# Energy Audit of St Mary and St Nicholas, Littlemore (II*)

January 2014

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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 Mary and St Nicholas, Littlemore.

The report was prepared following a site audit conducted by Marisa Maitland, Sustain on 22nd January 2014. She was accompanied by Tom Albinson.

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 Mary and St Nicholas 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 Mary and St Nicholas in Littlemore is the local parish church serving the community. It is located in Oxfordshire and dates back to 1836.

## 2.1 Listed Status

St Mary and St Nicholas 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 280m$^2$.

From discussions on site during the audit it has been established that the typical usage of the church is for 98 hours per month.

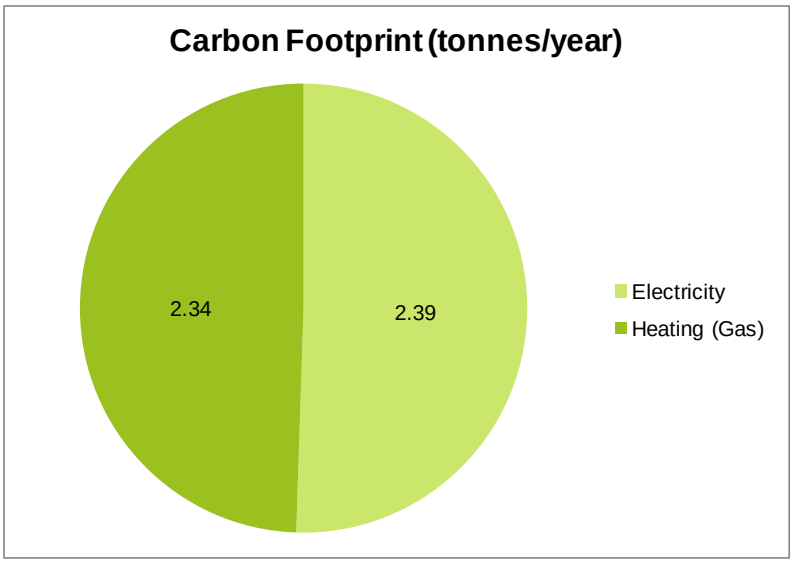
| | Description | Average Monthly Use |
|---|---|---|
| **Church Use** | 2 or 3 services per week, Morning Prayer. | 97 hours/month |
| **Community Use** | | |
| **Administration** | | |
| **Catering and Events** | Occasional | 1 hour/month |
| **TOTAL** | | **1104 hours/year** |

The average congregation size is dependent on the service, and varies between 40-50 people.

The Morning Prayer is usually held in the vestry, where only the electrical heaters are used.

## 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 4.73t$CO_2$e per year.



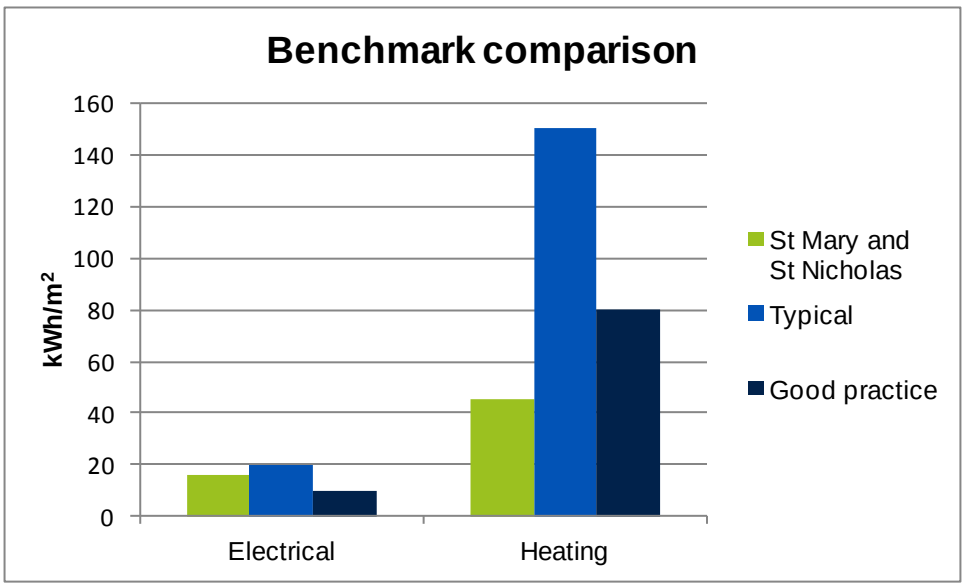
The annual energy consumption has been taken from the energy bills provided from December 2012 to December 2013. These may include the use of estimated readings where actual readings have not been taken.

