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Village Halls RCEF Project

Phase 2 report

For Ryedale Village Hall Consortium

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Executive Summary

The Ryedale Village Halls Solar PV project is a feasibility study funded under Stage 1 of the North East, Yorkshire & Humber branch of the Rural Community Energy Fund. Locogen were appointed to undertake this project on behalf of a consortium of village hall groups across the Districts of Ryedale and Hambleton in North Yorkshire. The project has been executed in two phases, with the first comprising a high-level appraisal of solar PV and renewable heating options for 26 participating halls. This report, presented in the Stage 1 RCEF format, summaries the work completed in the second phase of the project for the 18 halls carried through to Phase 2, as shown in the figure below.

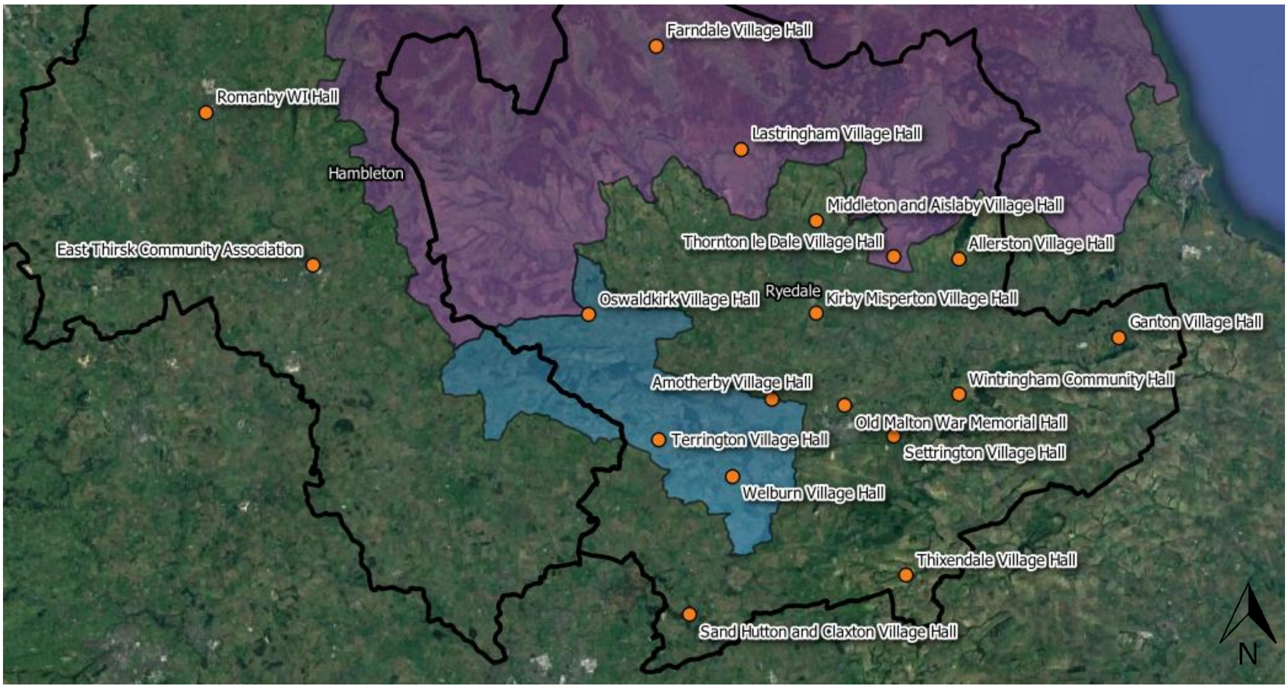

Figure 1: Locations of participating village halls
(Districts outlined in black, AONB shaded blue, NYMNP shaded purple)

Following a brief introduction, the locations of each site are analysed in section 2, in terms of the designations and constraints that influence renewable energy development. This highlights that three of the halls (Oswaldkirk, Terrington & Welburn) are located in the Howardian Hills Area of Outstanding Natural Beauty, and a further three (Lastingham, Farndale & Thornton le Dale) in the North Yorkshire Moors National Park. In addition, one hall (Thixendale) is a Grade 2 Listed Building and seven halls are located in conservation areas. This section also clarifies that each site has a suitable solar resource, grid connection and operating structure to accommodate a solar PV installation.

In section 3, an overview of solar PV and battery technology is presented, as well as the ancillary electrical equipment required for safety and controls. Based on Locogen's expertise as a commercial installer of renewables, solar PV modules with 330Wp generation capacity are recommended, along with lithium-ion batteries. The physical properties, operational lifetime, and (minimal) maintenance requirements are outlined in this section.

Planning and permitting requirements are discussed in section 4. It is established that, in accordance with local and national planning policies, the vast majority of proposed installations will be permitted developments, but that planning permission will be required for solar PV arrays at Allerston, Thixendale and Farndale village halls. In each of these three locations, the risk of a rejected application is mitigated by local precedent. Fees for planning applications and advice are presented in this section.

Subsequently, grid connection options are explained, these being G98 and G99 connections. The former is a free application for up to 3.68kW of generation per phase (so 3.68kW for a building with a single-phase electricity supply or 11.04kW for a three-phase supply – based on the inverter size, rather than the total PV capacity). For installations exceeding G98 limits, a G99 application is required. This involves a new studies and a new electricity connection agreement, which carries significant costs. Northern PowerGrid's online tools were used to determine the likely costs of a G99 grid connection at each site, which ranged from £7k to £48k. Owning to these high costs and the relatively low electricity consumption of each village hall building, G99s are not recommended for any of the halls. Grid connection options for battery storage are also discussed, namely the 'Fast track electricity storage applications (G99)' process, which is a free application for connections of battery capacity that meets G98 for a building which has a proposed or existing G98-compliant solar PV array. If the fast-track application was rejected, Locogen would recommend disregarding battery storage as the cost of a G99 application is extremely unlikely to be recuperated from a battery linked to a G98-compliant PV array.

In section 5, the financial considerations for solar PV-battery installations are discussed. This includes an overview of individually owned options and other routes. In the first case, the halls could, separately or in tandem, apply for grant funding and appoint a contractor to install solar PV and batteries. In terms of other routes, the halls could form their own solar co-op, but this is not advised due to the huge administrative burden associated, or they could appoint an existing co-op to install PV on their buildings. In this case, the PV would be owned and maintained by the co-op, and the hall would benefit from offset electricity costs (but not make income from exports to the grid). Also in this section, development, capital and operational costs are explained, as are income mechanisms, namely the Smart Export Guarantee (SEG). Lastly, the financial modelling process conducted for each hall is explained, as are the underlying assumptions.

In Section 6, an overview of the proposed solar PV array is presented for each hall, including the recommended array size, location and annual generation, calculated from 3D models (accounting for shading, pitch and orientation) in PVSol software. The development, capital and lifetime costs for each array and an optimally-sized battery are then presented. The insights from each hall's energy flow models are summarised, as per the example in the following figure which shows the monthly energy demand, generation, storage and export for Allerston Village Hall. Each energy flow model is based on half-hourly solar PV generation from PVsol, the hall's annual electricity demand and a half-hourly demand profile based on the occupancy and load information provided.

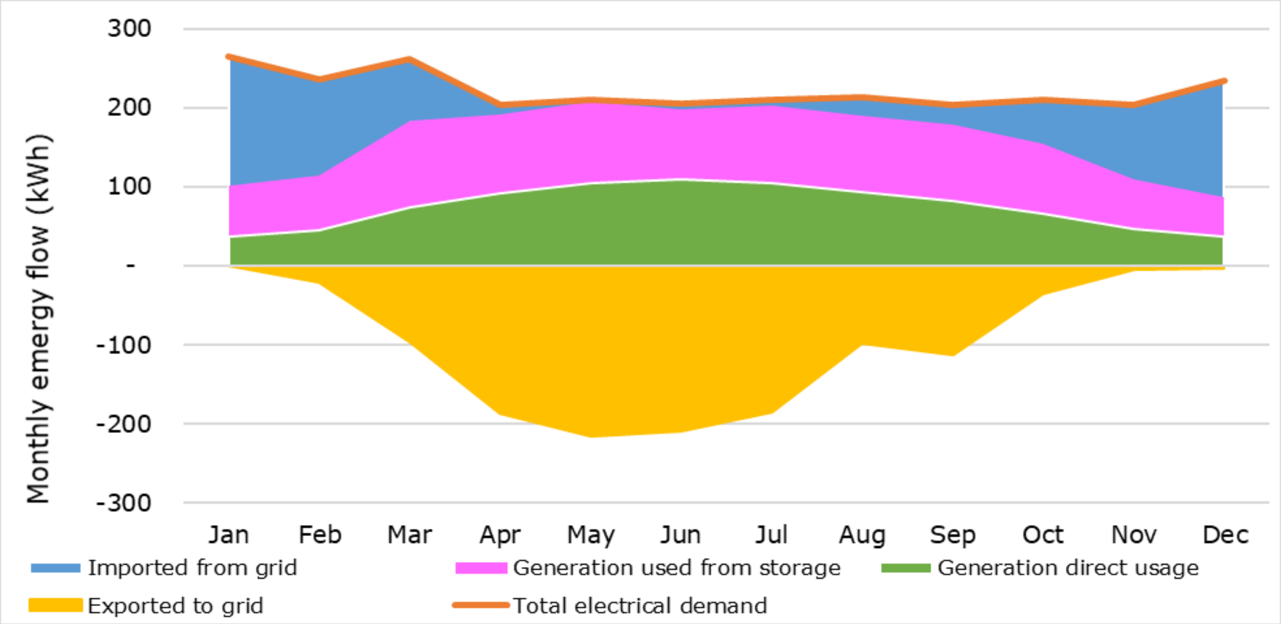

Figure 2: Example hall - monthly energy flows

The outputs of each energy flow model are used to inform a cost and emissions analysis. For each hall, financial returns and carbon offsets are tabulated for the cases with and without a battery, and with and without grant funding. In each case, the solar PV arrays are shown to bring impressive carbon benefits in terms of emissions reductions. The financial paybacks vary significantly across the halls, but are greatly enhanced by grant-funding, as expected. The high capital cost of batteries means that the addition of these assets provides higher annual financial benefits to each hall, but slows the returns for almost every hall. As such, batteries are generally recommended only if grant funding can be secured for them.

Several shorter sections form the remaining body of this report. Firstly, the community impacts of the recommended renewables systems are discussed in section 7. These include demonstrating replicable systems to local communities; contributions to local and national decarbonisation targets; and facilitating reduced overheads and modest income streams to each village hall. In section 8, operation and governance issues are summarised, and this section reiterates that the administration and maintenance burdens associated with owning and operating a solar PV-battery system are minimal. Section 9 provides a roadmap which explains the steps towards implementing an individually owned installation (as opposed to one owned by a co-op). Lastly, the conclusions section summarises the findings of the report and establishes that the next step for each village hall group is to decide whether to pursue a solar PV-battery system, and if so, whether the individually-owned or co-op owned option is preferred.

In the appendices to the report, a list of grant funding options is provided, as is a list of local installers. Draft specification documents have also been provided to assist with procurement. Finally, a risk register is included, which demonstrates the likely risks facing the development and operation of the installations and the recommended measures to mitigate their impacts.

Table of contents

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1. Introduction

1.1. Project background

A consortium of Village Hall groups across Ryedale and Hambleton, North Yorkshire, (collectively "the Client") have expressed interest in decarbonising their buildings' energy supplies. This project is supported by the BEIS funded Rural Community Energy Fund (RCEF) which is managed by the North East Yorkshire and Humber Energy Hub and administered by Tees Valley Combined Authority. Having been appointed as Tees Valley's RCEF framework partner, Locogen have undertaken a Stage 1 RCEF feasibility study on behalf of the client.

This document represents the work conducted under the second of two project phases and is the second report issued to the client. Phase 1 of the project was conducted in 2020 and considered the high-level technical and financial feasibility of renewable energy opportunities for each participating Village Hall. Initially, renewable heating systems and solar PV & battery installations were considered for 26 halls. Following issue of the Phase 1 report, two virtual workshops were held with representatives from each hall, in which Locogen presented the report's findings and facilitated a Q&A session. Following the workshops, 18 of a maximum of 20 halls were confirmed for participation in Phase 2, as listed below:

- Allerston Village Hall;
- Amotherby Village Hall;
- East Thirsk Community Hall;
- Farndale Village Hall;
- Ganton Village Hall;
- Kirby Misperton Village Hall;
- Lastingham Village Hall;
- Middleton and Aislaby Village Hall;
- Old Malton Village Hall;
- Oswaldkirk Village Hall;
- Romanby Women's Institute;
- Sand Hutton and Claxton Village Hall;
- Settrington Village Hall;
- Terrington Village Hall;
- Thixendale Village Hall;
- Thornton le Dale Village Hall;
- Welburn Village Hall; and
- Wintringham Village Hall.

1.2. Phase 2 outline

The aim of Phase 2 of the feasibility study is to consider in greater detail the solar PV and battery storage opportunities for the 18 halls. To do this, detailed energy modelling has been undertaken utilising information collected on each building and by the Client and several modelling tools. These include PVSol, a programme for designing solar PV arrays that generates half-hourly generation profiles, and Locogen's energy flow model which takes electricity demand and generation as inputs to determine the annual electrical energy flows within each system in half-hourly discretisation. This energy flow model has been used as the basis for energy storage (battery) sizing and financial modelling in Phase 2. Practical and regulatory considerations have also been explored, including the planning process and various options for funding the PV and battery projects.

This report is also required to follow the Stage 1 RCEF report requirements outlined by BEIS. As such, the remaining body takes the following structure:

- Site;
- Technology;
- Planning & permitting;

- Financial considerations;
- Financial projections;
- Community benefits;
- Community engagement;
- Operation and Governance;
- Scheduling; and
- Conclusions.

There are also five appendices to the report. The first is a list of potential sources of grant funding; the second a list of local certified PV installers; the third and fourth are draft specification documents for solar PV installations; and the fifth is a risk register which documents the risks associated with PV-battery installations and steps to mitigate them.

2. Site

A map showing the location of each of the 18 halls participating in Phase 2 is presented below in Figure 3. The majority of the village halls are located within small, rural settlements within the Districts of Ryedale and Hambleton, both in North Yorkshire, with a handful located in larger towns. As well as their districts, the two key designations that affect the sites are the North Yorkshire Moors National Park (NYMNP) and the Howardian Hills Area of Outstanding Natural Beauty (AONB), respectively shaded purple and blue in Figure 3. Three of the halls (Oswaldkirk, Terrington & Welburn) are located in the AONB, and a further three (Lastingham, Farndale & Thornton le Dale) in the National Park. In addition, one hall (Thixendale) is Grade 2 Listed and seven halls are located in conservation areas. These designations introduce development restrictions which would not usually be encountered for solar arrays of the scales considered in this project. Associated planning requirements are discussed in section 4 of this report.

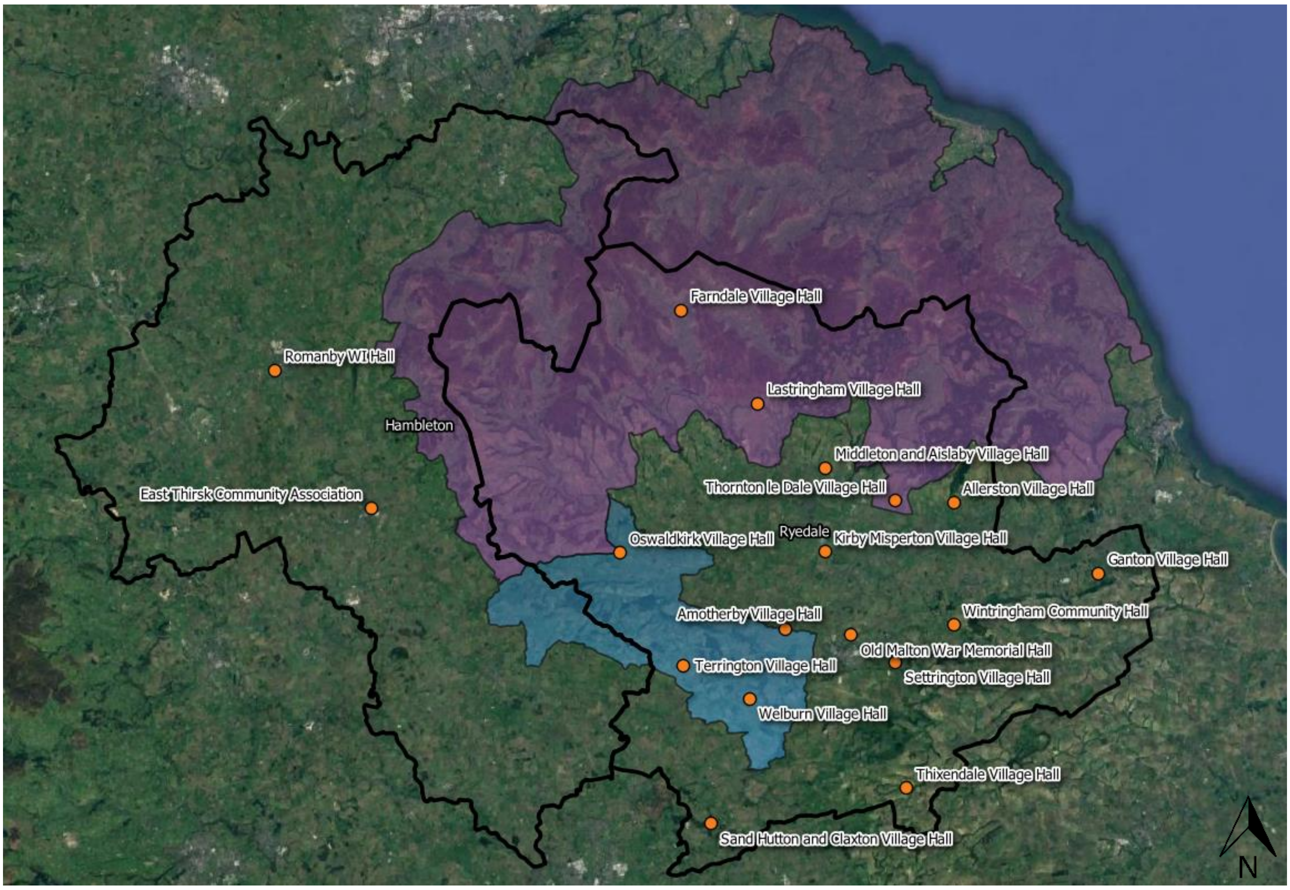

Figure 3: Site locations
(Districts outlined in black, AONB shaded blue, NYMNP shaded purple)

All participating organisations either own or lease their halls so there are no issues to be explored in terms of acquiring suitable sites. There are no day to day tasks associated with the installations, therefore each hall's Committee/Trust is anticipated to be able to take on the management of their own installation.

The halls are all suitable for rooftop solar PV installations, as they all have an electricity connection to the National Grid and are sited in locations that receive 900-950kWh/m^2 of solar energy annually. However, the buildings are of a range of sizes and orientations and are impacted by shading to different degrees. These aspects have been taken into consideration for the solar yield modelling performed for each hall. The condition and age of the roof also impacts cost of installation, this has been accounted for in the financial modelling performed for each hall. As such, the feasibility of installing PV at each location is reflected in the financial projections presented in section 4.

3. Technology

3.1. Overview

The technology that is the focus of this study is rooftop solar PV and will be complemented by battery storage. In phase 1 of the study, renewable heat options were also explored, but solar PV is the most widely beneficial option given that many of the rural villages in Ryedale and Hambleton are off the gas grid, and therefore have electric heating which will directly benefit from solar PV generation. The systems are proposed to maximise on-site usage of PV generation, with surplus to be exported to the national grid (as the scale and non-domestic nature of the proposed projects makes them unsuitable for other export arrangements or aggregation opportunities).

