SAFFRON WALDEN COMMUNITY ENERGY

Kickstart
Community Action on Climate Change

LITTLEBURY – PLANNING FOR DECARBONISATION

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PATHWAY TO NET ZERO

LITTLEBURY

PLANNING FOR DECARBONISATION

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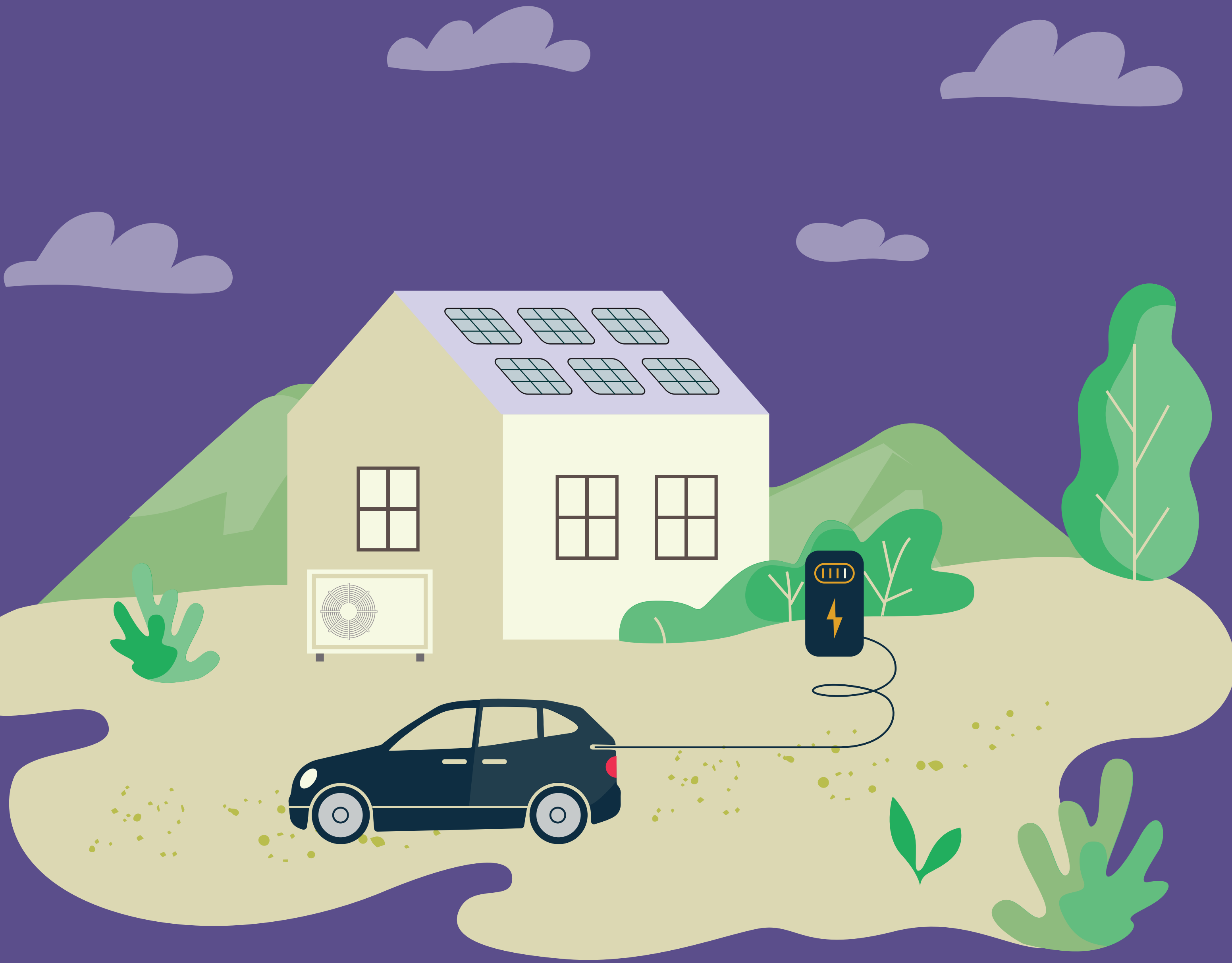

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1 Introduction

1.1 Background

The transition to zero-carbon has been gaining urgency over the last few years, with many national governments now having declared a ‘climate emergency’. The UK government did so in 2019 with a non-binding motion in the House of Commons [1]. In more concrete terms, the UK government has committed to reduce the UK’s carbon emissions by 78% by 2035 compared to 1990 levels [2].

At a local level, Uttlesford District Council declared a climate emergency on 30th July 2019, with a pledge of “acting now to prevent a climate and ecological catastrophe” [3].

More recently, the steep rise in energy prices driven by a number of global issues has highlighted the potential advantages of maintaining our own energy supplies. Renewable electricity generation in particular is attractive due to its relatively low cost, lack of climate impact and abundant opportunity in the UK.

While the positive intentions expressed in declarations are very welcome, including national targets for decarbonising energy and transport, the actual pathway to reaching zero-carbon is not yet clear. At a national level, tangible progress on reducing carbon emissions is now lagging behind policy ambition [4]. However, many individuals and communities are now investigating how they can act themselves to save energy, transition away from fossil fuels and even create their own renewable energy infrastructure.

Some elements of the national zero-carbon strategy rely on new technologies not yet used at scale, however technologies available for the transition to zero carbon at domestic and community scale are available and starting to become more widespread.

Littlebury Parish Council was approached by Essex County Council and Uttlesford District Council and expressed interest in developing a Community Energy Plan to investigate how a village could transition from mainly oil based heating. Together with Uttlesford District Council, a consortium was established to start the project, modelled on the CommuniHeat project (see sections 1.2 and 3.2.3).

The consortium comprises Littlebury Parish Council, Uttlesford District Council, Community Energy South, Saffron Walden Community Energy and Ovesco. See Appendix 1 for details on these organisations. Initial funding has been provided by Uttlesford District Council from their Climate Change budget.

The focus of the project is on the village of Littlebury rather than the wider parish. This is partly to keep the project’s scale manageable, but also because working with a compact cluster of homes broadens the options available for decarbonisation.

1.2 CommuniHeat and Kickstart – Community Action on Climate Change

One of the first whole village decarbonisation plans developed in England is the CommuniHeat project, which is taking place in the village of Barcombe, East Sussex. The project is a partnership between the people of Barcombe, the local Community Energy group based in Lewes (Ovesco CIC), UK Power Networks and additional third party engineering expertise.

Lessons from the CommuniHeat project have been distilled into an approach to community led village decarbonisation called Kickstart. This is intended to be rolled out more widely, and Littlebury is the first village to run a project based on this approach.

Kickstart gives the community the tools to start developing a Community Energy Plan which provides:

- The carbon and energy usage of the community, including information how properties are currently heated.
- Review of housing archetypes within the village/community and the potential for retrofit.
- Building up knowledge of local suppliers for home surveys, retrofitting advice and work, and if need-be developing the local market.
- Measuring the interest within the community to transition to net zero, and establishing the kind of projects achievable.

In a district-wide context, it is hoped that the results from the Littlebury Energy Project can be used by other rural communities within Uttlesford which are primarily dependant on oil heating.

1.3 The Village of Littlebury

The Village of Littlebury is about 1.5 miles north-west of Saffron Walden. It is the primary settlement within the Parish of Littlebury, the other two main settlements being Littlebury Green and Catmere End.

The area has been inhabited since prehistoric times with evidence of bronze age and iron age activity [5] [6]. It is situated on the River Cam, with the main village on the east side of the river, built on ground rising above the flood plain.

The medieval London to Newmarket road passes through the village [5] (now the B1383), and in the mid 19th century, the Liverpool Street to Cambridge line was constructed, passing just to the west of the village centre [7].

The railway on the west and River Cam on the east form the main boundaries of the village, though homes have also been built on the west side of the railway.

Littlebury sits on the southern edge East Anglian Chalk Ridge [8] which runs from West Norfolk, via Newmarket and southwest into Hertfordshire. Historically chalkland hills were grazed by sheep, but the land use is now predominantly used for cereal production [9].

Audley End Estate is a significant presence in Littlebury, owning nearly all agricultural land surrounding the village, and some of the homes in the village.

1.4 A Note About Energy

Providing energy and power to our homes is responsible for about one third of the UK's energy requirements. However, as a proportion of the UK's electricity is renewable, the share of UK green-house gas emissions from domestic properties for space and water heating is about 15% [10].

Reducing domestic emissions is one of the most significant changes we as individuals can make to the climate crisis, along with changing behaviour around transport and diet. The two main approaches to reducing our domestic emissions are 1) reducing the energy demand of homes and 2) using zero-carbon energy, which mainly means using electricity [11].

But why is electricity zero carbon? Currently, the UK's electricity is not zero-carbon, but a record of 47.8% of electricity was generated by renewables in 2020. Adding nuclear, the total of zero carbon electricity was 56% [12]. The aim is to reach 100% zero carbon electricity, possibly by 2035 [13], and so any heating systems using electricity will become zero carbon. The same also applies to transport.

There are other low carbon options:

Biomass: Burning wood or wood-chip for direct heating or electricity generation, or creating bio-gas. While this can contribute to carbon reduction, it is now apparent that there are issues around air-quality and competing with food production. Wood burning stoves have become more widespread, but according to a recent report from the UK government now produce more dangerous particulate pollution than motor vehicles [14].

