ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Christopher's Church
PCC of Chester

THE CHURCH OF ENGLAND

Author	Reviewer	Date	Version
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1. Executive Summary

An energy survey of St Christopher's 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.

St Christopher's Church is located in the small village of Pott Shringley, on the outskirts of Stockport. The building was initially founded in the late 14th century, with no significant extensions since it's first construction. Internally there are fixed box pews and a balcony overlooking the nave. The church is listed on the National Heritage List for England. 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 and a clear path towards net zero carbon. 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 diagram below are used as the action plan for the church in implementing these recommendations over the coming years.

Energy and decarbonisation recommendations	Estimated Annual Energy Saving (kWh)	Estimated Annual Cost Saving (£)	Estimated capital cost (£)	Payback (years)	Permission needed	CO2 saving (tonnes of CO2e/yr)
Contact suppliers to arrange for the meters to be changed to smart meters	None	None	Nil	N/A	None	N/A
Switch electricity (and gas) suppliers to ones which provide 100% renewable (or green gas) supplies	None	None	Nil	N/A	None	Offset 1.21 tonnes
Improve pipework lagging and insulation on existing boiler	1,352	£162	£1,120	6.9	List A	0.25
Timers on fuse spurs to water heaters	125	£38	£350	9.3	List A	0.02
Change existing lighting for low energy lamps/fittings	69	£21	£920	44.6	List B	0.01
Replace heating system for electrical based heating solution (underpew heaters)	16,580	£108	£23,303	216.4	Faculty	2.91
Consider registering for Eco Church	The Eco Church programme, which is recommended by the Church of England, helps congregations care for the environment in all aspects of church life. The programme is free; you can, however, make a donation to A Rocha UK towards its costs.					
Create a procurement policy for appliances (and other goods)	Commit to buying only appliances with the new energy efficiency ratings of A, B or C at the lowest when those you currently have reach the end of their useful life. (NB ovens, air conditioners and space or water heaters are still on the older rating scale, so for these, try for A+++.)					

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

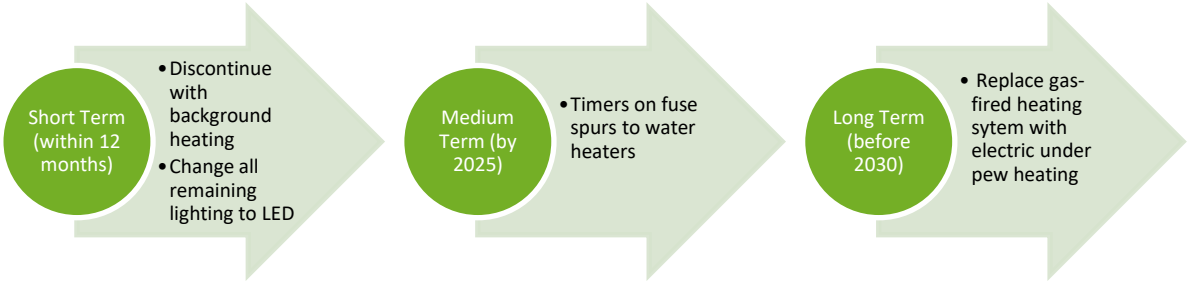
Figures in the table are based on current contracted/market prices of 30p/kWh and 10p/kWh for electricity and mains gas respectively. The carbon figures are based on the DEFRA 2022 carbon emission factors of 0.21107 for electricity, 0.18 for gas and 0.27 for oil. Do note that as energy prices increase, payback periods decrease.

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 St Christopher's 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 St Christopher's Church, Shrigley Rd, Pott Shrigley, Macclesfield SK10 5RT was completed on the 17th of November 2022 by Nathan Tonkin. Nathan is an experienced energy auditor with over 4 years' experience in sustainability and energy matters in the built environment.

St Christopher's Church	
Church Code	609287
Gross Internal Floor Area	202 m^2
Listed Status	Grade I
Average Congregation Size	75-80

The church typically used for 10 hours per week for the following activities

Type of Use	Hours Per Week (Typical)
Services	5 hours per week
Meetings and Church Groups	3 hours per week
Community Use	2 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 St Christopher's Church.