The main limitation of solar PV in this application is its seasonality, in that it produces more energy over the summer, whereas the halls' electricity demands are highest in during the winter. In addition, the halls have varying occupancies and many are empty most of the time. These factors can be mitigated by ensuring that battery storage is incorporated and SEG export contracts are in place.

3.2. Equipment

PV modules and mounting

The key element of a solar PV installation are the PV modules themselves. For modelling purposes, Locogen works with a 330Wp unit of standard size (1x1.7m) which weigh approximately 20kg each. The 330Wp output represents the upper end of performance for standard sized, widely available panels. Warranties for PV modules are now upwards of 25 years.

Locogen recommend that modules are secured to pitched roofs via non-penetrative mounting systems, to avoid the risks of penetrative systems, namely leakages. This can arise from drilling through the roof and using sealant which wears over time, or from structural movement, for example due to high winds moving the panels, and damaging the external roof material. For tiled and slate roofs, flash fixings can be used to ensure that the tiles or slates to not bare any of the load as they fix directly onto the roof's rafters.

For roofs which contain asbestos, we would advise against installing solar PV directly onto the roof, unless an asbestos surveyor identifies a solution. Instead, the roof may need to be replaced or overclad, which in either case would allow for enhanced insulation of the building. This cost has not been factored into the anticipated project costs for Amotherby and Romany WI halls. If a hall is due to be reroofed, or if planning permission is required, another option is an in-roof system, as shown in Figure 4. These systems have a lower visual impact but are roughly twice as expensive has on-roof systems, so are not recommended in the first instance.

Figure 4: In-roof PV example from Viridian Solar

Ancillaries

The ancillary equipment required for a roof-mounted solar array tends to be small and can be wall-mounted within storage cupboards or plant rooms. Necessary equipment is as follows:

- Inverters – The solar panels are connected in strings, which are then connected to inverters which convert the DC electricity generated to AC electricity, which is required for UK appliances and grid connections. For G98 systems, an export limitation device will also be required to ensure that the system complies with its grid connection arrangement. This functionally can be incorporated into inverters.
- Isolations – There will be two isolators, one on the DC side and one on the AC side of the inverter. These are ultimately safety features to ensure that electrical faults do not spread between equipment.
- Grid connection & metering equipment – Electricity will then pass through a generation meter (which tracks how much electricity is generated) before supplying the consumer unit.
- Diverter – This is a small control unit that allows onsite usage of PV to be maximised by directing surplus generation to a battery, heat sink, or other loads such as electric vehicle chargepoints.

Energy storage

Almost all domestic and small-scale batteries available in the UK are lithium-ion based devices and can be wall mounted (provided the wall has sufficient load-bearing capacity). They tend to require less than 1m^2 of wall area, and depth will vary from model to model but single units will take up around 0.2-0.5m plus access space. Batteries are also very heavy – a 5kWh model (the smallest proposed within this study) would weigh around 70kg. A well ventilated cupboard or utility room would be a suitable location for a battery, and although some models (such as the Tesla Powerwall) can be installed outdoors, this is not recommended to due to the potential of the development's local climate to affect performance.

Warranties for high quality batteries now extend up to 10 years, indicating that their lifetimes are likely extend a few years beyond this period (although as they are a very new technology, it is not yet possible to provide further certainty in terms of anticipated lifetime). It should be noted that batteries do not store or release all of the energy they receive, and charging/discharging efficiency of 90% is currently considered to be reasonable.

As they have no moving parts, there are no maintenance requirements for batteries, and provided that the battery is interfaced with an appropriate PV diverter, no regular operational requirements either. However, depending on the balance between generation and demand over the winter, batteries may be required to be manually switched to 'winter mode' to safeguard their performance if they are not likely to be used for longer periods. This function would not be required if the battery was programmed (by the smart diverter) to store off-peak electricity from a variable tariff.

3.3. Project assessments

In order to assess each village hall's suitability for solar PV installations, GIS mapping software was used to identify constraints and measure dimensions. In absence of site surveys (which have not been possible due to government coronavirus restrictions), various information has been collected from each hall. Most notably, the nature of the building's electricity connection – being single- or three-phase) as this dictates the maximum PV and battery capacity allowable under G98 grid connections. Locogen have also sought indicative grid connection costs from NPG for large arrays, but as per section 4.3, these are very expensive and therefore systems have been sized to avoid these (by complying with G98 requirements) unless the demand: generation relationship makes this financially viable. Installations are also designed to comply with the permitted development conditions – which require, amongst other factors, a 1m clearance between the PV system and a roof's external edges.

To quantify the electricity generation of each proposed installation, a model was created for each hall using PVSol software. In PVSol, a 3D model of each hall was created to estimate the annual generation on a half-hourly basis, relative to the size, position, orientation and pitch of a solar PV array and accounting for shading impacts of trees, chimneys and nearby buildings. The outputs of this exercise were interfaced with energy flow models in order to estimate the financial returns of each array, as reported in section 5.1.3.

4. Planning & Permitting

4.1. Permitted Development rights

For solar PV installations of up to 50kWp capacity, planning permission is not required, as per Schedule 2, Part 14 of the Town and Country Planning (General Permitted Development) (England) Order 2015[1]. The installation of small scale, indoor batteries does not require a planning application.

The Permitted Development order stipulates that solar PV can be installed on the roof of a non-domestic building, subject to the condition that an installation is sited *"so as to minimise its effect on the external appearance of the building and the amenity of the area"* and the following exclusions:

> *"(a)the solar PV equipment or solar thermal equipment would be installed on a pitched roof and would protrude more than 0.2 metres beyond the plane of the roof slope when measured from the perpendicular with the external surface of the roof slope;*
>
> *(b)the solar PV equipment or solar thermal equipment would be installed on a flat roof, where the highest part of the solar PV equipment would be higher than 1 metre above the highest part of the roof (excluding any chimney);*
>
> *(c)the solar PV equipment or solar thermal equipment would be installed on a roof and within 1 metre of the external edge of that roof;*
>
> *(d)in the case of a building on article 2(3) land, the solar PV equipment or solar thermal equipment would be installed on a roof slope which fronts a highway;*
>
> *(e)the solar PV equipment or solar thermal equipment would be installed on a site designated as a scheduled monument; or*
>
> *(f)the solar PV equipment or solar thermal equipment would be installed on a listed building or on a building within the curtilage of a listed building."*

All proposed arrays for this project have been sized and located such that the first three exclusions would not apply, and none of the halls or their surroundings are scheduled monuments. Exclusion (f) applies to Thixendale Village Hall, as it is a Grade 2 Listed building and therefore would need planning permission for solar PV.

In relation to exclusion (d), 'article 2(3) land' is protected land and includes Conservation Areas, AONBs and National Parks, whilst highways include roads and public rights of way. As such, several of the halls fall into this category. However, only in one case – Farndale Village Hall – is an installation proposed for a roof that fronts a highway. These considerations are summarised in Table 1.

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[1] https://www.legislation.gov.uk/uksi/2015/596/schedule/2/part/14

Hall	**Local authority**	**Designation**	**Permission required?**
Thixendale Village Hall	Ryedale	Grade 2 listed building	**Yes**
Sand Hutton and Claxton Village Hall	Ryedale	Conservation area	No
Allerston Village Hall	Ryedale	Conservation area	**Yes**
Old Malton Village Hall	Ryedale	Conservation area	No
Middleton and Aislaby Village Hall	Ryedale	Conservation area	No
Oswaldkirk Village Hall	Ryedale	Conservation area, AONB	No
Terrington Village Hall	Ryedale	AONB	No
Welburn Village Hall	Ryedale	AONB	No
Lastingham / Darley Village Hall	Ryedale	Conservation area	No
Thornton le Dale Village Hall	NYMNP	Conservation area, National Park	No
Lastingham Village Hall	NYMNP	National Park	No
Farndale Village Hall	NYMNP	National Park	**Yes**

Table 1: Permitted Development exclusion considerations

4.2. Planning permission

Ryedale - Thixendale & Allerston Village Halls

Within Ryedale, a solar PV planning application would be considered against SP18 of the Local Plan Strategy. The Policy states the following conditions for acceptable renewable energy proposals:

- *Can be satisfactorily assimilated into the landscape or built environment, especially in respect of the setting of the North York Moors National Park, the Howardian Hills Area of Outstanding Natural Beauty (and its setting), the Wolds and the Vale of Pickering;*
- *Would not impact adversely on the local community, economy, or historical interests, unless their impact can be acceptably mitigated;*
- *Would not have an adverse impact on nature conservation, in particular in relation to any sites of international biodiversity importance, unless their impact can be acceptably mitigated;*
- *Would not have an adverse impact on air quality, soil and water resources in Policy SP17, unless their impact can be acceptably mitigated.*

A small rooftop solar PV installation would be likely to be acceptable against these conditions. Promisingly, on the Ryedale planning portal, there are several approved applications for solar PV within conservation areas and on listed buildings, but there are also a small number of rejected applications in each case. Thixendale Village Hall has a slight disadvantage due to its Listed status. This means that the impact of solar PV on the building itself will be scrutinised in more detail, and the installation would also require listed building consent from the Council. One relative advantage of Thixendale Village Hall is that its south-facing roof is situated to the rear of the building and is not overlooked, making its visual impact on its surroundings minimal. As for Allerston Village Hall, there is a back-up option to install a PV array on the south-east facing roof to the rear, as this wouldn’t require planning permission, but it would be subject to much more shading and would accommodate half the capacity of the front roof. For both of these halls, Locogen strongly recommend that preapplication advise is sought.

North York Moors National Park - Farndale Village Hall

Within NYMNP, a solar PV planning application would be considered against Policy ENV8 of the North York Moors Local Plan. The Policy states the following conditions for acceptable renewable energy proposals:

- *It is of a scale and design appropriate to the locality and contributes to meeting energy needs within the National Park;*
- *It respects and complements the existing landscape character type as defined in the North York Moors Landscape Assessment;*
- *It does not result in an unacceptable adverse impact on the special qualities of the National Park, either on its own, or in combination with other schemes;*
- *It provides environmental enhancement or community benefits wherever possible; and*
- *It makes provision for the removal of the facilities and reinstatement of the site, should it cease to be operational.*

Based on these conditions, Locogen would anticipate that a PV installation is likely to receive planning permission at Farndale Village Hall. In addition, the majority of solar PV applications on the NYMNP planning portal are approved (as opposed to rejected) and the building already has PV, meaning that adding additional capacity to the same roof would not alter the character of the building. Still, Locogen would strongly recommend that preapplication advise is sought from the National Park's planning department.

Planning application fees

There are various fees for submitting planning applications and advise requests to any local authority. Relevant fees for this project are provided in xx below, along with those for 'Do I need planning permission?' forms for each district, which other halls may wish to apply for to provide peace of mind. This service is not available from Hambleton District Council for non-domestic buildings.

Application	Local Authority	Fee
Listed building consent	All	£0
Full planning permission	All	£234 (per 0.1 hectares)
Listed building advice	Ryedale	£50
Preapplication advice	Ryedale	£100
	NYMNP	£75
Do I need planning permission?	Ryedale	£25
	NYMNP	£50

Table 2: Relevant planning application fees

4.3. Grid notification requirements

Solar PV and battery installations involve 'new generation' connections to the National Grid. These are managed by the local electricity Distribution Network Operator (DNO), which, for each of the project's locations, is Northern PowerGrid (NPG). Depending on the capacity of generation to be connected, there are two different options. The options also depend on whether each building has a single or three-phase electricity supply.

Small solar PV connections (G98)

For connections up to 3.68kW per phase, a 'G98 - Single premises notification' would be required. This is a simple 'connect and notify' process with no fees and can be done quickly online via NPG's Micro-generator Notification form. The installer has 28 days to fill out this form from the date of commissioning.

Large solar PV connections (G99)

For larger connections (over 3.68kW per phase) an application to the DNO is required, as NPG needs to determine what impact the new generation will have on its network, and make local upgrades accordingly. This would typically be a 'Low voltage generation (G99)' connection application and would cost a minimum of £650. The cost of connection would be determined from the online application form and is guaranteed be established by NPG within 45 days.

Connection costs vary greatly depending on the location and type of building and are often more expensive for rural locations, where the network consists at least partially of overhead rather than underground cable systems – this classification applies to all the halls within this project. The medium cost of this kind of connection is £14,000 (according to NPG's current guide-prices[2]) meaning that the connection cost for rooftop solar can outweigh the cost of installing the array itself. The connection itself is completed by the DNO roughly 5-10 weeks after payment.

Table 3 shows the estimated G99 connection costs for new generation at each hall, according to NPG's 'Generation Connections Quick Calculator'. These are indicative values based on historic simple connections. For any hall interested in a larger connection, Locogen strongly recommend that a budget estimate is sought from NPG. These cost £150 and will provide a more reliable estimate than those presented below, which are useful for feasibility considerations only.

Hall	G99 cost	G99 application recommended?
Welburn Village Hall	£7,000	No – insufficient utilisation
Thixendale Village Hall	£10,550	No – insufficient space
Terrington Village Hall	£10,675	No – insufficient utilisation
Wintringham Village Hall	£9,125	No – confirmed by financial modelling
Sand Hutton and Claxton Village Hall	£10,500	No – insufficient utilisation
Amotherby Village Hall	£8,750	No – confirmed by financial modelling
Allerston Village Hall	£10,050	No – insufficient space
Old Malton Village Hall	£9,250	No – insufficient space
Kirby Misperton Village Hall	£11,000	No – confirmed by financial modelling
Middleton and Aislaby Village Hall	£7,500	No – insufficient utilisation
Farndale Village Hall	£7,000	No – insufficient space
Oswaldkirk Village Hall	£10,375	No – confirmed by financial modelling
Settrington Village Hall	£8,500	No – suboptimal orientation
Lastingham Village Hall	£7,250	No – insufficient space
Romanby WI Hall	£14,750	No – confirmed by financial modelling
Ganton Village Hall	£9,500	No – additional capacity not sufficient
East Thirsk Community Hall	£47,950	No – insufficient space
Thornton le Dale Village Hall	£11,300	No – confirmed by financial modelling

Table 3: Estimated costs for G99 connections to Northern PowerGrid's network

Given limited time and financial resources of community organisations, Locogen often recommend against pursuing G99 applications, in order to keep the grid connection process simple and to avoid uncertainty in the timescales and cost of the project, as this can negatively impact grant-funding applications. Lastly, expensive grid connections create a step-change in the capital costs of a solar PV project, as illustrated in Figure 5. This step-change, at the scales

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[2] https://www.northernpowergrid.com/guide-prices-and-timescales/generation-connection

applicable to this study as per Table 3, rarely leads to an improved financial outlook for the installation versus a maximised G98 system.

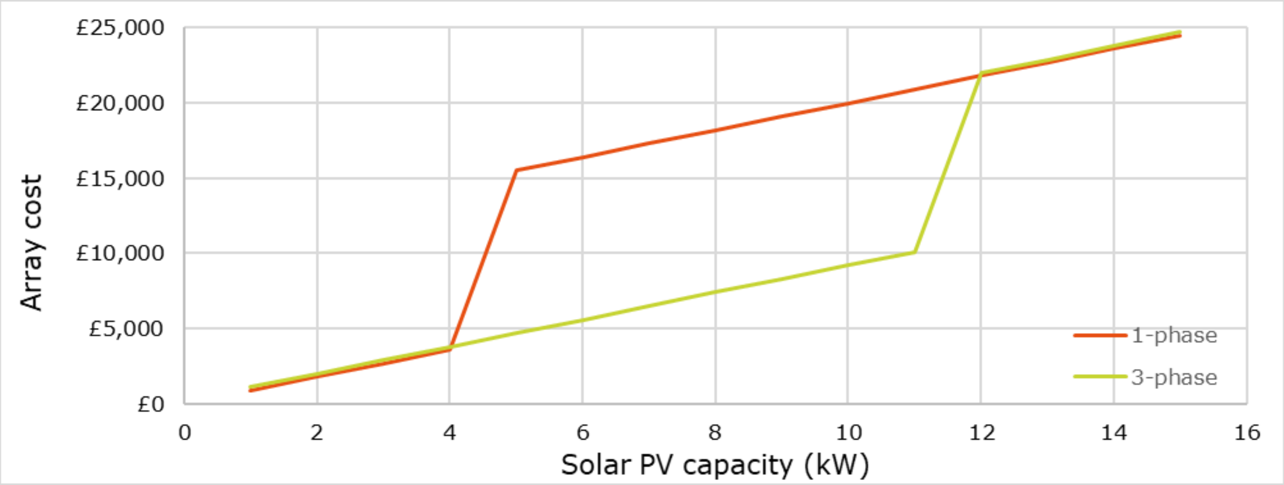

Figure 5: Illustrative impact of grid costs on PV array installation

Battery connections

In the UK electricity network, batteries are treated as generators, so have a similar connections process to solar PV installations. NPG recently introduced a 'Fast track electricity storage applications (G99)' process, which is a free application for connections of battery capacity that meets G98 limits (3.68kW per phase) for a building which has a proposed or existing G98-compliant solar PV array. A G100-compliant export limiting device is required so that the combined system can be guaranteed never to deliver more than 3.68kW per phase of electricity to the national grid. Also, the systems must be prevented from operating in island mode, meaning they could not be used during a power cut. Lastly, the proposed system must be commissioned within 10 days to 3 months of the application. If these conditions are met, the fast-track application is likely to be approved and the battery can then be installed without grid connection costs.

If the fast-track application was rejected, Locogen would recommend disregarding battery storage as the cost of a G99 application is extremely unlikely to be recuperated from a battery linked to a G98-compliant PV array.

For systems that do not meet the fast-track conditions, a G99 connection application would be required for the battery, although this could be done in tandem with (i.e., on the same form as) a G99 application for solar PV, such that only one fee would be incurred.

5. Financial considerations

5.1.1. Funding options

Arguably the most important and challenging aspect of the proposed solar PV & battery projects is how they are financed, which is directly related to how they are owned. Two key routes are explored below.

Individually owned systems

Under this conventional option, each village hall group would own their PV installations. They would be required to raise cash or seek grants to fund their own their own arrays. It would be possible to apply for grant funding individually or as part of a group, which will allow access to larger funding pots. Acting as a group would also allow for joint procurement exercise which may lead to capital savings of up to 10% per project. This would also reduce the administrative burden for most groups, although a lead would need to be appointed to coordinate funding and/or procurement activities. A list of potential funding sources is given in Appendix A.

In owning their PV & battery system, each community group would benefit from reduced electricity bills and from the income from selling to surplus electricity to the grid. This would be subject to securing a Smart Export Guarantee (SEG) tariff from a licenced energy supplier. SEG contracts tend to be renewed annually or biannually, and this would be the main administrative task associated with the system. To be eligible to receive the SEG, a PV array must have a Microgeneration Certification Scheme (MCS) or equivalent certificate. A list of local MCS-certified installers is given in Appendix B.

The operational costs of these systems would be minimal. Most buildings insurance policies accommodate solar PV installations at no extra charge, but this is always worth checking. Therefore, the main operation cost will be for cleaning, although this can be done by a window-cleaner on an ad-hoc basis, and arrays on roofs with a pitch of at least 15° to be classed as self-cleaning. Other ad-hoc costs over a system's lifetime include the replacement cost for the inverter and battery, both of which should last for around 10 years.

Alternative options

Instead of and funding their own systems, it may be possible for the halls to partner with a renewable energy co-operative. Co-ops tend to be funded by grants and also by individuals and organisations who buy shares in the co-op for a small, long-term return on their investment. Two relevant examples are the Big Solar Coop, which operates across the UK, and Kirkbymoorside and District Energy Society, which is based in Ryedale and is the only local solar energy co-op. If and when they have the resources to do so, a co-op would develop, install and own the system and manage its maintenance and export contract. Each hall would benefit from reduced electricity bills from solar generation used directly, but would not receive any income from exported electricity unless it invested in the co-op.

