ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Margaret of Antioch
PCC of St Margaret's

THE CHURCH OF ENGLAND
DIOCESE OF WORCESTER

Author	Reviewer	Date	Version
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1. Executive Summary

An energy survey of St Margaret of Antioch 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 Margaret of Antioch was built in 1907 and is of solid wall brick construction with a pitched clay tiled roof and exposed ceiling internally. The church is heated from wall mounted, direct gas fired Dugasar heaters, as well as a couple of electric wall heaters. The hot water is from electric point of use hot water heaters in the kitchen, vestry and WCs. The lighting in the church is predominantly lit by LED's whilst there is some inefficient fluorescent lighting. 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	140	£21	£50	2.35	List A (None)	0.04
Fit timed fused spurs to hot water heaters	810	£123	£450	3.66	List A (None)	0.21
Change existing lighting for low energy lamps/fittings	346	£53	£686	13.05	Faculty	0.09
Install PIR motion sensors on selected lighting circuits	26	£4	£71	18.25	List B	0.01
Fit flow regulators onto existing taps	166	£5	£90	18.30	List A (None)	0.03
Install Draughtproofing to External Doors	3,064	£91	£3,200	35.28	List B	0.57
Add secondary glazing to windows	10,215	£302	£18,000	59.53	Faculty	1.89
Replace heating system for electrical based heating solution	79,251	-£454	£31,414	-69.21	Faculty	13.05

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

Based on current contracted prices of 15.189p/kWh and 2.96p/kWh for electricity and mains gas respectively.

If all measures were implemented this would save the church £145per year and reduce its carbon footprint by 15.8 tonnes (79%).

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 Margaret of Antioch 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 Margaret of Antioch, Hagley Road, Halesowen, B63 4QD was completed on the 20th April 2021 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 Margaret of Antioch	
Church Code	642207
Gross Internal Floor Area	515 m^2
Listed Status	Unlisted

The church typically used for 17.5 hours per week for the following activities

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	10 hours per week	50
Meetings and Church Groups	5 hours per week	15-30
Community Use	2.5 hours per week	
Occasional services (weddings, funerals, etc)	2 weddings/yr, 4 funerals/yr	

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

4. Energy Procurement Review

Energy bills for gas and electricity have been supplied by St Margaret of Antioch and have been reviewed against the current market rates for energy.

The current electricity rates are:

Weekday Rate	15.486p/kWh	Below current market rates
Eve, weekend and night Rate	12.796p/kWh	Below current market rates
Standing Charge	37.799p/day	N/A

The current gas rates are:

Single Rate	2.96p/kWh	Below current market rates

The above review has highlighted that the current rates being paid are in line or below current market levels and the organisation can be confident it is receiving good rates and should continue with their current procurement practices.

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	100% 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 Margaret of Antioch uses 4,913kWh/year of electricity, costing in the region of £ £746.19 per year, and 102,145kWh/year of gas, costing £ £3,023.49. The total carbon emissions associated with this energy use are 20.09 CO_2e tonnes/year.

This data has been taken from the annual energy invoices provided by the suppliers of the site. St Margaret of Antioch has one main electricity meter, serial number 218759403. There is one gas meter serving the site, serial numberE016K1089218D6.

