ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

Christ Church
2buy2

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1. Executive Summary

An energy survey of Christ Church was undertaken by ESOS Energy to provide advice to the church on how it can be more energy efficient and provide a sustainable and comfortable environment to support its continued use. This audit has been provided in conjunction with 2buy2, the Church of England's Parish Buying scheme provider and is subsidised from Total Gas & Power, the Parish Buying schemes principal energy suppliers.

Christ Church is large Grade II listed, Victorian church which has been reordered with all the pews having been removed. There is an attached church hall which appears to have been built around the 1980's and contains a daily pre-school. Both church and hall are currently heated by direct gas air heaters. There is both gas and electricity supplied to the site.

The church has a number of ways in which it can be more energy efficient. Our key recommendations have been summarised in the table below and are described in more detail later in this report. It is recommended that this table and the route to net zero carbon are used as the action plan for the church in implementing these recommendations over the coming years.

Energy saving recommendation	Estimated Annual Energy Saving (kWh)	Estimated Annual Cost Saving (£)	Estimated capital cost (£)	Payback (years)	Permission needed	CO2 saving (tonnes of CO2e/year)
Install SavaWatt devices on fridges and freezers	820	£246	£270	1.10	List A (None)	0.21
Add or replace draught strips to external doors to church	923	£92	£450	4.88	List A (None)	0.17
Install a Solar PV array to roof of south aisle feeding both church and hall	8,460	£2,538	£12,950	5.10	Faculty	2.14
Install PIR motion sensors on selected lighting circuits	160	£48	£254	5.28	List B	0.04
Change existing lighting for low energy lamps/fittings	7,133	£2,140	£18,077	8.45	Faculty	1.81
Inject cavity wall insulation into walls to hall	3,692	£369	£6,000	16.25	Faculty	0.68
Top up roof insulation from 100mm to	2,307	£231	£4,800	20.80	List A (None)	0.43

270mm to hall and nave ceilings						
Replace windows to hall	6,922	£692	£19,461	28.12	Faculty	1.28
Install an Air Source Heat Pump into the building to replace existing heating system	32,302	£461	£76,500	165.78	Faculty	5.01
Consider installing Electric Vehicle Charging Points	0	N/A	£2,500	0.00	Faculty	-

The church should check any faculty requirements with the DAC Secretary at the Diocese before commencing any works.

Based on current market prices of 30p/kWh and 10p/kWh for electricity and mains gas respectively.

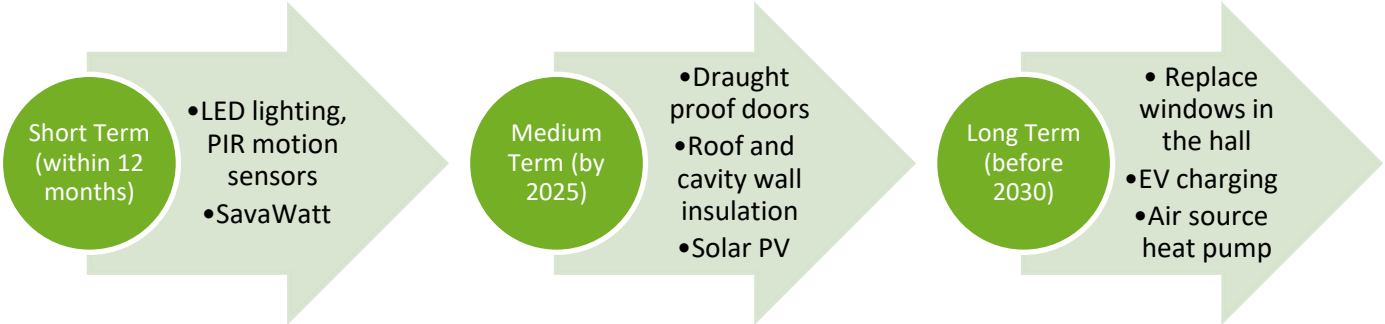
If all measures were implemented this would save the church £6,818 per year and reduce its carbon footprint by 12 tonnes (100%).

2. The Route to Net Zero Carbon

Our government has committed to move towards Net Zero Carbon – the point at which we have reduced emissions as much as we can and then balanced any residual emissions through removal of carbon from the atmosphere. They have done this as part of a worldwide agreement which aims to limit global warming to well under 2 degrees Celsius, with an aim of keeping it below 1.5 degrees Celsius. This will help protect all of us from the impacts of climate change.