Green Hydrogen: This is hydrogen generated by electrolysis using excess renewable electricity. As renewable electricity generation increases, supply will at times exceed demand, and so green hydrogen is a mechanism to store energy. As it can then be burned in hydrogen boilers in a similar manner to fossil fuels, it is thought to be a good replacement for gas/oil heating, particularly in old buildings.

There are several issues with green hydrogen. Firstly, generation at scale is many years away. Secondly, it is anticipated than an upgraded gas network could be used for distribution, however Littlebury does not have a gas network. And thirdly, there are energy losses in conversion of electricity to hydrogen, so being able to use the electricity directly for heating is more efficient and often preferable.

2 Present Day Littlebury

The current number of homes in the Parish of Littlebury as given by the Parish Council are:

- Littlebury village – 237
- Littlebury Green – 56
- Catmere End – 31
- Strethall (although not all within the parish) – 10

EPC values rate the energy performance of homes, and the breakdown of EPC values for the village (where available) is given in Figure 1.

The average for England is that 42% of homes have an EPC of C or higher [15], so the performance of Littlebury's homes is well below average, with only 15% with EPC C or better.

In the government's 2018 Clean Growth Strategy, it set out the aspiration that all homes should be EPC Band C by 2035 [16], though it is accepted that this will be costly and not always practical or affordable [17].

The age of a property is the biggest single factor in the energy efficiency of homes [15], so as part of the questionnaire sent to all homes (see section 2.3), we asked the age of the property. The breakdown of building age from the 70 responses is shown in Figure 2.

Figure 1. EPC ratings of homes in Littlebury village

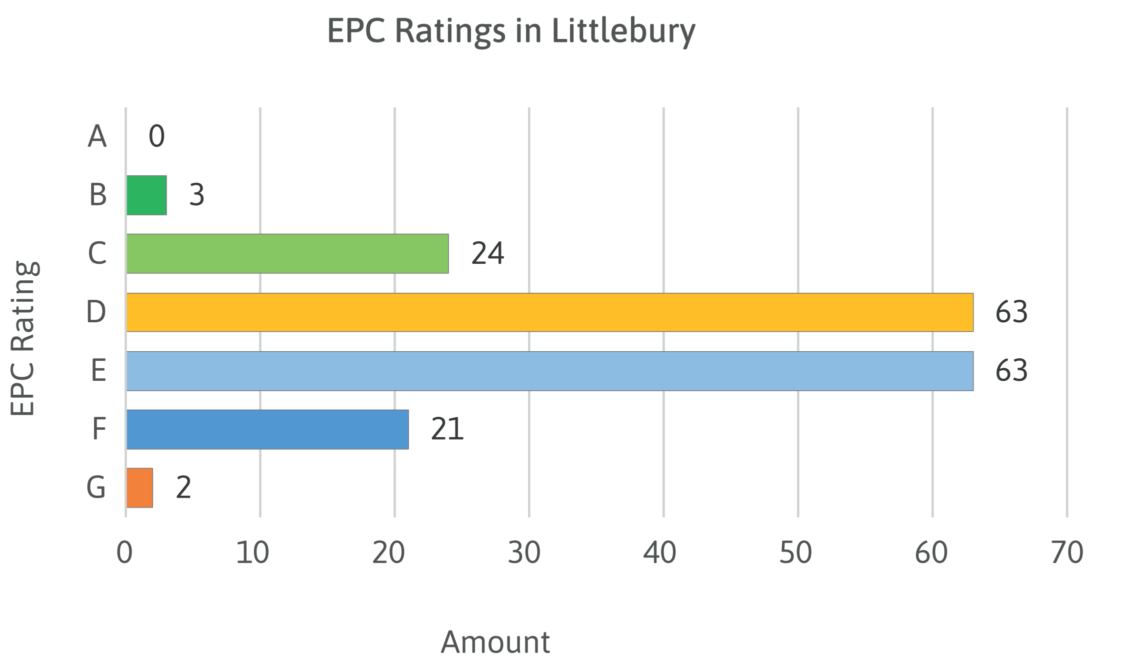
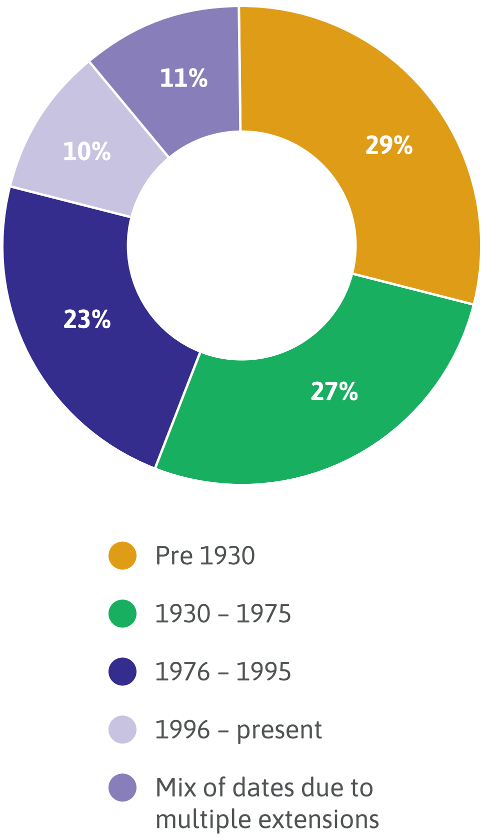


Figure 2. Building Age



Superficially, Littlebury village appears to have a very high percentage of old buildings, but the proportion from the questionnaire (see section 2.2) is that at least 60% are post-1930, so probably less constrained by listed building status. From Figure 3, one can see that listed buildings are located along the primary thoroughfares, giving the impression of a high proportion of old buildings.

The age of a building will determine its construction, energy efficiency measures likely to be already in place and the type of retrofit measures that can be taken. About 30% of the homes of those who responded to the questionnaire are pre-1930, so probably using more traditional construction methods. The inter-war years (1918-1939) saw a shift to the use of more modern construction methods and materials [18], and the last few decades have brought in a number of changes in Building Regulations and Part L legislation:

- Houses built before 1930: Typically, these won't have cavity walls. Likely to have single glazing and more likely to be listed. This is the most common archetype surveyed in Littlebury.
- Houses built between 1930-1975: Typically, these will have cavity walls with little or no insulation and may have single glazing.
- Houses built between 1976-1995: The cavity wall is likely to have been filled when the house was built and there may be some loft insulation.
- Houses built after 1996: These should be built to current building regulations.

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2.1 Conservation Area and Listed Buildings in Littlebury

The aim of a conservation area is to "ensure that the special characteristics of the conservation area are preserved" [19] which for Littlebury, the 2011 Conservation Area Appraisal summarises as:

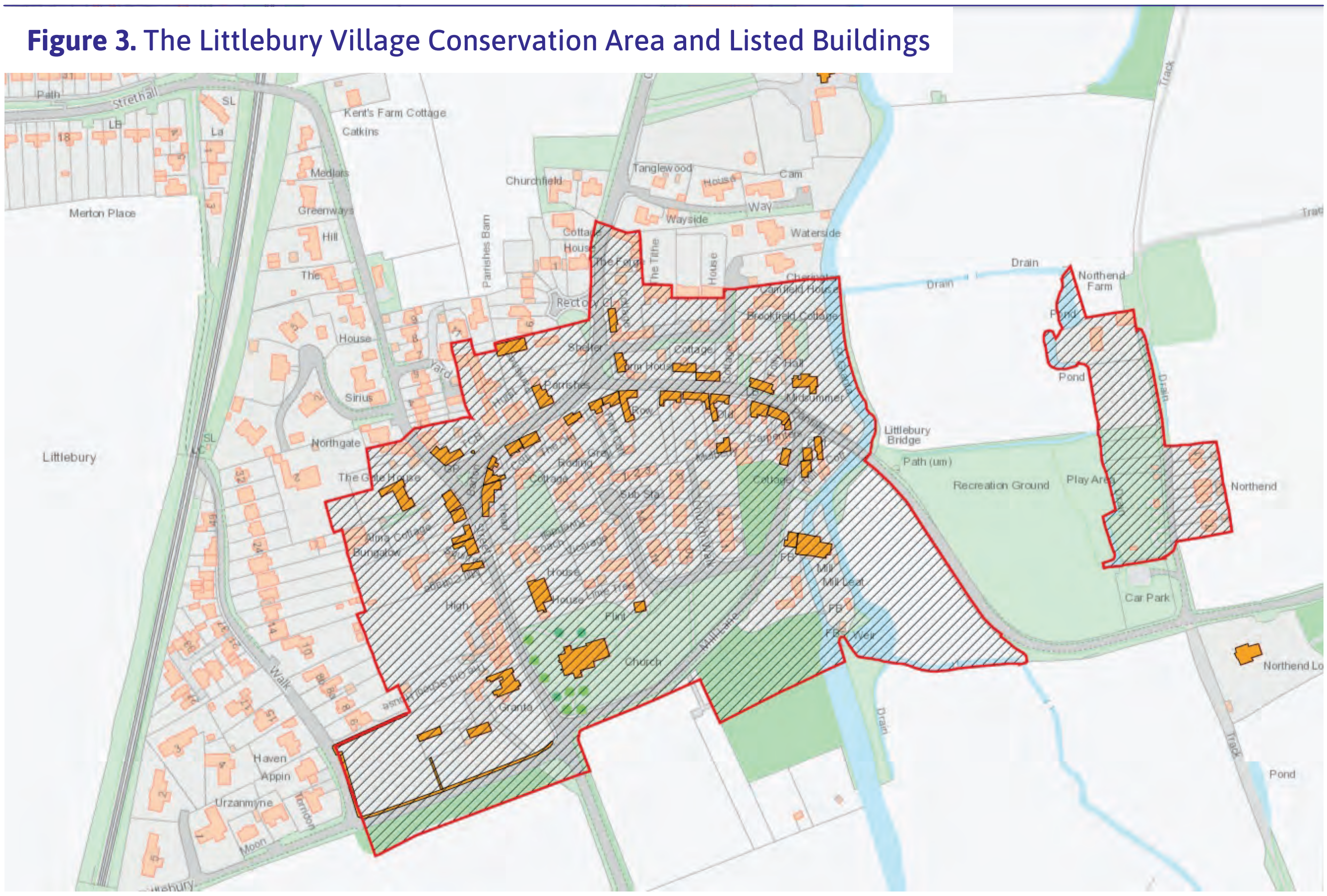
> Littlebury is a village of some importance in historical, visual and archaeological terms. Its range of listed timber-framed and plastered buildings principally dating from the 17th and 18th centuries, the church, and the mill in the historic core of the village make a particularly important contribution to the environment. Quality buildings from later periods provide diversity of architectural types. [8]

The core of the village is a conservation area as shown by the red outline in Figure 3, which contains 44 listed buildings. In the parish of Littlebury, there are a total of 71 listed buildings [8].