The current electricity rates are:

Day Rate	14.9590p/kWh
Night Rate	10.4260p/kWh
Standing Charge	£23.07/quarter
Availability Charge	0.5910p/kVA

The current gas rates are:

Single / Blended Rate	3.563p/kWh
Standing Charge	£51.40/month

The electricity is supplied by sse and is not purchased on a renewable tariff. Going onto a renewable tariff is an important part of the process of taking churches towards net zero. The church is therefore encouraged to consider procuring its electricity from suppliers that offer 100% renewable electricity, and in some cases 'green' or 'carbon neutral' gas.

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.

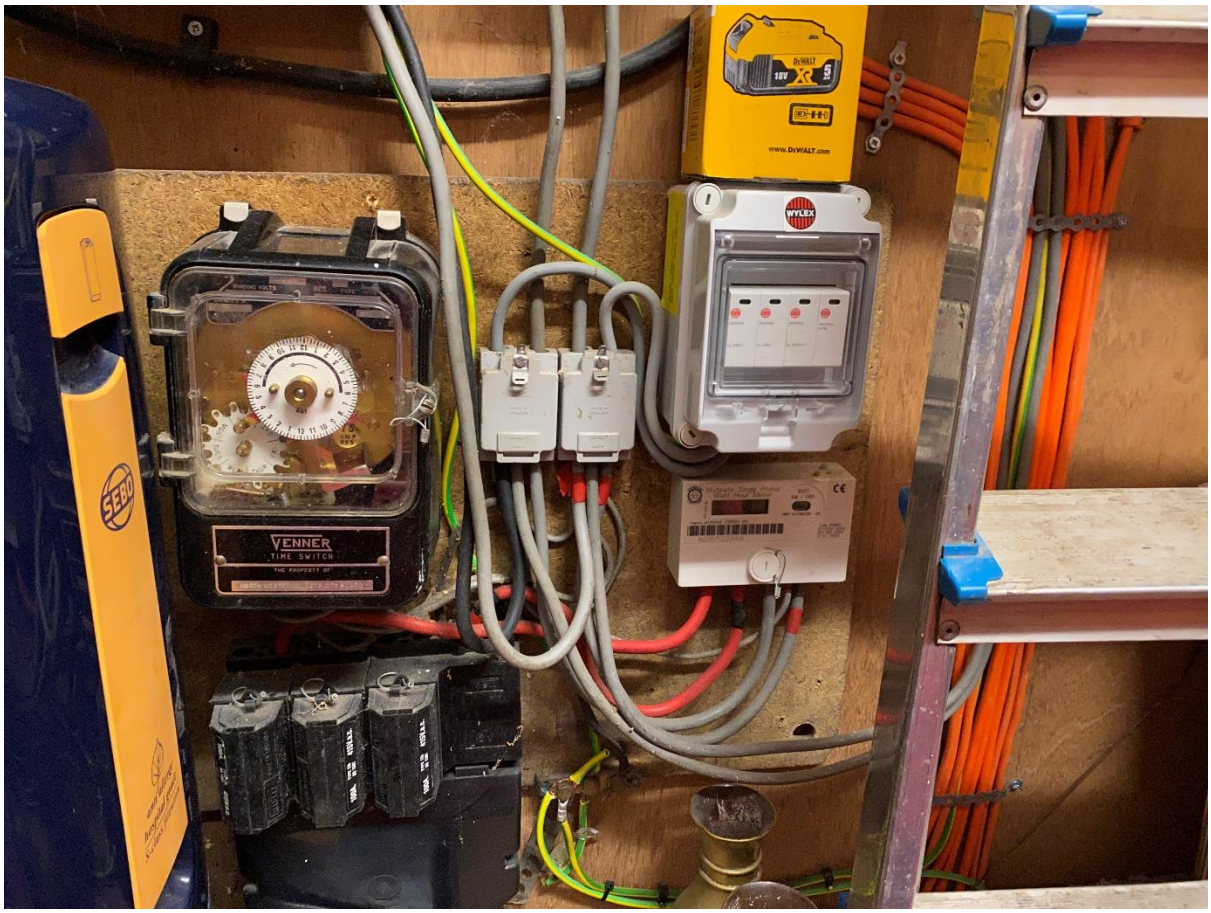
5. Energy Usage Details

St Christopher's Church uses 6,254 kWh/year of electricity, costing in the region of £1,876 per year, and 27,035 kWh/year of gas, costing £3,244. The total carbon emissions associated with this energy use are 6.14 CO_2e tonnes/year.

This data has been taken from the annual energy invoices provided by the suppliers of the site. St Christopher's Church has one main electricity meter, serial number A03M133944. There is one gas meter serving the site, serial number G4K00055191801.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	A03M133944	Single phase 100A	N	GF elec switch cupboard
