sustain

Energy Audit of St Britius, Brize Norton (II*)

December 2013

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1.0 Introduction

This report has been prepared to detail the energy saving measures and renewable energy generation potential that exist at St Britius, Brize Norton.

The report was prepared following a site audit conducted by Annie Westaway, Sustain on 4th December 2013. She was accompanied by Carolyn Peach.

A summary of recommendations is made in Section 8.0 of this report.

The findings of this report in no way negate the PCC of St Britius, to petition for a faculty in order to conduct any works at the church. For further advice on the requirement for a faculty the church should seek advice from the DAC Secretary.

Further advice in planning and implementation of the recommendations may be sought from the Diocesan Advisory Committee (DAC).

"...churches aren't just places of wonder, encounter and community; they're also real buildings which make an impact on the natural world, and it's our responsibility to make sure that their carbon footprint is as small as possible. We have over 800 church buildings in our diocese, and with all the people who pass through them in a year, we can influence literally hundreds of thousands more buildings."

Bishop of Oxford

This energy audit has been carried out as part of a scheme to encourage and support church buildings in Oxfordshire to become more energy efficient. The scheme is being run by the Trust for Oxfordshire's Environment (TOE2) in partnership with the Diocese of Oxford, with Sustain as the delivery partner.

TOE2 is an environmental funder for Oxfordshire, supporting and developing projects which improve and benefit Oxfordshire's environment and local communities. TOE2 supports projects in 3 main areas: biodiversity, access to green spaces and energy efficiency and the sustainable use of resources.

This church energy audit scheme for Oxfordshire is being supported by TOE2 with funds from the Patsy Wood Trust, the Beatrice Laing Trust and Charlie Laing, with additional funding provided by the Bishop of Dorchester and the Diocese of Oxford.

For further information about TOE2 please contact us at:
fionadanks@trustforoxfordshire.org.uk or www.trustforoxfordshire.org.uk

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2.0 Church Details

St Britius, in Brize Norton is the local parish church serving the community. It is located in West Oxfordshire and dates back to the 12th century.

2.1 Listed Status

St Britius is of a Grade II* listed status. This listing has been taken into account when determining the recommendations for energy saving measures and renewable energy within this building.

2.2 Size

During the site visit the approximate internal area of the church was measured as 185m^2.

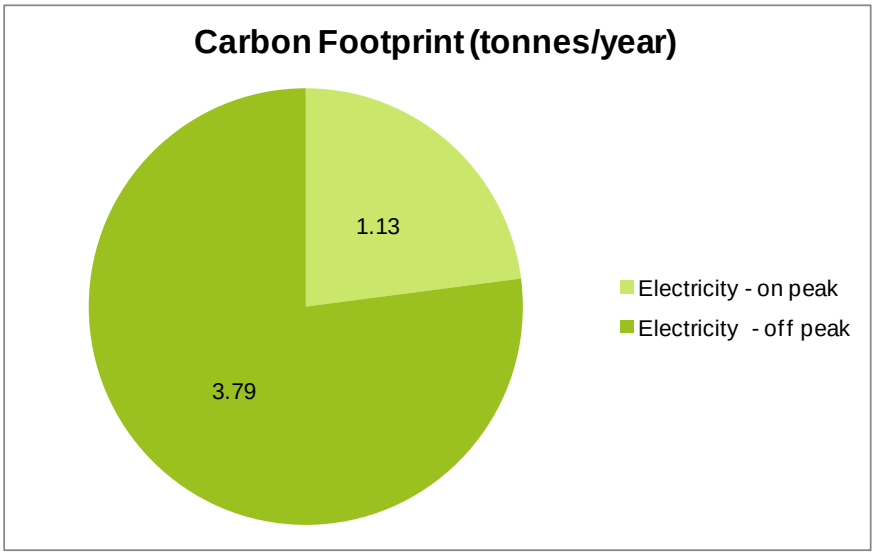
From the application form and discussions on site during the audit it has been established that the typical usage of the church is for 54 hours per month.