The extent of the Littlebury Village conservation area and the number of listed buildings indicates its special historic and architectural interest. This does however present its own set of challenges when looking at retrofit measures to improve building efficiency, not only in terms of permissions, but also in ensuring that over time, any modification will not damage the building fabric.

Central to the whole village decarbonisation plan is how to work with listed buildings in a conservation area and attempting to improve efficiency within the scope of current legislation. This is discussed in section 3.1.4, and is of broader relevance for the district as Uttlesford has around 3,500 listed buildings [20].

Figure 3. The Littlebury Village Conservation Area and Listed Buildings



2.2 Overview of the Questionnaire Results

To gain an understanding of the current state of properties in Littlebury including the opportunity for improving energy efficiency and transitioning to zero-carbon, a questionnaire was delivered to all homes in Littlebury Village.

From the approximately 240 questionnaires delivered, there were just over 70 responses either in paper format or via the on-line version, about a 30% response rate.

2.2.1 Housing Type and Ownership

About 60% of respondent's homes are detached, with about a quarter being semi-detached and the rest terraced.

78% of respondents are owner-occupiers, with the rest being private or social rental properties. The interest shown by both a relatively large proportion of owner occupiers and locally based major landlords means that community engagement offers a good route towards overall village decarbonisation.

More engagement with landlords will help tenants benefit from energy saving and retrofit initiatives.

2.2.2 Heating

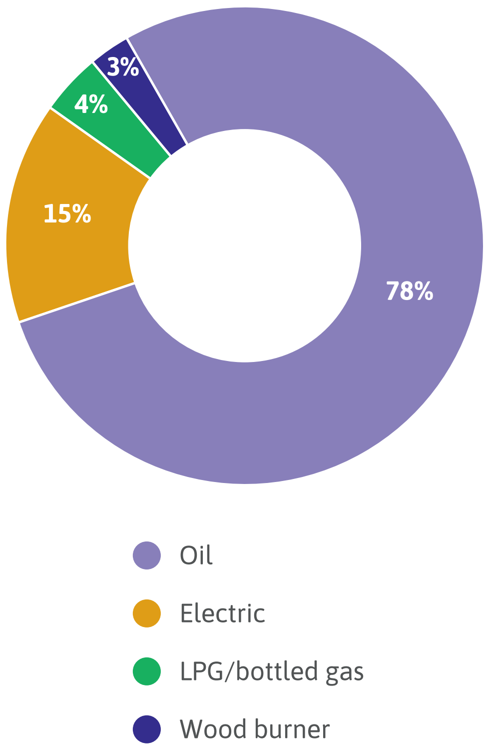
Figure 4 shows the heating type, with the vast majority using fossil fuels; a total of over 80% of respondents using either oil, LPG or bottled gas.

This underlines the challenge of this project; the transition away from fossil fuel based heating has not been started by the majority of home owners due to the barriers in doing so. It also shows the opportunity for village decarbonisation if affordable and practical alternatives to fossil fuel based heating can be found.

15% already use electric heating, but for some this is via electric heaters while some have heat-pumps. From discussions at the open day, direct electric heating has the advantage of relatively low installation cost, but combined with generally below average levels of insulation the resultant high heating costs are becoming an issue.

Almost 70% of respondents have some form of secondary heating, the most common being a wood burner (almost two-thirds) and about one third using standalone, plug-in electric heaters.

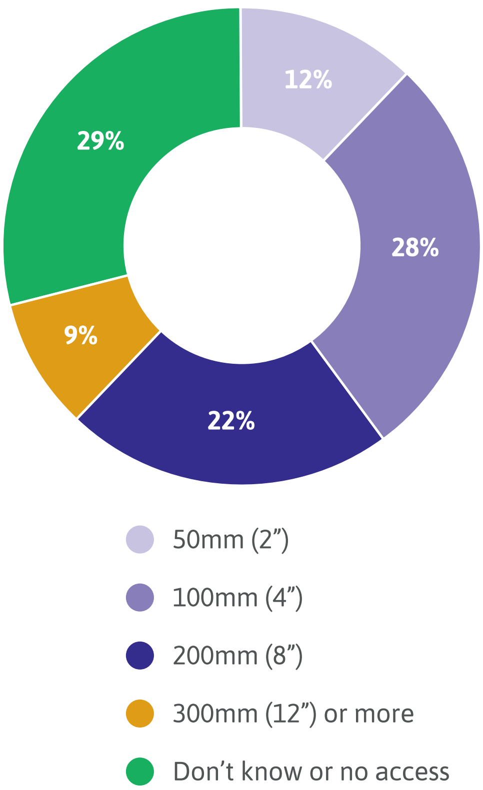
Figure 4. Heating types



2.2.3 Insulation and Current Building Standards

The questionnaire asked about insulation measures to gain an understanding of the potential for improvement. Figure 5 shows the results, and there was a general trend of older buildings having less insulation.

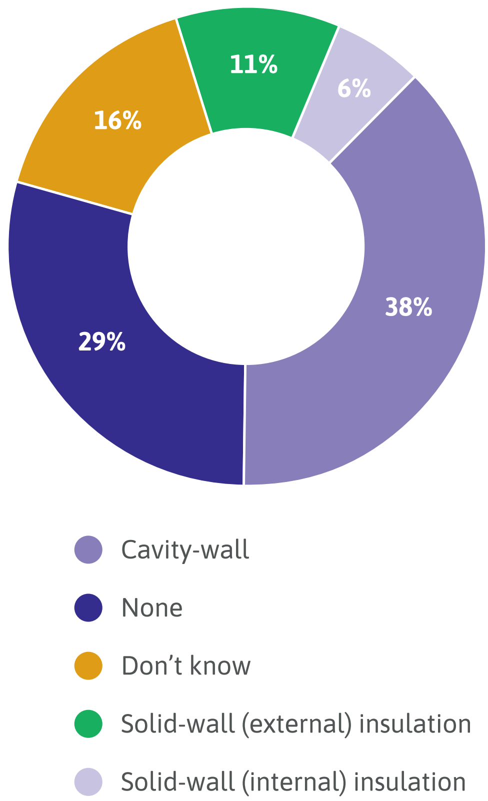
Figure 5. Loft insulation results



Only a small proportion have the currently recommended 30cm of insulation, and so there is significant potential for improvement across most properties.

Wall insulation provided a better picture, with over half of homes having wall insulation of some form, either internal, cavity or external as shown in Figure 6. There was an overall correlation between wall insulation and how recent a house had been built; the older the house the lower the probability of wall insulation.

Figure 6. Cavity wall insulation results



75% of respondents have double-glazing, with the rest being single glazing. Nearly all single glazing is found in pre-1930 properties.

2.2.4 Renewable Technologies

Only 6 out of the 70 households have some form of renewable technology; two with air source heat pumps while four have solar panels (PV).

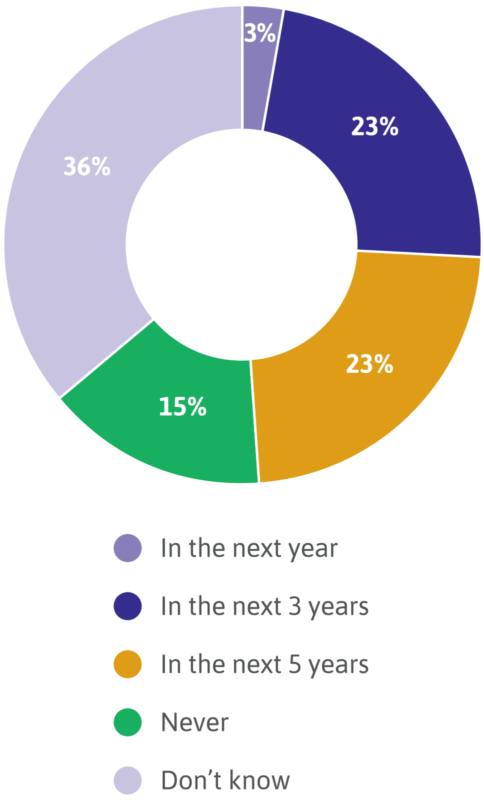
This highlights that there is significant scope for a wider roll-out of renewable technologies, though clearly not all homes are suitable.