The upside of this option is that it allows a hands-off approach from the hall groups, as well as significantly reduced, or indeed zero capital costs. Conversely, systems are not guaranteed to be allowed to include batteries, and the co-op may have limited capacity for new systems which may result in a long-waiting list or competitive application process. At present, the Big Solar Coop is actively looking for candidate rooftops[3]. Kirkbymoorside and District Energy Society is

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[3] https://bigsolar.coop/submit-a-site/

not actively looking for sites and, having been contacted by Locogen, is not currently able to take on a large number of new projects.

A further option is for the village hall groups to form their own co-op. This is not recommended given the extensive administrative requirements before any success is guaranteed, especially not before the above options have been exhausted. Furthermore, the combined capacity of the village hall projects is not sufficient to allow for meaningful benefits in terms of buying power or in securing competitive rates for Power Purchase Agreements (PPAs) – which are an alternative to the SEG used by most large-scale renewables projects. However, if this option was of interest, organisations such as Co-operatives UK exist to support communities to create co-ops and offer development grants as well as match funding for community shares raised[4].

5.1.2. Cost elements

Development costs

Locogen would recommend that a structural survey is carried out at an early stage to ensure that a given roof is capable of hosting new or additional PV capacity without reinforcement. Generally, truss roofs are suitable for PV, especially when relatively new. These surveys typically cost £100-250 and should be carried out by a licensed professional. For roofs known or suspected to contain asbestos, a more thorough survey would be required, costing £550-800.

Where required, planning application would cost £234, with fees for addition planning advice as indicated in section 4.2. Similarly, grid connection costs would apply, as estimated in section 4.3, and these estimates could be improved through a budget estimate application to NPG at a cost of £150.

Installation costs

Solar PV installations can broadly be expected to cost £800-1,200 per kWp installed, depending on the size of the installation, the condition of the roof and access requirements. This is inclusive of the invertor and other ancillaries listed in section 3.2. For each proposed array, Locogen have provided estimates based on our experience as a commercial installer of solar PV systems.

Batteries are still a very expensive technology and cost in the region of £250-350 per kWh to install, as they have shorter lifetimes than PV, replacement costs will also need to be factored into financial plans. Lastly, the costs of control equipment, namely solar generation divertors need to be considered. These cost in the region of £300-500, depending on how many loads they are connected to.

Operational costs and income

As established above, the maintenance burden for solar is minimal. If a given array is not found to be self-cleaning, semi-annual maintenance is recommended, costing £50-£100 depending on the size of the array. Battery and inverters will both need to be replaced at least once over the lifetime of a solar PV array. Given that they both have a 10+ year lifetime, the replacement costs are likely to be lower than their upfront capital costs.

Operational income from a solar PV array depends on the SEG tariff secured and how much of the generation is directly used on site and stored. Generally, it is always better to utilise as much electricity on site. At present, high SEG rates range from 5-5.6p/kWh.

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[4] https://www.uk.coop/start-new-co-op/support/community-shares/booster-programme

5.1.3. Project financial models

For each village hall an annual energy flow model have been utilised in order to determine the impact financial and carbon impacts of the proposed solar PV and battery systems. A 'typical' weather year's half-hourly energy yields from solar PV systems have been incorporated into the model from the PVSol simulations. The electricity demands, renewable generation and electricity exports and imports represent the energy flows in each model.

The energy flow models have also been used to size battery capacity for each PV array, based on an objective that the battery capacity guarantees a beneficial financial impact. A 20-year horizon is considered, accounting for PV and battery performance degradation over this period and for replacement costs of inverters and batteries after 10 years, due to their shorter guaranteed lifetimes.

The financial model illustrates the impact of the PV and battery systems through net annual benefits; payback periods; Net Present Value (NPV); and Internal Rates of Return (IRR). Carbon impacts are also demonstrated, in terms of annual emissions savings (for the first year of operation – assumed to be 2022) and cumulative emissions savings after 20 years, based on the predicted rate of decarbonisation of the UK electricity grid.

The outputs of the financial model are presented for each hall in section 6 and the assumptions used in the model are presented in the table below.

Variable	Value	Notes
Solar yield degradation	0.4%	Per annum
Battery efficiency	92%	Per charge/discharge
SEG rate	5 p/kWh	
Max electricity import cost	20 p/kWh	Applied if hall's current cost is >20p/kWh
RPI	1.00%	Applies to electric/gas/oil prices, SEG, OPEX
Discount rate	3.5%	
Year 1 grid carbon	0.113 kg/kWh	BEIS figures
Year 20 grid carbon	0.027 kg/kWh	BEIS figures

Table 4: Financial model assumptions

6. Hall-by-hall financial projections

6.1. Allerston Village Hall

6.1.1. Overview

The extent of the proposed PV array for Allerston Village Hall is shown in the figure below. The modelled array size is 4kWp, consisting of 12x 330Wp modules, and is anticipated to produce 3,245 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a smaller array could also be installed depending on the budget available.

Figure 6: Allerston Village Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for Allerston Village Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£100
Planning advice	£100
Planning permission	£234
Grid connection	£0
4 kWp Solar PV installation & ancillaries	£4,800
5 kWh Battery installation	£1,750
Annual maintenance budget	£50
Invertor replacement after ~10 years	£600
Battery replacement after ~10 years	£1,750

Table 5: Allerston Village Hall - anticipated project costs

6.1.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 34% of the hall's annual electricity demand is met, and 71% of PV generation is exported. With a battery, 72% of demand is met and 40% of generation is exported.

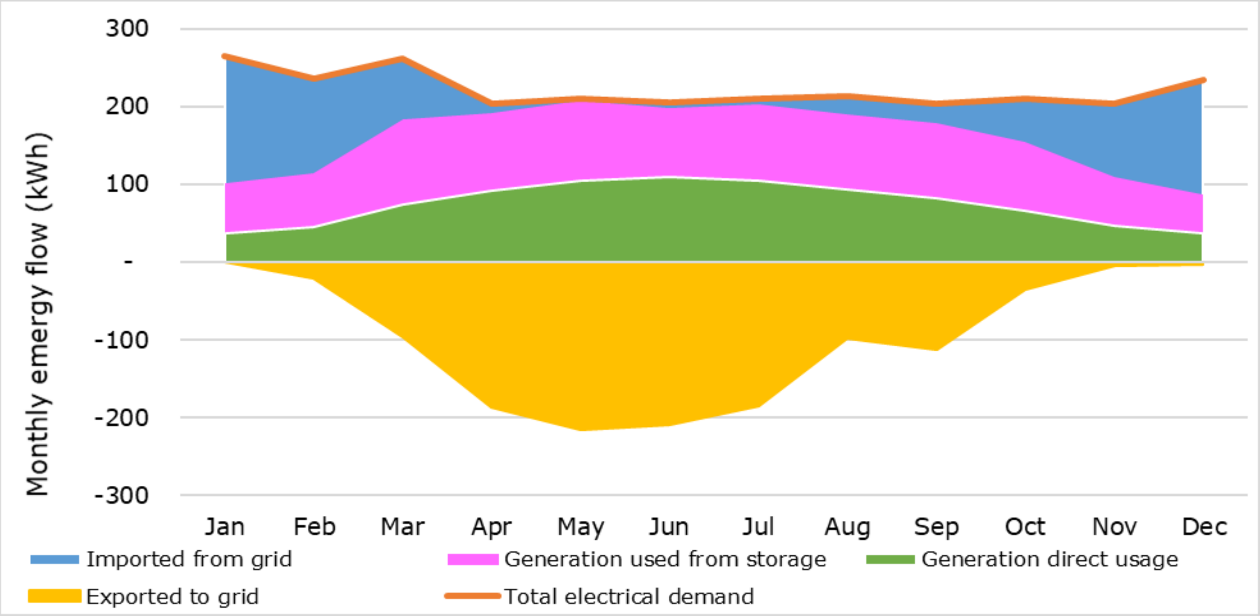


Figure 7: Allerston Village Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	**No grant**	**50% grant funding**	**No grant**	**50% grant funding**
Energy Storage	No Battery		With Battery	
Whole system capex	£5,234	£2,617	£6,984	£3,492
Annual savings	£188		£391	
Annual export income	£117		£57	
Net annual benefit	£255		£398	
Y20 NPV	-£1,587	£941	-£1,847	£1,527
Y20 IRR	0%	7%	0%	8%
Payback years	21.2	12.1	20.3	10.5
Carbon offset Y1	371 kg			
Carbon offset Y20	4.8 Tonnes			

Table 6: Allerston Village Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a modest annual benefit to the hall, and that a battery would greatly enhance the annual benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

6.2. Amotherby Village Hall

6.2.1. Overview

The extent of the proposed PV array for Amotherby Village Hall is shown in the figure below. The modelled array size is 8kWp, consisting of 24x 330Wp modules, and is anticipated to produce 6,875 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a larger (up to 12kWp) or smaller array could also be installed depending on the budget available.

Figure 8: Amotherby Village Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for Amotherby Village Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£200
Asbestos survey	£550
Planning permission	£0
Grid connection	£0
8 kWp Solar PV installation & ancillaries	£7,950
5 kWh Battery installation	£1,750
Annual maintenance budget	£50
Invertor replacement after ~10 years	£1,000
Battery replacement after ~10 years	£1,315

Table 7: Amotherby Village Hall - anticipated project costs

6.2.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 33% of the hall's annual electricity demand is met, and 60% of PV generation is exported. With a battery, 46% of demand is met and 44% of generation is exported.

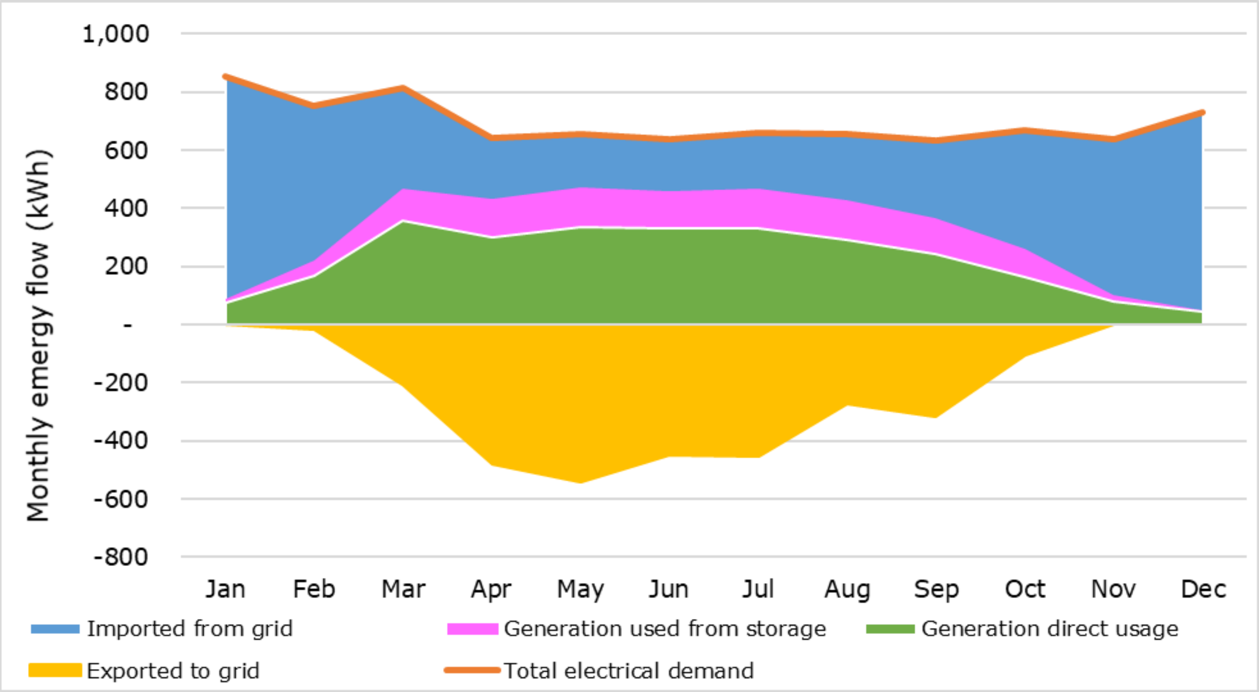


Figure 9: Amotherby Village Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	No grant	50% grant funding	No grant	50% grant funding
Energy Storage	No Battery		With Battery	
Whole system capex	£7,950	£3,975	£9,700	£4,850
Annual savings	£393		£567	
Annual export income	£215		£148	
Net annual benefit	£558		£665	
Y20 NPV	£131	£3,971	-£647	£4,039
Y20 IRR	4%	13%	3%	11%
Payback years	15.2	7.0	16.8	7.1
Carbon offset Y1	777 kg			
Carbon offset Y20	10.1 Tonnes			

Table 8: Amotherby Village Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a significant annual benefit to the hall, and that a battery would slightly enhance this benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

6.3. East Thirsk Community Hall

6.3.1. Overview

The extent of the proposed PV array for East Thirsk Community Hall is shown in the figure below. The modelled array size is 12kWp, consisting of 36x 330Wp modules, and is anticipated to produce 9,995 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a smaller array could also be installed depending on the budget available.

Figure 10: East Thirsk Community Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for East Thirsk Community Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£200
Planning permission	£0
Grid connection	£0
12 kWp Solar PV installation & ancillaries	£11,000
15 kWh Battery installation	£4,500
Annual maintenance budget	£50
Invertor replacement after ~10 years	£1,500
Battery replacement after ~10 years	£3,375

Table 9: East Thirsk Community Hall - anticipated project costs

6.3.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 33% of the hall's annual electricity demand is met, and 56% of PV generation is exported. With a battery, 53% of demand is met and 28% of generation is exported.

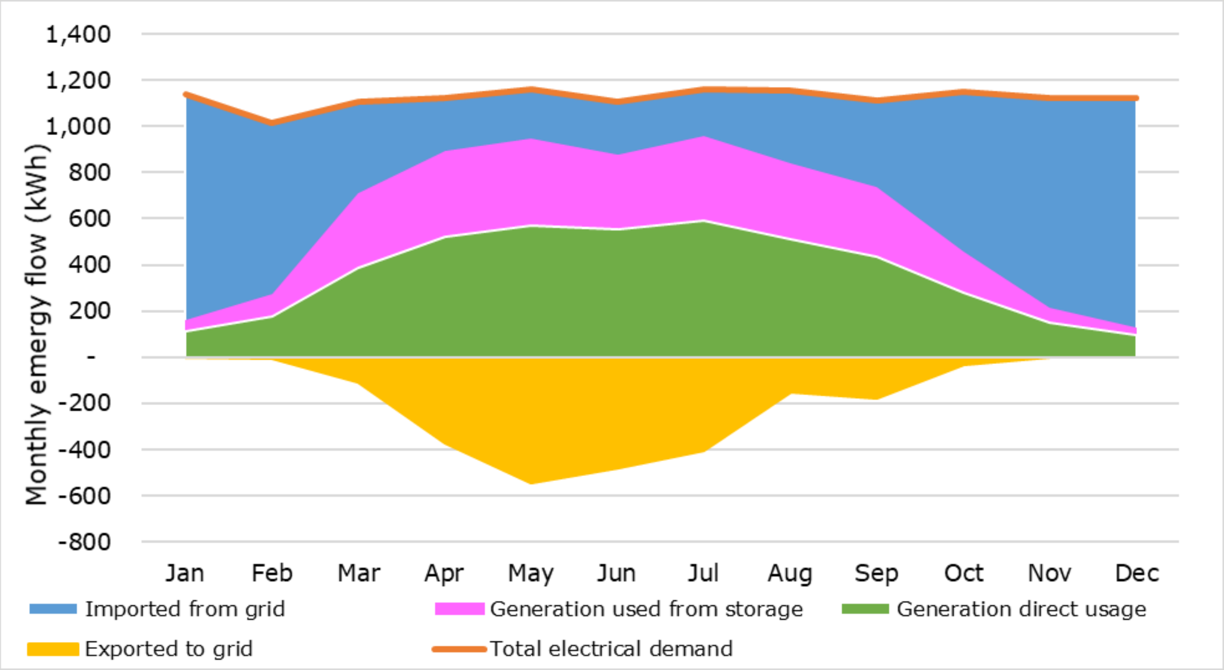


Figure 11: East Thirsk Community Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	No grant	50% grant funding	No grant	50% grant funding
Energy Storage	No Battery		With Battery	
Whole system capex	£11,000	£5,500	£15,500	£7,750
Annual savings	£785		£1,288	
Annual export income	£280		£114	
Net annual benefit	£1,016		£1,353	
Y20 NPV	£3,867	£9,181	£2,761	£10,249
Y20 IRR	7%	18%	5%	16%
Payback years	11.8	5.3	14.1	5.6
Carbon offset Y1	1131 kg			
Carbon offset Y20	14.7 Tonnes			

Table 10: East Thirsk Community Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a significant annual benefit to the hall, and that a battery would slightly enhance this benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

6.4. Farndale Village Hall

6.4.1. Overview

The extent of the proposed additional PV array for Farndale Village Hall is shown in the figure below. The modelled array size is 4kWp, consisting of 12x 330Wp modules, and is anticipated to produce 3,875 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a smaller array could also be installed depending on the budget available.

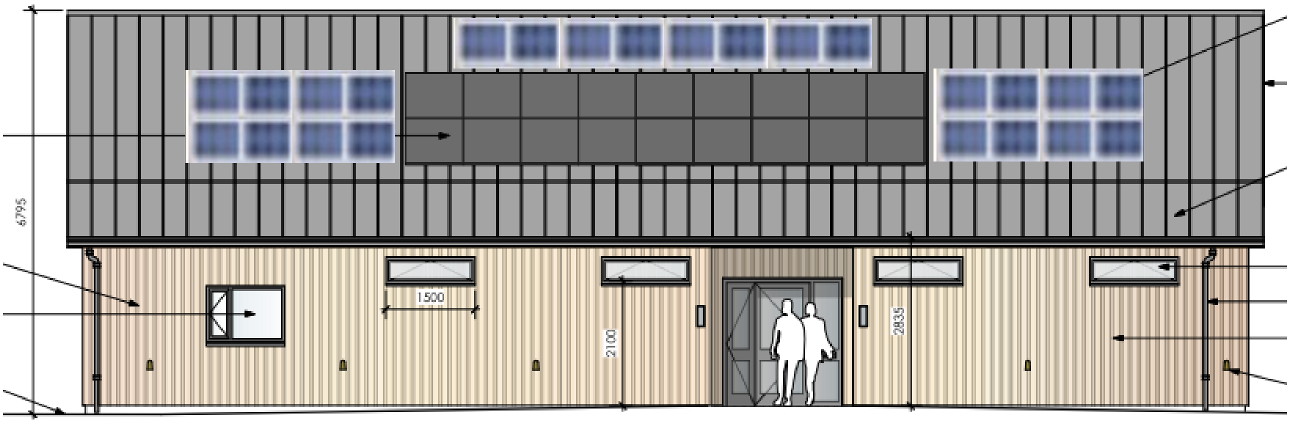


Figure 12: Farndale Village Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for Farndale Village Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£100
Planning advice	£75
Planning permission	£234
Grid connection	£0
8 kWp Solar PV installation & ancillaries	£7,609
15 kWh Battery installation	£4,500
Annual maintenance budget	£50
Invertor replacement after ~10 years	£1,000
Battery replacement after ~10 years	£3,375

Table 11: Farndale Village Hall - anticipated project costs

6.4.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 31% of the hall's annual electricity demand is met, and 61% of PV generation is exported. With a battery, 58% of demand is met and 26% of generation is exported.

