ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Andrews Church
PCC of St Andrew's, Rugby

Author	Reviewer	Date	Version
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Contents

1. Executive Summary

An energy survey of St Andrews 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 Andrews Church is Grade II* listed Victorian church built in 1879 which is in a town centre position. There is both oil and electricity supplied to the site.

The church has a number of ways in which it can be more energy efficient and reduce its carbon emissions. 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)
Change existing lighting for low energy lamps/fittings	2,469	£318	£1,819	5.72	List B	0.63
Replace heating system for electrical based heating solution	143,541	£4,525	£38,501	8.51	Faculty	38.92
Insulate above choir vestry	4,430	£180	£1,125	6.26	List B	0.82
Add secondary glazing to windows in choir vestry	2,215	£111	£1,200	10.84	Faculty	0.59
Refurbish external doors to seal holes and prevent draughts	4,430	£221	£600	2.71	List B	1.19
Install a Solar PV array to roof of building (assumed 100% of energy generated used in building)	8,633	£1,112	£16,187	14.56	Faculty	2.19
Install an Air Source Heat Pump into the building to replace existing heating system	31,009	£503	£22,500	44.71	Faculty	8.50
Insulate beneath pew platforms	11,075	£554	£1,020	1.84	List B	2.97

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

Based on current contracted prices of 12.8p/kWh and 5p/kWh for electricity and oil respectively.

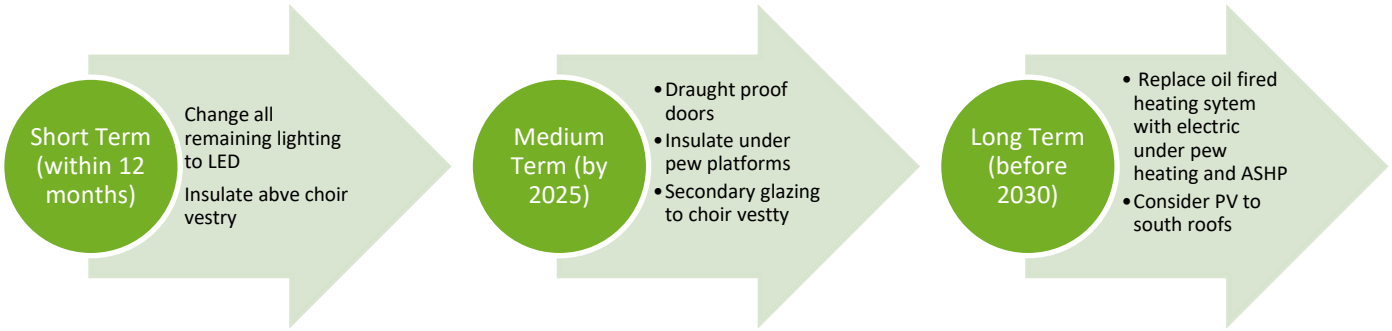
If all measures were implemented this would save the church £7,344 per year and reduce its carbon footprint by 54.97 tonnes (83%).

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 Andrews 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 Andrews Church, Church Street, Rugby, CV21 3PT was completed on the 20th April 2021 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.

St Andrews Church	
Church Code	611116
Gross Internal Floor Area	1,035 m^2
Listed Status	Grade II*

The church typically used for 84 hours per week for the following activities

Type of Use	Hours Per Week (Typical)
Services	12 hours per week
Meetings and Church Groups	2 hours per week
Community Use (café etc.)	72 hour per week

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

4. Energy Procurement Review

Energy consumption data has been provided but no bills have been provided as part of this audit therefore the energy procurement review has not been possible.

5. Energy Usage Details

St Andrews Church uses 26,600 kWh/year of electricity, costing in the region of £3,426 per year, and 221,490 kWh/year of oil, costing £11,075. The total carbon emissions associated with this energy use are 66.04 CO_2e tonnes/year.

This data has been taken from the annual energy data and readings provided by the church. St Andrews Church has three electricity meters, serial number E43D38-H and F72FT06610 with the cellar serial number not known. There is one bunded oil tank located to the south of the church.