2.2.5 Electric Vehicles

As discussed in section 1.4, electricity will become the primary energy source as we head towards zero carbon. This includes transport and the use of electric vehicles.

Only 7% of respondents currently have an electric vehicle, but of the 93% who don't have one, about half are considering buying one in the next five years as shown in Figure 7.

Figure 7. Of those who don't own an electric vehicle, when would you consider buying one?



One advantage of a rural area is a high proportion of homes with a driveway so that a car can be charged – 84% of those currently without an electric car.

The village will need to consider how to provide public chargers for those without a driveway.

2.2.6 Average Energy Costs – Spring 2022

Some statistics were collected about energy costs, and as to be expected, the annual energy cost increased with the size of the house as shown in Table 1. The numbers were received in Spring 2022 with an average electricity price of £0.35 per kWh.

Table 1. Energy costs vs house size

	Average annual cost	
Bedrooms	Heating and hot water	Electricity
2	£ 832.73	£ 1,174.41
3	£ 969.25	£ 1,229.78
4	£ 1,673.75	£ 1,383.17
5	£ 2,323.33	£ 2,036.00

2.3 Reducing Energy Consumption in Littlebury

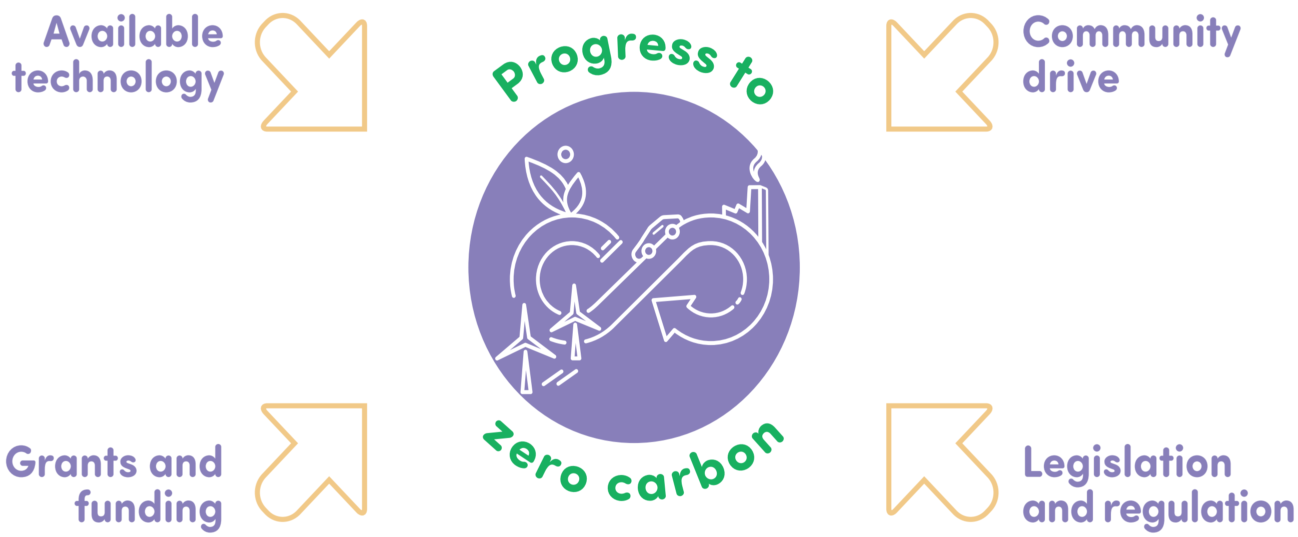
The lower than average EPC ratings for homes in Littlebury and the high energy bills being incurred both indicate the potential scope for energy efficiency improvements and reducing costs for residents. With lower usage the incorporation of low-carbon technology is likely to become more straightforward and potentially less costly.

3 Transition Pathways

The primary aim of this report is to provide an overview of the various routes to a low-carbon community. The suggestions here are based on information collected during the project, plus case studies from other individuals, groups, and communities.

The progress that the Littlebury community takes towards low-carbon targets depends on several factors, shown in Figure 8.

Figure 8. Factors influencing the route to becoming a low-carbon community



The rest of this section discusses available technology and approaches, and how these have been used in individual properties and by groups. Some aspects of legislation and regulation are also discussed.

Grants and funding for renewable energy and low-carbon projects have been inconsistent over the last few years, and several successful funding streams have now been terminated. These include feed-in-tariffs, the Domestic and Non-Domestic Renewable Heat Incentive, the Rural Community Energy Fund and the Plug-in Car Grant Scheme. Nonetheless, some funding sources remain, and these are listed in Appendix 2.

In addition to standard grant programs, other funding and finance opportunities do exist, often for innovative projects looking to establish solutions that can be more widely adopted. Community drive is critical here, in doing the appropriate groundwork with sufficient ambition to be able to make the most of opportunities as they arise.

3.1 Individual Home Efficiency Improvement

Regardless of whether participating in a community project or acting individually, most residents are motivated to try and reduce energy use and costs. Many are also concerned about climate change and want to reduce their carbon footprint.

This section lists a number of approaches to home energy efficiency improvement, which for home owners, those renting and also landlords can be considered on an individual property basis. However, the opportunity is also available for a community to work together to accelerate retrofit work, which is discussed in section 3.2.

3.1.1 DIY Energy Saving Measures

When considering energy use and carbon footprint size, the first place to start is to see what simple, DIY energy saving measures can be taken. These can be low tech and sometimes low cost as well so a fast payback in terms of the initial outlay.

Some examples are:

- Draught proofing windows and doors, including letter boxes and key holes. Curtains can reduce drafts and cut heat loss.
- Adding self-mounted, seasonal secondary glazing film to single-glazed windows.
- Switch to LED light bulbs.
- Ensure the hot water tank is well insulated.
- Adding or improving loft insulation if loft easily accessible.
- Switch off lights and other devices when not in use.
- Understand heating and hot water controls. Turn the thermostat down one degree.
- Optimise energy use: Only boil water needed, fully load washing machines and dish washers, take short showers etc.

3.1.2 Deeper Retrofit Measures

While the above measures help reduce energy use, deeper retrofit measures can further reduce costs and contribute to a more comfortable home. Not all of these can be used on listed buildings, the issues around which are discussed in section 3.1.4.

- Loft insulation. If this cannot be done as DIY, then it is often one of the easier and less costly measures for a third party to do.
- For single glazing, adding permanent secondary glazing or upgrading to double or triple glazing.
- Cavity wall insulation if the house is of cavity wall construction. Additional insulation can be added internally or, more easily, externally, to further reduce heat losses.
- Solid wall insulation, which can be done internally or externally.

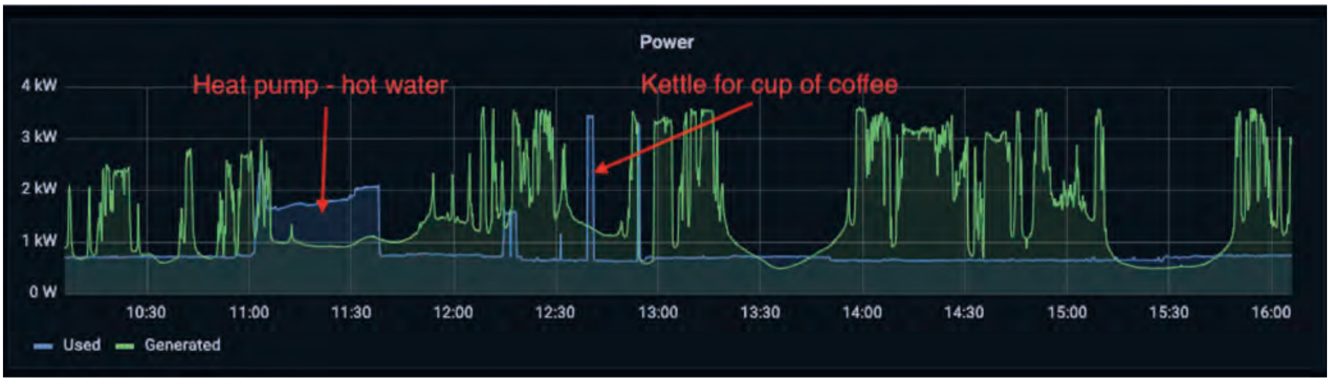
In addition to energy savings, other retrofit measures can help reduce reliance on fossil fuels, one of the primary aims of this project. These include:

- Adding solar panels, most commonly photo-voltaic (PV) to generate electricity. Solar thermal for hot water is another option, though less common.
- Exchange a gas/oil/LPG boiler for a heat-pump.

3.1.3 Gaining an Insight into Energy Use and Loss

The measures outlined above are based on what generally works, but properties vary considerably, so understanding the energy use of a home can help determine which measures would be most effective.

Figure 9. Live electricity data. Green = solar power. Blue = electricity used.



3.1.3.1 Smart Meters and Real-Time Electricity Use

The smart meter roll-out in the UK started in 2011 with a target of full customer coverage by 2025 [21]. They are a useful tool in monitoring electricity (and gas) usage by providing the instantaneous consumption and half-hourly historical values. While this is a great improvement over standard electricity meters in helping understand how much electricity is being used, it is nonetheless difficult to link this data back to individual electricity consuming devices in the home.

Real-time electricity data graphs provide more specific detail as shown in Figure 9. The green plot is solar power being generated, which can be intermittent due to passing clouds. The blue line is the power used in the home.