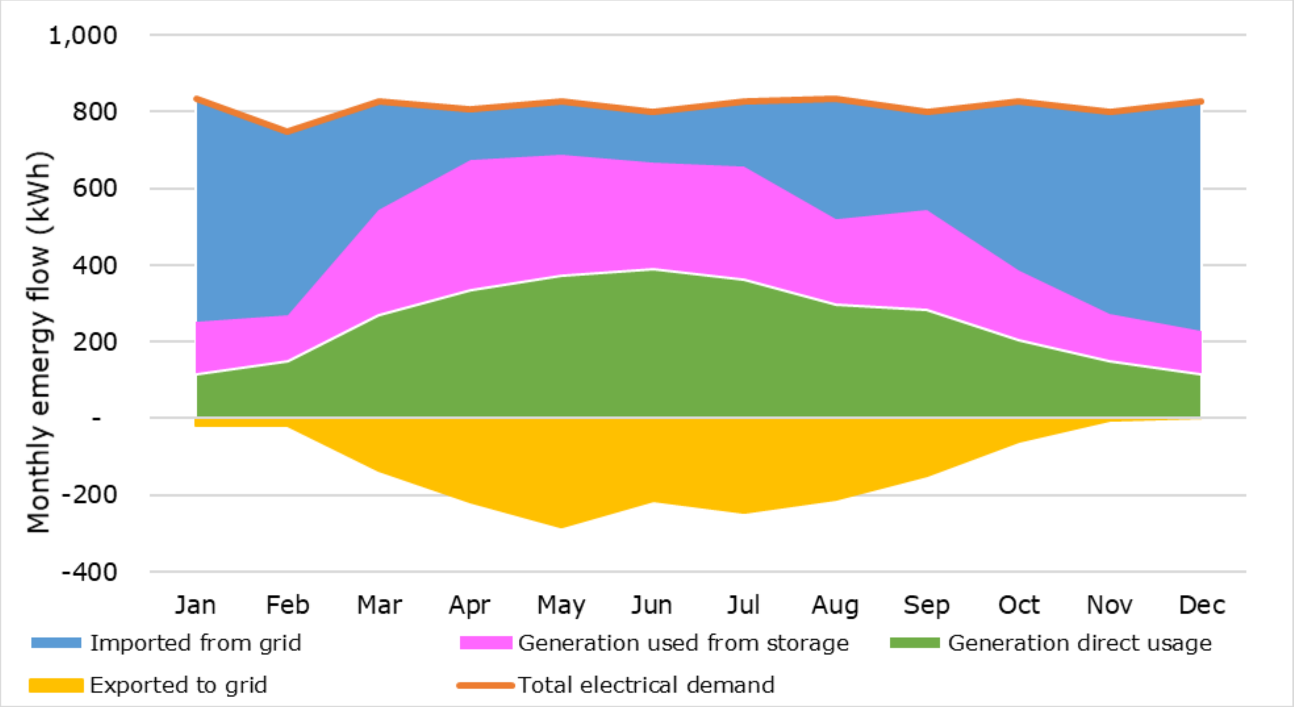


Figure 13: Farndale Village Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	No grant	50% grant funding	No grant	50% grant funding
Energy Storage	No battery		With Battery	
Whole system capex	£7,609	£3,805	£12,109	£6,055
Annual savings	£463		£867	
Annual export income	£235		£78	
Net annual benefit	£648		£895	
Y20 NPV	£1,825	£5,501	-£711	£5,139
Y20 IRR	6%	16%	3%	12%
Payback years	12.7	5.8	17.0	6.6
Carbon offset Y1	876 kg			
Carbon offset Y20	11.4 Tonnes			

Table 12: Farndale Village Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a significant annual benefit to the hall, and that a battery would greatly enhance this benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

6.5. Ganton Village Hall

6.5.1. Overview

The extent of the proposed PV array for Ganton village hall is shown in the figure below. The modelled array size is 8kWp, consisting of 24x 330Wp modules, and is anticipated to produce 7,075 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a larger (up to 12kWp) or smaller array could also be installed depending on the budget available.

Figure 14: Ganton Village Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for Ganton Village Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£100
Planning permission	£0
Grid connection	£0
8 kWp Solar PV installation & ancillaries	£7,400
10 kWh Battery installation	£3,500
Annual maintenance budget	£50
Invertor replacement after ~10 years	£1,000
Battery replacement after ~10 years	£2,625

Table 13: Ganton Village Hall - anticipated project costs

6.5.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 39% of the hall's annual electricity demand is met, and 79% of PV generation is exported. With a battery, 82% of demand is met and 55% of generation is exported.

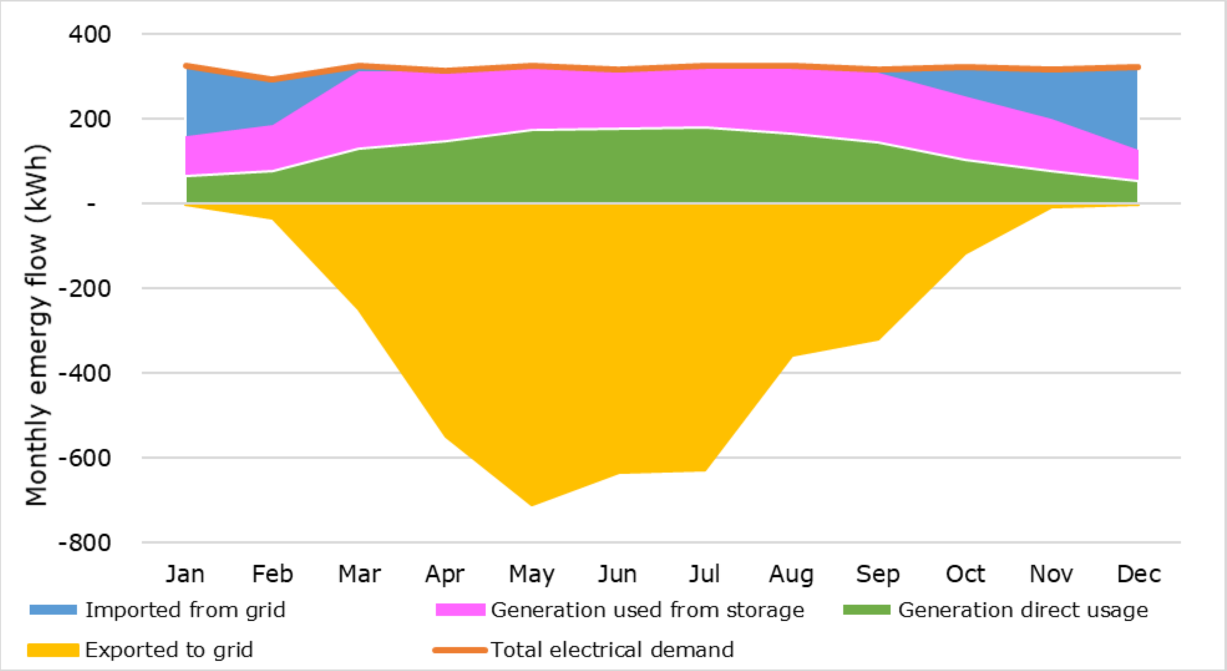


Figure 15: Ganton Village Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	No grant	50% grant funding	No grant	50% grant funding
Energy Storage	No Battery		With Battery	
Whole system capex	£7,400	£3,700	£10,900	£5,450
Annual savings	£253		£534	
Annual export income	£279		£181	
Net annual benefit	£482		£665	
Y20 NPV	-£527	£3,048	-£2,648	£2,618
Y20 IRR	3%	11%	1%	8%
Payback years	16.5	7.5	19.9	7.9
Carbon offset Y1	800 kg			
Carbon offset Y20	10.4 Tonnes			

Table 14: Ganton Village Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a significant annual benefit to the hall, and that a battery would slightly enhance this benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

6.6. Kirby Misperton Village Hall

6.6.1. Overview

The extent of the proposed PV array for Kirby Misperton Village Hall is shown in the figure below. The modelled array size is 4kWp, consisting of 12x 330Wp modules, and is anticipated to produce 3335 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a smaller array could also be installed depending on the budget available.

Figure 16: Kirby Misperton Village Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for Kirby Misperton Village Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£200
Planning permission	£0
Grid connection	£0
4 kWp Solar PV installation & ancillaries	£5,000
5 kWh Battery installation	£1,750
Annual maintenance budget	£50
Invertor replacement after ~10 years	£600
Battery replacement after ~10 years	£1,315

Table 15: Kirby Misperton Village Hall - anticipated project costs

6.6.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 38%

of the hall’s annual electricity demand is met, and 70% of PV generation is exported. With a battery, 72% of demand is met and 44% of generation is exported.

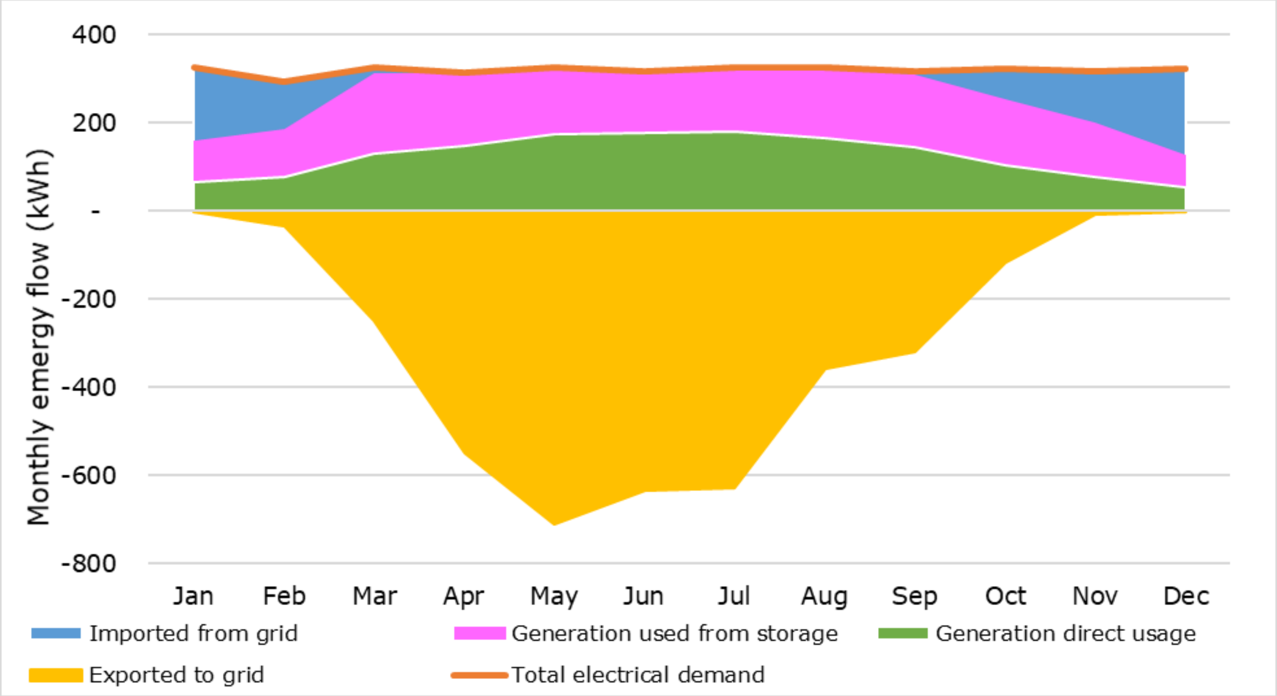


Figure 17: Kirby Misperton Village Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	No grant	50% grant funding	No grant	50% grant funding
Energy Storage	No Battery		With Battery	
Whole system capex	£5,000	£2,500	£6,750	£3,375
Annual savings	£166		£313	
Annual export income	£117		£66	
Net annual benefit	£234		£329	
Y20 NPV	-£1,691	£724	-£2,695	£566
Y20 IRR	-1%	6%	-1%	5%
Payback years	22.2	12.7	23.6	15.0
Carbon offset Y1	377 kg			
Carbon offset Y20	4.9 Tonnes			

Table 16: Kirby Misperton Village Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a modest annual benefit to the hall, and that a battery would slightly enhance this benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

6.7. Lastingham / Darley Village Hall

6.7.1. Overview

The extent of the proposed PV array for Lastingham / Darley Village Hall is shown in the figure below. The modelled array size is 5.94kWp, consisting of 18x 330Wp modules, and is anticipated to produce 5300 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a larger or smaller array could also be installed depending on the space and budget available. (Assuming a 3ph electricity supply, up to 12kWp could be installed without a grid connection cost, but there does not appear to be sufficient space for this capacity.)

Figure 18: Lastingham / Darley Village Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for Lastingham / Darley Village Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£100
Planning permission	£0
Grid connection	£0
5.94 kWp Solar PV installation & ancillaries	£7,228
5 kWh Battery installation	£1,750
Annual maintenance budget	£50
Invertor replacement after ~10 years	£600
Battery replacement after ~10 years	£1,315

Table 17: Lastingham / Darley Village Hall - anticipated project costs

6.7.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 39% of the hall's annual electricity demand is met, and 79% of PV generation is exported. With a battery, 81% of demand is met and 58% of generation is exported.

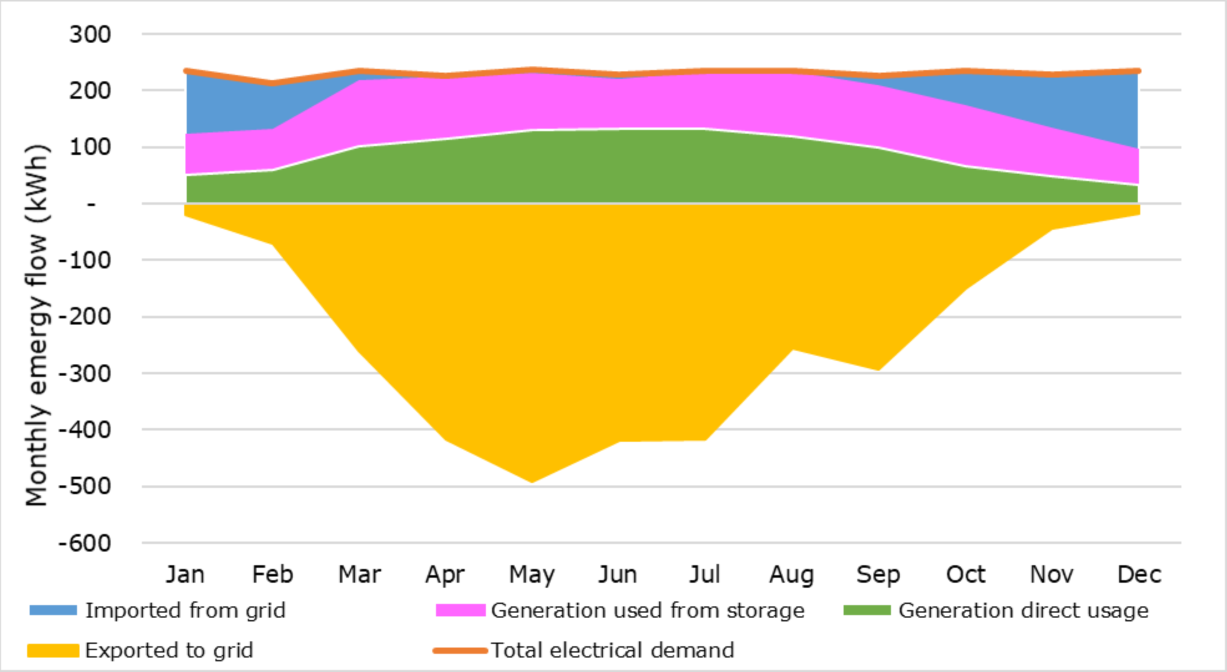


Figure 19: Lastingham / Darley Village Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	No grant	50% grant funding	No grant	50% grant funding
Energy Storage	No Battery		With Battery	
Whole system capex	£7,228	£3,614	£8,978	£4,489
Annual savings	£177		£362	
Annual export income	£210		£143	
Net annual benefit	£337		£455	
Y20 NPV	-£2,294	£1,198	-£2,916	£1,422
Y20 IRR	0%	7%	0%	7%
Payback years	21.6	12.0	21.7	13.2
Carbon offset Y1	599 kg			
Carbon offset Y20	7.8 Tonnes			

Table 18: Lastingham / Darley Village Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a modest annual benefit to the hall, and that a battery would slightly enhance this benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

6.8. Middleton and Aislaby Village Hall

6.8.1. Overview

The extent of the proposed PV array for Middleton and Aislaby Village Hall is shown in the figure below. The modelled array size is 4kWp for each building, consisting of 12x 330Wp modules, and is anticipated to produce 3,575 kWh of solar energy annually from the main building and 3,255 kWh from the small building. This size of array was found to provide the fastest payback, although a larger (up to 12kWp) or smaller array could also be installed depending on the budget available.

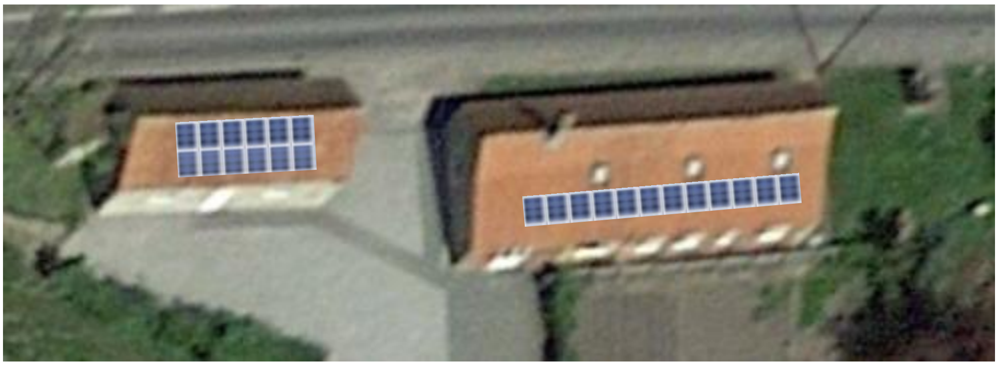


Figure 20: Middleton and Aislaby Village Hall– proposed extent of PV systems

The anticipated development, installation and operational costs for a solar PV and battery system for Middleton and Aislaby Village Hall presented in the table below, with costs equal for each of the two buildings. The battery system for each building has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost (per building)
Roof survey	£100
Planning permission	£0
Grid connection	£0
4 kWp Solar PV installation & ancillaries	£4,900
5 kWh Battery installation	£1,750
Annual maintenance budget	£50
Invertor replacement after ~10 years	£600
Battery replacement after ~10 years	£1,315

Table 19: Middleton and Aislaby Village Hall - anticipated project costs

6.8.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the main building are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 44% of the building's annual electricity demand is met, and 65% of PV generation is exported. With a battery, 74% of demand is met and 43% of generation is exported.

