.8

Renewable Heat Premium Payments (RHPP)

Domestic properties are not yet eligible to receive the Renewable Heat Incentive (RHI). At time of print the Government are proposing to bring domestic installations onto the RHI scheme in the summer of 2013. This is delayed form the original date of October 2012. As a result more budget has been set aside to cover the Renewable Heat Premium Payments (RHPP), which is the current financial incentive for domestic installations. The RHPP is a government scheme that gives money to householders to help them buy renewable heat technologies – solar thermal panels, heat pumps and biomass boilers. This is a short-term scheme making one-off payments.

For solar thermal products, any householder in England, Scotland and Wales can apply for the scheme. For ground to water, air to water or water to water heat pumps, and for biomass boilers, householders without gas central heating in England, Scotland and Wales can apply (in other words those who are not connected to the gas grid and currently rely on fuels such as oil, liquid gas, solid fuel or electricity for their heating).

The amount received as part of the Renewable Heat Premium Payment scheme depends on which technology you are applying for. The voucher values for each of the technologies are listed below:

Table 55 – Renewable Heat Premium Payments

Technology	Value
Solar Thermal Hot Water	£300
Air to Water Source Heat Pump	£850
Ground Source or Water Source Heat Pump	£1250
Biomass boiler	£950

People who have installed the kit under the RHPP scheme will also be eligible for support through the RHI, once brought in for the domestic market, providing they meet the eligibility criteria of the full RHI scheme. Applications for phase 2 of the RHPP opened on 1st May for applications to the scheme. To find out the latest information on these scheme visit www.energysavingtrust.org.uk/Generate-your-own-energy/Financial-incentives/Renewable-Heat-Premium-Payment

Appendix 4 – Planning

National Policy

The UK's national planning policy strongly encourages the development of renewable energy in order to meet European targets on CO2 reduction.

The key national policy statement is Planning Policy Statement 22 'Renewable Energy' (PPS22) which sets out the Government's policies for renewable energy. It advises that a positive approach should be taken towards renewable energy proposals in locations where technology is viable and environmental and social impacts can be satisfactorily addressed. It goes on to state that small scale projects can provide a valuable contribution to overall outputs of renewable energy and to meeting energy needs both locally and nationally.

PPS22 also provides guidance for developments in nationally designated areas such as the North York Moors national park and states:

'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.'

Regional Policy

The Yorkshire and Humber Plan is the Regional Spatial Low carbon plan (RSS) for the region. The Plan was adopted in May 2008. The RSS is a statutory document and part of the development plan. It informs the preparation of Local Development Frameworks and is an important consideration in the determination of planning applications.
Policy ENV5 from the Yorkshire and Humber Plan covers energy and its main goals are to:

- Maximise improvements to energy efficiency and increase in renewable energy capacity
- Reduce greenhouse gas emissions, improve energy efficiency and maximise the efficient use of power sources
- Maximise renewable energy capacity through the delivery of regional and sub-regional targets
- Promote greater use of local renewable energy in new development

Policy ENV5 also sets targets for individual authority areas and whilst these do not apply to the National Park, It is however presumed that National Parks will contribute to these via appropriate developments, in accordance with National Planning Policy PPS22.

It should be noted that in July 2010, the UK Government announced its intention to abolish Regional Spatial Strategies. These will be replaced as part of the National Planning Policy Framework which is due later this year. This means that Yorkshire and Humber Plan will no longer form part of the Development Plan for the National Park.

The aim of the National Planning Policy Framework is to make the planning system less complex and more accessible, and to promote sustainable growth. It forms part of the localism Bill which aims to shift power from central government back into the hands of individuals, communities and councils.

In the revocation announcement of the Regional Spatial Strategies, the Chief Planner stated in support of Renewable Energy Developments:

" Through their local plans, authorities should contribute to the move to a low carbon economy, cut greenhouse gas emissions, help secure more renewable and low carbon energy to meet national targets, and to adapt to the impacts arising from climate change"

In August 2011 the decision to abolish RSS was challenged successfully in the high court. In light of this he North Yorkshire Moors Planning Authority are able to continue to use the RSS as part of its Statutory Development Plan until the Localism Bill is passed into law at which point the RSS will be superseded by the new Bill.

Local Policy

Planning within the Esk Valley comes under the North York Moors National Park Authority. Planning within National Parks is a careful balancing act in meeting the needs of those who live, visit and work in each National Park now, and protecting these areas for the future.