Of note in this chart is that the air-source heat pump uses quite a lot of electricity to heat the hot water cylinder. This is however quite a bit less electricity than an immersion heater would use for hot water. We can see how expensive direct electrical heating of water is by looking at the power needed for the kettle, which was for one or two mugs of water.

The blue line also shows the background "baseload" of the home, which is caused by devices on standby, WiFi routers, heating pumps etc. Reducing this a little can have a disproportionate impact on electricity use as it is for 24 hours a day, for example a reduction of the baseload by 42W could save over £100 per year[2].

[2] If the baseload could be reduced by 42W, then over 24 hours this would save 1kWh. Over a year this would be 365kWh, which at 30p/kWh (approximate value at time of writing) is almost £110.

3.1.3.2 Thermal Imaging

Thermal cameras can be a useful tool, providing almost a sixth sense to see temperature variations across buildings, giving a unique insight into its thermal behaviour. They are quite straightforward to use, though some care is needed to prevent false readings (such as reflected sunlight) or misinterpretation. For example, when looking at the outside of a building, cold areas are good, but inside a building cold areas are bad!

Figure 10. External heat loss images

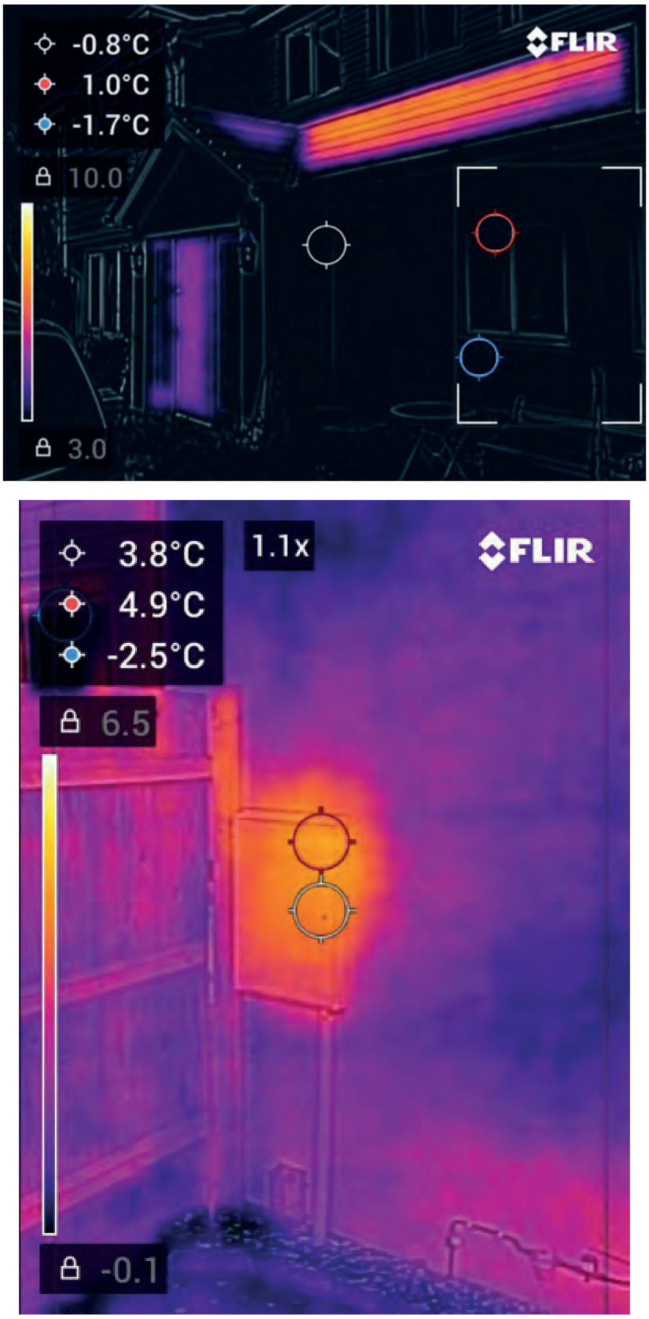
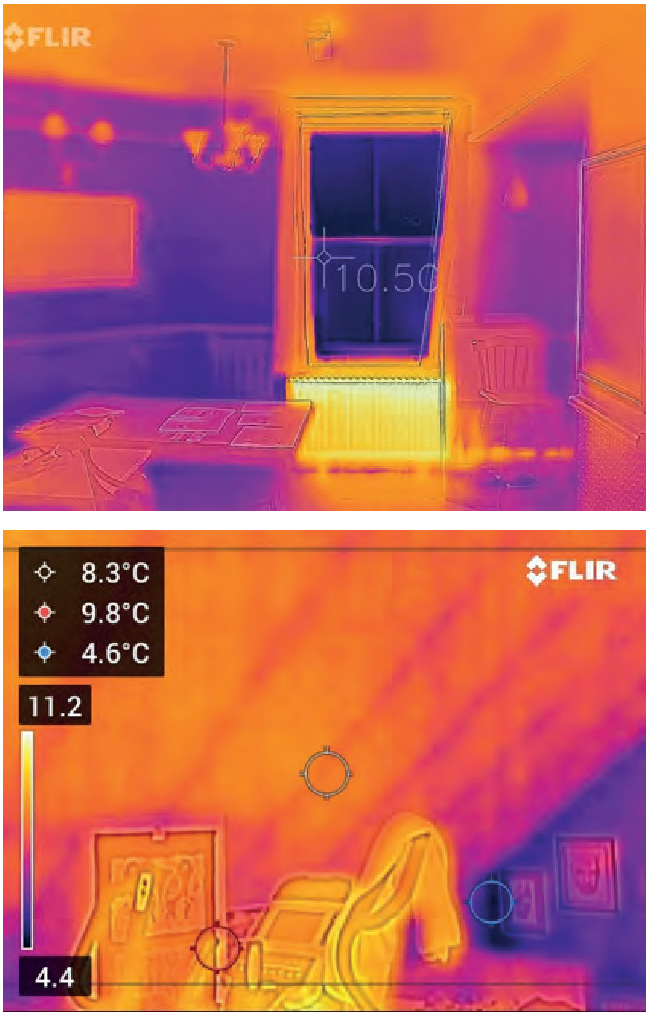


Figure 10 shows thermal images of the outside of a home, the brighter areas showing where additional insulation would reduce heat loss.

Figure 11 has two internal thermal images, the dark areas being cold so indicating heat loss from the inside. The first image is a single glazed window over a hot radiator. The second image is a loft room with colder rear-wall.

Interestingly the rafters can be seen as they are acting as "cold bridges", in this case not too significant. Modern building techniques are designed to eliminate such cold bridges, but lack of detail in building works often results in missing or incomplete insulation.

Figure 11. Internal thermal images



3.1.4 Listed Buildings and Renovation

Littlebury village has 44 listed buildings, and much of the village centre is a conservation area – see section 2.1. This presents additional challenges when attempting to improve the energy efficiency of buildings, partly in terms of what renovation measures are permitted, but also ensuring that building modifications do not cause long term damage. Modern building techniques take a very different approach to handling moisture and breathability, which can work against how an older building functions [22].

If building work is being planned, the two main types of consent needed are Buildings Regulation Approval and Planning Permission. For listed buildings, a further Listed Building Consent is needed for a broad range of works, including but not limited to [20]:

- altering part of the building
- adding an extension or conservatory
- replacing doors or windows or adding new ones (including internal doors)
- removing or altering chimneys
- replacing the roof covering
- removing staircases, skirtings, panelling, floorboards or plasterwork and removing, adding or altering structural elements of the building (including partitions)
- adding satellite dishes and burglar alarms
- putting in dormer windows or a roof-light

In addition, for buildings in a conservation area, whether listed or not, there may be some additional constraints or exceptions, depending on the type of work.

Uttlesford District Council's Planning Department can advise whether planning consent will be required for building or renovation work, and also have a pre-application advice service [20].