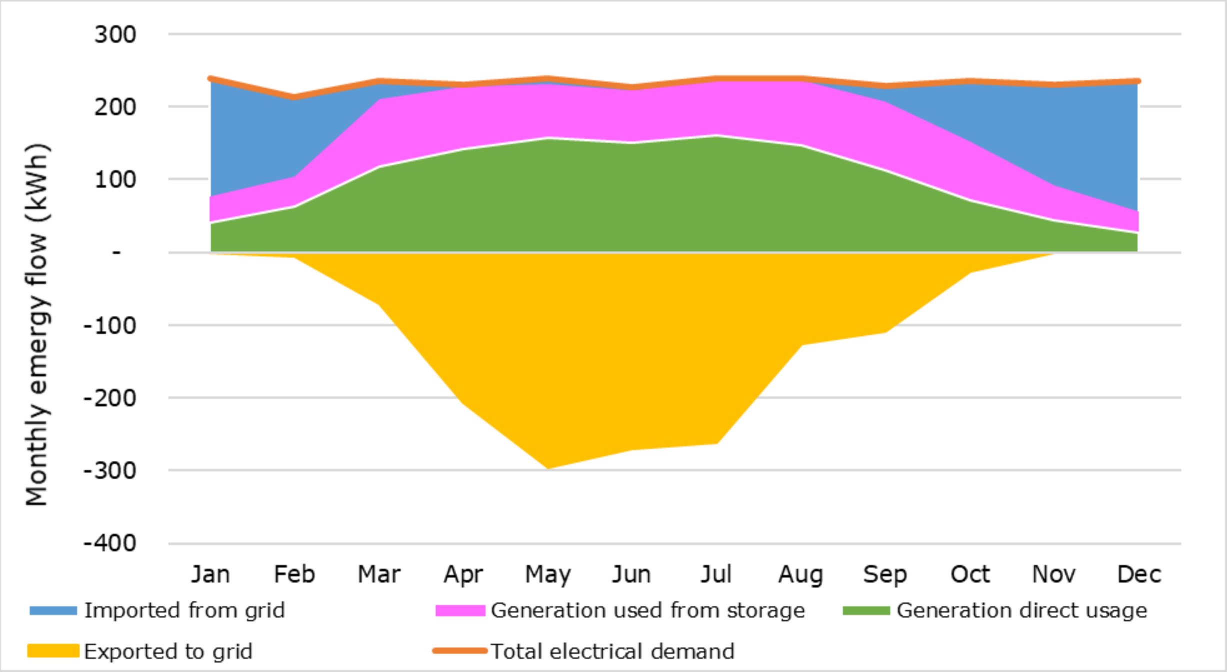


Figure 21: Middleton and Aislaby Village Hall - main building - monthly energy flows

In the following figure, the monthly energy flows for the other building are demonstrate, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 54% of the building's annual electricity demand is met, and 89% of PV generation is exported. With a battery, 99% of demand is met and 81% of generation is exported.

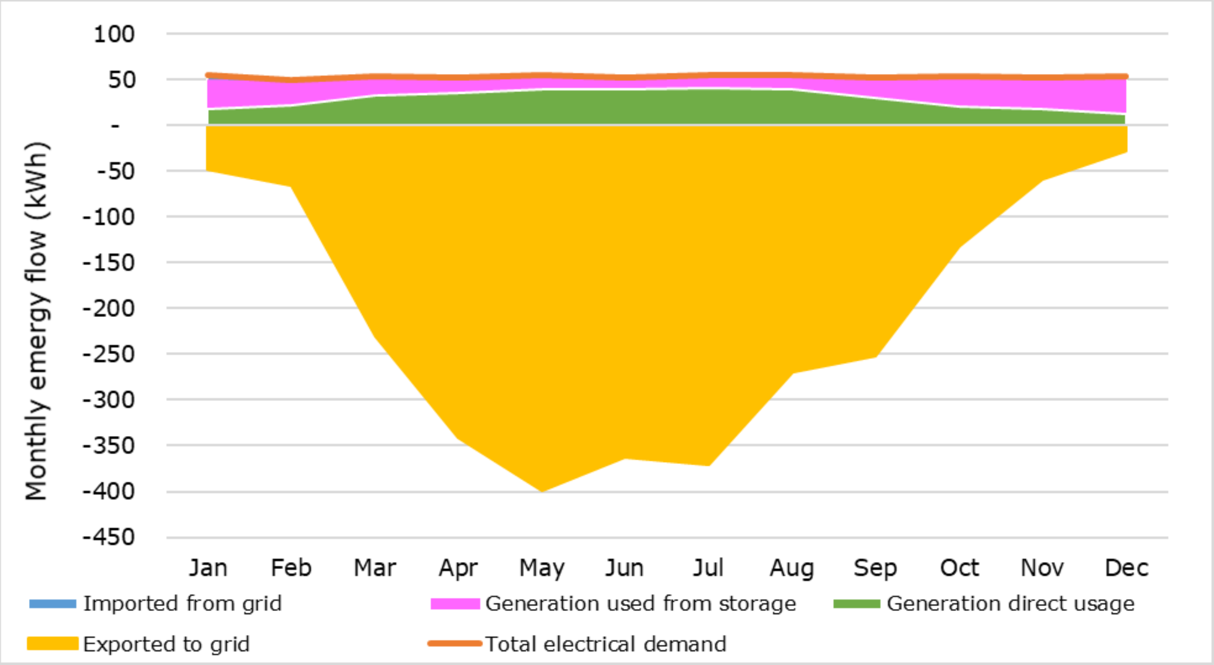


Figure 22: Middleton and Aislaby Village Hall - small building - monthly energy flows

The tables below demonstrates the anticipated financial returns of the proposed systems for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	**No grant**	**50% grant funding**	**No grant**	**50% grant funding**
Energy Storage	No Battery		With Battery	
Whole system capex	£4,900	£2,450	£6,650	£3,325
Annual savings	£187		£310	
Annual export income	£117		£69	
Net annual benefit	£253		£329	
Y20 NPV	-£1,296	£1,071	-£2,611	£601
Y20 IRR	0%	8%	-1%	5%
Payback years	20.2	10.5	23.4	14.9
Carbon offset Y1	404 kg			
Carbon offset Y20	5.3 Tonnes			

Table 20: Middleton and Aislaby Village Hall - main building - anticipated project returns

Indicator	**No grant**	**50% grant funding**	**No grant**	**50% grant funding**
Energy Storage	No Battery		With Battery	
Whole system capex	£4,900	£2,450	£6,650	£3,325
Annual savings	£69		£127	
Annual export income	£145		£128	
Net annual benefit	£164		£205	
Y20 NPV	-£2,672	-£305	-£4,566	-£1,354
Y20 IRR	-4%	2%	-6%	-2%
Payback years	30.6	17.7	n/a	23.4
Carbon offset Y1	4.8 Tonnes			
Carbon offset Y20	£6,650			

Table 21: Middleton and Aislaby Village Hall - small building - anticipated project returns

The tables above illustrates that a solar PV system would deliver a modest annual benefit to the hall, and that a battery would enhance this benefit. Of course, the addition of the battery raises the capital cost of the systems, which makes grant funding even more important in order for the system to provide strong returns. It is also clear that, owing to higher utilisation, the main building would benefit from a PV array to a much higher degree than the smaller building.

6.9. Old Malton Village Hall

6.9.1. Overview

The extent of the proposed PV array for Old Malton Village Hall is shown in the figure below. The modelled array size is 9.9kWp, consisting of 30x 330Wp modules, and is anticipated to produce 9,100 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a larger (up to 12kWp) or smaller array could also be installed depending on the space and budget available.

Figure 23: Old Malton Village Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for Old Malton Village Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£200
Planning permission	£0
Grid connection	£0
9.9 kWp Solar PV installation & ancillaries	£9,110
10 kWh Battery installation	£3,500
Annual maintenance budget	£50
Invertor replacement after ~10 years	£1,000
Battery replacement after ~10 years	£2,625

Table 22: Old Malton Village Hall - anticipated project costs

6.9.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 28%

of the hall’s annual electricity demand is met, and 48% of PV generation is exported. With a battery, 41% of demand is met and 25% of generation is exported.

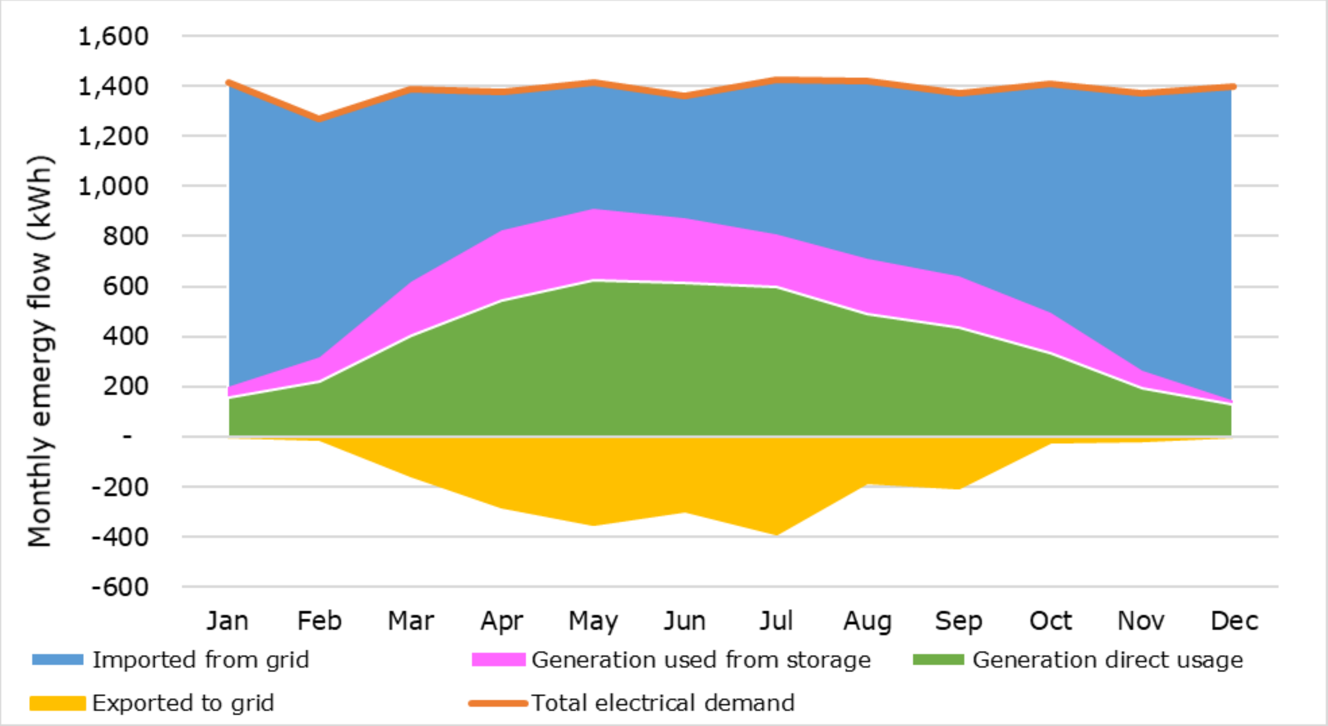


Figure 24: Old Malton Village Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	No grant	50% grant funding	No grant	50% grant funding
Energy Storage	No Battery		With Battery	
Whole system capex	£9,110	£4,555	£12,610	£6,305
Annual savings	£747		£1,073	
Annual export income	£218		£96	
Net annual benefit	£915		£1,119	
Y20 NPV	£4,494	£8,895	£2,738	£8,830
Y20 IRR	8%	20%	6%	16%
Payback years	9.6	4.9	13.6	5.5
Carbon offset Y1	1029 kg			
Carbon offset Y20	13.4 Tonnes			

Table 23: Old Malton Village Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a significant annual benefit to the hall, and that a battery would enhance this benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

6.10. Oswaldkirk Village Hall

6.10.1. Overview

The extent of the proposed PV array for Oswaldkirk Village Hall is shown in the figure below. The modelled array size is 4kWp, consisting of 12x 330Wp modules, and is anticipated to produce 3900 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a smaller array could also be installed depending on the budget available.

Figure 25: Oswaldkirk Village Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for Oswaldkirk Village Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£200
Planning permission	£0
Grid connection	£0
4 kWp Solar PV installation & ancillaries	£4,900
5 kWh Battery installation	£1,750
Annual maintenance budget	£50
Invertor replacement after ~10 years	£600
Battery replacement after ~10 years	£1,315

Table 24: Oswaldkirk Village Hall - anticipated project costs

6.10.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 41% of the hall's annual electricity demand is met, and 86% of PV generation is exported. With a battery, 93% of demand is met and 68% of generation is exported.

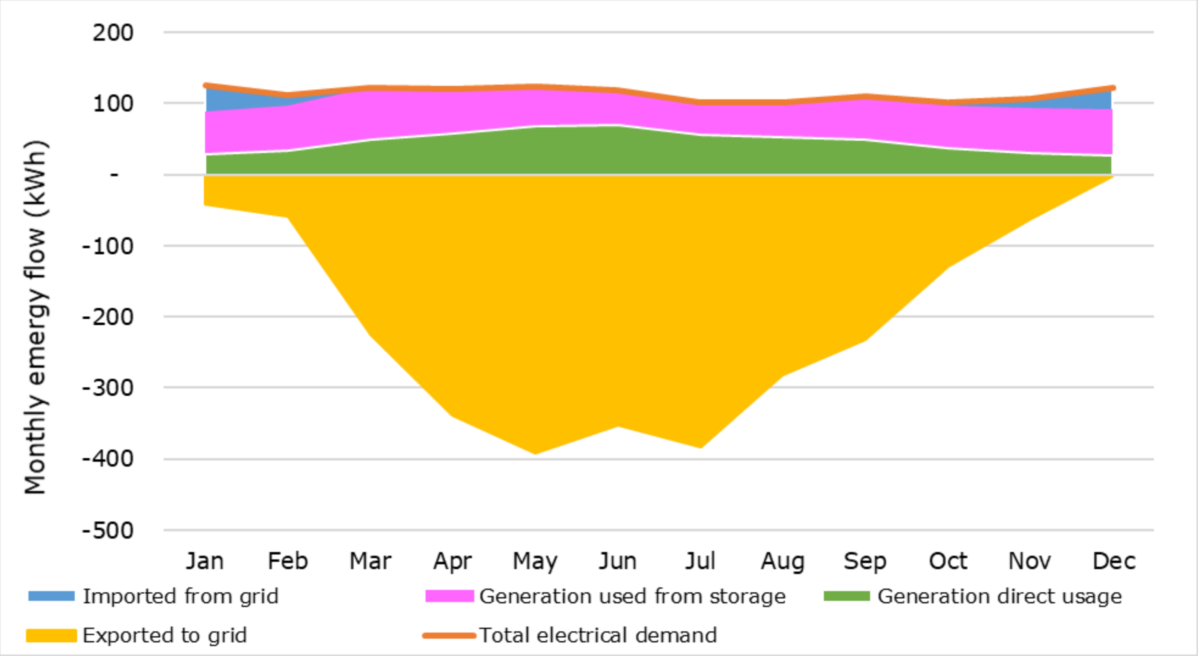


Figure 26: Oswaldkirk Village Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	No grant	50% grant funding	No grant	50% grant funding
Energy Storage	No Battery		With Battery	
Whole system capex	£4,900	£2,450	£6,650	£3,325
Annual savings	£93		£211	
Annual export income	£167		£125	
Net annual benefit	£210		£286	
Y20 NPV	-£1,978	£389	-£3,282	-£69
Y20 IRR	-2%	5%	-3%	3%
Payback years	24.3	13.9	26.7	17.0
Carbon offset Y1	441 kg			
Carbon offset Y20	5.7 Tonnes			

Table 25: Oswaldkirk Village Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a modest annual benefit to the hall, and that a battery would slightly enhance this benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

6.11. Romanby WI Hall

6.11.1. Overview

The extent of the proposed PV array for Romanby WI Hall is shown in the figure below. The modelled array size is 4kWp, consisting of 12x 330Wp modules, and is anticipated to produce 3290 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a smaller array could also be installed depending on the budget available.

Figure 27: Romanby WI Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for Romanby WI Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£100
Asbestos survey	£550
Planning permission	£0
Grid connection	£0
4 kWp Solar PV installation & ancillaries	£5,450
5 kWh Battery installation	£1,750
Annual maintenance budget	£50
Invertor replacement after ~10 years	£600
Battery replacement after ~10 years	£1,315

Table 26: Romanby WI Hall - anticipated project costs

6.11.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 37% of the hall's annual electricity demand is met, and 66% of PV generation is exported. With a battery, 69% of demand is met and 37% of generation is exported.

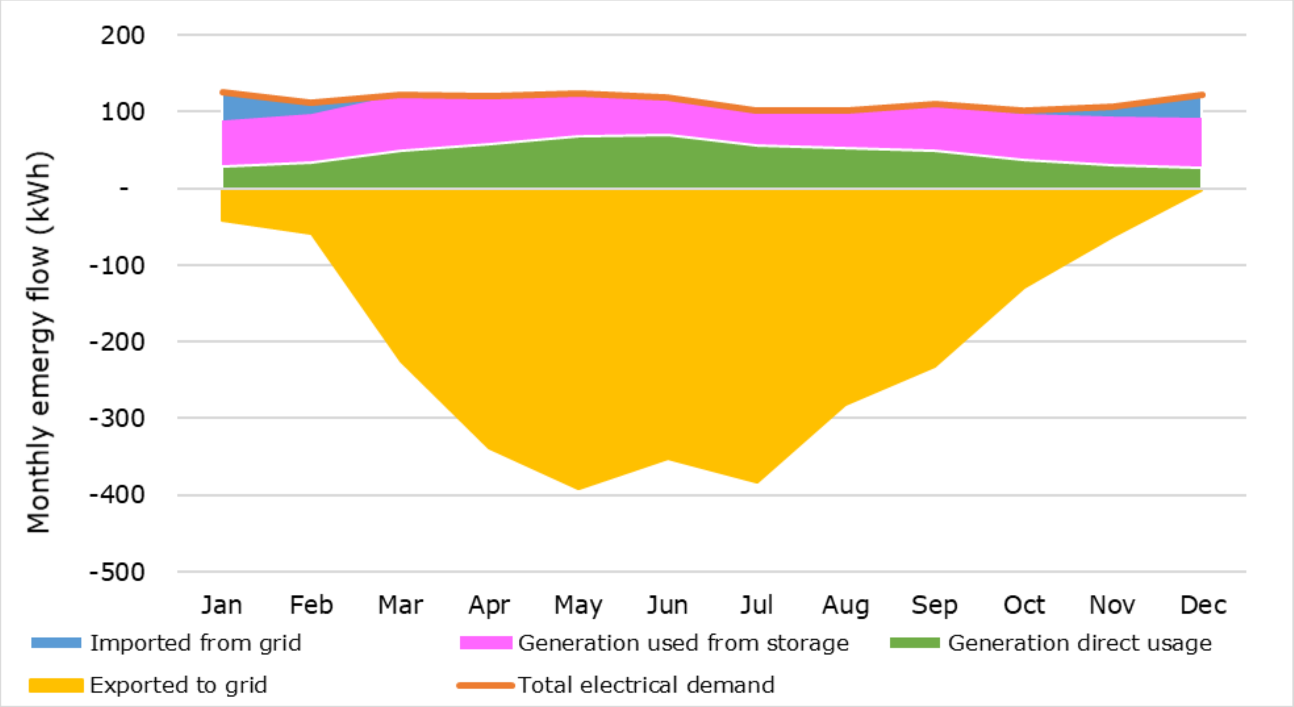


Figure 28: Romanby WI Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	No grant	50% grant funding	No grant	50% grant funding
Energy Storage	No Battery		With Battery	
Whole system capex	£5,450	£2,725	£7,200	£3,600
Annual savings	£226		£417	
Annual export income	£108		£52	
Net annual benefit	£284		£418	
Y20 NPV	-£1,343	£1,290	-£1,741	£1,737
Y20 IRR	1%	8%	1%	8%
Payback years	19.8	10.7	19.8	10.5
Carbon offset Y1	372 kg			
Carbon offset Y20	4.8 Tonnes			

Table 27: Romanby WI Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a modest annual benefit to the hall, and that a battery would significantly enhance this benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

6.12. Sand Hutton and Claxton Village Hall

6.12.1. Overview

The extent of the proposed PV array for Sand Hutton and Claxton Village Hall is shown in the figure below. The modelled array size is 4kWp, consisting of 12x 330Wp modules, and is anticipated to produce 3600 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a smaller array could also be installed depending on the budget available.

Figure 29: Sand Hutton and Claxton Village Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for Sand Hutton and Claxton Village Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£100
Planning permission	£0
Grid connection	£0
4 kWp Solar PV installation & ancillaries	£5,450
5 kWh Battery installation	£1,750
Annual maintenance budget	£50
Invertor replacement after ~10 years	£600
Battery replacement after ~10 years	£1,315

Table 28: Sand Hutton and Claxton Village Hall - anticipated project costs

6.12.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 38% of the hall's annual electricity demand is met, and 72% of PV generation is exported. With a battery, 78% of demand is met and 44% of generation is exported.

