



Energy Efficiency and Zero Carbon Advice



St Nicholas Church, Broadway 2buy2 Church of England Audits



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1. Executive Summary

An energy survey of St Nicholas Church, Broadwey 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 Nicholas Church, Broadwey has origins from the C12 but was principally rebuilt in the C19, with the nave built in 1834 and the chancel and vestry added in 1874, and finally the South aisle and chapel added in the 1900s. The Grade II listed church is located in a suburban area and is built of Portland stone ashlar with a pitched slate tiled roof and exposed wooden ceilings internally. There is a mix of flooring internally with timber suspended floors as well as parquet flooring. The windows are stained glass or leaded windows in stone surrounds and mullions and there is a solid timber door to the South porch. The church is heated by a (currently unworking) gas fired boiler to perimeter radiators. 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)
Replace heating system for electrical based heating solution	2,536	-£239	£5,592	-23.39	List B	0.38
Install SavaWatt devices on fridges and freezers	280	£84	£100	1.19	List A (None)	0.06
Fit timed fused spurs to hot water heaters	486	£146	£270	1.85	List A (None)	0.10
Change existing lighting for low energy lamps/fittings	834	£250	£998	3.99	Consult DAC	0.18
Add secondary glazing to windows	2,500	£250	£2,400	9.60	Faculty	0.45
Fit 270mm of insulation into the roof space	500	£50	£500	10.00	Consult DAC	0.45
Install Draughtproofing to External Doors	750	£75	£3,200	42.67	Consult DAC	0.14



Install PIR motion sensors on selected lighting circuits	2	£0	£24	52.33	List B	0.00
Install an Air-to-Air Source Heat Pump to replace the existing heating system served from the Main Boiler Room	11,978	£513	£46,836	91.24	Faculty	2.05

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.

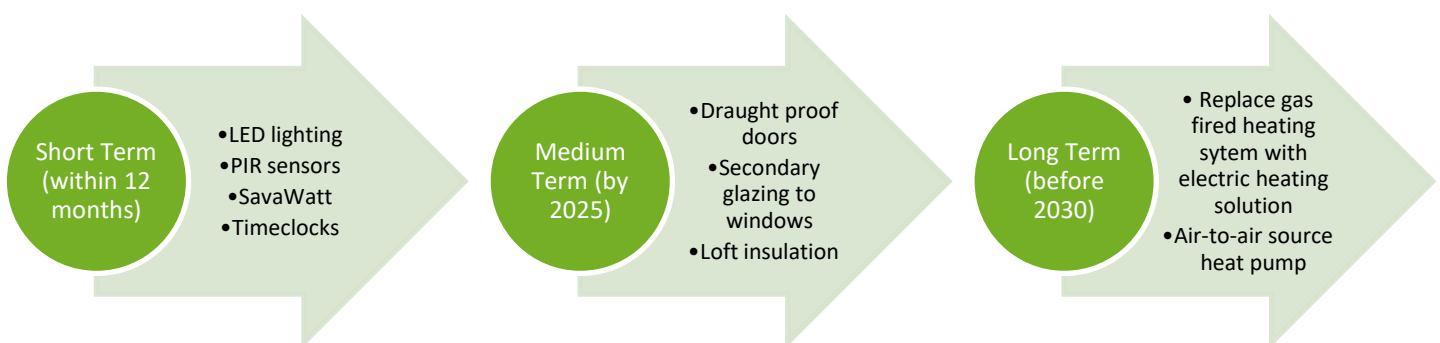
If all measures were implemented this would save the church £1,183 per year and reduce its carbon footprint by 3.66 tonnes (73%).

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 Nicholas Church, Broadway 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 Nicholas Church, Broadway, 681 Dorchester Rd, Weymouth DT3 5LW was completed on the 4th of November 2022 by David Legge. David is an experienced energy auditor with over 10 years' experience in sustainability and energy matters in the built environment. David is a fully qualified ESOS lead assessor with CIBSE and a CIBSE Low Carbon Consultant and a fully qualified ISO50001 lead auditor.