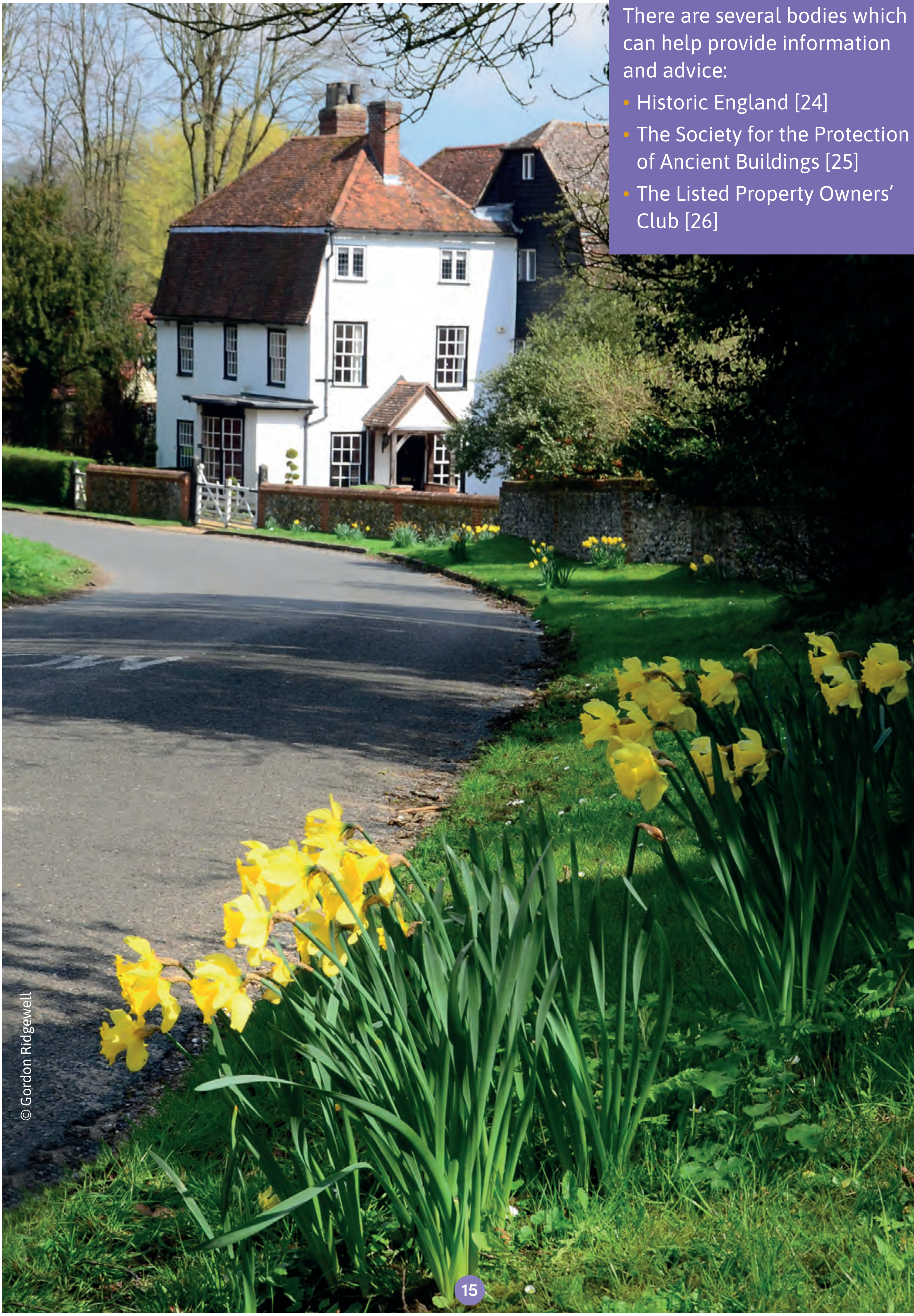
3.1.4.1 A Whole Building Approach

Old buildings are arguably sustainable in nature; not only have they lasted a long time, but are likely to have used local, less mass-produced materials. Repair and restoration work may require the use of similar materials, which need sourcing and understanding of use.

Historic England recommend taking a whole building approach when looking at measures to improve the energy efficiency:

> A true 'whole building approach' is one that uses an understanding of a building in its context to find balanced solutions that save energy, sustain heritage significance, and maintain a comfortable and healthy indoor environment. A whole building approach also takes into account wider environmental, cultural, community and economic issues, including energy supply. It ensures improvements are suitable, proportionate, timely, well integrated, properly coordinated, effective and sustainable, and helps to highlight and resolve uncertainties, reconcile conflicting aims, and manage the risks of unintended consequences. [23]

While this no doubt leads to a good outcome, balancing conservation, building health and energy use, it does depend on finding the necessary skills, expertise and finance to undertake the project.



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There are several bodies which can help provide information and advice:

- Historic England [24]
- The Society for the Protection of Ancient Buildings [25]
- The Listed Property Owners' Club [26]

3.1.5 Case Studies

Some local case studies are presented in this section, with the aim of providing some actual experience of using some of the technologies mentioned above.

3.1.5.1 Solar PV panels

An example of a 3.6kWp solar photovoltaic (PV) system installed on a south-east facing roof.

We had PV panels fitted in 2018 by Solarbarn, a local company. A very good, well planned installation. We use quite a lot of electricity, and the panels have supplied about half our annual consumption each year. It's a SE facing roof, max 3.6KW output array. The output is high enough to, for example, cook breakfast, then power the washing machine plus background usage, fridge etc., for about 7 months of the year.

Financially, maximising self consumption makes most sense, so we have a Solar iBoost device that diverts surplus output to the immersion heater before anything is exported to the grid. In practice it means almost all our (usually five people) domestic hot water is heated by PV for much of the year. See Figure 12.

The headline production/consumption figures, averages for three full years:

Total production	**4.0MWh**
Self consumption	**3.1MWh**
Exported	**0.9MWh**
Percentage exported	**22%**

Financial

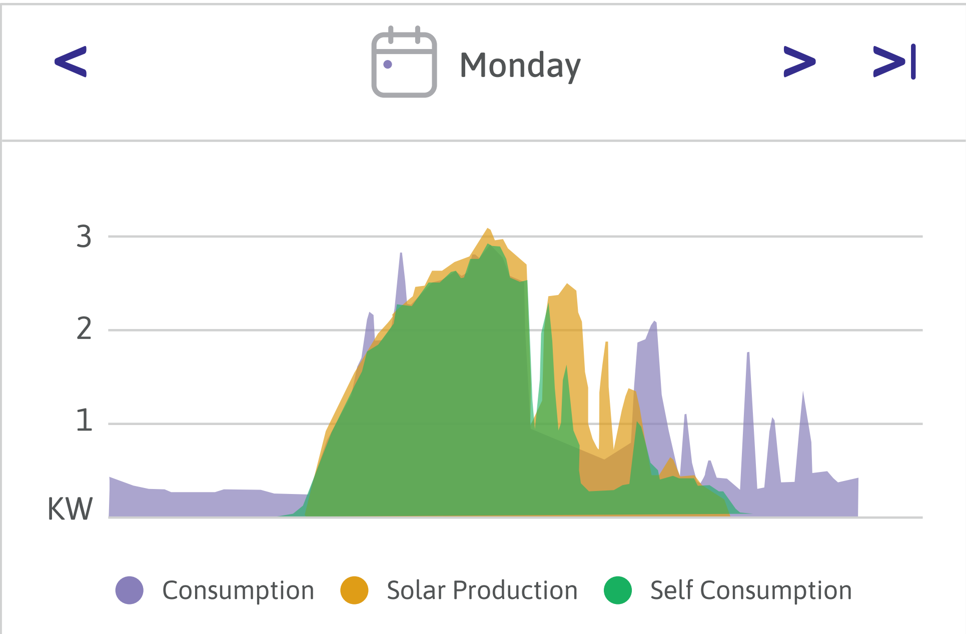
Cost of installation £8,000, anticipated life 25 years.

Value of energy produced and consumed per year at 2018 prices: £580 inc 5% VAT

Value of energy produced and consumed per year at 2022 prices: £950 inc 5% VAT

We are still exporting nearly 1MWh to the grid per year, so if we were to get an electric car and fit the right home charging box we could use more of the PV output. Assuming 50% of the amount we are currently exporting could be used for charging, that's around 1,800 miles per year, otherwise currently costing £450, effectively free.

Figure 12. High self consumption of solar power on a sunny day using an iBoost for hot water



3.1.5.2 Retrofitted Air-Source Heat Pump

An example of a 12kW air-source heat pump replacing a gas boiler in a 1930's four-bedroom semi-detached house in Saffron Walden.

In 2019, we had building work done to add an external office and workshop. This required that the gas boiler and hot water tank be moved, so it was a good opportunity to replace it with an air-source heat pump.

A company from Royston surveyed the house and found that a 12kW system would be adequate to heat the house and extension. The new parts of the house have underfloor water heating, and the older parts radiators, but as the previous gas-based system had been well designed, no radiators needed to be replaced.

The external unit is a NIBE F2040-12, a Scandinavian design so it has no problems heating with cold external temperatures.

It is 100cm high and 115cm wide and placed in front of the house on a car parking space and is generally very quiet in operation.

The installation of a larger hot water tank was required; 300 litres of hot water and a 60-litre buffer tank for the heating system. Its control system is quite advanced, allowing fine tuning and on-line monitoring, though once configured correctly it can run throughout the year without any adjustment or intervention.

Initially we thought it cost neutral to run; it uses about a third to a quarter of the input energy of the gas heating system (the rest being taken from the air) but as electricity is about 3 to 4 times the price per kWh, the overall input energy cost is similar. However, as gas prices have risen more quickly than electricity we think our total energy bills are lower than they would have otherwise been.

We have been very pleased with the result; the house remains warm at an even temperature throughout the year. It was more expensive to install than a replacement gas boiler, but we were able to apply for Renewable Heat Incentive (RHI) payments, which will approximately cover the install costs, paid back over a period of seven years. RHI payments are no longer available, but there are now other grants to support heat-pump installations.

3.1.5.3 Listed Home Restoration

As previously discussed, working with listed buildings presents many challenges, and that a whole building approach is often recommended. While a whole building approach is not always possible, a case study of complete building restoration is given to illustrate what can be achieved.

The Old Bakery is a Grade II Listed building in Littlebury, with the majority of the house dating from the early to mid 1700's. It was originally a number of small cottages, including the village shop and presumably a bakery.

Over the years the house was modified and extended, including the combination of the various cottages into one property and the addition of several extensions all in the mid-20th century. All of this work pre-dated current regulations, was of poor quality and inappropriate to the historic nature of this timber-framed building.

On purchase the building was barely habitable, so required a full restoration to bring it back into a habitable state. This also provided the opportunity to sensitively improve the accommodation working closely with the local Planning Authority.