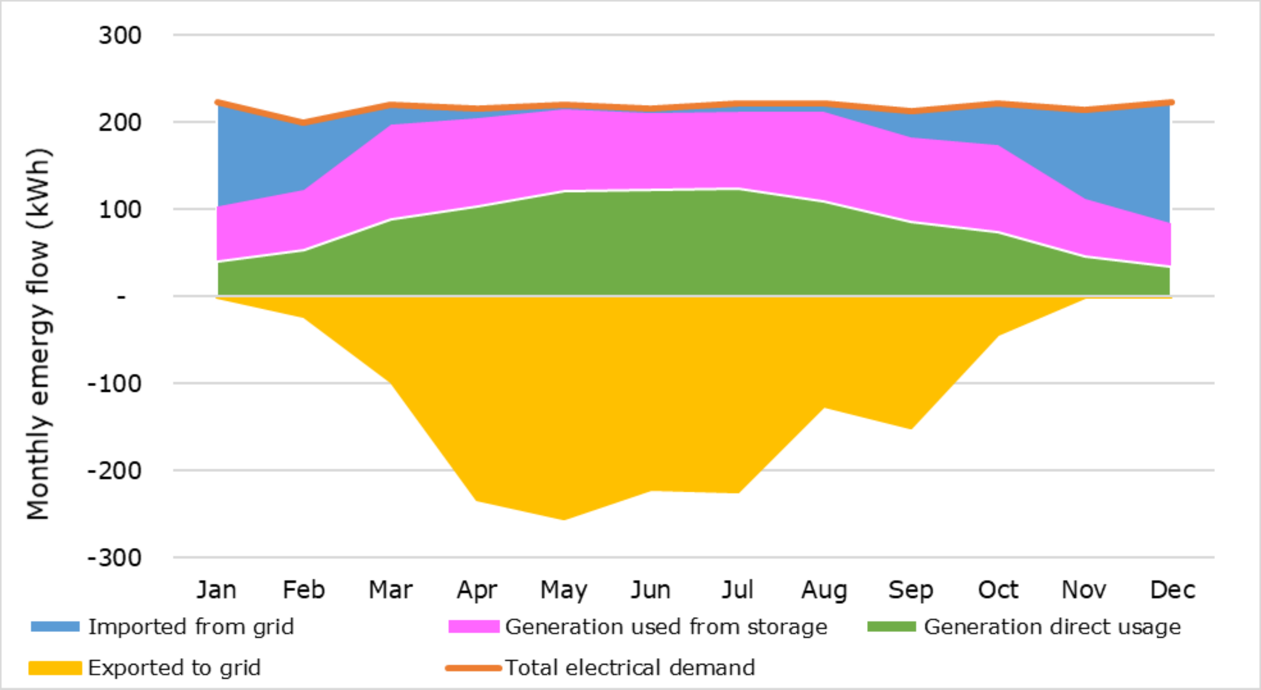


Figure 30: Sand Hutton and Claxton Village Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	**No grant**	**50% grant funding**	**No grant**	**50% grant funding**
Energy Storage	No Battery		With Battery	
Whole system capex	£4,900	£2,450	£6,650	£3,325
Annual savings	£160		£325	
Annual export income	£130		£69	
Net annual benefit	£240		£345	
Y20 NPV	-£1,500	£867	-£2,352	£861
Y20 IRR	0%	7%	-1%	6%
Payback years	21.3	12.2	22.4	14.2
Carbon offset Y1	407 kg			
Carbon offset Y20	5.3 Tonnes			

Table 29: Sand Hutton and Claxton Village Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a modest annual benefit to the hall, and that a battery would significantly enhance this benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

6.13. Settrington Village Hall

6.13.1. Overview

The extent of the proposed PV array for Settrington Village Hall is shown in the figure below. The modelled array size is 12kWp, consisting of 36x 330Wp modules, and is anticipated to produce 10480 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a smaller array could also be installed depending on the budget available. The array modelled is one that is in line with the roof, in order to avoid the additional costs of mounting system that orientates the array to the south. This would increase the annual yield of the array but may require planning permission and would not provide a significant improvement in terms of financial returns.

Figure 31: Settrington Village Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for Settrington Village Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£200
Planning permission	£0
Grid connection	£0
12 kWp Solar PV installation & ancillaries	£11,000
10 kWh Battery installation	£3,500
Annual maintenance budget	£50
Invertor replacement after ~10 years	£1,500
Battery replacement after ~10 years	£2,625

Table 30: Settrington Village Hall - anticipated project costs

6.13.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 37% of the hall's annual electricity demand is met, and 75% of PV generation is exported. With a battery, 69% of demand is met and 54% of generation is exported.

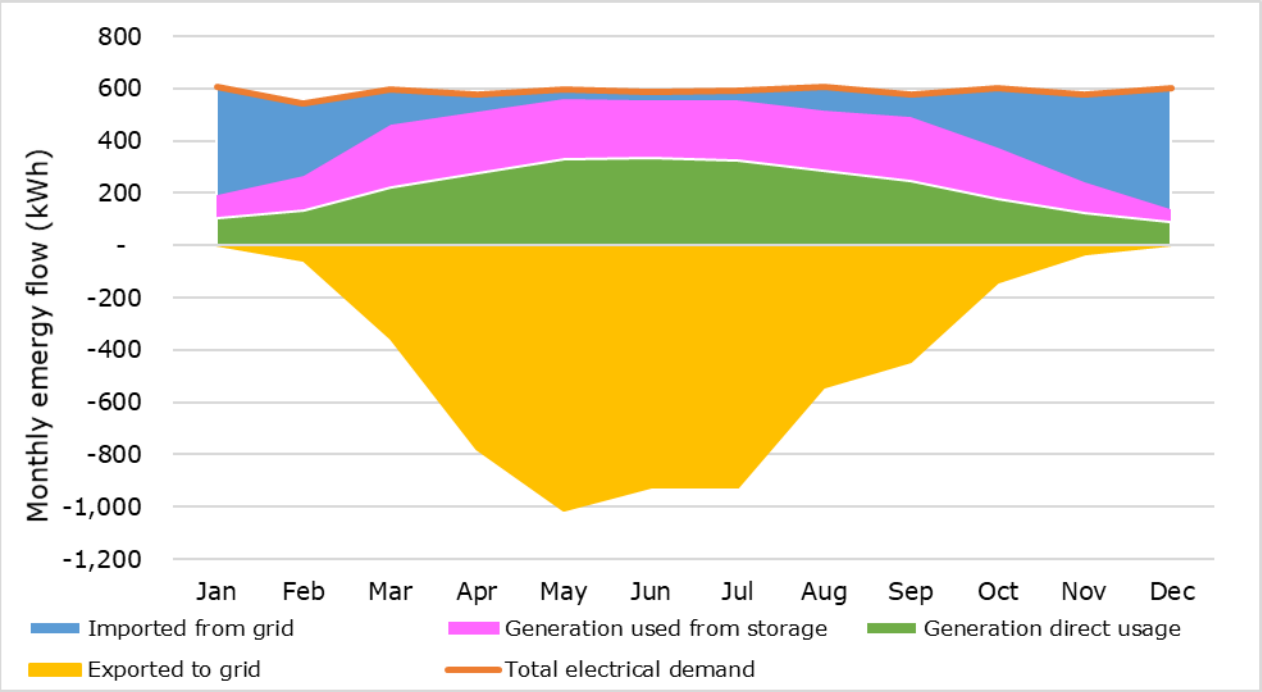


Figure 32: Settrington Village Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	**No grant**	**50% grant funding**	**No grant**	**50% grant funding**
Energy Storage	No Battery		With Battery	
Whole system capex	£11,000	£5,500	£14,500	£7,250
Annual savings	£529		£972	
Annual export income	£392		£261	
Net annual benefit	£871		£1,183	
Y20 NPV	£1,602	£6,916	£1,546	£8,551
Y20 IRR	5%	15%	5%	14%
Payback years	13.7	6.2	14.7	6.0
Carbon offset Y1	1186 kg			
Carbon offset Y20	15.4 Tonnes			

Table 31: Settrington Village Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a modest annual benefit to the hall, and that a battery would significantly enhance this benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

6.14. Terrington Village Hall

6.14.1. Overview

The extent of the proposed PV array for Terrington Village Hall is shown in the figure below. The modelled array size is 4kWp, consisting of 12x 330Wp modules, and is anticipated to produce 3735 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a smaller array could also be installed depending on the budget available.

Figure 33: Terrington Village Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for Terrington Village Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£100
Planning permission	£0
Grid connection	£0
4 kWp Solar PV installation & ancillaries	£4,900
5 kWh Battery installation	£1,750
Annual maintenance budget	£50
Invertor replacement after ~10 years	£600
Battery replacement after ~10 years	£1,315

Table 32: Terrington Village Hall - anticipated project costs

6.14.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 33% of the hall's annual electricity demand is met, and 55% of PV generation is exported. With a battery, 52% of demand is met and 28% of generation is exported.

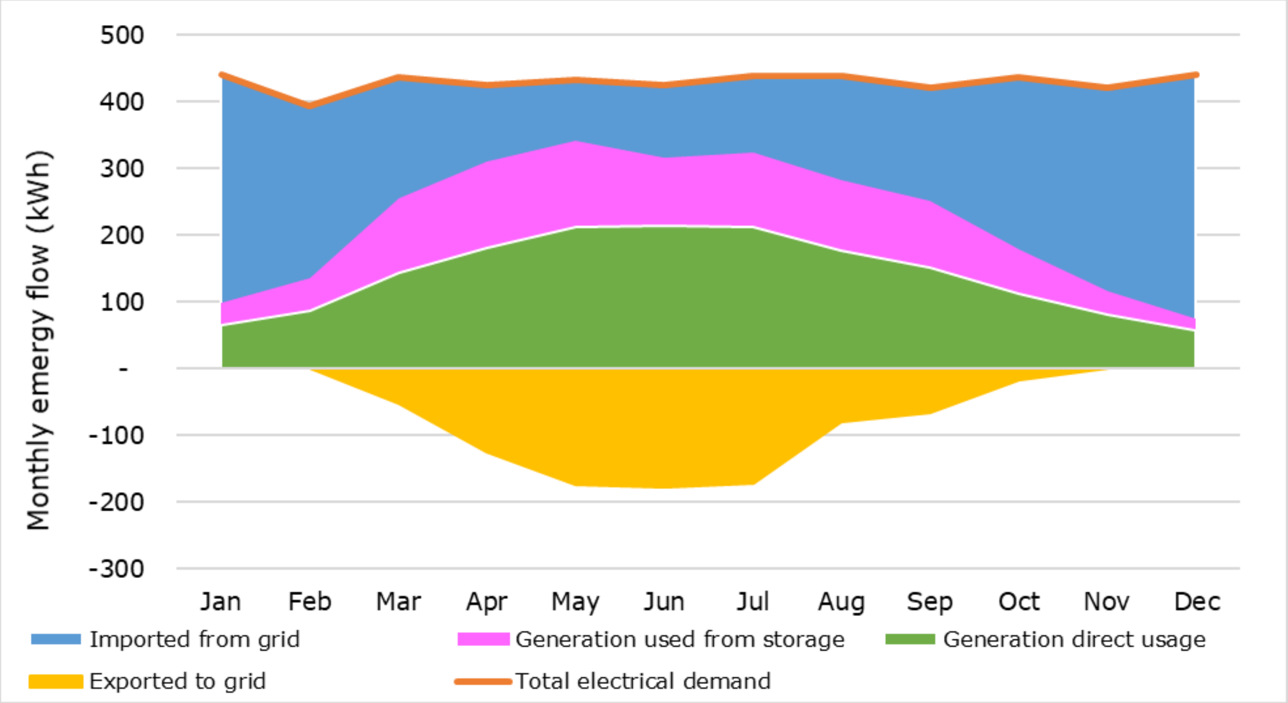


Figure 34: Terrington Village Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	No grant	50% grant funding	No grant	50% grant funding
Energy Storage	No Battery		With Battery	
Whole system capex	£4,900	£2,450	£6,650	£3,325
Annual savings	£261		£415	
Annual export income	£102		£43	
Net annual benefit	£314		£408	
Y20 NPV	-£368	£1,999	-£1,368	£1,845
Y20 IRR	3%	11%	1%	9%
Payback years	16.5	7.6	19.2	7.9
Carbon offset Y1	422 kg			
Carbon offset Y20	5.5 Tonnes			

Table 33: Terrington Village Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a modest annual benefit to the hall, and that a battery would significantly enhance this benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

6.15. Thixendale Village Hall

6.15.1. Overview

The extent of the proposed PV array for Thixendale Village Hall is shown in the figure below. The modelled array size is 5.9kWp, consisting of 18x 330Wp modules, and is anticipated to produce 4925 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a larger (up to 12kWp) or smaller array could also be installed depending on the space and budget available.

Figure 35: Thixendale Village Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for Thixendale Village Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£200
Preapplication advice	£100
Planning permission	£234
Grid connection	£0
5.9 kWp Solar PV installation & ancillaries	£7,662
5 kWh Battery installation	£1,750
Annual maintenance budget	£50
Invertor replacement after ~10 years	£600
Battery replacement after ~10 years	£1,315

Table 34: Thixendale Village Hall - anticipated project costs

6.15.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 36%

of the hall's annual electricity demand is met, and 69% of PV generation is exported. With a battery, 65% of demand is met and 44% of generation is exported.

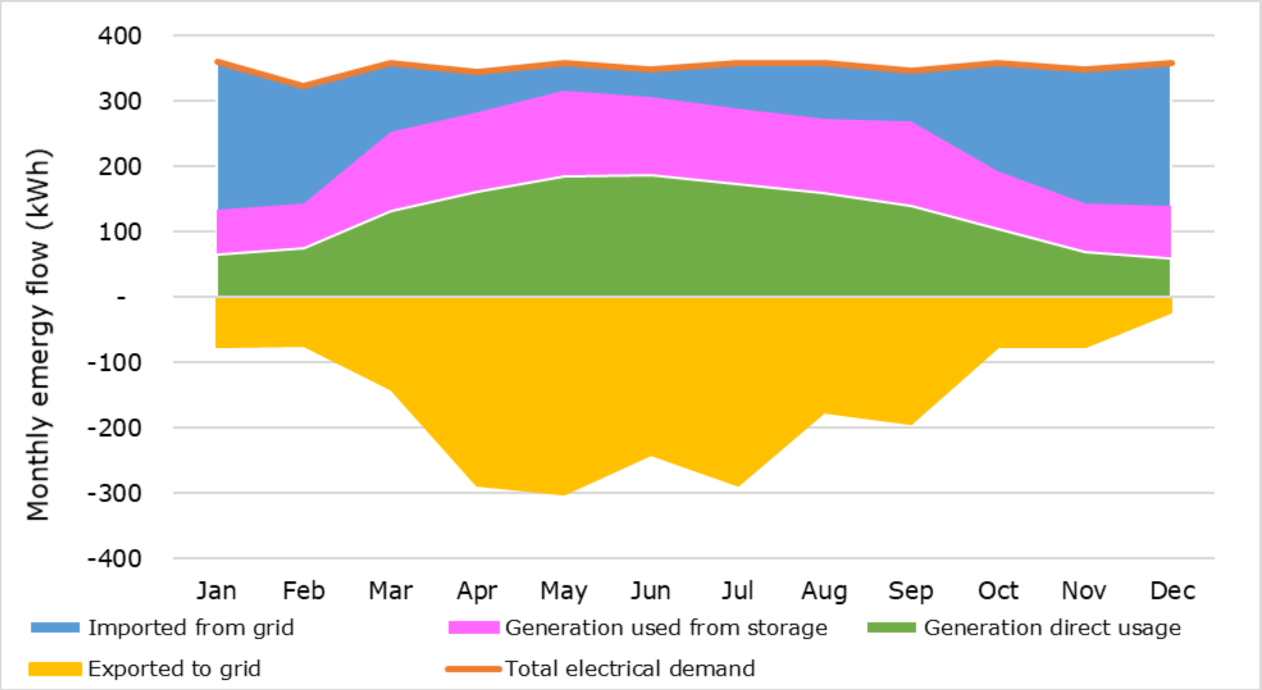


Figure 36: Thixendale Village Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	No grant	50% grant funding	No grant	50% grant funding
Energy Storage	No Battery		With Battery	
Whole system capex	£7,662	£3,831	£9,412	£4,706
Annual savings	£238		£434	
Annual export income	£171		£98	
Net annual benefit	£359		£482	
Y20 NPV	-£2,359	£1,343	-£2,909	£1,638
Y20 IRR	0%	7%	0%	7%
Payback years	21.3	11.9	21.3	13.0
Carbon offset Y1	557 kg			
Carbon offset Y20	7.3 Tonnes			

Table 35: Thixendale Village Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a modest annual benefit to the hall, and that a battery would significantly enhance this benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

6.16. Thornton le Dale

6.16.1. Overview

The extent of the proposed PV array for Thornton le Dale Village Hall is shown in the figure below. The modelled array size is 4kWp, consisting of 12x 330Wp modules, and is anticipated to produce 3170 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a smaller array could also be installed depending on the budget available.

Figure 37: Thornton le Dale Village Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for Thornton le Dale Village Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£100
Planning permission	£0
Grid connection	£0
4 kWp Solar PV installation & ancillaries	£4,900
5 kWh Battery installation	£1,750
Annual maintenance budget	£50
Invertor replacement after ~10 years	£600
Battery replacement after ~10 years	£1,315

Table 36: Thornton le Dale Village Hall - anticipated project costs

6.16.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 24%

of the hall's annual electricity demand is met, and 33% of PV generation is exported. With a battery, 32% of demand is met and 11% of generation is exported.

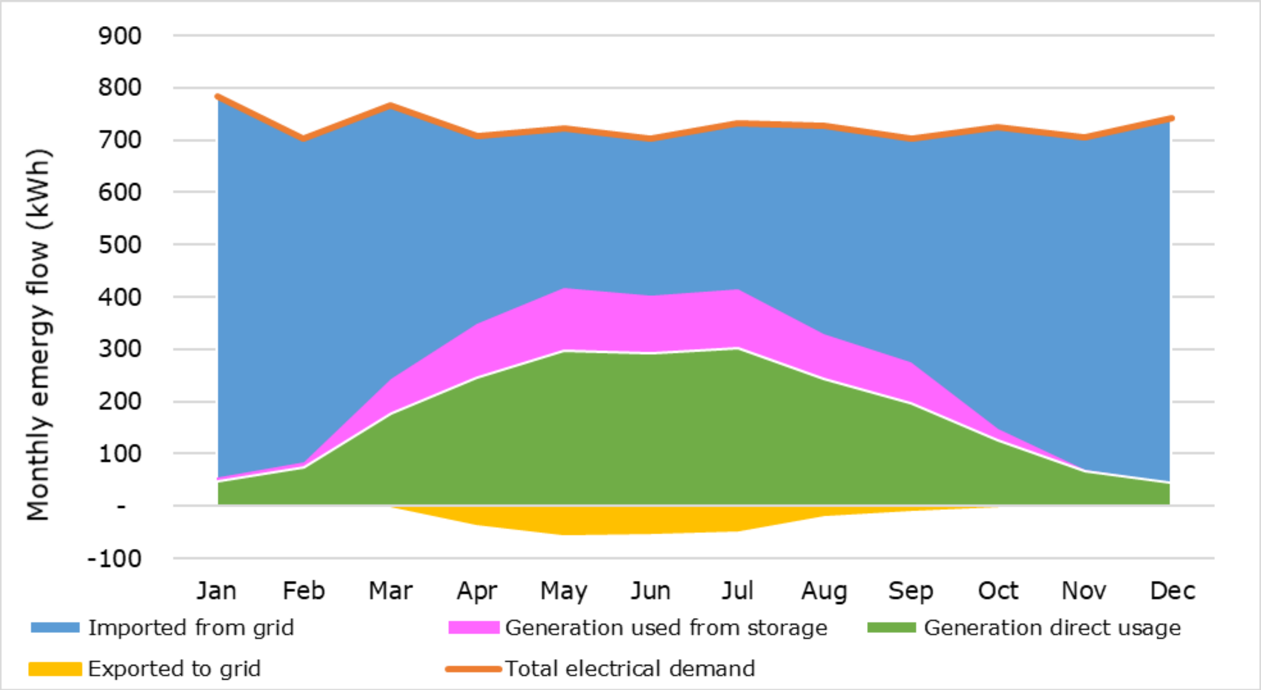


Figure 38: Thornton le Dale Village Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	**No grant**	**50% grant funding**	**No grant**	**50% grant funding**
Energy Storage	No Battery		With Battery	
Whole system capex	£4,900	£2,450	£6,650	£3,325
Annual savings	£398		£532	
Annual export income	£52		£10	
Net annual benefit	£400		£492	
Y20 NPV	£996	£3,363	-£74	£3,138
Y20 IRR	6%	16%	3%	12%
Payback years	13.1	6.0	16.1	6.6
Carbon offset Y1	358 kg			
Carbon offset Y20	4.7 Tonnes			

Table 37: Thornton le Dale Village Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a modest annual benefit to the hall, and that a battery would significantly enhance this benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

6.17. Welburn Village Hall

6.17.1. Overview

The extent of the proposed PV array for Welburn Village Hall is shown in the figure below. The modelled array size is 8kWp, consisting of 24x 330Wp modules, and is anticipated to produce 6735 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a larger (up to 12kWp) or smaller array could also be installed depending on the budget available.