Every proposal and location will be different and each application will need be considered by the planning authority on its own merits. In particular, proposals affecting Conservation Areas or Listed Buildings may require careful consideration to ensure that these receive the necessary level of protection. Early discussion with Planning Officers and local communities is essential in helping to identify and resolve any potential issues.

Preserving the picturesque landscape of the Esk Valley is a paramount consideration when assessing the viability of renewable energy technologies in the area. Less obtrusive renewables, such as GSHPs would pose minimal contention in conservation areas.

Local Development Framework

The local Development Framework for the North York moors national park consists of a number of different documents to guide future development whilst ensuring that the National Park's special qualities are conserved and enhanced.

The Core Low carbon plan and Development Policies document is a key part of this framework [3]. It brings together the core plans and strategies for the National Park and sets out a policy framework up to 2026.

Core Policy D (Climate Change) of this document) states:

Activities in the National Park will address the causes of climate change and contribute to reducing greenhouse gas emissions, by:

1. *Reducing the use of energy and the need to use energy.*

2. *Generating energy from renewable sources where these are of a location, scale and design appropriate to the locality and which contribute towards meeting domestic, community or business energy needs within the National Park.*
3. *Requiring residential developments of 5 or more houses and other uses of 200sqm or more to generate energy on-site from renewable sources to displace at least 10% of predicted CO2 emissions.*

However this is needs to be taken into context alongside Development Policy 3 -Design:
To maintain and enhance the distinctive character of the National Park, development will be permitted where:

1. *The siting, orientation, layout and density preserves or enhances views into and out of the site, spaces about and between buildings and other features that contribute to the character and quality of the environment and will not result in the loss of an open space which contributes to the amenity, character and setting of a settlement.*

2. *The scale, height, massing, proportion, form, size, materials and design features of the proposal are compatible with surrounding buildings, and will not have an adverse effect upon the amenities of adjoining occupiers.*

3. *A high standard of design detailing is used whether traditional or contemporary, which reflects or complements that of the local vernacular.*

4. *Provision is made for adequate storage and waste management facilities.*

5. *.Good quality sustainable design and construction techniques are incorporated in the development including measures to minimise energy use and where possible use energy from renewable sources.*

6. *A satisfactory landscaping scheme forms an integral part of the proposal.*

7. *The design takes account of the safety, security and access needs for all potential users of the development and provides car parking provision in line with the standards adopted by the Authority.*

North York Moors National Park Management Plan

Alongside specific planning policy, the National Park Authority has a National Park Management Plan which provides the main source of strategic policies for managing the Park. It describes the special qualities of the North York Moors and sets out objectives and policies not just for the Authority but for all organisations and agencies whose work or activities affect the National Park.

The North Yorkshire Moors National Park Management Plan has a number of Development Objectives which support renewable energy development:

Planning and Sustainable Development Objective 3:

To promote concepts, designs, orientation and aspects of development that minimise the use of energy and to encourage the use of sustainable resources in the construction of new development providing that the conservation of the landscape and built environment of the National Park is not adversely affected.

Planning and Sustainable Development Objective 4:

To promote the use of renewable energy sources that provide energy for communities within the National Park providing that any development involved does not significantly detract from the conservation of the landscape and built environment of the National Park.

[3] http://tinyurl.com/774mwse **North York moors** Core Low carbon plan and Development Policies document

Renewable Energy - Supplementary Planning Document

The Park authority has also issued a Renewable Energy Supplementary Planning Document. Whilst this is not policy, it does provide guidance to anyone looking at developing renewable technology within the National park area.
This document provides an overview of each technology and details of what an application for each should comprise off. With reference to large scale installations the document also states:
'Whilst the Authority recognises the importance of reducing the causes of climate change and is actively seeking to reduce greenhouse gas emissions, large scale renewable energy developments can be particularly damaging to the landscape and environment of the National Park which is protected through the 1995 Environment Act. The basis for consideration of all applications will therefore be that the need for renewable energy must not override the statutory purposes'

Permitted Development

Installing certain renewable energy technologies, such as solar panels and biomass boilers, has now been made a lot simpler thanks to Permitted development rights introduced in 2008

The General Permitted Development Order (GPDO) grants rights to carry out certain limited forms of development on the home, without the need to apply for planning permission. If covered under GPDO we would still recommend discussing any proposed development with the Planning Authority to ensure

The scope of the GPDO in England now extends to the following technologies which have been discussed in this report:

Roof Mounted PV or Solar Thermal

In many cases fixing solar panels to your roof is likely to be considered 'permitted development' under planning law with no need to apply for planning permission. There are, however, important exceptions and provisos which must be observed.