	Description	Average Monthly Use
Church Use	2 or 3 services per week	23 hours/month
Community Use	Children's group, Choir practise, Concerts	31 hours/month
Administration	n/a	
Catering and Events	n/a	
TOTAL		**54 hours/month**

The average congregation size is 20-30 people at the Sunday morning services.

2.3 Current Energy Usage

Annual energy bills for the church have been provided and examined. These show that the current carbon footprint of the church is 4.9 tCO_2e per year.



The annual energy consumption has been taken from the energy bills provided from November 2012 to November 2013. These may include the use of estimated readings

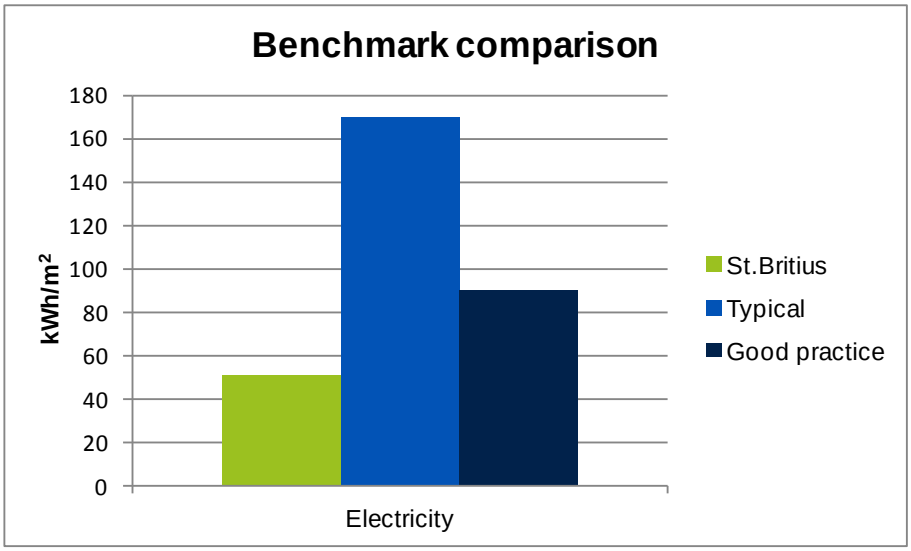
where actual readings have not been taken. **These also include the electricity used by the roofing contractor during the roofing works in mid 2013.**

	kWh/year	Cost/kWh	Total £	Total CO_2e (tonnes)
Electricity - on peak	2,147	£0.14	£295	1.13
Electricity – off peak	7,212	£0.10	£733	3.79
TOTAL	**9,359**	**-**	**£1,028**	**4.91**

Note: The above costs are for the energy only and do not include standing charges, VAT etc

Typical and good practice energy benchmarks[1] exist for non heating electricity use and gas use for churches with gas heating. It is difficult to compare a church with electric heating to these as we do not know the proportion of electricity that is used for heating. We have therefore presented just the combined picture below. This shows St Britius is consuming less electricity than would be expected for a church of the same size. This is positive but there will certainly be room for improvement. The main limit to benchmarking is that it does not take into account occupancy hours.

	kWh/m^2	kWh/m^2 benchmark (typical)	kWh/m^2 benchmark (good)
Electricity	51	170	90



All energy bills should apply the VAT rate of 5% due to the charitable status of PCC's and this is being correctly applied at this church.

[1] CIBSE (2012) *Guide F Energy Efficiency in Buildings*

2.4 Energy purchasing

The church may benefit from obtaining reduced energy rates by switching energy suppliers. The church could also use the opportunity of switching suppliers to explore ‘green electricity’ options.

The Church of England has created the National Parish Buying scheme to provide churches access to negotiated schemes with energy providers and pool their energy to buy in bulk with an ‘energy basket’ – in the first instance this is a ‘brown energy’ basket, but a ‘green’ version will be available if enough churches express an interest, so please specifically register an interest in a ‘green option’ when contacting Parish Buying. By bulk buying energy it is anticipated that the costs will be 10% lower compared to buying alone.