Figure 39: Welburn Village Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for Welburn Village Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£200
Planning permission	£0
Grid connection	£0
8 kWp Solar PV installation & ancillaries	£7,400
10 kWh Battery installation	£3,500
Annual maintenance budget	£50
Invertor replacement after ~10 years	£1,000
Battery replacement after ~10 years	£2,625

Table 38: Welburn Village Hall - anticipated project costs

6.17.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 37%

of the hall's annual electricity demand is met, and 74% of PV generation is exported. With a battery, 75% of demand is met and 47% of generation is exported.

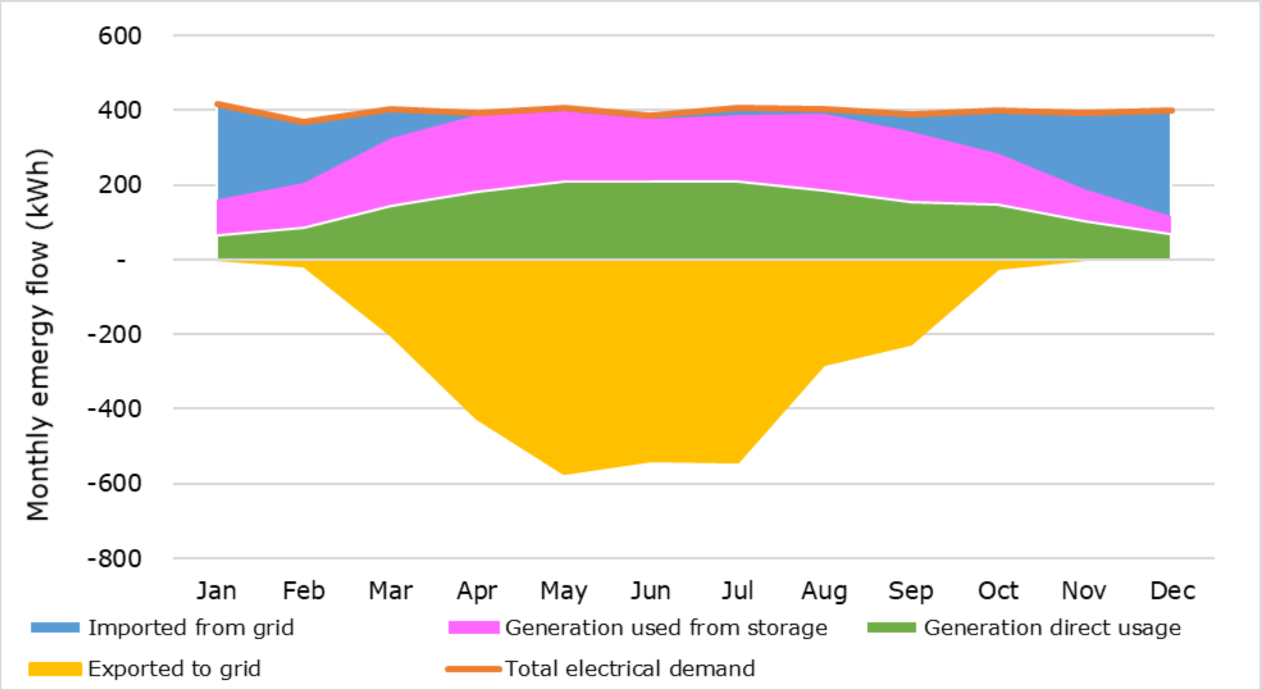


Figure 40: Welburn Village Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	No grant	50% grant funding	No grant	50% grant funding
Energy Storage	No Battery		With Battery	
Whole system capex	£7,400	£3,700	£10,900	£5,450
Annual savings	£257		£523	
Annual export income	£249		£142	
Net annual benefit	£456		£614	
Y20 NPV	-£921	£2,654	-£3,421	£1,845
Y20 IRR	2%	10%	0%	7%
Payback years	17.4	7.9	21.4	13.9
Carbon offset Y1	762 kg			
Carbon offset Y20	9.9 Tonnes			

Table 39: Welburn Village Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a modest annual benefit to the hall, and that a battery would significantly enhance this benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

6.18. Wintringham Village Hall

6.18.1. Overview

The extent of the proposed PV array for Wintringham Village Hall is shown in the figure below. The modelled array size is 8kWp, consisting of 24x 330Wp modules, and is anticipated to produce 6735 kWh of solar energy annually. This size of array was found to provide the fastest payback, although a larger (up to 12kWp) or smaller array could also be installed depending on the budget available.

Figure 41: Wintringham Village Hall – proposed extent of PV system

The anticipated development, installation and operational costs for a solar PV and battery system for Wintringham Village Hall are presented in the table below. The battery system has been sized to optimise returns whilst meeting grid connection conditions.

Item	Cost
Roof survey	£200
Planning permission	£0
Grid connection	£0
12 kWp Solar PV installation & ancillaries	£11,000
15 kWh Battery installation	£4,500
Annual maintenance budget	£50
Invertor replacement after ~10 years	£1,500
Battery replacement after ~10 years	£3,375

Table 40: Wintringham Village Hall - anticipated project costs

6.18.2. Energy flow and financial model results

In the following figure, the monthly energy flows for the hall are demonstrated, based on the results of the energy flow modelling for the optimum scale of solar PV. Without a battery, 38% of the hall's annual electricity demand is met, and 69% of PV generation is exported. With a battery, 73% of demand is met and 42% of generation is exported.

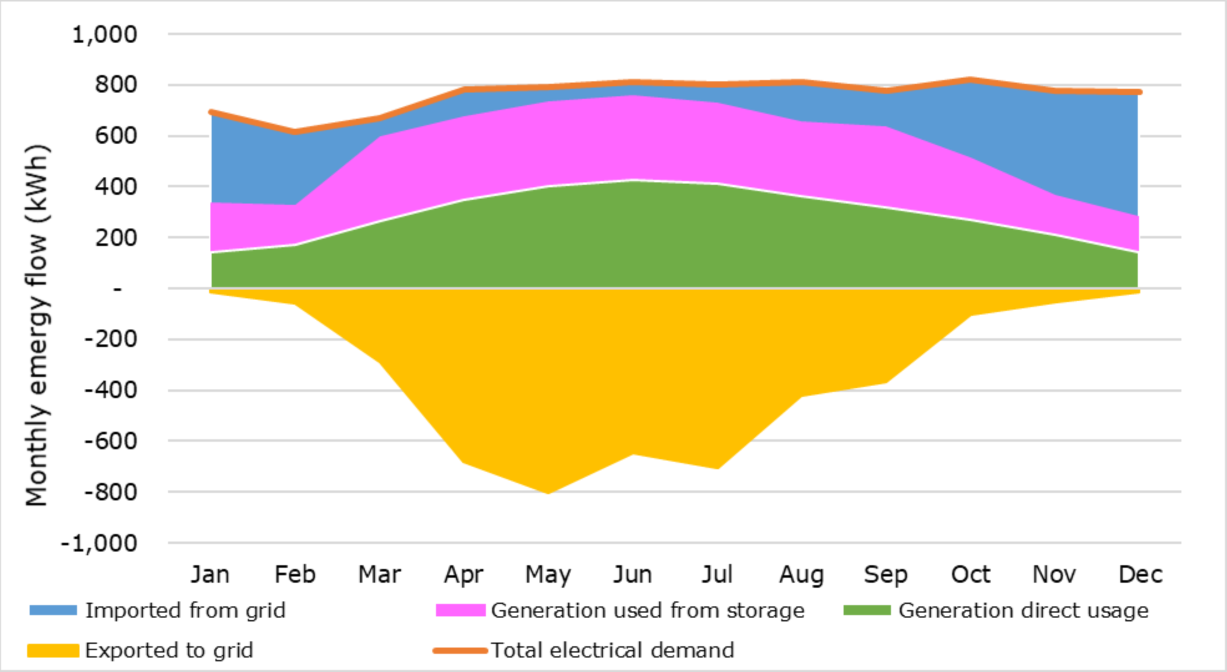


Figure 42: Wintringham Village Hall - monthly energy flows

The table below demonstrates the anticipated financial returns of the proposed system for two funding scenarios and with and without energy storage. If the project was fully grant funded, only the net annual benefit would be relevant. If the project was financed by a co-op, only the annual savings would be relevant.

Indicator	No grant	50% grant funding	No grant	50% grant funding
Energy Storage	No Battery		With Battery	
Whole system capex	£11,000	£5,500	£15,500	£7,750
Annual savings	£535		£1,020	
Annual export income	£394		£208	
Net annual benefit	£879		£1,178	
Y20 NPV	£1,715	£7,029	£44	£7,532
Y20 IRR	5%	15%	4%	13%
Payback years	13.6	6.1	16.0	6.4
Carbon offset Y1	1285 kg			
Carbon offset Y20	16.7 Tonnes			

Table 41: Wintringham Village Hall - anticipated project returns

The table above illustrates that a solar PV system would deliver a significant annual benefit to the hall, and that a battery would significantly enhance this benefit. Of course, the addition of the battery raises the capital cost of the system, which makes grant funding even more important in order for the system to provide strong returns.

7. Community Impacts

7.1. Community benefits

The proposed renewable energy systems have the potential to benefit multiple communities across Ryedale and Hambleton. First of all, installing rooftop solar PV will lead to reduced electricity bills, which will be enhanced if energy storage is also incorporated. Further (assuming the hall's own their installations) they will benefit from income associated with exporting surplus electricity under a SEG contract. These benefits will lead to lower overheads for operating the halls, which will free up capital for other activities and, where buildings have electric heating, reduce the likelihood and occurrence of the halls being underheated. The reduced overheads will allow for the hall operators to charge lower hiring fees, which in turn will allow for reduced fees for attendees of fitness classes, workshops and day-care etc. As such, the projects will be able to help every community and visitor member who engages with one of the 18 village halls in the study.

Installing PV and battery systems will also facilitate wider benefits. For instance, the renewable electricity generated will reduce the carbon footprint of the halls, and contribute to local and national decarbonisation targets by making a small contribution to decreasing the carbon intensity of the national grid. In addition, the projects will serve as exemplar renewable energy installations in their communities, and will allow local residents and small businesses to see how to procure and operate PV and battery storage systems. Similarly, and particularly if several projects are pursued, the local supply chain will be strengthened through the provision of short-term contracts for installers and other contractors such as scaffolders and surveyors.

7.2. Community Engagement

Community engagement is central to is feasibility study, given that it is being conducted on behalf of a group of 18 local village halls. Each group has a committees or management team which has agreed to participate in both phases of the study, due to their interest in renewable energy for their respective halls. A further 10 community groups participated in the first phase of the project but did not chose to participate in the second phase because they chose to focus their limited time resource on other areas, including energy efficiency and renewable heat projects. All groups are vocally supportive of solar PV installations on their buildings, and no objections have been raised, although the biggest reservation noted was the high potential capital costs.

Following the first phase of this study, Locogen help two workshops to engage with 22 of the hall's representatives and to answer their questions about potential solar PV installations and renewable energy projects in general. Also present at these workshops were representatives from the York & North Yorkshire Local Enterprise Partnership (who co-facilitated the workshops), Community First Yorkshire and Ryedale District Council. All these organisations have voiced strong support for the project. In addition, NYMNP and the Howardian Hills AONB have indicated their support. As such, all key stakeholders are on board with the projects, subject to the installations meeting planning restrictions, as appropriate (this applies to 3 of the 18 projects in this phase).

8. Operation and Governance

8.1. Governance

Assuming the installations are self-owned (rather than owned by a co-op), each village hall's community will have to appoint a person or team to raise finance and manage the delivery of the project. Given the similarity and proximity of the proposed projects, there is scope to develop a consortium to manage joint funding applications and/or joint procurement exercises.

The main tasks in terms of delivery will be to appoint a structural surveyor, apply for planning permission (if necessary) and appoint a contractor to carry out the installation and manage its grid connection. Locogen recommend that three quotes are collected, and have provided draft tender documents in Appendix C and Appendix D. which can be used to ensure that quotes can be compared on a like-for-like basis and that contractors meet the necessary safety and design standards.

8.2. Operation

Once commissioned, the PV and battery systems will be able to operate without interference. Therefore, the main burden is associated with the administration of SEG contracts to ensure that the project generates income from its surplus generation. This is a very similar process to managing electricity import contracts, therefore no specialist experience or training will be required.

Outwith the service requirements for any system, allowances should be made for component failure and replacement parts. Typically, it is recommended that a contingency fund be put aside to cover replacement parts over time. For solar PV and battery systems, an annual allowance of between 2-5% of the capital costs of the project would be a reasonable contingency fund.

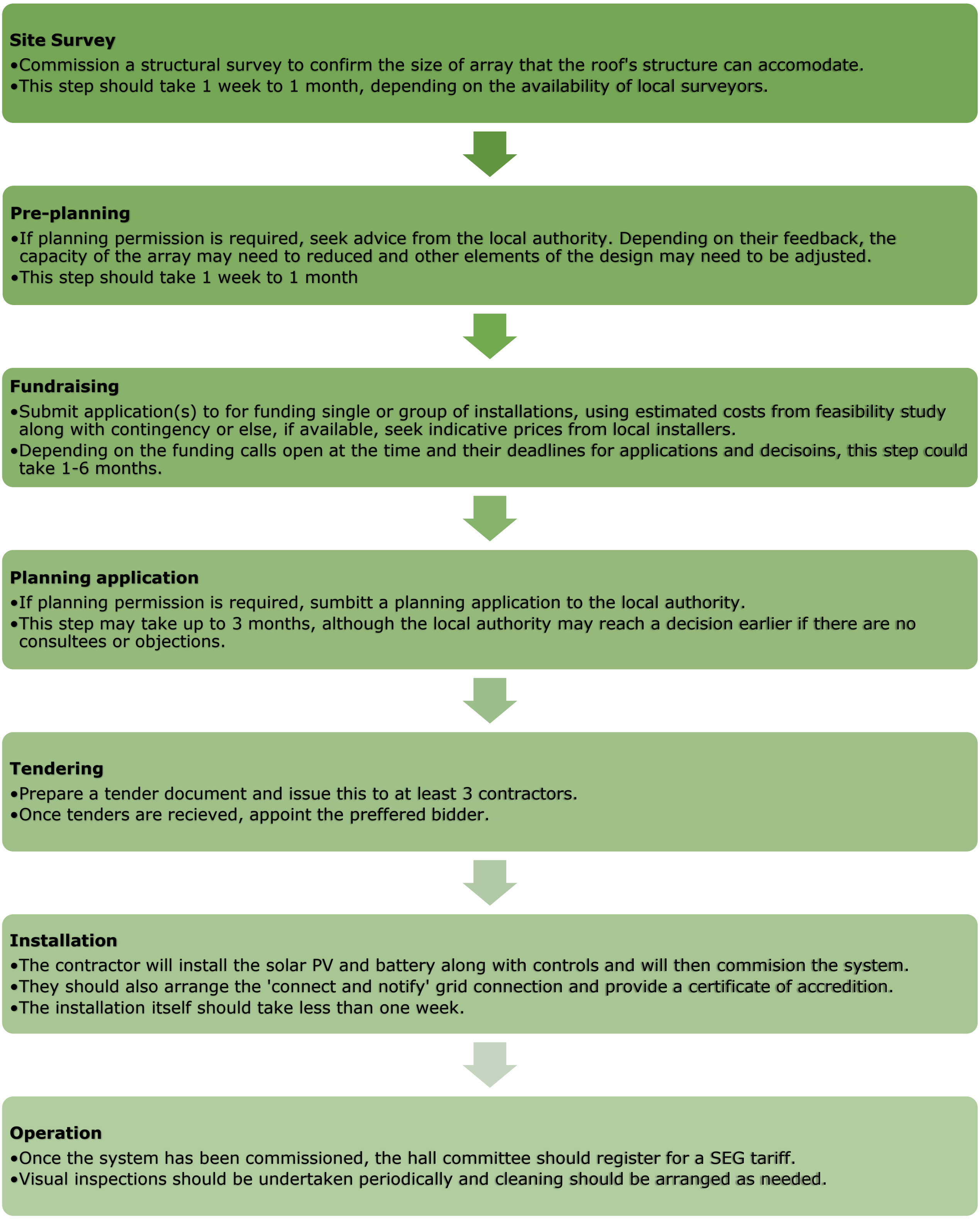
Electrical connections – All non-domestic buildings with an electrical connection should have an Electrical Installation Condition Report (EICR) undertaken at least every 5 years (although this period can be less if deemed necessary). This would include all wiring up to any renewable installations. This could cost £100-300 per building.

Photovoltaic systems – There is no requirement to service a PV array to any extent further than the electrical testing regulations. However, it is recommended that the system be visually inspected each year, any filters on the inverters be cleaned, and the modules checked for dust or leaf build-up. In areas with dust, nesting birds or other contaminants the modules may require regular cleaning, but this can be gauged during the initial operational period. This can typically be done by a window cleaning service from the ground unless the array is too high/awkward to be accessed.

Battery storage – Batteries have no moving parts and do not have any servicing requirements. Faults are unlikely and will generally be communicated to the PV-battery control system.

9. Scheduling

An implementation pathway for a small (G98-compliant) solar PV and battery installation is presented in Figure 43 below. If the preferred option was to engage with an existing solar co-op, the only necessary step would be to approach the co-op. If the co-op had the resource to take on the project and deemed the site to be suitable, then they would handle the rest of the process.



Site Survey

- Commission a structural survey to confirm the size of array that the roof's structure can accomodate.
- This step should take 1 week to 1 month, depending on the availability of local surveyors.

Pre-planning

- If planning permission is required, seek advice from the local authority. Depending on their feedback, the capacity of the array may need to reduced and other elements of the design may need to be adjusted.
- This step should take 1 week to 1 month

Fundraising

- Submit application(s) to for funding single or group of installations, using estimated costs from feasibility study along with contingency or else, if available, seek indicative prices from local installers.
- Depending on the funding calls open at the time and their deadlines for applications and decisoins, this step could take 1-6 months.

Planning application

- If planning permission is required, sumbitt a planning application to the local authority.
- This step may take up to 3 months, although the local authority may reach a decision earlier if there are no consultees or objections.

Tendering

- Prepare a tender document and issue this to at least 3 contractors.
- Once tenders are recieved, appoint the preffered bidder.