In February 2020, the Church of England's General Synod set its own Net Zero Carbon target. The first stage of this target covers energy used by churches, cathedrals, schools, vicarages, other church buildings, as well as emissions caused by reimbursed transport. The target date is 2030.

This church has a clear route to become net zero by 2030 by undertaking the following steps:



3. Introduction

This report is provided to the PCC of Christ Church to give them advice and guidance as to how the church can be improved to be more energy efficient. In doing so the church will also become more cost effective to run and seek to improve the levels of comfort. Where future church development and reordering plans are known, the recommendations in this report have been aligned with them.

An energy survey of the Christ Church, Block Lane, Chadderton, OL9 7QB was completed on the 29th of November 2022 by Matt Fulford. Matt is a highly experienced energy auditor with over 15 years' experience in sustainability and energy matters in the built environment. He is a chartered surveyor with RICS and a CIBSE Low Carbon Energy Assessor. He is a Member of the DAC in the Diocese of Gloucester and advises hundreds of churches on energy matters.

Christ Church	
Church Code	624253
Gross Internal Floor Area	984 m^2
Listed Status	Grade II

The church typically used for 37 hours per week for the following activities

Type of Use	**Hours Per Week (Typical)**
Services	4 hours per week
Meetings and Church Groups	3 hours per week
Community Use	30 hour per week

There is additional usage over and above these times for festivals, weddings, funerals, and the like.

4. Energy Procurement Review

Energy bills for gas and electricity have been supplied by Christ Church and have been reviewed against the current market rates for energy.

The current electricity rates are:

Day Rate	15.726p/kWh
Night Rate	12.9p/kWh
Standing Charge	60p/day

The current gas rates are:

Single / Blended Rate	4.273p/kWh
Standing Charge	£20/month

The energy supplies are purchased through SSE and appear to be on a renewable energy contract. This should be continued with as it is an important part of the process of making churches more sustainable.

A review has also been carried out of the taxation and other levies which are being applied to the bills. These are:

VAT	5%	The correct VAT rate is being applied.
CCL	Not charged	The correct CCL rate is being applied.

The above review confirmed that the correct taxation and levy rates are being charged.

5. Energy Usage Details

Christ Church uses 12,726 kWh/year of electricity, costing in the region of £3,817.92 per year, and 46,146 kWh/year of gas, costing £4,614.58. The total carbon emissions associated with this energy use are 12 CO_2e tonnes/year.

This data has been taken from the annual energy invoices provided by the suppliers of the site. Christ Church has one main electricity meter, serial number 215038065. There is one gas meter serving the site, serial number M025K0409315D6.

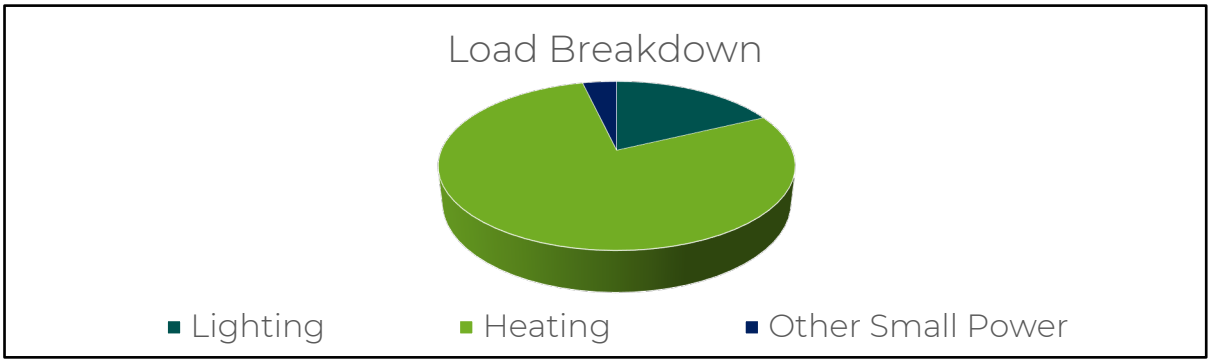
Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	215038065	3 phase 100A	Full AMR Connected	Church cellar
Gas – Church	M025K0409315D6	BKJ-G16M	Full AMR Connected	Church cellar

All the meters are AMR connected and as such energy profile for the entire energy usage should be possible. Half hour meter data has been provided for the purpose of this report and this has been used to verify the data.