Gas – Church	G4K00055191801		N	GF cupboard

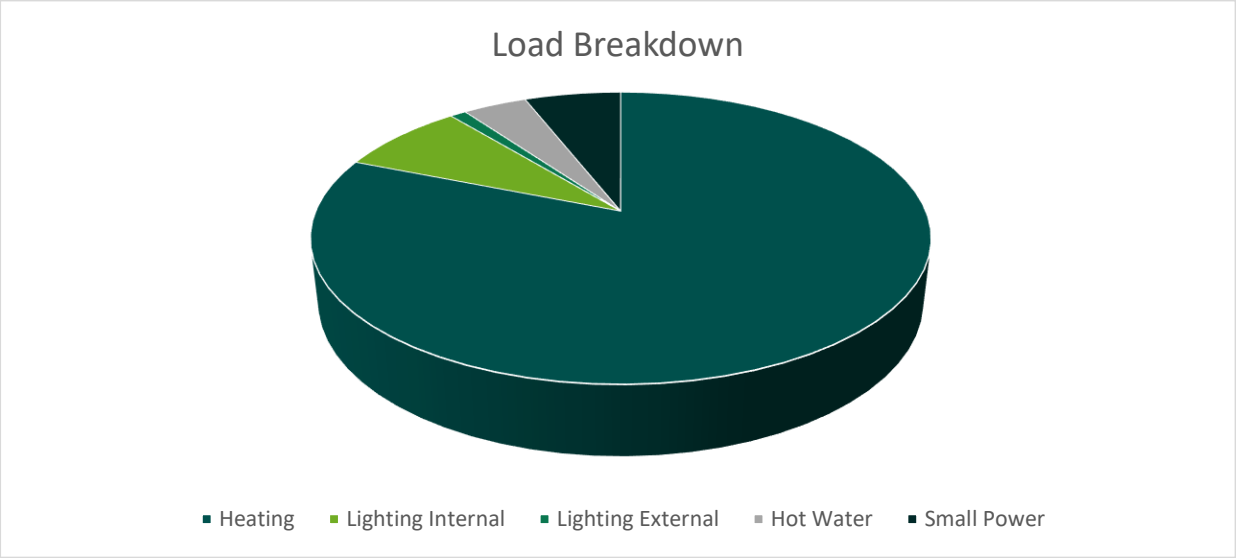
It is recommended that the church consider asking their suppliers to install smart meters so that the usage can be monitored more closely, and the patterns of usage reviewed against the times the building is used.



5.1 Energy Profiling

The main energy consuming plant can be summarised as follows:

Service	Description	Estimated Proportion of Usage
Lighting	**Main Church** <25 LED bulb chandeliers in nave >10 LED spotlights in chancel <5 fluorescent tube lighting around entrance and toilets	9%
Heating	**Main Church** 1x ACV Prestige condensing gas boiler 75kW input	81%
Hot Water	**Main Church** 1x Stiebel Eltron undersink HW heater serving toilet sinks	4%
Other Small Power	**Main Church** 1x projector with assorted AV equipment Other IT equipment	6%



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 St Christopher's Church uses 55% more electricity and 11% less heating energy than would be expected for a church of this size. It should be noted that the national benchmarks do not make any specific adjustment for the amount of time the church is used, and the usage of this church will therefore affect how it performs against this benchmark.