Installation

- The contractor will install the solar PV and battery along with controls and will then commision the system.
- They should also arrange the 'connect and notify' grid connection and provide a certificate of accreditation.
- The installation itself should take less than one week.

Operation

- Once the system has been commissioned, the hall committee should register for a SEG tariff.
- Visual inspections should be undertaken periodically and cleaning should be arranged as needed.

Figure 43: Implementation pathway for self-owned solar PV & battery system

10. Conclusions

In this study, the feasibility of installing solar PV and battery systems has been explored for 18 village halls across the districts of Ryedale and Hambleton, with the goal of generating 'oven ready' projects. All of the halls would benefit from a solar PV array and complementary battery storage to maximise the onsite usage of the solar electricity generated.

In order to assess each site in detail, planning and grid restrictions were first examined. Due to the high costs associated with G99 grid applications, each hall is recommended to install a G98-compliant system, meaning that generation storage capacity must be limited to 3.68kW per phase. Similarly, all arrays should be designed to comply with permitted development rights for non-domestic PV installations. This will allow all but three hall's systems to be installed without the need to apply for planning permission. These three halls are recommended to engage with their local planning authorities at an early stage to determine the likelihood of a successful planning application. Promisingly, precedent suggests that they are likely to receive planning permission, and key local stakeholders have voiced support for the goals of study.

The above constraints informed the outline design of each proposed solar array, which was then modelled in PVSol software in order to assess the anticipated annual generation. This information was fed into an energy flow model, along with the current electricity demands and occupancy patterns of each hall, in order to determine the likely financial returns. This exercise allowed the optimum battery capacity to be determined in each case. The financial returns were presented for cases with no and partial grant funding, and can be interpreted for cases with full grant funding.

The energy flow modelling also highlighted the environmental benefits of the proposed systems through reducing the carbon emissions of each building, and by contributing to the decarbonisation the national grid. Furthermore, the reduction in overheads for each hall has the potential to benefit every member of the community that pays to use it, and the installations themselves will act as exemplar renewables projects for each local community.

Provided that planning permission can be obtained, and sufficient capital funding can be raised, all the halls have a very high chance of successfully implementing renewable energy systems. If raising capital proves to be a difficult or undesirable process, an alternative option would be to partner with a solar co-op, who would design, procure and manage a system. The halls would benefit from reduced electricity costs, and other financial benefits (from export sales) would be proportional to the degree of investment by the hall into the co-op. Accordingly, deciding which of these two options to prioritise is the next step for each hall committee.

Appendix A. Grant funding and loans

Currently, the UK government is incentivising the uptake of small-scale renewable energy installations through the Sustainable Export Guarantee (SEG) and the Renewable Heat Incentives (RHI). Both of these provide an income proportional to the volume of renewable energy exported, but the RHI is due to close shortly and will likely be replaced by the Clean Heat Grant (which is expected to offer up to £4,000 to homes and small businesses for renewable heating). The SEG is administered by energy companies, who are able to set their own tariff rates. A list of SEG suppliers can be found on Ofgem's website.

Regardless of these incentives, capital funding is key to realising renewables projects, especially for community groups who tend not to have large cash reserves. Locogen has identified the following funding pots which the client may be eligible to apply to. This a non-exhaustive list, and further lists are available on the Community Energy England and Centre for Sustainable Energy websites.

Local Grants

- **Ryedale Community Grants:** Grants of up £5,000 or 25% of eligible project costs (whichever is the lesser) for projects that make a positive impact on community managed spaces: https://www.ryedale.gov.uk/living-here/community-living/community-grants

- **Howardian Hills AONB**: Small grants for community facilities and renewable energy technologies: http://www.howardianhills.org.uk/your-community/community-support/

- **Hambleton Community Grants:** Locogen has been advised that any participants in Hambleton should liaise directly with the Council's grants team to explore capital funding options.

- **North York Moors National Park Village Improvement Scheme:** Grants of up to £3,000 , available to community groups for projects that improve the character or accessibility of a village: https://www.northyorkmoors.org.uk/looking-after/advice-and-grants/village-improvement-scheme

- **Community Partnering Fund:** Grants of between £1,000 and £10,000 available for community groups in the North East for energy and sustainability projects: https://www.communityfoundation.org.uk/post/community-partnering-fund-open-to-groups-in-the-north-east/

Large grants and loans suitable for group applications

- **Reaching Communities England:** Large grants (minimum £10,000) for community projects including refurbishments and equipment: https://www.tnlcommunityfund.org.uk/funding/programmes/reaching-communities-england

- **Energy Redress Scheme**: Large grants (minimum £20,000) for charities conducting emissions reductions projects: https://energyredress.org.uk/apply-funding

- **People and communities:** Grants from £10,001 to £500,000 for community projects including systems and equipment: https://www.tnlcommunityfund.org.uk/funding/programmes/people-and-communities

- **Aviva Community Fund**: Grant of up to £50,000 available for community resilience projects:https://www.avivacommunityfund.co.uk/uploads/terms/aviva-community-fund-eligibility.pdf

- **Social and Sustainable Fund:** Loans of £250,000+ for community projects including those addressing fuel poverty and energy efficiency: https://www.socialandsustainable.com/community-investment-fund/

Other grants and loans

- **Village Hall Improvement Grant Fund:** Grants of £10,000 to £75,000, for up to 20% of eligible costs – currently closed but accepting Expressions of Interest: https://acre.org.uk/our-work/village-hall-improvement-grant%20fund

- **The National Lottery Awards for All:** Grants £300 and £10,000 for community projects including refurbishments and equipment: https://www.tnlcommunityfund.org.uk/funding/programmes/national-lottery-awards-for-all-england

- **Tesco Bags of Help**: Small grants for community projects including environmental improvements: https://tescobagsofhelp.org.uk/home/community-apply-bags-help-grant/

- **Sureserve Foundation Community awards:** Grants of up to £5,000 for community projects that enhance energy efficiency and/or combat fuel poverty: https://www.thesureservefoundation.org/

- **Rural Community Buildings Loan Fund:** Loans of up to £20,000 for energy efficiency in community buildings: https://acre.org.uk/our-work/rural-community-buildings-loan-fund.php

Appendix B. MCS-Certified installers

The list below has been compiled from the Microgeneration Certification Scheme's 'Find an Installer' web search. The following installers are certified to install solar PV and are based within or near to Ryedale and Hambleton.

Installer	Location	Contact
C W Strickland and Son Ltd	Kirkbymoorside, Ryedale	cwstricklanduk@yahoo.co.uk
Peak Power Systems Ltd.	Pickering, Ryedale	mark@peakpowersystems.co.uk
IWE Services Ltd	Staxton, Ryedale	enquiries@iweservices.co.uk
Go Eco Renewables Ltd	Buttercrambe, Ryedale	info@goecorenewables.co.uk
Life's Energy Ltd	Scarborough, Scarborough	darren@lifesenergy.co.uk
My Electrical	Flixton, Scarborough	dan@myelectrical.co.uk
Oval Renewables Limited	York, York	info@ovalrenewables.com
Energi North East Limited	North Allerton, Hambleton	chris@energinortheast.co.uk
Ward Renewable and Energy Ltd	Sandhutton, Hambleton	alex@ward-electrical-renewable.co.uk
Steven J Dresser Electrical Contractors Ltd	Thirsk, Hambleton	stephen.moon@stevenjdresser.co.uk
Collective Green Energy Yorkshire Ltd	Thirsk, Hambleton	info@cgeplumbingandheating.co.uk
IPS Roofing Limited	Richmond, Richmondshire	info@ipsgroup.uk.com

Table 42: Local Certified solar PV installers

Appendix C. Summary specification for roof-mounted solar PV

Item	Criteria	Possible Solution/Information Required
1.	Method of access	Full edge protection and scaffold along building and eaves. Any scaffold to accommodate fire exits as required.
2.	Method of lifting equipment to roof (panels, mounting system)	Manual lifting via scaffold or forklift/telehandler.
3.	Panel specification	The PV modules shall fulfil the requirements of the International Electro-technical Commission (IEC) standard IEC61215, shall be of Class ll, Tier 1 and shall be approved under the UK accreditation scheme MCS. Monocrystalline or polycrystalline silicon cells with a module peak power output ≥330 Wp at Standard Test Conditions (STC).
4.	Method of fixing	Pitched roof mounting system.
5.	External cable containment and route	All DC cables to be mounted on cable tray across roof to plant room and attached to the external walls with trunking. Cables to be brought into the building via a weatherproof entry point into plant room. Cables could be contained within containment similar in finish and colour to existing containment.
6.	Cable entry point	Through external vertical wall into plant room.
7.	Waterproofing cable entry	Contractor to provide appropriate proposal.
8.	Internal (DC) cable route	Route via new cable tray/trunking to inverter location in the plant room.
9.	Inverter location	Located in plant/storage room.
10.	Inverter make and model	Preferred manufacturers are SMA, Fronius, ABB and Solis. Contractor to provide appropriate proposal and make sure they can fit the model specified into the available space.
11.	Electrical schematic describing location of equipment including inverters, AC and DC isolators, meter, dedicated PV distribution board	Schematic required from contractor.
12.	Metering	Contractor to supply and install metering.
13.	AC cable specification and route to proposed point of connection	Contractor to confirm proposed cable specification.
14.	Mains circuit breaker (MCB) specification and point of connection	Contractor to confirm proposed MCB specification.

Table 43: Summary specification for roof-mounted solar PV

Appendix D. Performance Specification for Solar PV installations

Supplier design requirements

The summary specifications in Appendix C are provided for information only. The selected Contractor(s) shall provide a full design service for all aspects of the solar PV system(s). It is anticipated that the design shall generally follow the summary specification. The Contractor will be required to liaise with the Client to confirm the final design is acceptable. This is to include the following:

- Optimum layout of the solar panels on the roof/land to maximise return on investment for the Client;
- Optimise the solar panel and inverter configuration to maximise return on investment for the Client, ensuring that:
  - The solar panels specified are MCS certified; and
  - The inverters are manufactured by either Fronius, SMA, ABB or Solis or equivalent.
- Solar PV mounting system design including carrying out topographical surveys, ground investigations, services checks and the structural and wind load calculations;
- Design the mounting system to fix the panels to the roof, optimise the number of fixings and length of rails;
- Design the mounting system to use anodised rails and fixings and bird deflectors;
- Design the ballast (if required);
- Ensure the structural loadings on the building do not exceed those assessed by the structural engineer and , if required, liaise with the structural engineer to reassess the structural loadings on the building to confirm structural suitability;
- Design the roof fixings and cable entry penetrations to prevent leaks;
- The design of the electrical system between the solar array and the DNO main incomer;
- DC and AC cabling and containment/trenching, isolators and switchgear, inverters, outdoor lockable inverter container (if no space in the building);
- Earthing system, surge protection and lightning protection;
- Single line diagram (SLD) detailing the electrical design of the array up to and including the point of connection to the existing site infrastructure;
- Safe access and lifting for the installation;
- Metering arrangements, ensuring that the meter is OFGEM accredited; and
- Independent monitoring system linked to the onsite Trend BMS system to allow the Client to remotely analyse the performance of the solar PV system.

The design and construction of the solar PV plant must be consistent with the planning approval for the site including any relevant planning and easement conditions. The designs shall comply with all building regulations and relevant British and European standards. In addition, the systems shall be designed in compliance with (among others):

- MIS3002 Issue 3.5: Requirements for Contractors Undertaking the Design, Supply, Installation, Set to Work Commissioning and Handover of Solar Photovoltaic Microgeneration Systems;
- Photovoltaics in Buildings – Guide to the installation of PV systems. 2nd Edition 2006;
- Guide to the Installation of Photovoltaic Systems 2012 (MCS and ECA);
- BS IEC 62548: 2016 Photovoltaic (PV) arrays. Design requirements; and
- BS 7671 and the latest version of the IEE Wiring Regulations.

Supply and install the solar PV system

The Contractor shall procure and install the solar PV systems and this shall include the following services:

- Prepare a site condition report with photographic evidence of the condition of the site including any existing damage to public and private property;
- Discharge all consenting conditions and submit notification of commencement of works forms (as required);
- Procure all equipment and deliver to site;
- Provide storage facilities for all equipment;
- Provide a site compound, welfare facilities and site security;
- Provide all access and lifting equipment;
- Provide all health and safety documentation and PPE equipment;
- Provide a fully qualified team to carry out the installation;
- Carry out trenching and backfilling for electrical installation;
- Install outdoor lockable inverter container (if no space in the building);
- Install solar PV system and cabling; and
- Make good all surfaces and penetrations and any damage to the site.

Commissioning and takeover

The Contractor will inspect and test the completed system to the requirements of:

- MIS3002: Requirements for Contractors Undertaking the Design, Supply, Installation, Set to Work Commissioning and Handover of Solar Photovoltaic Microgeneration Systems, Issue 3.5;
- Photovoltaics in Buildings – Guide to the installation of PV systems. 2nd Edition 2006;
- BS IEC 62548: Photovoltaic (PV) arrays. Design requirements;
- BS 7671 and the current edition of the IEE Wiring Regulations;
- Engineering Recommendation G98 and P28;
- The Distribution Network Operator’s (DNO) requirements; and
- Manufacturer’s guidance for all component parts.

A representative of the Client shall be present at the tests and the Tests on Completion. The Contractor shall make all necessary records during the tests and on completion thereof shall provide the Client with a test report and record in the handover documentation.

Trial operation period

A Taking-Over Certificate shall not be issued until at least 120 hours of continuous operation without fault has been recorded by an independent OFGEM accredited meter.

Once the Trial Operation Period has been satisfied, and assuming all other documentation is complete and the Client has approved completion, the Taking-Over Certificate shall be issued.

Training

The Contractor shall provide the Client with training on the safe operation of the Solar PV systems. This is to include but not be limited to:

- Safe shut down and start up procedures;
- Taking meter readings;
- Identifying inverter and other component faults and procedures in the event faults are identified; and
- Operation of the live data recording system and the visual display.

Handover documentation

The Contractor should provide handover documentation, including drawings (in AutoCAD format to the Client’s satisfaction) and operation and maintenance manuals, providing sufficient detail for the Client to operate, maintain, dismantle, reassemble, adjust and repair the works. The Contractor will provide two copies of the Health and safety file to the Client on completion of all works and prior to the issue of the Taking-Over Certificate.

The handover documentation should include the following as a minimum (and any other pertaining information:

- As-built drawings;
- All results of relevant tests and the Tests on Completion;
- Tests on Completion certificates;
- MCS certificate;
- IEE wiring regulations certificate;
- Operation and Maintenance Schedule detailing the operation and maintenance requirements of the system and including the operation manuals for the equipment;
- Health and safety file and Construction Phase Plan;
- Warranty information; and
- All other relevant information.

The Taking-Over Certificate will not be issued by the Client for the works until all Tests on Completion are complete, the results documented and approved by the Client.

Services and responsibilities

The full list of services and division of responsibilities between the Client and Contractor is provided in Table 44 below. **The Client should define Contractor's responsibilities before procurement of the services.**

Description	**Contractor**	**Client**
Consenting Service		
Confirmation of permitted development rights		
Full planning consent (where required)		
Bat survey		
Building warrant and building control approval		
Application to the DNO for grid connection		
Grid connection agreement		
Application and registration for the SEG Tariff		
Design Service		
Structural survey of the building		
Structural design of any upgrade works required to the building/land to accommodate the solar PV system		
Solar PV array design		
Safe access and lifting design		
Mounting system and fixings		
Ballast design (if required)		
Trenching and backfilling for electrical installation (if required)		
AC and DC cabling, switchgear, inverters, outdoor lockable inverter containers (if required), meter, G99 relay protection and grid connection design		
Annual energy yield calculation		
All relevant design documentation		
Programme		
Health and safety and CDM compliance		
Installation Service		

Description	**Contractor**	**Client**
Site condition report with photographic evidence		
Health and safety and CDM compliance as Principle Contractor and Designer		
Delivery		
Off loading facilities		
Secure site storage facilities		
Crane / lifting equipment		
Cable trenching equipment		
Scaffolding / safe access equipment / edge protection		
Supply all necessary hardware for the complete installation of the solar PV system		
Installation of solar PV system including (but not limited to) fixings, mounting system, ballast, PV panels, DC and AC cabling, inverters, outdoor lockable inverter containers (if required), isolators, G99 protection, meter, PV distribution board, connection to the private electrical infrastructure, etc		
Trenching/backfilling, ducting, containment, roof/wall/building entry, water proofing, etc for all DC cabling from the PV system to inverters and for all AC cabling from the inverters to the point of connection to the private electrical infrastructure		
Spare ways in distribution board		
MCBs in distribution board or new DB where required		
Labelling in compliance with MCS and British Standards		
Commissioning Service		
Commission the solar PV system (including attending a DNO witness test where required)		
Training on site to the Client in the safe operation of the solar PV system		
Revised EPC documentation for the building		
Handover manual (one electronic and two hard copies)		
Generalities		
Contractor's documents		
Project management		
Site management		
Traffic management		
Site clearance and reinstatement		
Parking		
Connection charges from the DNO		
Inform electricity supplier of installation		
Inform planning department of start/end of works (where required)		
PPA and MOP contract (where required)		
Installation of import/export meter		

Table 44: Services and division of responsibilities between Contractor and Client

Appendix E. Risk Register

ID	Phase	Section	**Risk** (Description of the risk)	Severity	Likelihood	Risk level	**Required mitigation** (How to reduce the risk)	Severity	Likelihood	New Risk level	Risk owner
R1	Design and procurement	Financial	Project does not secure grant funding	4	2	8	Prior to any applications, engage actively with funders and to confirm eligibility and address their concerns about the project	4	1	4	Village hall committee
R2	Design and procurement	Financial	Project does not have budget available for match funding	4	3	12	Seek several alternative means of fund raising, such as crowd funding or opportunities to invest in the projects	4	2	8	Village hall committee
R3	Consenting	Planning	Planning application rejected	5	2	10	Engage with local authority at an early stage and follow advise from application feedback.	5	1	10	Village hall committee
R4	Consenting	Grid	G99 grid application too expensive / or fast-track battery storage application rejected	3	2	6	Seek budget estimate for G99 application from DNO at an early stage. Install G98-compliant PV array if too expensive.	2	2	4	Village hall committee
R5	Construction	Programme	Equipment delivery is held up and delivered late to the project.	3	3	9	Project to allow suitable time for procurement/mobilisation	2	2	4	Contractor
R6	Construction	Programme	Bad weather delays programme	3	2	6	Allow float in the programme to allow for uncontrollable weather delays. If possible, prioritise summer period for installation works.	2	2	4	Contractor
R7	Construction	Programme	Contractor takes longer than programmed to undertake the work as identified in their programme	4	2	8	Contractor to confirm their programme and provide regular updates. Contractor to apply additional resources if required to keep to the project programme.	3	2	6	Contractor

ID	Phase	Section	**Risk** (Description of the risk)	Severity	Likelihood	Risk level	**Required mitigation** (How to reduce the risk)	Severity	Likelihood	New Risk level	Risk owner
R8	Construction	Financial	There is an increase in capital costs	4	3	12	Consultant to actively engage with suppliers at feasibility stage to identify costs. Contingency of 5% capital cost increase has been included, and costs should be agreed upon prior to construction phase.	2	2	4	Village hall committee
R9	Construction	Financial	There is an increase in operational costs	4	3	12	Contingency should be allowed at an appropriate level (5% highlighted in feasibility study)	2	2	4	Village hall committee
R10	Operational	Financial	Solar performs poorly compared to expected generation	2	4	8	Financial modelling includes appropriate generation losses to ensure anticipated returns are robust.	2	2	4	Village hall committee
R11	Operational	Security	Equipment is stolen or damaged	4	4	16	In the detailed design phase, it may be decided that security measures beyond those anticipated are required.	2	2	4	Village hall committee