Alternatively the Diocese of Oxford has negotiated green electricity schemes with both Good Energy and Ecotricity, who supply electricity from renewable energy sources at competitive prices.

For more details on all of the above options visit: http://www.oxford.anglican.org/mission-ministry/environment/resources/switch-your-church-to-green-electricity/"

It is further recommended that any cost savings obtained from improved rates through the purchasing scheme or from the reduction in VAT are re-invested in the energy saving measures outlined within this report.

3.0 Electrical Saving Recommendations

3.1 Internal Lighting

The energy used for the internal lighting within churches typically makes up the largest use of electricity (except where all electric heating is installed) and therefore savings made to this area can result in significant overall reductions to energy usage.

The internal lighting within the church has been surveyed and it is recommended that the following improvements are made.

3.1.1 Replace bulbs/lamps within existing fittings

The following lights can simply have a new low energy bulb fitted to them to generate an energy saving. The specification of the existing lamps has had to be estimated as they were located at too great a height to be inspected and there were no spare lamps available.

Location	Existing Lamp Type	Recommended Lamp Type	Example Source
Chancel	100W R80 spot	Replace with CFL R80 15W spots	http://www.tlc-direct.co.uk/Products/MGR8015ES.html
Choir lighting	150W incandescent	Warm white CFL 85W lamps	www.efficientlight.co.uk/Light-Bulbs/85W-FULL-SPIRAL-85WFULLSPIRAL.aspx

The lamps recommended for the choir lighting have been chosen to match the look of the existing lamps in the nave. The only difference in look is that these are a 'warm white' colour rather than the "cool white" colour of the other lamps. These will give the church a warmer feel. These lamps are CFLs (compact fluorescents).

If all of the above lamps are changed we estimate this to **cost £82** but **save £11** per year therefore providing a payback in 7.5 years. We have assumed that the church can safely purchase and install the new lamps themselves without use of an external contractor. The changing of lamps within existing fittings will not require a faculty.

The current lighting is primarily provided by CFLs, however LEDs are fast becoming the more energy efficiency lamp of choice for many people and can give a better quality of light for a lower wattage. Although St Britius is not currently installing LEDs, it is something that should be considered if the lighting is to be changed in the future.

When sourcing alternative lamps it is important to consider the aspects listed below. Suppliers can provide advice and will often allow customers to trial lamps as long as they are returned in re-saleable condition. It is usually not recommended to mix lamp types within a fitting so it may be necessary to change all the lamps at once rather than as each fails.

- The lumen output of the light - a measure of how bright the light is, higher is better.
- Lamp efficacy measured in lumens/Watt - a measure of the lamp's energy efficiency. A good quality LED will now have over 70 lumens per watt output.
- Lamp life expectancy in hours - if a lamp has a short life expectancy, this will have an impact on your maintenance costs. One of the main secondary benefits of LEDs is that the maintenance time is vastly reduced due to the 20,000 - 50,000 hour lifespans.

- The time it takes to get to full brightness, LEDs are often instantly at full brightness, whereas even the best compact fluorescents often only start at 80%, and take a while to fully "warm up".
- Colour rendering quality and index (i.e. 100 - Excellent to 0 - Poor) - a measure of the accuracy with which colours can be seen.
- The beam angle/spread - think of a torch, the wider the beam the less the average illuminance (brightness) is, you get the same light out with a wide beam but it is spread more "thinly" over a wider area, compared to a narrow, bright spot for a "tight" beam.
- Colour temperature - a measure of the colour appearance of a light source ranging from "warm" light (for example, the light a candle produces) through to "cool" light (for example, a bright white fluorescent light). This is measured in Kelvin (K). Lamps below 3,300K are classed as "warm" whilst those above 5,300K are "cold" or "daylight".
- If the light is suitable for use with dimmers.

3.1.2 Controls

The lights are currently controlled by switches located by the South door. In order that those using the building only turn on the lights they need at that time it can help if each switch is labelled with red and green dots to indicate which lights are required for general visiting.