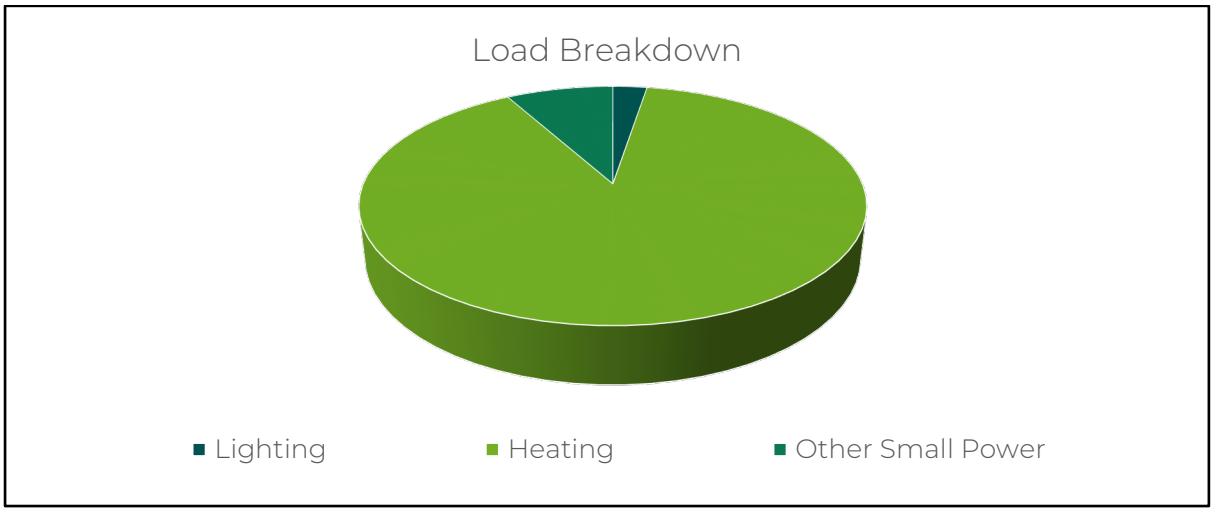
Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Cellar	Unknown	3 phase 100A	Unknown	Boiler Room area
Electricity – Loft	E43D38-H	3 phase 100A	None	Loft area above WCs
Gas – Church	F72FT06610	3 phase 100A	None	Cupboard by entrance

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	Lighting throughout the church	2.6%
Heating	Oil fired heating to the church	89.3%
Other Small Power	Café kitchen usage, electrical heating to café and other areas, office equipment, cleaning equipment, organ and the like	8.1%



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 the café.

5.2 Energy Benchmarking

In comparison to national benchmarks for church energy use St Andrews Church uses 29% more electricity and 41% 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 Andrews Church (elec)	1,035	26,600	25.70	20.00	29%
St Andrews Church (oil)	1,035	221,490	214.00	150.00	43%
TOTAL	1,035	248,090	239.70	170.00	41%

The extended hours and use of the church as a café will be the most significant cause of the increased energy use over a typical church use.

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."

The key for St Andrews is to move off oil and on to an electrical form of heating. There appears to be three good electrical connections already in the church and therefore electrical capacity may not be an issue. The church already uses a form of pew heating by way of wet panel radiators within the pews. It is proposed that these could easily be replaced with electric panel heaters in the same location. Good quality electric panels heaters could be used in other areas where pews have or may be removed.

It is the café and office area along the north aisle that are in most frequent use and therefore these enclosed and self-contained areas could be best served by a relatively small air source

heat pump system to radiators in these spaces which would run relatively constantly to provide a pleasant background heat.

The existing boiler was installed in 2017 and therefore can be expected to have a further 15-20 year life expectancy, this programme of change can therefore we well planned and carefully considered over a number of years and undertaken just prior to the boiler reaching the end of its life.

6.1 Install Electric Under Pew Heaters

Electric under pew heaters could be installed to replace the existing oil fired wet pipes heating the pews. 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:

> 28 rows with three PH45 heaters 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.

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

To the Lady Chappel, High Altar and South aisle, where there are no pews, it is recommended that the PCC consider installing electrical panel heaters in these area on a time delay switch and remove the existing radiators.

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 Choir Vestry

The choir vestry already uses overhead radiant heaters (and the multi-purpose room uses portable heater). It is recommended that these heaters be retained and uses as the sole heating solution when the oil fired system is removed. This would be supplemented by improvements to the insulation of this space (see below) which would result in the thermal comfort being improved overall.

6.3 North Enclosed Areas

There are a number of enclosed areas to the north aisle behind glazed screens in the arches, this form the areas of the café, office and the like. As these are the areas which are used most frequently and have an almost daily use to them, it is recommended that consideration is given to installing an air source heat pump to provide heating to these areas. Air source heat pumps use electricity to power the heat pump which takes heat from the air and puts this into water which can then go into the heating system. A heat pump can create around 3 units of heat for every one unit of electricity.

A new air source heat pump is likely to need a heating capacity of around 20kW and could be located in hidden area of the roof or in the tower area. As heat pumps operate on a low temperature basis some of the radiators and other heat emitters around the site may require upgrading. 3 phase electrical power may also be required to power the units.

Good local renewable companies can be contacted for further detailed assessment of heat pumps and quotes or contact www.yourfutureenergy.co.uk

There are currently government incentives available for installing air to water heat pumps but these are subject to future change and adaption so should be reviewed at the time of implementation.