St Nicholas Church, Broadway	
Church Code	634137
Gross Internal Floor Area	397 m ²
Listed Status	Grade II

The church typically used for 7 hours per week for the following activities

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	5 hours per week	25
Meetings and Church Groups	Ad hoc use only	Varies
Community Use	2 hours per week	25

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





4. Energy Usage Details

St Nicholas Church, Broadwey is estimated to use 2,500 kWh/year of electricity, costing in the region of £750 per year, and 25,000 kWh/year of gas, costing £2,500. The total carbon emissions associated with this energy use are 5.03 CO₂e tonnes/year.

This data has been taken from the annual energy invoices provided by the suppliers of the site. St Nicholas Church, Broadwey has one main electricity meter, serial number S03C25204. There is one gas meter serving the site, serial number E016 K03883 19D6.

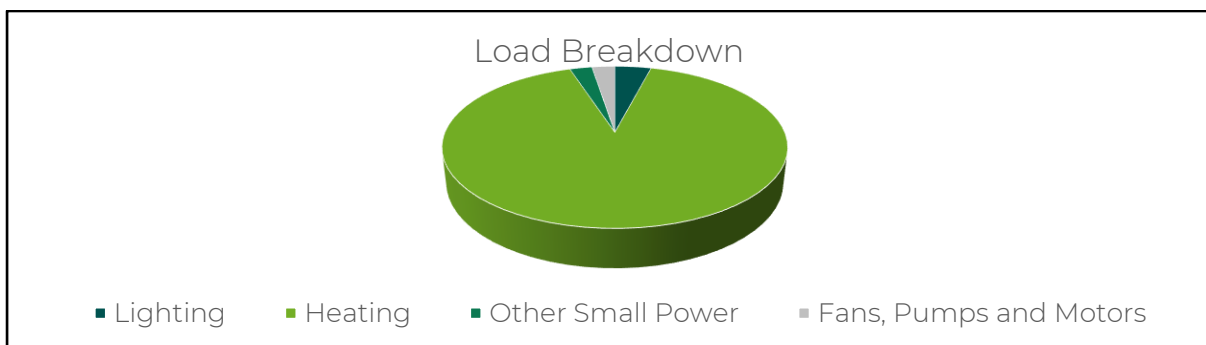
Utility	Meter Serial	Type	Pulsed output	Location
Electricity	S03C25204	3 phase 100A	Pulse Capable, no pulse block or AMR connected	Vestry
Gas	E016 K03883 19 D6	BK G10E	Pulse Capable, no pulse block or AMR connected	Boiler room

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.

4.1 Energy Profiling

The main energy consuming plant can be summarised as follows:

Service	Description	Estimated Proportion of Usage
Lighting	Predominantly PAR38 spotlights and some replacement LED flood lights	4%
Heating	Gas fired boiler to perimeter radiators throughout. Overdoor heater to S porch	91%
Other Small Power	Organ power, kitchen appliances	2%
Fans, pumps, and motors	Heating pump	3%





As can be seen from this data, the heating makes up by far the largest proportion of the energy usage on site.

4.2 Energy Benchmarking

In comparison to national benchmarks for church energy use St Nicholas Church, Broadwey uses 69% electricity and 58% 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
St Nicholas Church, Broadwey (elec)	397	2,500	6.30	20.00	-69%
St Nicholas Church, Broadwey (gas)	397	25,000	62.97	150.00	-58%
TOTAL	397	27,500	69.27	170.00	-59%





5. 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 is currently heated by a gas fired boiler which was installed in 1999 and has reached the end of its serviceable life and now requires replacement, particularly as the boiler is not currently working despite a gas engineer having attended site. The boiler would typically provide heating to both panel and cast iron column radiators around the perimeter of the church, including to the altar and chancel. In addition, there is oversized and exposed pipework in trenches within the South aisle which contributes to the heating of the church. All of the existing pipework and distribution have also passed the end of its serviceable life and requires replacement as it is also reported that the system has rust and sludge within. An overdoor heater above the South porch door provides a warm welcome to the church.



The church makes use of flexible seating to all areas with the exception of the fixed choir stalls in the chancel.