Due to the low usage and the background heating strategy, it would be expected that the church uses less electricity and more heating kWh. However, this benchmark shows the opposite.

	Size (m^2 GIA)	St Christopher's Church use kWh	St Christopher's Church use kWh/m^2	Typical Church Use kWh/m^2	Variance from Typical
Electricity	202	6,254	30.96	20	54.80%
Heating Fuel	202	27,035	133.84	150	-10.78%
TOTAL	202	33,289	164.80	170	-3.06%

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. Heating also often uses gas or oil as its primary fuel. These are fossil fuels with high carbon emissions and little opportunity to decarbonise in the near future. Mains gas does have some potential to reduce its carbon content through the use of bio gas and hydrogen, but these are less developed solutions and will be unable to deliver 'zero carbon mains gas' in the foreseeable future

It is therefore important to review and set out a plan to make heating more efficient and less carbon intensive. One way to achieve this is to consider a transition to electrical heating where this also represents an efficient and comfortable solution for churches. Electricity currently has carbon emissions of around the same level as mains gas, but the carbon emissions associated with electricity are reducing rapidly as the UK builds more renewable energy and decommissions its remaining oil and coal-fired power stations.

The church is currently heated by a gas fired boiler which was installed in approximately 2012 and appears to have a further 10-15 years serviceable life before requiring replacement. The boilers provide heating to cast iron column radiators around the perimeter of the church, including to the altar and chancel. In addition, there is oversized and exposed pipework which contributes to the heating of the church.

The church makes use of fixed wooden pews in the nave and aisles, and there is one row of fixed choir stalls in the chancel.

The church is used twice per week on a Sunday for service and the typical congregation size is 75-80. There are a few other events that happen during the week, including evening prayer meetings. The heating is set to come on several hours earlier in the winter to ensure the church is warm for this service.

The various options for a decarbonised heating solution have been reviewed in the table below.

Decarbonisation Heating Solution	Viable
Air to Water Source Heat Pump	No – unsuited to current heating pipework and heat emitters
Air to Air Source Heat Pump	No – does not suit use of building
Water Source Heat Pump	No – no water source locally
Ground Source Heat Pump	No – significant archaeology
Under Pew Electric Heating Panels	Yes – fixed pews and building usage mean this is the most efficient way of heating
Electric Panel Heaters (to provide supplemental heating only)	Yes – supplemental heating in chancel and balcony
Over Door Air Heater (to provide a supplemental warm welcome at the door only)	No – already installed
Overhead Infra-Red Heaters	No – visual intrusion to the church would do harm, least preferred heating source due to comfort
Heated Chair Cushions	No – other solutions preferred

The recommendation is therefore that the church consider electric under pew heaters. As described below.

6.1 Install Electric Under Pew Heaters

Electric under pew heaters provide a high level of thermal comfort to people sat in the pews. They are not installed to try and heat the entire air volume of the church, instead thermal comfort is achieved through a flow of warm air rising past the person in the pew. This means that the heaters should be installed under the entire length of all the pews that are likely to be used.

These heaters warm up almost instantly and a flow of warm air over the pew area is created within around 15 minutes of their being turned on. This significantly reduces the amount of preheating required before each use of the building and can make electric heating cost competitive with gas. It is important that this reduced 'on time' is properly reflected in any comparisons with other types of heating.

We would therefore suggest that the following works could be considered:

Install under pew heaters suspended from brackets from the underside of the pew seat as follows:

Nave, 2x 7 rows with three 650W heaters in each row between uprights

South aisle, 6 rows with two 450W heaters and one 300W heater between uprights

North aisle, 4 rows with two 650W heaters in each row between uprights

Cable runs to the pew heaters should run along the along the existing routes (all cabling should be in armoured cable or FP200 Gold when above ground) to both rows of pews. Each pew heater to be switched with a neon indicated fused spur located underneath the pew seat.