3.2 External Lighting

This church only has minor external lighting to the porch and there are no recommendations of alternative lamps/fittings necessary

3.3 Small Power

There is one point of use hot water heater to provide heating for the toilet and washing up. This is only turned on when the church is in use. The use of this water heater is well managed.

4.0 Heating System Saving Recommendations

4.1 Electric Heating System

The heating at the church is currently mainly provided by electric tube heaters these are located under the pews and attached to the front of pews along the aisle running from the South door to North aisle. It was reported that the heating is inadequate and the church usually feels cold resulting in some parishioners not attending the church in the winter. This may be partly due to the design of the tube heaters which do not have convector fins on them for maximum heat transfer. The heaters are also aging and some may no longer be working. The church is looking to improve the heating in the church and is interested in options for upgrading the heating system.

There are also two 10kW trench fan heaters located adjacent to the main South door and in the chancel.

Lastly there is a small electric panel heater in the toilet for heating the toilet when the church is being used. If this radiator is used for frost protection to ensure the water pipes do not freeze it should be carefully controlled to make sure it is not being left on at a higher than necessary temperature. The church shut down procedure should also include setting this heater back to frost protection setting (see section 7.4).

Underfloor heating fans

To convert the church to heating with gas or biomass (wood) with a boiler and a piped heating system with radiators and/or fan convectors would require significant investment and financially would not result in significant enough savings to warrant the conversion unless the occupancy hours dramatically increase. A slightly larger electrically heated church in the middle of Oxford was recently quoted in the order of £40k for the installation of a new gas boiler, radiators and distribution system and this did not include the connection to the mains gas supply. A biomass system would require an additional external fuel store to be built and requires more attention than a gas system especially in the first year. The current usage of the church is for 54 hours per month with a combination of regular use and occasional use. Given the current usage and that the village hall also provides space for community use, continuing with electric heating appears to be the most suitable heating option for the church.

The current electric heating tubes could be replaced with new heaters, such as Dimplex SCH5 skirting heater. This is a heater originally designed to be fitted above a skirting board which works very well when attached to the back of pews where it radiates onto the legs of the pew occupant and up to where they are sitting, alternatively they can also be located under the seats so that they are hidden. The church treasurer carried out a test for us after our visit and took meter readings at the start and end of one hour when the heaters were running. This gave an energy consumption of 11.8kWh (£1.20). If all of the electric tubes were replaced with 24 no. Dimplex SCH5 skirting heaters (500W) this would consume 17kWh per hour. This is higher but they would not need to be on for as long and the heating effect would be much more effective. St. Margarets in Little Faringdon will soon be installing new electric under pew heaters and could provide their experience. The church could always consider installing a couple of these heaters to test them and switch them manually. The warm up time would be shorter than the existing heaters.

The choice of heating system is also influenced by whether the pews are likely to be removed in the near future. There is currently no free wall space in the nave for radiators/fan convectors. If it is decided to remove the pews then new electric pew heating would not be appropriate.

4.2 Controls and Frost Protection

The electric heating tubes and trench heaters are controlled by a timeclock and switches, located in the tower. The switches are well labelled. However all the heaters are controlled by one timer, therefore regardless of congregation size, all of the heaters will be on.

The settings on the timeclock where checked, and it was found that the settings matched occupancy fairly well, being set for 7.30am - 10.30 on a Sunday morning and 6.00-7.40pm on a Wednesday.

When the current heaters are replaced, we recommend that they are able to be controlled either separately or in banks of heaters, so that they can be turned on to match with the occupancy of the church at any one time. The new design of electric heaters such as the Dimplex SCH5 can be turned on much nearer to the start of the service rather than just under 2 hours as currently.

5.0 Building Fabric

While it is acknowledged that the potential to undertake significant improvements to the traditional and protected fabric is limited, there are a number of areas noted below where improvements can be made which will result in a reduced amount of energy consumed and improved levels of comfort being achieved.

5.1 Roof

There is no loft space in the roof in which to install any insulation. The roof has just been replaced, but there was no serious discussion on including insulation at the same time which is a shame.

5.2 Walls

Given the listed and historic nature of the building and that the walls are exposed both internally and externally no improvement recommendations have been made in this regard.