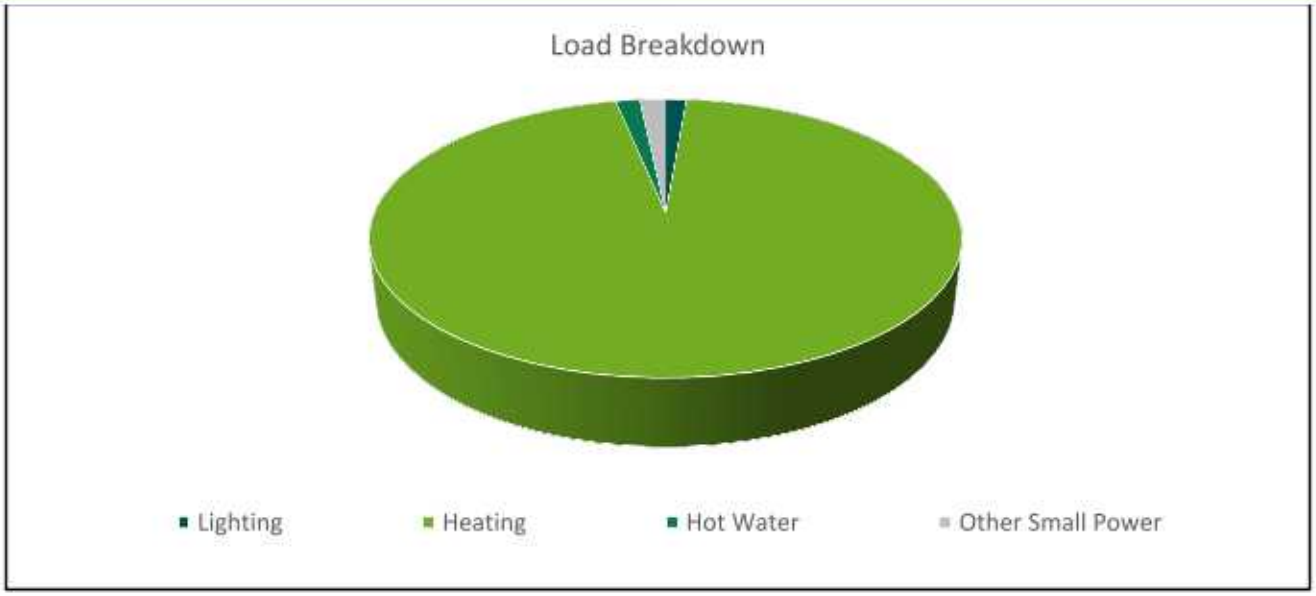
Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	218759403	EDMI Atlas MK7C	Yes but no AMR connected	Corner Cupboard NW
Gas – Church	E016K1089218D6	Honeywell Themis BK G10E	Full AMR Connected	WC

It is recommended that the church consider asking their suppliers to install smart meters for the electricity 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	LED in main church, some fluorescent in vestries and halogen spots in the chancel.	1%
Heating	Direct gas fired heaters in main church	95%
Hot Water	Point of use hot water heaters	2%
Other Small Power	Fridge, electric wall heaters	2%



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

5.2 Energy Benchmarking

In comparison to national benchmarks for church energy use St Margaret of Antioch uses 52% less electricity and 32% more 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 Margaret of Antioch (elec)	515	4,913	9.54	20.00	-52%
St Margaret of Antioch (gas)	515	102,145	198.28	150.00	32%
TOTAL	515	107,058	207.82	170.00	22%

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 bio gas 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."

In the long term we would recommend replacing the gas fired wall heaters wall are replaced with an electrical based heating system. It is reported that as the gas heaters have passed the end of their serviceable life a replacement strategy should be made to move to an electrically based heating solution.

An electrically based heating solution is made more challenging with the removal of the pews and heaters would have to be sited on the walls and if viable on the nave columns, but only as aesthetics and conservation of the fabric allows. In the kitchen,

electric plinth heaters would be a suitable means of heating this space.

Prior to the gas system being replaced, smaller (midweek and evening) services could be held either in the choir stalls or lady chapel with electric under pew and wall heating and then the gas heaters are only required for main Sunday Eucharist and for the Monday after school clubs.

6.1 Install Electric Under Pew Heaters

We recommend that the church consider installing under pew heating in the choir stalls and in the Chancel to give heat for smaller services.

For replacement, two most popular under pew heaters within churches are BN Thermic PH65 heaters (http://www.bnthermic.co.uk/products/convection-heaters/ph/) or similar from http://www.electricheatingsolutions.co.uk/Content/PewHeating.

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

Install BN Thermic Under Pew Heaters suspended from brackets from the underside of the pew seat as follows:

Area	Type/ Size	Length (mm)	Watts	Number Required
Choir Stalls	Electric Under Pew 650W	948	650	9
Chancel	Electric Under Pew 650W	948	650	2

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 the both rows of pews. Each pew heater to be switched with a neon indicated fused spur located underneath the pew seat.

The under pew (see photo below) and panel heaters have been recently installed at St Andrews Church, Chedworth, Gloucestershire, GL54 4AJ. The church is open in daylight hours so can be viewed at any time.

6.2 Install Electric Panel Heaters

In additional to the under pew heaters, the church has the majority of areas which are not able to be heated from pew heaters, and in these areas is recommended that the PCC consider installing electrical panel heaters in the Main Nave, Lady Chapel, Choir Vestry and Vestry on a time delay switch and remove the existing gas fired heaters.