A similar installation could be fitted to the narrow row choir stalls if so, desired which would consist of:

2 rows with two 650W heaters between uprights

A case study of a church which has adopted this solution is available at https://www.churchofengland.org/about/environment-and-climate-change/st-andrews-chedworth-electric-heating

Photos of installations are shown below. In addition, several churches have recently installed such systems. If you would like to find out about churches whom you could ask about their experiences, please contact the diocese.

Brown BN Thermic 650W under pew heaters fixed to underside of pew seats for pews which have no solid backs.

Black 650W Norel under pew heaters fitted to solid pew backs.

6.2 Install Electric Panel Heaters

Electric panel heaters can provide additional heating to areas where there are no pews. Suitable electric panel heaters would be far-infrared panels. These heaters have a strong radiative effect (where heat is reflected to people from the surface) as well as a light convective effect (where air is warmed and moves around to heat the general space). For this reason, these heaters tend to provide a relatively instant sense of heat and comfort within a specific space and only need to be on for short periods of time. The heating effect spreads out from the panel by up to 3 meters, although this is reduced by people and furniture. This means that these heaters provide a useful source of supplementary heating or primary heating for some well-defined areas, but are not very well suited to providing a complete heating solution for a church without other forms of heating (such as under pew). As these heaters warm up almost instantly, this reduces the amount of preheating required before each use of the building and can make electric heating cost competitive with gas. It also means that areas using this form of heating can rapidly and economically be brought into used for short or unplanned meetings if needed.

It is recommended that the PCC consider installing supplementary electrical panel heaters in this area (on a time delay switch) allowing removal of the existing radiators.

These can be purchased widely and fitted by any competent electrician. It is recommended that they are fitted with a time delay switch so they cannot be left on accidently after use.

If you would like to discuss panel heaters with a church in the diocese that already makes use of them, please contact the diocese.

Electric panel heater installed behind an altar

7. Improve the Existing Heating System

In the years before the replacement of the existing heating system it is recommended that measures are taken to improve the efficiency of the existing heating system. These should include:

7.1 Discontinue with Background Heating Strategy

Most traditional churches were constructed without any form of heating. The modern addition of heating is not needed to preserve the fabric but only to provide thermal comfort to occupants. The previous trend of 'conservation heating' for fabric issues is now largely considered to be unnecessary and is being avoided by the likes of National Trust and English Heritage. The only times when background heating may be required is if there are historic wall paintings or for the preservation of large artefacts such as tapestries. The organ (and other sensitive areas such as historic papers stored in the vestry) may require some local background heating specific to that area. In general, sensitive paper records should be removed for storage in the county archive. Organs can be installed with a local background tube heater within the organ casing in order to provide the heat where it is required. The fabric is often subject to the greatest damage by humidity (which is naturally higher when the air is warmer as warmer air has greater capacity for holding more moisture), as a result of large temperature swings (from central heating systems turning on and off) and from the excessive drying out/baking of timbers where high temperature heating units have been fixed to them (such as overhead heaters fixed to timber wall plates).

Providing constant background heating to the church building as a whole is excessive and wasteful of energy. At the very least we would recommend that this background level is reduced to a maximum of 8°C and ideally avoided all together.