The church is used three times per week for service (Thursday, Friday, and Sunday) and the typical congregation size is 25 for the main eucharist on Sunday. 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 aged heating pipework and heat emitters
Air to Air Source Heat Pump	Yes – preferred heating solution
Water Source Heat Pump	No – no water source locally
Ground Source Heat Pump	No – significant archaeology
Under Pew Electric Heating Panels	No – no fixed pews
Electric Panel Heaters	Yes – to provide supplemental heating to smaller areas
Over Door Air Heater (to provide a supplemental warm welcome at the door only)	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 an air to air source heat pump and supplemental electric heating as described below.

5.1 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 it is 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.

The Centre for Sustainable Energy model¹ can be used to estimate heat load for the building.

$$\text{Heat Load (kW)} = \text{Volume V (m}^3\text{)} \times \text{Insulation Factor}$$

¹ www.cse.org.uk/local-energy/download/estimating-the-heat-demand-of-a-hypothetical-community-building-79



Insulation Factors

Condition	Factor kW/m ³
Poorly insulated with open or broken windows, draughty doors (add 5%)	0.034
Poorly insulated (assume no interventions)	0.033
Some insulating features	Estimate value
Well insulated	0.022
Insulated to 2010 regulations	0.013

Area	Volume m ³	Insulation Factor kW/m ³	Heat Required (Space heating) kW
Church	2,184	0.033	72

Therefore, a heat pump of 72 kW would be required.

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 convactor 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](#)

5.2 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 the following areas on a time delay switch and remove the existing radiators.

Area	Type/ Size	Length (mm)	Watts	Area Heated	Number (or m) required
Sunday school	Electric Far IR Wall Panel 1200W	1200	1200	17-29 m2	2
WC	Electric Far IR Wall Panel 350W	600	350	4-7 m2	2
Vestry	Electric Far IR Wall Panel 900W	1200	900	13-22 m2	1
Lady chapel	Electric Far IR Wall Panel 900W	1200	900	13-22 m2	2
Chancel	Electric Far IR Wall Panel 1200W	1200	1200	17-29 m2	3

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 accidentally 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



6. 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.

6.1 New LED Lighting

The lighting makes up a relatively small 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 still remains a large number of inefficient fluorescent fittings within areas such as the Sunday school room and the lady chapel.



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 £250 The annual cost saving would be £998 resulting in a payback of around 4 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/>

6.2 Lighting Controls (Internal)

There are several lights which currently remain on all the time in areas such as the toilet area. 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.

6.3 Refrigeration Controls



Within the church kitchenette there is a fridge. 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.

6.4 Timers on Fuse Spurs to Water Heaters

There are a number of electric point-of-use water heaters 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 its 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. An example of such a unit would be a TimeGuard FST77. 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.



6.5 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

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.



6.6 Secondary Glazing

The windows of the church are mostly stained glass and leaded single glazed in stone mullions. It is not possible or desirable to change the windows as the building carries listed status. However, the windows in the WC and Sunday school room are relatively small and have a simpler surround, and that they are not primary or important windows within the church, they would be suitable to have secondary glazing installed.

The introduction of secondary glazing would considerably reduce the heat loss through the existing windows and improve both thermal comfort and noise levels, as well as providing added security.



Any possible installation would need to be carefully specified, and companies such as <https://www.selectaglaze.co.uk/heritage-listed-buildings> or <https://www.stormwindows.co.uk/> can provide very discrete and appropriate systems for all types of spaces.

6.7 Insulation to Roof

The loft void above the ceiling was inspected as part of this audit and found to have no 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).



7. 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	No – not sufficient demand
Wind	No – no suitable land away from buildings
Battery Storage	No – no viable PV
Micro-Hydro	No – no water course
Solar Thermal	No – insufficient hot water need
Biomass	No – not enough heating load as well as air quality issues
Air Source Heat Pump	Yes
Ground Source Heat Pump	No – archaeology in ground and radiator system

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 most 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.

8. 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.pariahresources.org.uk/resources-for-treasurers/funding/>

9. 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 as 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.

10. 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 CO₂ out of the atmosphere. These either involve locking up ('sequestering') CO₂ 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 and Aisles	16	PAR38 LED	£216	£272	1.26
Lady chapel	2	PAR38 LED	£11	£34	3.08
Vestry	1	PAR38 LED	£14	£17	1.26
Sunday school room	1	5ft Double LED	£4	£96	21.66
WCs	2	2D LED 7W	£5	£109	22.06