Area	Type/ Size	Length (mm)	Watts	Number Required
Lady Chapel	Electric Far IR Wall Panel 1200W	1200	1200	4
Choir Vestry	Electric Far IR Wall Panel 1200W	1200	1200	2
Vestry	Electric Far IR Wall Panel 900W	1200	1200	1
Nave columns	Electric Far IR Wall Panel 450W	800	800	16
N and S aisle walls	Electric Far IR Wall Panel 1200W	1200	1200	10

Suitable electric panel heaters would be far infrared panels such as https://www.warm4less.com/product/63/1200-watt-platinum-white- . These can be purchased widely and fitted by any competent electrician. It is recommended that they are fitted with a time delay switch such as https://www.danlers.co.uk/time-lag-switches/77-products/time-lag-switches/multi-selectable-time-lag-switch/159-tlsw-ms so they cannot be left on accidently after use.

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 the space and only need to be on for short periods of time. 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 the building can rapidly and economically be brought into used for short or unplanned meetings if needed.

6.3 Upgrade to 3 Phase Electricity Supply

To be able to have sufficient electrical power to supply enough energy into an electrical heating system the church will need to increase the existing electrical supply from single phase 60A supply to a 3 phase 100A supply.

The upgrade to the supply has to be carried out by the District Network Operator in the areas.

The DNO in your area is thought to be Western Power Distribution - www.westernpower.co.uk; 0800 0963080 (East Midlands, West Midlands, South Wales & South West England)

The cost of bringing in a new 3 phase supply can range from £300 to £30,000 but the DNO will provide a quotation for free so it is well worth obtain a quotation in the short term so that decisions can be made on a well informed basis.

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. There are large areas of the building which have had efficient LED lights installed but there still remains a small number of inefficient fluorescent/halogen/SON fittings within the Choir vestry, Vestry, Chancel and WC's.

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 £686. The annual cost saving would be £53 resulting in a payback of around 13 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/

There are some fittings such as 2D in the WC's where the existing fitting can be made more efficient by simply changing the bulb/lamp within the existing fitting to a new LED bulb/lamp. This could be carried out by competent members of the churches internal team, very cost effectively and would be a List A item so no permissions would be required.

7.2 Lighting Controls (Internal)

There are several lights which currently remain on all the time in areas such as vestry, 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 church there is a domestic refrigeration unit within the kitchen. This unit runs 24/7 and contributes to the baseload electrical consumption of the building.

To reduce the electrical consumption of this appliance, it is recommended that it is 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, butthe 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 Timers on Fuse Spurs to Water Heaters

There are various electric hot water heaters and water boilers (for tea making and hand washing) located around the church. These only need to heat the water to the required temperature when the building is in occupation but at the moment these heaters are directly wired in without any form of time control and therefore maintain their 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.

7.5 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.

7.6 Secondary Glazing

The majority of the windows in the church are singled glazed with metal frames. Given that the windows to these areas 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.

8. Saving Recommendations (Water)

8.1 Tap Flow Regulators

The taps to the wash hand basins within the building have been checked as part of the audit and the average flow rate within these has been measured to be 8l/min. The recommended flow rate for hand washing is 4.8l/min and therefore the taps are providing around double the amount of water that is necessary.

The overprovision of water for hand washing is not only a source of excessive water use, but in the case of hot water, it is also a source of wasted energy in the heating that has to go into providing the hot water.

The flow rate of the taps can be easily regulated by fitting flow regulators within the taps. It is recommended that flow regulators are fitted into all the viable hand wash basin taps to save on both water and heating of the hot water.

These regulators can be self-installed or by any good facilities staff or it can be installed by anyone with competent DIY skills.

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 – but only if a private wire to the neighbouring school is agreed, otherwise not worth doing (even if an ASHP installed). Would also need to cut trees/bushes back by south aisle roof.
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	No – insufficient electricity supply, insufficient demand throughout week
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. However, the neighbouring school could benefit from the electricity that a solar PV array could generate and there would need to be a defined commercial agreement made between the church and the school should this be a serious consideration. Any solar array would also require the large trees/bushes to be cut back on the South side of the church to allow for maximum solar gain.

Having reviewed the site as a standalone, 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.

10. Funding Sources

There are a variety of charitable grants for churches undertaking works and a comprehensive list of available grants is available at https://www.parishresources.org.uk/wp-content/uploads/Charitable-Grants-for-Churches-Jan-2019.pdf .

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
WCs	3	2D LED 11W	£9	£208	23.67
Choir vestry	2	5ft Single LED	£22	£176	8.08
Clergy vestry	1	5ft Single LED	£9	£88	9.71
Chancel spots	3	R63 LED	£13	£65	4.96