5.1 Energy Profiling

The main energy consuming plant can be summarised as follows:

Service	Description	Estimated Proportion of Usage
Lighting	Some LED but mainly fluorescent units to the hall and high-level sodium flood lights to the nave.	18%
Heating	Direct fired gas heaters to both hall and church.	78%
Other Small Power	Kitchen, cleaning, and AV appliances.	4%



As can been seen from this data, the heating makes up by far the largest proportion of the energy usage on site. The other significant load is lighting.

5.2 Energy Benchmarking

In comparison to national benchmarks for church energy use Christ Church uses 35% less electricity and 69% less heating energy than would be expected for a church of this size.

	Size (m^2 GIA)	Annual Energy Usage (kWh)	Actual kWh/m^2	Benchmark kWh/m^2	Variance from Benchmark
Christ Church (elec)	984	12,726	12.93	20.00	-35%
Christ Church (gas)	984	46,146	46.90	150.00	-69%
TOTAL	984	58,872	59.83	170.00	-65%

6. Efficient / Low Carbon Heating Strategy

The energy used for heating a church typically makes up around 80% to 90% of the overall energy consumption. Putting in place a heating strategy that is energy efficient and low carbon is, therefore, of the highest priority

The Church of England is in the process of reviewing its heating guidelines. The process has already established some principles for heating that can help churches as they seek an acceptable combination of comfort, conservation, affordability, and environmental care. The principles can be found at https://www.churchofengland.org/sites/default/files/2020-04/CBC%20Heating%20guidance%20principles%20FINAL%20issued.pdf

As the principles make clear, every church's strategy will be unique to it, informed by many factors, including the nature of its usage, the system it's starting from, the conservation needs of the building, and the resources available. The strategies in this audit are designed specifically for your church.

Our recommendations on heating generally fall within three major areas. Firstly, for all churches we make recommendations that will help to reduce energy wastage and, as a starting point, to optimise the system that you already have

Secondly, we recommend options for many churches that focus on heating people rather than the full volume of the church. Some of the changes that can help with this will be 'soft' changes – others will relate to the heating system itself.

Finally, we make recommendations about moving away from fossil fuels. Moves away from fossil fuels are key to cutting emissions. For most churches, this will involve moving from gas, oil, or LPG to electricity. Electricity currently creates carbon emissions around the same level as mains gas, but the carbon emissions associated with it are reducing rapidly as the UK builds more renewable energy and decommissions its remaining oil and coal fired power stations. Mains gas does have some potential to reduce its carbon content through the use of biogas and hydrogen, but these are less developed solutions and will be unable to deliver 'zero carbon mains gas'. Some local areas may also be considering the option of district heating networks.

While moving away from fossil fuels may not always be possible, as the principles state, "churches should be expected to have at least carefully considered the option of moving away from fossil-fuel based heating (gas and oil boilers) towards electric-based heating." And if such options are not viable now, the churches "can try to be ready for a future retro-fit when technology and the grid has progressed."

The church and larger rooms to the hall are heated via direct fired gas heaters. The units to the church are around 10 to 15 years old and can be expected to have a further 10+ years life left within them. They are an efficient way of heating the church and should be continued until they require replacement and then could be replaced with air to air heat pumps using floor mounted units as a direct replacement of the existing units. The units to the larger hall rooms are much older and in need of replacement in the short term. These can also be replaced with air-to-air heat pumps. Ceiling mounted units may better suit the halls usage and could be combined with replacement lighting and an upgrade of the existing ceiling finishes.

6.1 Air to Air Source Heat Pumps

Air-to-Air Source Heat Pumps (AASHP) work by having an external unit which sucks air in and extracts the heat from it. The pumps concentrate this heat and put it into a refrigeration gas (in the same way as a fridge or freezer works). This refrigeration gas is then piped inside the building in a small pipe where is it then allowed to expand in an internal unit with a fan. This heat is then blown out into the space. This system is identical to an air conditioning system, but it works in reverse to heat the space. As warm air is blown into the space this type of system can heat spaces from cold relatively quickly. Air-to-Air Source Heat Pumps provide around 4.5 units of heat for every 1 unit of electricity used in the heat pump; they therefore have a Coefficient of Performance (CoP) of 4.5.