All solar installations are subject to the following conditions:

- Panels on a building should be sited, so far as is practicable, to minimise the effect on the appearance of the building.
- They should be sited, so far as is practicable, to minimise the effect on the amenity of the area.
- When no longer needed for microgeneration they should be removed as soon as possible.

The following limits apply to roof and wall mounted solar panels:

- Panels should not be installed above the ridgeline and should project no more than 200mm from the roof or wall surface.
- If your property is a listed building installation is likely to require an application for listed building consent, even where planning permission is not needed.
- If the property is in a conservation area, or in a World Heritage Site, planning consent is required when panels are to be fitted on the principal or side elevation walls and they are visible from the highway. If panels are to be fitted to a building in your garden or grounds they should not be visible from the highway.

Biomass

Planning permission is not normally needed when installing a biomass system in a house if the work is all internal. If the installation requires a flue outside, however, it will normally be permitted development if the conditions outlined below are met.

- Flues on the rear or side elevation of the building are allowed to a maximum of one metre above the highest part of the roof.
- If the building is listed or in a designated area even if you enjoy permitted development rights it is advisable to check with your local planning authority before a flue is fitted. Consent is also likely to be needed for internal alterations.
- In a conservation area or in a World Heritage site the flue should not be fitted on the principal or side elevation if it would be visible from a highway.

If the project also requires an outside building to store fuel or related equipment the same rules apply to that building as for other extensions and garden outbuildings.

Air Source Heat Pumps

From 1 December 2011 the installation of an air source heat pump on domestic premises is considered to be permitted development, not needing an application for planning permission, provided ALL the limits and conditions listed below are met.

These permitted development rights apply to the installation, alteration or replacement of an air source heat pump on a house or block of flats, or within the curtilage (garden or grounds) of a house or block of flats, including on a building within that curtilage. A block of flats must consist wholly of flats (e.g. should not also contain commercial premises).

Limits to be met:

- The volume of the air source heat pump's outdoor compressor unit (including housing) must not exceed 0.6 cubic metres.

- Only the first installation of an air source heat pump would be permitted development,
- All parts of the air source heat pump must be at least one metre from the property boundary.
- Installations on pitched roofs are not permitted development. If installed on a flat roof all parts of the air source heat pump must be at least one metre from the external edge of that roof.
- Permitted development rights do not apply for installations within the curtilage of a Listed Building or within a site designated as a Scheduled Monument.
- On land within a Conservation Area or World Heritage Site the air source heat pump must not be installed on a wall or roof which fronts a highway or be nearer to any highway which bounds the property than any part of the building.
- On land that is not within a Conservation Area or World Heritage Site, the air source heat pump must not be installed on a wall if that wall fronts a highway and any part of that wall is above the level of the ground storey.

In addition, the following conditions must also be met. The air source heat pump must be:

- Used solely for heating purposes.
- Removed as soon as reasonably practicable when it is no longer needed for microgeneration.
- sited, so far as is practicable, to minimise its effect on the external appearance of the building and its effect on the amenity of the area