Figure 13. The Old Bakery prior to restoration

The restoration work involved:

- Removing all modern cement-based render to the external timber frame and replacing with a breathable lime render on timber laths allowing the owners to fully repair and insulate the timber frame walls, although only with sheep's wool (a traditional breathable insulation) to a max depth of 5cm where the timber frame allowed.
- Replacing the poor-quality concrete ground floor with a fully insulated limecrete slab sympathetic to the breathable nature of the original construction, allowing underfloor heating to be installed, heated by an Air Source Heat Pump which is beneficial to the timber-frame, keeping it at a more even temperature throughout the year, minimising any movement and cracking.

Figure 14. The Old Bakery following restoration

The final design involved lengthy consultation with the Planning Authority. The owner is an Architect and Passivhaus Designer with many years' experience working on Listed Buildings, which allowed for a fairly smooth process to gain Listed Building consent.

The modern alterations to the building during the restoration only occur in the less valuable 20th Century additions, ensuring the original and historic fabric of the building was preserved. A "glass box" Boot Room was added to the rear elevation containing the relocated main door and the mid-20th Century asbestos roofed extension was converted into a Garden Room with large glass doors that slide away to open the space out to the south-facing garden. Both were constructed to current regulations.

The property is carefully designed to allow solar gain to heat the living spaces during colder months and minimise solar gain in the warmer summer months, helping reduce the heat load.

Original single glazed windows have been refurbished and despite not having secondary glazing, the building is heated with an air-source heat-pump, with back-up support from wood-burning stoves (although these are rarely used for anything other than creating a cosy atmosphere).

Queens Platinum Jubliee

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3.2 Community Wide Initiatives

The previous section looked at the measures that can be taken at the individual building level, how information about the building combined with appropriate technologies can radically change the carbon use of a home.

Community wide initiatives can take the same approaches, but make a difference here in two respects:

- Building community momentum. This includes the sharing of know-how and experience, whist developing a market for trusted installers and tradespeople.
- Working at scale can provide more options. This may be simple economies of scale, but certain types of technology work better in larger installations. More options are available for grants and fund raising at community level.

This section introduces a number of community scale initiatives to help transition from fossil fuels. It is not an exhaustive list of project types, for example wind energy isn't included, but they all clearly demonstrate that broad community initiatives can be ambitious and achieve impressive outcomes.

3.2.1 Heat Networks

Heat networks (or district heating) supply heat for hot water and space heating to multiple homes from a central source via underground pipes, usually through a heat exchanger connected to a domestic radiator circuit. Measuring equipment enables residents to be billed for the heat they have used. The way heat is generated centrally varies, from power stations, waste facilities to geothermal sources. In the context of this discussion, we are looking at zero-carbon heat-networks which use electricity to generate heat (although biomass is sometimes used).

In the UK, most heat-networks are found in cities due to the density of the building. Many new developments in London and elsewhere have this type of installation as it is generally more efficient than individual heating sources [27]. Several other countries use district heating much more widely. The heat source can vary widely, from old coal plants to waste incineration to biomass but the principle of district heat distribution via (generally) buried pipework is now well established.

While heat-networks are not new, looking at their applicability for rural communities in the UK is quite novel. Decarbonisation targets, particularly where oil is the primary heating fuel are bringing low-carbon heat-networks into the picture. The example of Swaffham Prior in Cambridgeshire is a good case in point.

3.2.1.1 The Swaffham Prior Community Heat Network

Swaffham Prior is a village of greater than 300 homes, and like Littlebury is not on the gas network. The project was started in 2018 and aims to go live in July 2022 with 70 homes connected by the end of 2022.

The energy centre (shown below) is a combination of large air-source and ground-source heat-pumps; air-source for summer and ground-source for winter. There are approximately 100 ground-source boreholes within a 25-to-30-acre area, each borehole being 200m deep.

Thermal energy is stored in large tanks, in total containing 200 tonnes of liquid, which is sufficient energy for about 12 hours of heating in winter when fully connected up. It is designed to heat a maximum of 300 homes. The overall coefficient of performance (COP) is expected to be between 2.9 and 3.2.

Insulated pipework has been laid throughout the village, with spurs off to each home to be connected. In the house there is a heat interface unit which acts as a boiler, but rather than burning oil for heat energy, it transfers heat from the heat-network to the internal heating system. The heat-network supplies hot water at up to 72C, so it is not necessary to modify the existing home heating system as radiators can be run at high-temperature when needed.

As part of the project the insulation has been improved on many homes, which will reduce their energy consumption and future bills. Each connected home pays energy costs to the network at a rate which is less than the cost of oil, but which tracks the oil and later, the electricity, price.

3.2.2 Community Solar Farms

Until recently, community solar farms were popular and set up by many community groups. Revenue from the Feed-in-tariff (FiT) provided the security needed to raise community funds to create the solar farm, provide a small amount of interest on the loans and feed other profits back into the community.

As FiTs were reduced and then stopped in 2019, the viability of new ground-mounted community solar was all but eliminated. Community groups moved to roof-top solar projects, often viable if the building they are on consumes a significant proportion of the generated electricity. For Littlebury this model is not applicable as there are no suitable large roofs. However, with some emerging and quite innovative approaches to electricity use, ground-based community solar may be possible.

3.2.2.1 FiT Supported – Reach Community Solar Farm

One FiT supported local example of a is Reach Community Solar Farm in Cambridgeshire [28], which started operating in 2016. While the approach is no longer applicable, it is perhaps interesting to list as an example of the kind of fund raising possible by a small village.

The village of Reach has a population of around 360 [32] and in 2013 initiated a project to create a community solar farm. A total of £340,000 was raised from a total of 112 people to install a ground based solar farm of 264kW peak output on a 1.5 acre site. This provides enough electricity to power 50 homes, about half the village.

It began generating electricity in 2016, and has an expected operational life of 20 years. Shareholders receive 2% – 3% interest on their investment, and charity donations are made each year out of profits.

3.2.2.2 Post FiT – Dottery Solar Array

Examples of community sized, ground-based solar project post-FiT are rare, but just such a project is being planned in the hamlet of Dottery in Dorset. It is still a work in progress, but the aim is to build the solar array in 2023.

Dorset Community Energy are hoping to build a 250kWp solar PV array in a field in Dottery. The site area will be about 1.2 acres and has been chosen to minimise the impact on the landscape and ecology. It will be screened from view with native planting, also aimed to increase biodiversity [32]. Funding will be raised through a community share offer.

Without Fit payments, the revenue made in exporting the solar electricity to the grid via the Smart Export Guarantee is quite low. Dottery aim instead to provide cheaper electricity to 200 households in the area via an Energy Local Club. This innovative scheme matches electricity generators and local consumers, which agree a “match tariff” that is paid to the generator when they match their electricity use to the local generation. It requires a partner energy supplier, such as Octopus Energy, which handles smart meter data and the matching calculations [29].

CommuniHeat
PATHWAY TO NET ZERO

3.2.3 Barcombe CommuniHeat – A Village Wide Project

CommuniHeat is an innovative project to look at how the off-gas grid village of Barcombe can develop a roadmap to smoothly transition to low carbon heating as a blueprint for all off gas villages in the UK. The Littlebury Energy Project is following the example of Barcombe, and while differences in the two villages may mean the Barcombe roadmap is not fully applicable to Littlebury, it is nonetheless interesting to look at the Barcombe approach.

Barcombe is a village in East Sussex of about 700 houses within the parish spread over an area just under 7 square miles. There is the main hub of Barcombe Cross, an older much smaller hamlet called Barcombe (or Old Barcombe) and then Barcombe Mills of around 18 houses close to the River Ouse. It sits in the lovely East Sussex countryside north of Lewes.

CommuniHeat

The aim of the project was to develop a community led energy plan to transition from fossil fuels to renewable power. It is hoped that this would help with energy affordability through communally owned local renewable projects such as roof top PV and small scale ground mounted PV schemes, keeping the price of electricity lower, and also by keeping the grid upgrades planned and minimal and therefore to keep this cost lower. A communal planned approach will also mean that more heat pumps will be fitted and the process will be smoother and better supported.

A digital twin was developed of the village to enable different future scenarios to map the best (i.e. the cheapest and quickest route) to net zero for the whole village. Detailed heat monitoring was undertaken, and houses surveyed for heat loss to build up a detailed accurate picture of the energy use of the village. Publicly available data was input into the digital twin along with UK Power Networks grid to see what the future could look like.

The outcome is a community plan with the following achievable aims in the next ten years verses an uncoordinated approach:

- 20% saving in overall electricity demand.
- 27% reduction in overall household energy costs by 2030.
- 430 homes to get a building fabric retrofit.
- 500 heat pumps installed vs 340 without coordinated work.
- Community owned renewables to deliver 37% of total electricity demand, spread over 17 renewable sites. Solar PV farms to generate up to 4.5 MWp and two wind farms to generate 1.6 MWp.
- Estimated £4m community investment needed.
- 75% saving in network reinforcement costs. (UK Power Network costs impact our electricity bills in the form of network costs – 23% of the cost of a kWh of electricity. Ofgem the regulator makes sure that these costs are kept to a minimum while asking that UK Power Networks keeps the lights on by keeping the network going and investing in innovation.)

Two events have been held at the village hall to inform the village around retrofitting and electric heating with local suppliers and partners of the project. Numerous webinars have been held and a steering group formed out of which a plan is being constructed by the local residents to retrofit houses in Barcombe Mills well as installing renewable generation.

Ovesco has also worked with the Church in the village to put plans into place to retrofit the main church and insulate the church hall. All houses have now received a Home Action Plan specific to Barcombe on how to decarbonise.

Further work will be ongoing and will be scaled up depending on future funding.