AASHPs require the installation of external units which look like air conditioning modules in well ventilated external locations. These external units will need an electricity supply and pipework running from them to the heating system. They will also need a drain nearby as the back of the units can build up moisture, which condenses and sometimes freezes on the coils. The larger units do create some low-level noise and therefore the location and baffling of the units may need to be considered carefully.

Examples of external units for ASHP comprising of three smaller 3kW units and two larger 10kW units.

Internal units come in a variety of styles. The most appropriate internal units for most churches are floor mounted units which look very similar to a fan convector heater.

FUA-A - Under ceiling cassette air conditioning unit

Unique under ceiling cassettes for high rooms with solid ceilings or false ceilings with a shallow void. Suitable for all types of commercial applications.

The FUA-A range provides comfortable heating and cooling even for rooms with high ceilings and has individual louvre control flexibility to suit every room layout.

FTXM-R - Wall mount air conditioning unit

Attractive, wall mounted design with perfect indoor air quality. 2 area motion detection sensor: air flow is sent to a zone other than where the person is located at that moment; if no people are detected, the unit will automatically switch over to the energy-efficient setting.

FVXM - Floor Mount Air Conditioning Unit

Designed to fit rooms of any size and shape, it blends well with the interior due to the new design which incorporates more flowing lines and softer edges. These units are ideal when it is not possible to fit a high level wall mount unit for aesthetic or practical reasons.

They are suitable for a wide range of applications including domestic, small to medium offices and commercial uses.

All these units do have a fan element within them and therefore a small amount of fan noise is emitted. This tends to be less than a fan convector heater on a boiler-based system and similar to the noise from a fridge or freezer. Air conditioning units are commonplace in hotel rooms, indicating that the noise is low enough even to be suitable for sleeping environments.

A case study of a church which has installed such a solution is available at 5. Air-source heat pumps at Hethel Church - All Saints Church, Hethel - A Church Near You

7. Energy Saving Recommendations

In addition to having a revise heating strategy there are also a number of other measures that can be taken to reduce the amount of energy used within the church.

7.1 New LED Lighting

The lighting makes up a relatively small overall energy proportion of the electricity used within the church and the hall. There are some areas of the building which have had efficient LED lights installed but there still remains a large number of inefficient fluorescent and SON fittings within the nave, store, Preston room, WC, corridor, and main hall.

It is recommended that the fittings scheduled in Appendix 1 are all changed for LED. There are a vast number of specifications of LED lights on the market, but it is recommended that any LED light should come with branded chips and drivers and offer a 5 year warranty. An example of such a range of fittings is available from http://www.qvisled.com/

If all the lights were changed on a simple "like for like" the total capital cost (supplied and fitted) would be £18,000. The annual cost saving would be £2,000 resulting in a payback of around 8.5 years. This estimate includes for the supply of the lights, the labour to install them and the access required. It does not include for any upgrade to the wiring or a new lighting design both of which the church may wish to consider. Guidance on lighting, produced by Historic England for churches, can be found at https://historicengland.org.uk/advice/caring-for-heritage/places-of-worship/making-changes-to-your-place-of-worship/advice-by-topic/lighting/

7.2 Lighting Controls (Internal)

There are several lights which currently remain on all the time in areas such as the corridor, stores, kitchen, toilet areas and the like. Some of these areas are only used occasionally and for a short amount of time so that, in actuality, the light does not need to remain on constantly. There are also spaces which benefit from a good amount of natural daylight coming in through the windows, such that artificial lighting is not required for much use during the year.

It is recommended that a motion sensor is installed on these specific lighting circuits so that the lights come on only when movement is detected in the space and turn off approximately two to five minutes after the last movement has been detected (note that the duration of the time lag after which the light goes off needs to be considered alongside the type of light that is fitted. LED lights are much more suited to being switched off after only a short duration than some fluorescent lights). These movement sensors, commonly called PIRs, also have light sensors integrated into them so they can be used to make sure that the light does not come on if there is already sufficient daylight in the space.

Your existing electrician or any NICEIC registered electrical contractor can install PIR sensors onto existing lighting circuits. This can be carried out without significant disruption to the use of the space.