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

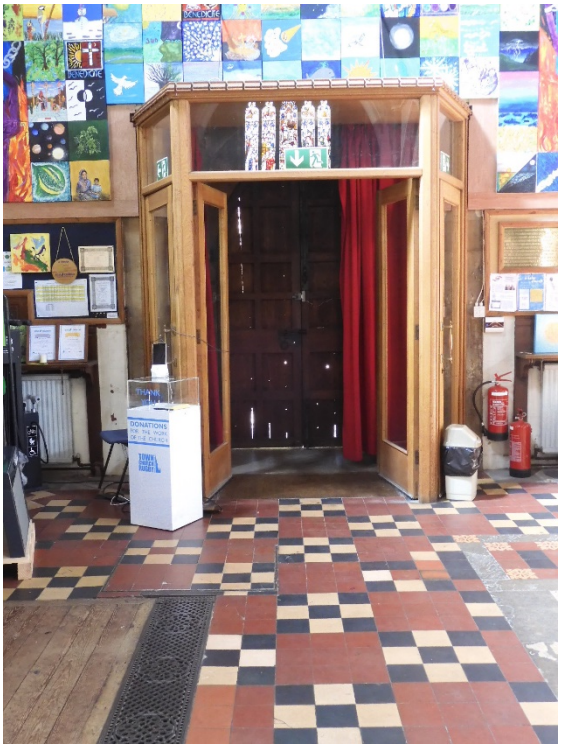
The lighting makes up a relatively small overall energy proportion of the electricity used within the church. There are many areas of the building which have had efficient LED lights installed but there still remains some inefficient fluorescent fittings within the café, office, choir vestry etc.

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 £1,819. The annual cost saving would be £318 resulting in a payback of around 5.72 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 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. The doors themselves also have visible gaps within the timbers



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 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.

7.3 Secondary Glazing

The windows of the choir vestry are singled glazed with metal frames. It is not possible or desirable to change the window(s) as the building carries listed status. Given that the windows to this area are relatively small and have a more simple 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.

7.4 Insulation to Roof

The loft void above the ceiling of the choir vestry was noted to have hatch entrance and thought to have little or 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).

7.5 Insulate beneath timber pew platforms

There is a large void below the timber pew platforms which is thought to have little or no insulation present.

In cases where there is little insulation beneath a suspended timber floor it is recommended that insulation be added to prevent heat loss, and unpleasant cold draughts coming up from the floor and create a more comfortable environment for the occupants.

A suspended timber floor should have ventilation going into it from outside which is required to remove any damp from the timbers, but this ventilation also means the void under the floor is cold. Insulating directly between the floor joints from underneath reduces heat loss from the building and also prevents the cold draughts coming through the floorboards. Insulation measures such as this also need to be combined with control measures such as TRV's or room sensors to ensure that the space does not overheat because of the additional insulation. The insulation is usually fitted by gaining access through the floor by cutting in or using an existing access hatch and then installing from underneath.

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

8. 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	Maybe! – There is a visible south facing roof but it is not highly visible on the primary elevation and the roof is slate. A well designed and discrete array may be possible if it were presented as part of an overall environmental strategy linked to the mission of the church although planning and DAC permission will be a significant challenge but would act as a test case for others.
Wind	No – no suitable land away from buildings
Battery Storage	Yes – in conjunction with 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 – Recommended that a small unit serving the enclosed areas of the north aisle (café, office etc.) would be prudent
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.

There is potential for a meaningful PV array on the roof of the south nave/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 church's energy consumption is fairly significant throughout the day given the use of the church as a café and with the office, therefore a good sized PV array with a battery storage element would be feasible.

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. This is a new but fast-growing technology with prices expected to fall substantial over the next 2 to 3 years.

9. 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 .

10. 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.

11. 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.

12. Other Observations

It was noted that there is a leak to the current boiler around the joint to the burner. This needs to be urgently addressed and the oil that has leaked on the floor cleaned up. The oil has not yet reach any drain or is likely to have seeped into the ground and therefore notification of the leak to the Environment Agency may not be required but if prompt action is not taken the leak will become worse and an environmental contamination incident could occur.

Appendix 1 – Schedule of Lighting to be Replaced or Upgraded

Room/Location	Number of Fittings	Recommended Upgrade	Annual Saving (£)	Total Cost (£)	Payback
WC's	8	NO CHANGE			
Nave	72	NO CHANGE			
Café	4	AR111 LED	£162	£170	1.05
Kitchen	2	5ft Single Vapour LED	£50	£219	4.41
Office	2	5ft Single Proteus LED	£35	£255	7.27
Lobby	4	5ft Double Proteus LED	£36	£674	18.57
Choir Vestry	2	5ft Single Proteus LED	£35	£255	7.27