4 Next Steps for the Littlebury Energy Project

Reducing energy consumption by upgrading insulation and heating system controls seems to offer the quickest and most effective way of permanently reducing heating bills. The benefits are long term, and do not depend on changes to the heat source.

With the cost of energy increasing so quickly in 2022, and likely to do so again, the standard of insulation thought to be adequate and cost effective 10-15 years ago is likely to be well below what is worthwhile now and in the future. As an example, the best double glazing available loses half as much heat as older installations, and a quarter of losses through single glazing. From June 2022 most newly built homes must achieve lower heat losses, though most existing homes will need upgrading.

During the course of this project the UK has recorded the highest ever summer temperatures around 40C, with the prediction that this will be commonplace in future. Improving insulation works both ways, reducing heat lost from the home in colder weather and helping keep out excess heat from the sun. So improving insulation is likely to make homes more comfortable in both winter and summer.

The route that Littlebury takes to move away from fossil fuels can be split into three high-level options:

- Individual zero-carbon initiatives.
- Individual initiatives supported by group projects and coordination, potentially with joint solutions for some groups of properties.
- A "big bang" village wide project, with additional support for those homes where participation is not possible or economic.

A number of ideas are presented below, modelled on the CommuniHeat project and other community energy work.

4.1 Short to Medium Term: (Autumn 2022 to Spring 2023)

- Hold regular village energy information events (Autumn and Spring) – introducing local experts and keeping up to date with changing energy market
- Start a Bulk Buying Club in the village for insulation, PV panels etc. (This will depend on residents working together.)
- Hold thermal image camera events in the winter and then meet to discuss improving Insulation.
- Support residents to apply for grants e.g. for insulation improvements.
- Work with Council and other villages to fund an Energy Champion hosted by Saffron Waldon Community Energy that supports the villagers (Ongoing)
- Join the CommuniHeat programme (start to do in depth analysis of homes in the village). This will potentially open up home energy assessments and provide potential for winter heat monitoring for the homes to thoroughly assess the thermal requirements for the villages housing stock. (NOTE: This is pending industry funding that both UKPN and Community Energy South are working on)

- Establish a village Energy Advice service via a website.
- Start to train an energy champion to give advice and how to save energy.
- Talk to the council about Listed Buildings and how to manage retrofits.
- Liaise with landlords about their homes in Littlebury.
- Establish a local listed building renovation group to gain collective expertise and share knowledge.

4.2 Long Term: (2023/2025)

- Become a leading pilot through CommuniHeat project, developing and implementing a detailed energy transition plan for the community, ideally one that could be replicated for other villages.
- Plan to start a bulk buying club for insulating homes, solar PV and heating.
- Start an Eco Open House event (Summer 2023).
- Launch local EV Car Sharing Club.
- Provide accessible EV charging points for homes without on plot parking.

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6 Appendices

Appendix 1

Littlebury Energy Project Consortium

Littlebury Parish Council act as primary representatives of the village and helped initiate this project in discussion with Uttlesford District Council and Essex County Council.

Uttlesford District Council provided funding for the first phase of the project as part of their climate change strategy. It is hoped that other areas in Uttlesford can follow the lead taken by Littlebury.

Saffron Walden Community Energy Ltd is a new community energy group, setup to work on renewable energy and transport projects in Saffron Walden and area. It was established in 2021 and is currently being supported by the Essex County Council Community Energy Pathways programme.

Ovesco are a community energy company in Lewes established in 2009. They have a track record of renewable energy projects, including solar panels on schools, an electric cargo bike rental scheme and the CommuniHeat project. Experience gained from CommuniHeat is being used to guide the Littlebury Energy Project.

Community Energy South is the umbrella organisation for community energy groups in the South of England. It provides mentoring and support for community energy groups, and acts as a voice for the sector in the region. CES also works closely with councils and other public bodies to help build capacity within the community driven renewable energy sector.

Appendix 2

Grants and Funding

For Households

Sustainable warmth – Local Authority Delivery Scheme

Essex homeowners may be eligible for up to £10,000 of work to make energy efficiency improvements to a home. The measures are determined by a full home survey, and could include fitting loft insulation, cavity or solid wall insulation or energy efficient heating.

Owner occupiers, and private rented properties are eligible for the scheme. Home owners will have the upgrade measures fully funded. For rented properties, the landlord will need to contribute one third of the costs of the upgrades.

Householders also need to meet certain eligibility criteria to qualify for funding:

- The home must have a low energy efficiency rating (an EPC rating of D, E, F, or G – this will be assessed by Warmworks)

The household also needs to meet one of the following eligibility criteria:

- Annual household income of less than £30,000 (after tax and deductions)
- Annual household income of less than £20,000 a year (after housing costs are deducted)
- Unemployed or receiving benefits related to income, disability or health
- Subject to an income payment agreement (such as bankruptcy, IVA or step change)
- State pension age and receiving housing credit

Interest in the scheme can be registered here: https://surveys.est.org.uk/s/GreenHomesGrantSchemeLAD

Boiler Upgrade Scheme (BUS)

The Boiler Upgrade Scheme is intended to upgrade gas/oil boilers to low carbon heating. It provides a one-off grant to cover part of the costs of the boiler installation.

- Grants of £5000 will be available for air-source heat pumps and biomass boilers
- Grants of £6000 will be available for ground-source heat pumps.

The grant is paid to the MCS certified installer who has to apply for it on behalf of the customer.

Energy Company Obligation

A government energy efficiency scheme to help reduce carbon emissions and tackle fuel poverty. It is a requirement for energy suppliers to help households reduce the costs of their home heating by fitting energy-saving measures, supporting mainly those on low income or fuel poor households, as well as those in vulnerable situations.

To qualify for ECO support you must own your home or have the permission of your landlord. Eligibility can be checked at: www.simpleenergyadvice.org.uk/grants

Further details: https://www.ofgem.gov.uk/environmental-and-social-schemes/energy-company-obligation-eco

For Communities and Organisations

The Green Heat Network Fund

The Green Heat Network Fund (GHNF) is a three-year, £288m capital grant fund that opened to applicants in March 2022. It will provide support to organisations in the public, private, and third sectors in England.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1076541/ghnf-r1-scheme-overview.pdf

LoCASE Grant for Businesses

This is an EU funded grant of up to 40% of the cost of carbon reduction measures and energy efficiency improvements beyond that required by regulation.

1. Any business can use this money toward having energy efficiency measures installed for their business. The grant can contribute to both the cost of materials or equipment and any installation. Projects which save on fuel/mileage are also acceptable.
2. If your business offers low carbon (or "green") goods or services, a business development grant is also available to you. You can claim against costs such as marketing, consultancy, equipment, IT software, product/process development, accreditation and certification.

Appendix 3

Latest U-value Regulations June 2022

Main changes in relation to U-values

Whilst there are significant changes on the Part L documents, below are the U-value changes:

Table 1 – Notional dwelling specification of new dwelling

Element Type	Previous Minimum U-value	Updated 2022 Minimum U-value
Roof	0.13	0.11
Wall	0.18	0.18
Floor	0.18	0.13

Table 2 – New elements in existing dwellings

Element Type	Previous Minimum U-value	Updated 2022 Minimum U-value
Roof	0.18	0.15
Wall	0.28	0.18
Floor	0.25	0.18

Table 3 – Limiting U-values for existing elements in existing dwellings

Element Type	Previous Minimum U-value	Updated 2022 Minimum U-value
Roof	0.18	0.16
Wall	0.30	0.30
Floor	0.25	0.25

Source: Approved Document L: Conservation of fuel and power – Volume 1: Dwellings [30].

What are the key changes?

- From 15 June, new-build homes will need to produce at least 31 per cent less carbon emissions. The installation of electric heating systems combined with renewable energy sources such as solar are both seen as enablers for doing so
- New non-domestic builds will need to produce at least 27 per cent less carbon emissions with similar low energy measures to the previous in place
- A new metric for measuring energy efficiency has been introduced. 'Primary energy' will be used to measure the efficiency of a building's heating as well as the energy required to deliver fuel to a building (this even extends to including the efficiency of the power station supplying the electricity)
- New minimum efficiency standards have been provided. In all new domestic builds, the new U-value for walls will be 0.18 W/m^2, 1.4 for windows and rooflights and 1.4 for doors. In non-domestic builds there's a lowered U-value of 0.26 for walls and majority of windows/curtain walling must achieve 1.6 W/m^2
- New and replacement heating systems in both domestic and non-domestic builds must have a maximum flow temperature of 55°C
- Existing non-domestic buildings must improve the efficiency of heating and hot water boiler systems through installation of new controls. In new buildings (non-domestic), the minimum lighting efficacy has been raised to 80 luminaire lumens per circuit watt for display lighting and 95 for general lighting
- Background trickle vents have been recommended for non-domestic buildings along with a new requirement for CO_2 monitors in all offices. The recommended minimum air supply rate is 0.5 $l/s.m^2$
- The Fabric Energy Efficiency Standard (FEES) level in new homes will be set by a 'full fabric specification' and SAP compliance will now be applied to extensions built on existing properties
- The new Approved Document O introduces glazing limits in new-build homes, care homes, schools and student accommodation to reduce unwanted solar gain. It also enforces new levels of cross-ventilation
- The new Approved Document S requires all domestic new builds to have the preparatory work completed for future installation of an electric vehicle charging point

The interim measures will apply to all projects after 15 June 2022, except where a building notice has been given or full plans have been submitted with local councils. However, the new regulations will apply to all projects regardless from 15 June 2023.