7.3 Refrigeration Controls

Within the hall there are various domestic and commercial refrigeration units such as fridges within the kitchen area. These units run 24/7 and contribute to the baseload electrical consumption of the building.

To reduce the electrical consumption of these appliances, it is recommended that they are all fitted with a SavaWatt unit. These units work by automatically detecting the load of the compressor and turning down the power when it is not in full load. This reduces the energy consumption of the refrigeration unit by around 18% while maintaining the cooling of the appliance. It does this by reducing the voltage delivered to the unit when it is idling but allowing the full energy to the unit when it is required.

Supply and installation and further details can be undertaken by SavaWatt directly http://savawatt.com/. (Note the self-installed SavaPlug has been discontinued, but the professionally installed Savacontrol option is available) The installation does not cause any significant disruption to operations and can be undertaken during normal operating times.

7.4 Draught Proof External Doors

There are a number of external doors in the church. The historic timber doors do not close tightly against the stone surround and hence a large amount of cold air is coming into the church around the side and base of these doors.

It is recommended that the draughtproofing around the door is improved and draught strips are added. This could be achieved in a number of ways:

For timber doors that close onto a timber frame a product called QuattroSeal (see link below) is often used in heritage environments to provide appropriate draught proofing.
http://www.theenergysavers.co.uk/application/files/1714/7197/4194/National_Trust_Case_Study.pdf

For timber doors that close onto a stone surround more traditional solutions such as brush draught strips rebated into the edge of the door by a skilled joiner. Other traditional methods such as using hessian or felt pads tacked to the door could be used. Keeping the door maintained in a good condition is also important.

Simple measures such as having a 'sausage dog' style draught excluder laid along the base of a door (it needs to be sufficiently heavy to stay in place), using plasticine of the right colour to fill gaps where daylight can be seen, and putting painted fridge magnets over large keyholes can all be simple DIY measures which are effective.

7.5 Replace windows

The windows on the hall building are single glazed with timber casements and as such are very poor in terms of thermal quality. In addition, many of the openings do not close well against the frames and excessive cold air is being let into the space.

The introduction of new double glazed units would considerably reduce the heat loss from the building and improve thermal comfort. This measure would be costly and disruptive to install but could be considered as part of a refurbishment programme. The use of high quality windows will also reduce external noise transfer and provide added security. To enhance heat ingress in particularly cold areas, double glazing with low emissivity (Low-E) glass could be selected as this allows more solar gain than standard double glazing.

It is therefore recommended to replace these windows with new double glazed windows with wooden/aluminium/uPVC casements set into the existing surrounds. It is suggested that any window installation is undertaken by a FENSA Approved Installer www.fensa.org.uk

7.6 Cavity Wall Insulation

The hall is constructed with a cavity wall method, and the inspection of the wall showed no signs that insulation has been added. Prior to the early 1990's, building regulations did not require walls to be fully insulated and therefore it is likely that there is no insulation present. It could, however, be added through injection into the cavity walls.

It is recommended that cavity wall insulation is considered and added to the walls where appropriate. A survey to check the width of the cavity, exposure of the wall and condition of the cavity should be carried out by a CIGA-approved installer who will then be able to provide you with a quotation to undertake the works. Installing cavity wall insulation will help to reduce heat loss and improve the comfort of the space but needs to be considered alongside other control measures such as TRV's or room sensors to ensure that the space does not overheat because of the additional insulation.

A free survey and quotation for the supply and installation of insulation to the loft spaces can be arranged through ESOS Energy Ltd (contact Adrian Newton 0117 9309689, adrian@esos-energy.com).

7.7 Insulation to Roof

The loft void above the hall ceiling was inspected as part of this audit and found to have little insulation present. In all cases where there is 100mm or less of insulation within accessible roof spaces it is recommended that insulation be added to prevent heat loss and create a more comfortable environment for the occupants of the building.

Because heat rises, the ceiling/roof of a building is the largest contributing area to heat loss from a building. The insulation of such spaces can therefore have a dramatic impact on both the efficiency of the heating system and the temperature of the space below.

A free survey and quotation for the supply and installation of insulation to the loft spaces can be arranged through ESOS Energy Ltd (contact Adrian Newton 0117 9309689, adrian@esos-energy.com).