Appendix 5 – Timeline for action

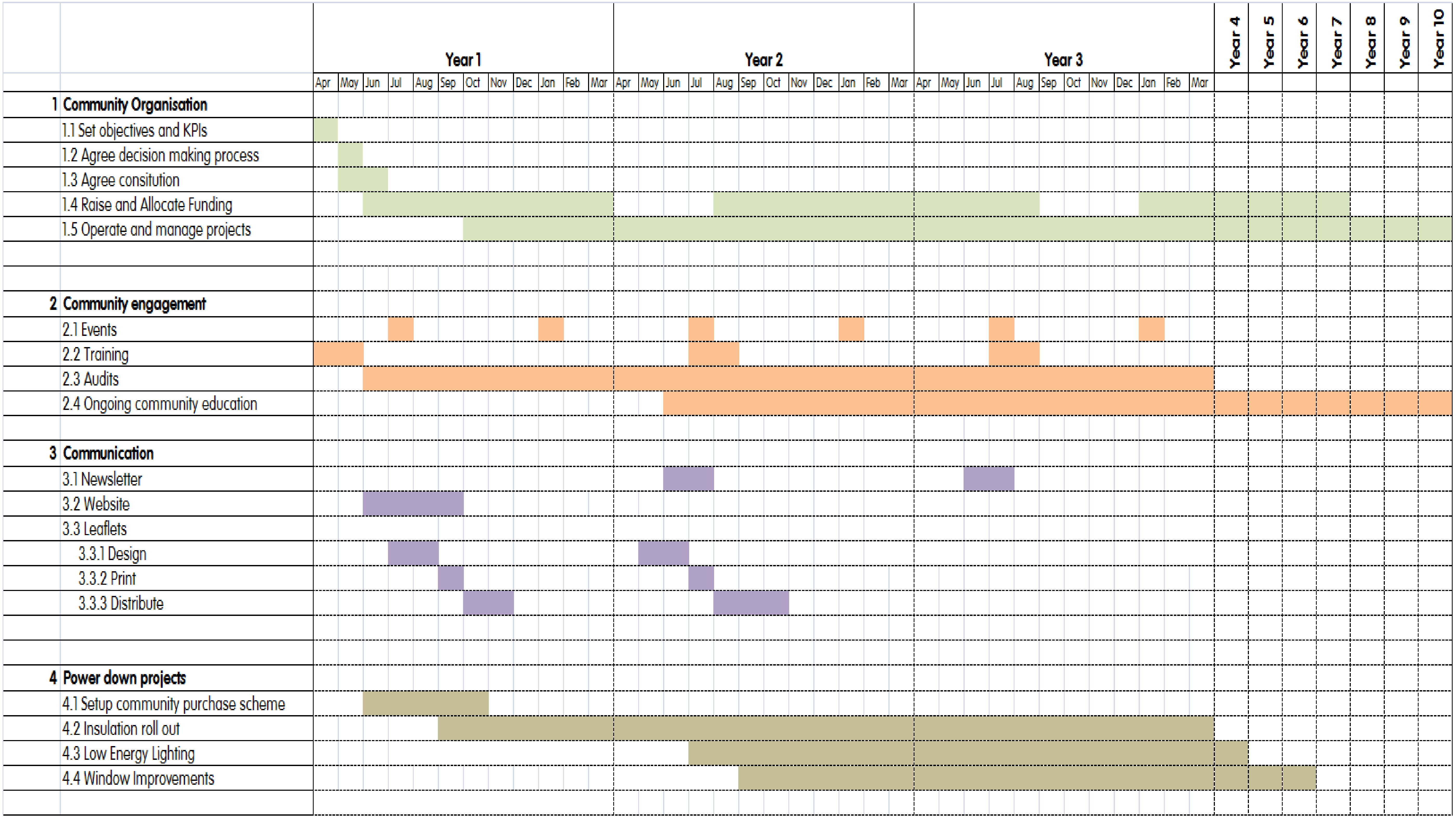


Figure 44 – Timeline for community action (full time line provided in Appendix 6)