5.3 Floors

No opportunities for insulation were found.

5.4 Windows

On our visit we discovered one window which was not fully closed in the Vestry. This was rectified and we recommend that the church warden keeps a close eye that all windows are kept fully closed. We also observed some cracks in the windows which we recommend being mended to minimise draughts within the church.

5.5 Doors

The South door appeared to be in good condition and free from gaps which create draughts. We would however recommend the church considers installing an air curtain above the internal side of the South door. This would be instead of the 10kW trench fan heater in the floor.

An air curtain is a device used for separating two spaces from each other, usually at the exterior entrance. The most common configuration for air curtains is a downward-facing blower fan mounted over an opening, blowing air across the surface of the opening. Air curtains can come with, or without heaters to heat the air. It helps keep out outside air, reducing infiltration though the opening. They can also be used to avoid cold draughts by mixing in warm air heated by the air curtain. The fan must be powerful enough to generate a jet of air that can reach the floor.

This will help to reduce heat loss and cold air entering the building just prior to a service and reduce the need for longer warm up times. The air curtain must go across the full width of the door way to be effective. It is likely that the DAC will need to be consulted before installing this measure. There are many manufactures of air curtains, the unit in the photograph is a Dimplex unit. The church will need to employ an electrician to carry out the installation.

Example of an air curtain in a church

5.6 Tower screen

There is a considerable draught that occurs in the church from the tower. There has already been an attempt to reduce this with the installation of a cloth screen between the main body of the church and the tower. This will provide some improvement, but not be fully effective. An improvement to create a fully draught free barrier by still let light into the church would be to glaze the whole area and this could include the arch ways in the wooden screen. This has been done at St.Stephen's in Clanfield.

6.0 Renewable Energy Feasibility

The below reviews the viability of renewable technologies at the church and indicates if it would be possible for each of the technologies to be installed.

More details on the major technologies can be found by going to the following website www.oxford.anglican.org/mission-ministry/environment/resources.

Also included in this website is a directory of installers who will be able to help you in providing you with specific costs for either a feasibility study or installation at your church depending on what your requirements are.

6.1 Solar Photovoltaics

The nave roof is comprised of two pitched roofs, resulting in a South facing valley running the full length of the church which is potentially a very suitable location for a solar photovoltaic (PV) array. A small section of the East end of the valley is visible from the road, so the panels would not be allowed to be installed all the way to the end. Planning permission on Grade II* churches is only granted if the panels are not at all visible.

Aerial view of church
(Taken from Google Earth)

Ideally a solar PV system should face between south east and south west, and be free of shade. For best performance they should be angled at 30 to 40 degrees – although you will still catch a reasonable level of sunlight at angles of 20 – 50 degrees. Solar panels can be fairly heavy, so your roof must be strong enough to hold them, however Solar PV systems are easy to install, need virtually no maintenance and are estimated to last 40 years. Solar PV systems generate electricity from the solar radiation from the sun, and any electricity that is being generated can be used within the building or fed back to the National Grid. Some arrays do not work if any part of the array is shaded and it would be important to check whether the system proposed will still work if partially shaded.

There is space for the inverter in the vestry. The availability of distribution board spare ways of a suitable capacity would need to be checked.

An initial assessment indicates that there would be space for at least a 2.5kWp installation with a yield of approximately 2,125kWh. The church will be able to use this electricity when it is occupied during the day, reducing the electricity bill. The installation would be eligible for Feed-In Tariff payments which are currently 13.5/6.85p/kWh (depending on the building's energy rating) for generated electricity and 4.64p/kWh for exported electricity. Depending on the amount of electricity generated and exported, the church could expect to pay off the initial investment within 20 years. However this would vary slightly depending on the exact make and model of the PV units being considered and the Feed-In Tariff rate at the time.

6.2 Micro-Wind

Micro wind units require highly exposed sites and should be located 250m away from buildings. They are not suitable to be located in the curtailage of listed buildings. Given these parameters it is concluded that micro wind generation is unsuitable at this site.