8. Other Recommendations

8.1 Electric Vehicle Charging Points

The church hall has a car park to the side and rear of it which serves the church and also the frequently used church hall. In order to make a visible statement on the churches mission of stewardship and to facilitate more sustainable transport choices by those visiting the church and/or using the hall, the church may wish to consider installing an electric vehicle charging point, probably on the side of the church hall to allow visitors to charge their electric cars.

Installing a unit such as a Rolec Securi-Charge http://www.rolecserv.com/ev-charging/news/view/Robust-EV-Charging-With-Rolecs-SecuriCharge-EV-Wall-Unit-Coin-Token-PAYG would allow the organisation control over who is allowed to use the unit with a key operated system. Or given the type of use of the building and control over the usage of the car park as a whole a simple 32 amp type 2 wall pod type charger may be most suitable and these are widely available through many suppliers such as http://www.rolecserv.com/ev-charging/product/EV-Charging-Points-For-The-Home.

Because of the parish office within the building, the church can be considered as a place of work and, as such, installation grants are available through the workplace charging scheme https://www.gov.uk/government/publications/workplace-charging-scheme-guidance-for-applicants-installers-and-manufacturers which will fund 75% of the installation cost up to £500.

9. Renewable Energy Potential

The potential for the generation of renewable energy on site has been reviewed and the viability noted.

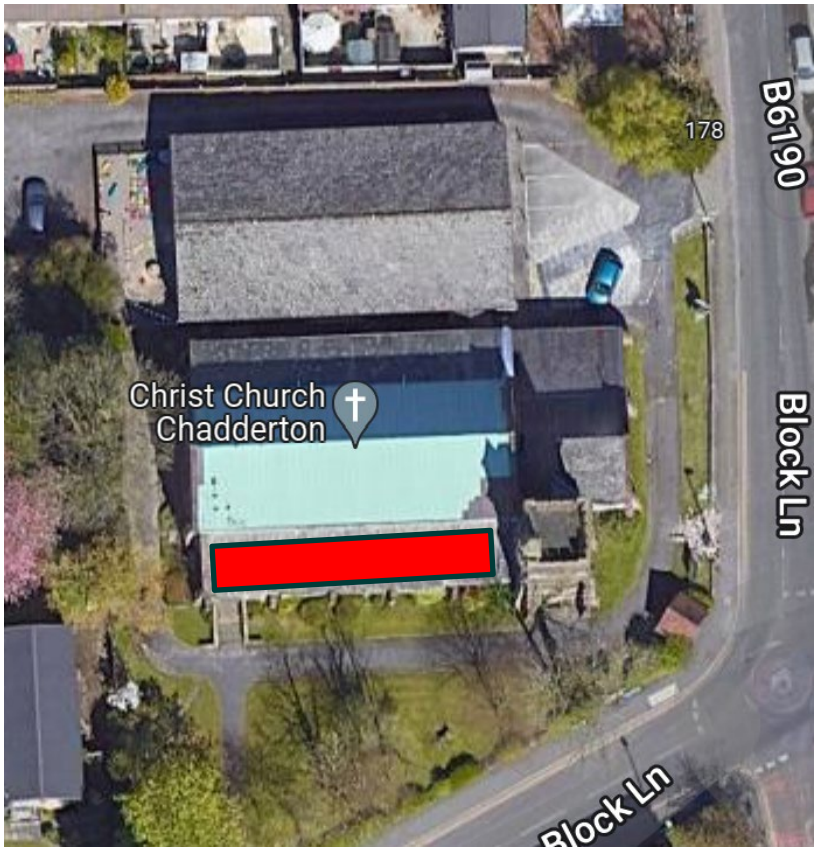
Renewable Energy Type	Viable
Solar PV	Yes
Battery Storage	Yes

Now that the Feed in Tariff scheme has come to an end the installation of solar PV panels in situations where there is not almost full usage of the electricity generated on site is not really viable.

There is potential for a PV array on the roof of the lower South Aisle. The current arrangements around solar panels mean that to be financially viable the building on which they are mounted

needs to consume the vast majority of the energy that they produce. The hall has a constant demand for electricity due to its daily use by the pre-school therefore this would be well suited to being supplied by a PV system. There is a single combined electricity supply for both parts of the building therefore a PV installation on the church would provide electricity into the hall.