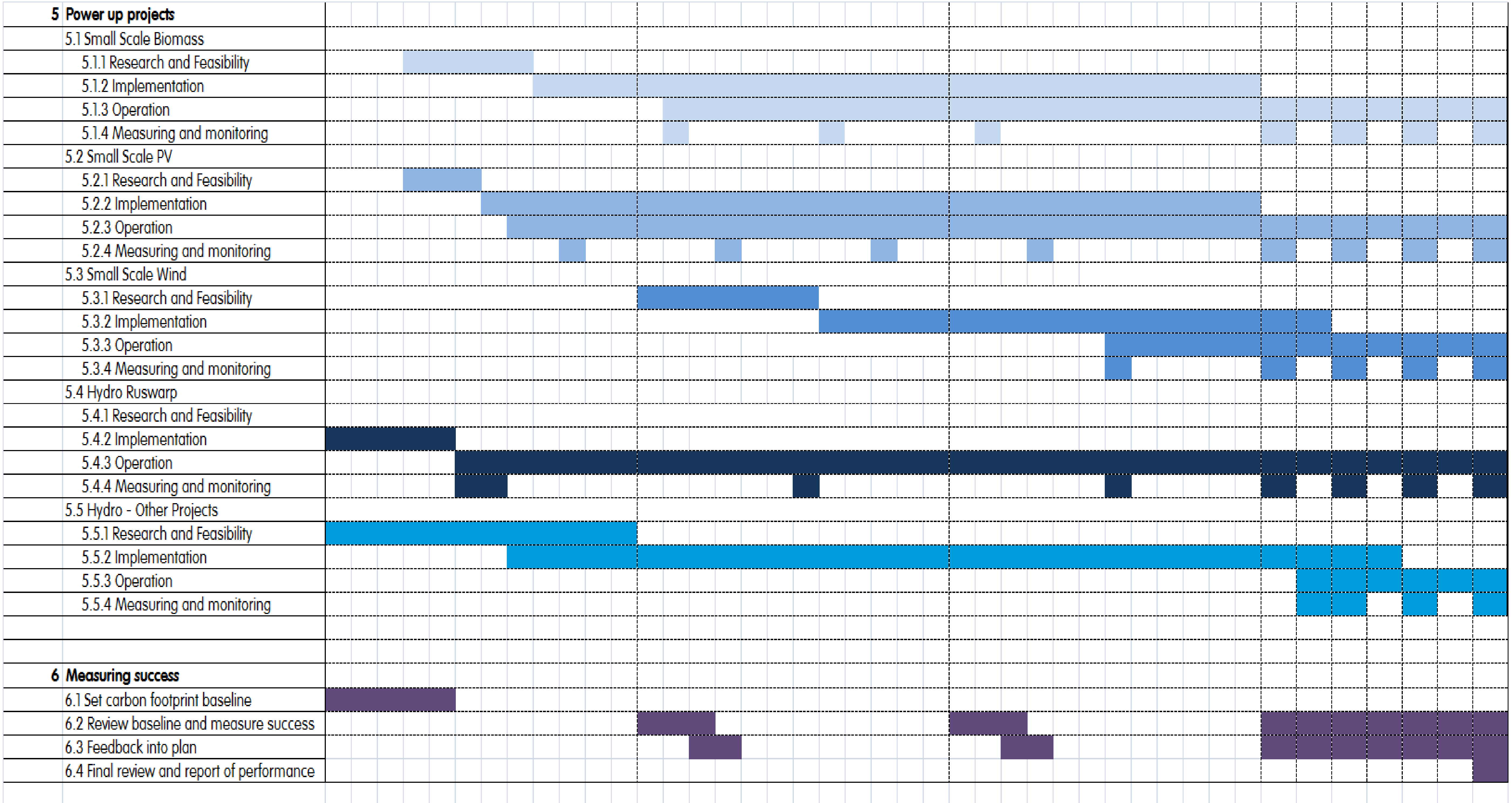


Figure 45 – Timeline for renewable energy action

Appendix 6 - Abbreviations and Glossary

AD	Anaerobic Digestion
AGL	Above Ground Level
ALMO	Arms length management organisation
AONB	Area of Outstanding Natural Beauty
AQMA	Air Quality Management Area:- 6 designated areas whereby annual nitrogen dioxide emission is controlled.
ASHP	Air Source Heat Pump
BERR	Former (Department for Business, Enterprise and Regulatory Reform)
Biomass	Biomass is anything derived from plant or animal matter and Includes agricultural, forestry wastes/residues and energy crops. It can be used for fuel directly by burning or extraction of Combustible oils.
BMS	Building Management System
BREEAM	BRE Environmental Assessment Method
CERT	Carbon Emissions Reduction Target
CESP	Community Energy Saving Programme
CHP	Combined heat and Power Power plant that simultaneously generates both electricity and useful heat.
CIBSE	Chartered Institute of Building Services Engineers
CLG	Department for Communities and Local Government
CO_2	Carbon Dioxide
CRC	Carbon Reduction Commitment
DECC	Department of Energy and Climate Change
District Heating systems	is a system for distributing heat generated in a centralised location to meet residential or commercial space heating or hot water requirements
DNO	District Network operator
EA	Environment Agency
ESCos	Energy Servicing Companies
EST	Energy Saving Trust
EV	Electric Vehicles
FiT	Feed in tariff
GIS	Geographical Information System
GSHP	Ground Source Heat Pump
Heat Anchor	A facility with a constant heat base load
Heat Load	A site or area that requires a heat source such
Heat Pumps	transfers and transforms low temperature heat, by way of a refrigeration vapour compression cycle, to useful higher temperature heat
HLC	Heat Loss Coefficient
IPS	Industrial Provident Society
kW	Kilo Watt
kW/m^2	Kilo Watt per metre squared
kWh/yr	Kilo Watt hours per year
kWp	Kilo Watt peak
LF	Load Factor
LLSOA	Lower Level super output area
LPA	Local Planning authority
LZC	Low and Zero carbon
LZCT	Low and Zero carbon technologies
MLSOA	Middle Level super output area
MVHR	Mechanical Ventilation with Heat Recovery
MW	Mega Watt
MWh/yr	Mega Watt hours per year
PFI	Private finance initiative
PV	Photovoltaics (PV)
ROCs	Renewable Obligation Certificates
RWTF	Residual Waste Treatment Facility
RHI	Renewable Heat incentive
SHW	Solar Hot Water
Solar thermal	Solar thermal collectors absorb the sun irradiation which is utilised as hot water
SPV	Special purpose vehicle
U-Value	Measure of heat loss through material, W/m^{2}K