6.3 Micro-Hydro

Hydro electricity is a highly efficient source of renewable energy but requires a flowing body of water with a differential height, this is not present at this site and therefore such an installation would not be feasible.

6.4 Solar Thermal

Solar thermal installations are best suited to heat water for use in washing up, hand washing and bathing. The demand for hot water is very minimal within the church and therefore the use of renewable heat for such a small demand is not recommended.

6.5 Ground Source Heat Pump

Given the church yard has numerous archaeological features with graves and the like it is not recommended that any consideration is given to the feasibility of ground source heating within this building. The church would also need to have a wet heating system (i.e. radiators) to be compatible with this technology.

6.6 Air Source Heat Pump

Air source heat pumps are most effective in very well insulated buildings with long occupancy hours. The church would also need to have a wet heating system (i.e. radiators) to be compatible with this technology. They are therefore not deemed to be appropriate for this site.

6.7 Biomass

A biomass boiler could be installed at this church as there is access for fuel deliveries (the fuel can be blown from the delivery vehicle to the fuel store) and there is hidden space for an external boiler house and fuel store to be built behind the tower. It would need to be built in-keeping with the adjacent church building. A wet heating system would however need to be installed in the church and we have concluded that it is not currently suitable for the church on financial grounds (see section 4.1). We have however given further information below in case the church occupancy rises in future and it is decided to install a wet system.

Biomass boilers burn logs, wood chips, wood pellets or other forms of biomass. The most advanced boilers are fully automatic. They control the amount of fuel and air supplied to the combustion chamber. As a result they are highly efficient and emissions are low.

They are fed with wood chips or pellets from a large hopper sited nearby. If you've got space, manufacturers recommend a hopper that's big enough to hold a year's supply of fuel. This minimises transport and delivery costs for fuel, as well as work for the owner. Maintenance is minimal – although you will need to clean it and remove the ash about once a month.

The boiler would require slightly more maintenance than a gas boiler so a service and maintenance contract should be put in place. The system would be eligible for the Renewable Heat Incentive which is currently 8.6p/kWh (small commercial biomass, tier 1).

The cost of the installation of the boiler would need to be obtained from installers due the specific requirements of the church. A biomass boiler alone can cost between £5,000 to £11,000, however the cost of the installation, distribution system, radiators and boiler room would all also need to be included. As these costs are specific to the church we are not able to provide an estimate as the parameters are wide ranging.

You also might find it useful to contact Oxfordshire Woodfuel Programme (setup by TOE2) who provide advice and support in this area www.oxonwoodfuel.org.uk.

7.0 Energy Management

Energy savings can be achieved by simply keeping a closer eye on your church's energy use and communicating your carbon footprint to the congregation. Typical steps would be as follows.

7.1 Measure

- Nominate someone to have lead responsibility for energy management
- Take monthly meter readings and keep a record of these
- You could even take a meter reading at the start and end of when your church is used on a Sunday and use this to calculate the carbon footprint and costs of the service
- If you would like to establish how much it costs to run the church heating per hour you could take a meter reading at the beginning and end of an hour when only the heating is on (e.g. before a service if the heating is turned on more than an hour in advance).

7.2 Calculate and monitor

- Calculate the energy use using the meter readings and look for any stories behind the numbers e.g. how does this year compare with last? If it's greater, what are the reasons behind this? Is there anything that could be done to mitigate the increase?
- Calculate the church's carbon footprint.
- If you have not joined the scheme already, in order to provide more detailed review and measurement of the church's carbon footprint in the future, we recommend that the church join the CofE's national Shrinking the Footprint Energy Monitoring Scheme with sMeasure or a similar energy monitoring scheme. This will help the church estimate its future costs of energy and report on its carbon.
- For more information on the scheme please visit www.oxford.anglican.org/mission-ministry/environment/resources/energy-monitoring-scheme

7.3 Communicate

- Let the congregation know the carbon footprint of the church and the annual energy running cost
- Ask them to consider energy efficiency where it is under their control
- Ask for suggestions and ideas on how to reduce the church's carbon footprint
- Communicate to the congregation with a poster for example the latest carbon footprint figure each month / quarter and how it compares with the same period last year

7.4 Housekeeping

- Write up a procedure for energy efficiency in the church and associated buildings to help user of the building use the space more efficiently and effectively, and giving them the ability and know-how to make these changes.
- These procedures could include what to turn on (such as lighting and heating) when the building is being used for different functions, e.g. open for public during the day, services on a Sunday and midweek or larger public events such as flower displays.