Battery Storage is not strictly a renewable energy solution, but battery storage does however provide a means of storing energy generated from solar PV on site to be able to be used at peak times or later into the day when the PV is no longer generating. It therefore extends the usefulness of the existing PV system particularly in this sort of church and would be worth considering alongside the PV installation.



10. Funding Sources

There are a variety of charitable grants for churches undertaking works and a comprehensive list of available grants is available on this Parish Resources page:
https://www.parishresources.org.uk/resources-for-treasurers/funding/

11. Faculty Requirements

It must be noted that all works intended to be undertaken should be discussed with the DAC at the Diocese.

Throughout this report we have indicated our view on what category of permission may be needed to undertake the work. This is for guidance only and must be checked prior to proceeding as views of different DACs can differ.

Under the new faculty rules;

List A is for more minor work which can be undertaken without the need for consultation and would include changing of light bulbs within existing fittings, repair and maintenance works to heating and electrical systems and repairs to the building which do not affect the historic fabric.

List B is for works which can be undertaken without a faculty but must be consulted on with permission sought from the Archdeacon through the DAC. This includes works of adaptation (but not substantial addition or replacement) of heating and electrical systems and also the replacement of existing boilers so long at the same pipe work, fuel source and flues are used. It can also be used to replace heating controls.

All other works will be subject to a full faculty.

Works which affect the external appearance of the church will also require planning permission (but not listed building consent) from the local authority and this will be required for items such as PV installations.

12. Offsetting

As you take action to reduce your emissions, you may also wish to offset those that you cannot yet reduce. If you would like to engage in offsetting, it is important to use a reputable scheme. The Church of England recommends Climate Stewards, which has a simple calculator that can help you to work out how much you would need to offset. https://www.climatestewards.org/

Climate Stewards encourages people to 'reduce what you can and offset the rest' as part of your journey to Net Zero carbon emissions. They provide training and resources to help you understand climate change and its impacts, and to calculate the carbon footprint from your activities including travel, energy, expenditure, and food. Their online carbon calculators for individuals and smaller organisations are free to use, and they provide bespoke carbon footprint audits for larger organisations.

Having reduced as much of your organisation's carbon footprint as you can, there will always be unavoidable emissions from your work and travel. Carbon offsetting allows you to compensate for the negative impact of your carbon emissions by funding projects which take an equivalent amount of CO_2 out of the atmosphere. These either involve locking up ('sequestrating') CO_2 as trees grow or reducing emissions by using low-carbon technology such as fuel-efficient cookstoves or water filters.

Climate Stewards has a close relationship with all their project partners in Ghana, Uganda, Kenya, Tanzania, Nepal, and Peru. They work closely with them to design, develop, implement, and monitor projects which will not only mitigate carbon, but also bring tangible benefits to the local community - including improved health, savings in time and money previously spent on buying or collecting fuel, and improvements in local biodiversity. Each project is assessed using their Seal of Approval protocol which enables us to assess and monitor carbon mitigation and ensure robust, sustainable, and transparent partnerships.

Appendix 1 – Schedule of Lighting to be Replaced or Upgraded

Room/Location	Number of fittings	Recommended Upgrade	Annual Saving	Total Cost	Payback
Nave (17.4 x 23.4)	8	3 Spot Track lights	£862	£12,000	13.93
Store	1	5ft Single LED	£25	£88	3.57
Preston room	4	600 x 600 25W Panel	£225	£299	1.33
WC	2	2D LED 11W	£18	£118	6.68
WC	1	4ft Single LED	£10	£72	7.18
Corridor	7	5ft Single LED	£134	£615	4.58
Meeting room	4	600 x 600 25W Panel	£225	£299	1.33
Main Hall	9	600 x 600 25W Panel	£437	£1,123	2.57
Stores	4	5ft Single LED	£98	£351	3.57
Kitchen	1	600 x 600 25W Panel	£28	£299	10.54
Cleaners	1	2D LED 11W	£22	£59	2.64
WCs	2	2D LED 11W	£18	£118	6.68
WCs	2	5ft Single LED	£38	£176	4.58

Appendix 2 – Window Replacement

Height	Width	Number	Area
1.5	1.2	5	9
1.9	1.5	2	5.7
0.6	1.8	5	5.4
0.6	1.2	3	2.16
2.4	3.2	1	7.68
			29.94