8. Energy Saving Recommendations

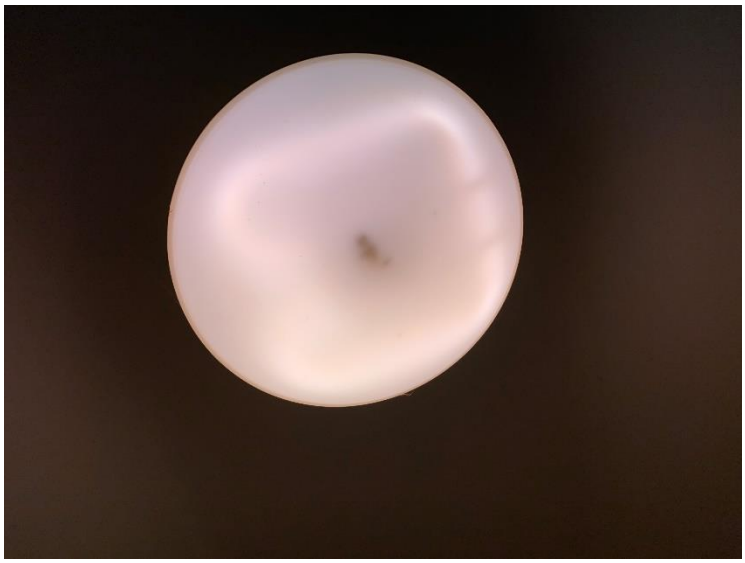
In addition to having a revised heating strategy there are also a number of other measures that can be taken to reduce the amount of energy used within the church.

8.1 New LED Lighting

The lighting makes up a relatively large overall energy proportion of the electricity used within the church. There are some areas of the building which have had efficient LED lights installed but there are still a large number of inefficient fluorescent fittings within the toilets and entrance.

It is recommended that the fittings scheduled in Appendix 1 are all changed for LED fittings. There are a vast number of specifications of LED light fittings on the market, but it is recommended that any purchased should come with branded chips and drivers and offer a 5 year warranty. An example of such a range of fittings is available through Parish Buying.

If all the light fittings were changed on a simple “like for like” the total capital cost (supplied and fitted) would be £920. The annual cost saving would be £21 resulting in a payback of around 45 years. This estimate includes the supply of the lights, the labour to install them and the access required. It does not include 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/



8.2 Insulation of Pipework and Fittings

The pipework around the boiler has the majority of its straight lengths insulated, but the more complex-shaped pipework fittings, such as valves, have been left uninsulated. These exposed areas of pipework contribute significantly to heat loss from the system and make the plant room unnecessarily warm. The exposed hot surfaces also represent a health and safety risk of burns for those working in the area.

It is recommended that these areas of exposed pipework and fittings are insulated with bespoke flexible insulation jackets. These wrap around the various elements but can be removed and then replaced for any servicing activities.

8.3 Timers on Fuse Spurs to Water Heaters

There are a number of electric point of use water heaters in the toilet to provide hot water for hand washing. This only needs to heat the water to the required temperature when the building is in occupation but at the moment this heater is directly wired in without any form of time control and therefore maintains it set temperature 24/7.

It is recommended that the heaters are fitted with a 24 hour/7 day timeclock to replace the fused spur switch. They should be set up with times to match the times that the building is occupied. This will prevent the standing losses from the unit wasting energy during periods when the building is not occupied.

Such units can be purchased at any electrical wholesaler and fitted by your existing electrician or any NICEIC registered electrical contractor.

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 Photo Voltaic (PV)	No – not sufficient demand
Battery Storage	No – no viable solar PV

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.

Having reviewed the site it is not considered that there is good viability for any renewables and instead a good clear focus on reducing the energy demand of the building should continue with a targeted approach on reducing the heating energy.

Battery storage is not strictly a renewable energy solution, but it does 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 solar PV is no longer generating. It therefore extends the usefulness of the existing solar PV system particularly in this sort of church. This is a new but fast-growing technology with prices expected to fall substantially over the next 2 to 3 years.

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 includes the installation of under pew heaters to pews which are made in or after 1850 and are not of historic interest.

All other works, including the like for like replacement of gas and oil boilers 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. This includes items such as solar PV installations.

Appendix 1 – Schedule of Lighting to be Replaced or Upgraded

Room/Location	Number of Fittings	Recommended Upgrade	Annual Saving (£)	Total Cost (£)	Payback
Entrance	2	35 W LED Column	£10	£340	32.4
Nave	2	11W LED 2D	£2	£220	133.5
Toilet	4	600 x 600 LED Panel	£8	£360	42.4