8.0 Summary of Recommendations

This report has made numerous recommendations on improvements that can be carried out to reduce energy and carbon emissions from the operation and use of this church.

These have been summarised here in short, medium and long term measures taking into consideration the payback, capital investment and ease of carrying out each improvement.

These recommendations and this report should be presented to the next available PCC meeting and an action plan developed to implement as many of these actions as possible.

The costs below are indicative only based on our experience and are not specific to this church.

Short Term Improvement Measures			
Description	**Estimated Cost**	**Estimated Saving per year**	**To be actioned by**
Measure	£0	The savings depend on how much energy wastage there is currently. A fair estimate is 5% of energy consumption a year ~ £50.	
Calculate and monitor	£0		
Communicate	£0		
Housekeeping	£0		
Label light switches	£0	Saving included in the above	

Medium Term Improvement Measures			
Description	**Estimated Cost**	**Estimated Saving per year**	**To be actioned by**
Replace chancel lamps x 4	£36	£24	
Replace choir lamps with warm white CFL x2	£48	£9	
Installation of air curtain	£1,400	Improved comfort. There may also be some saving in heating use but probably church would just be heated to higher temp.	
Fix broken glazing	Dependant on how many panes to be fixed at one time. Another church was quoted £400.		

Long Term Improvement Measures			
Description	**Estimated Cost**	**Estimated Saving per year**	**To be actioned by**
Glaze gap between church and tower	Obtain quotation from specialist glazing installer	Improved comfort. There may also be some saving in	

		heating use but probably church would just be heated to higher temp.	
Replace electric heaters with modern electric skirting heaters	£3,400 for whole church (Approx £100 per heater including labour, assume 24 required). Could be installed in just most heavily used pews first.	Improved comfort. £104 (assume warm up time of new heaters 1 hour rather than 2 and assume controls allow only 25% of church to be heated)	
Consider installing gas boiler and wet heating system	Quotation to be obtained from installer – likely to be in the range of £35-50K plus maintenance costs.	Not calculated as assumed this will only happen if occupancy dramatically changed.	
Consider installing biomass boiler and wet heating system	Quotation to be obtained from installer – likely to be in the range of £40-55K plus maintenance costs.		

9.0 Funding options

You may wish to consider seeking funds to implement the energy efficiency improvements recommended in this report. For further information please contact:

- **Diocese of Oxford** – for the latest funding advice for energy efficiency improvements that the diocese is aware of please contact the Diocesan Environment Officer using environment@oxford.anglican.org or 01865 208745.

- **TOE2** – can consider applications for up to £10,000 for works recommended in the Sustain report, usually supported with funds from Grundon Waste Management through the Landfill Communities Fund (LCF). www.trustforoxfordshire.org.uk

- **Other Landfill Community Funds** – the following organisations may consider applications from projects within 10 miles of the relevant landfill sites.
  WREN – www.wren.org.uk
  Viridor Credits – www.viridor-credits.org.uk
  Biffaward – www.biffa-award.org

- **Renewable Technologies** – Technologies that produce heat or electricity may be eligible for an on-going payment based on the amount of energy produced.
  - For heat generating technologies, such as biomass boilers, the Renewable Heat Incentive (RHI) might be applicable. For further information, please go to www.energysavingtrust.org.uk/Generating-energy/Getting-money-back/Renewable-Heat-Incentive-RHI
  - For electricity generating technologies, such as solar PV, the Feed In Tariff (FIT) will be applicable. For further information please go to www.energysavingtrust.org.uk/Generating-energy/Getting-money-back/Feed-In-Tariffs-scheme-FITs