| | kWh/year | Cost/kWh | Total £ | Total $CO_2e$ (tonnes) |
|---|---|---|---|---|
| **Electricity** | 4,552 | £0.1123 | £511 | 2.39 |
| **Gas** | 12,719 | £0.0409 | £520 | 2.34 |
| **TOTAL** | **17,271** | | **£1,031** | 4.73 |

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

In comparison with national benchmarks[1] St Mary and St Nicholas's consumes less electricity and gas than would be expected for a church of this size. This is positive but there will still be room for improvement. The main limit to benchmarking is that it does not take into account occupancy hours.

| | kWh/m$^2$ St Mary and St Nicholas | kWh/m$^2$ benchmark (typical) | kWh/m$^2$ benchmark (good) |
|---|---|---|---|
| **Electricity** | 16 | 20 | 10 |
| **Gas** | 46 | 150 | 80 |




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 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 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 existing fittings with new low energy fittings

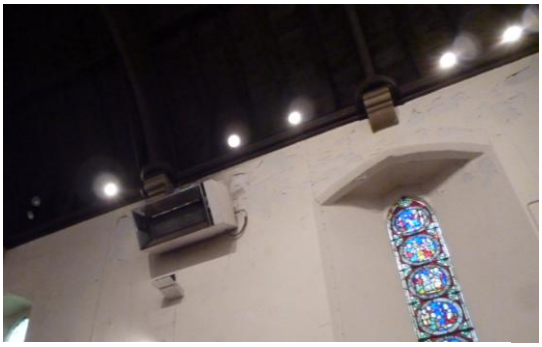
Due to the nature of the existing fittings the following lights would require the fitting to be replaced to create a low energy light source.

| Location | Existing Fitting | Recommended New Fitting | Example Source |
|---|---|---|---|
| Nave and Chancel spot lights | Assumed PAR38, 120W fittings. | Dimmable 15W LED lamps | http://www.lyco.co.uk/philips-15-5w-master-ledspot-par-38-warm-white-dimmable.html#collateral-tabs |

If all of the above lamps are changed we estimate this to **cost £2,800** but **save £200** per year therefore providing a payback in 14 years. The calculation is based on the assumption that the church lighting is only on for Sunday services and ad-hoc during each week, to a total of 8 hours per week. If the use of these lamps increases, the payback will be shorter. The cost savings also do not take into account the cost of replacing the existing bulbs and the reduced maintenance costs from installing lamps with a longer lifetime.

Changing the light fittings should be carried out by a qualified electrical contractor and advice on the requirement of a faculty should be sought.

When sourcing alternative bulbs 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.



Current spot lights in the nave

- 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 vestry and they are clearly labelled.
In order that those using the building only turn on the lights they need at that time it is advised that each switch is labelled with a green or red dot to show which lights are required for the difference uses of the building.

Light switches

## 3.2 External Lighting

This church only has minor external lighting to the vestibule and on one of the external walls. The vestibule light is left on during the day so visitors to the church can see the church inside, as access is limited to the vestibule. This light is a low wattage CFL.

## 3.3 Small Power

There is not much small power electrical equipment in the church, there is an amplifier and sound system which are used for services, and these were switched off at the time of the visit.

# 4.0 Heating System Saving Recommendations

## 4.1 Heating overview

The heating at the church is currently provided by a mix of ceiling mounted gas radiant heaters and portable gas room heaters.

The four radiant heaters were installed at the church in 2000, but in recent years they have not been performing well which has resulted in one of the heaters now unsafe to use, and one of the others works intermittently. As 50% of the heaters are out of action, it has resulted in the church buying four portable gas heaters which are located in the aisle and more are possibly going to be bought in the future.

Wall gas heaters

Portable gas heaters

The gas heaters are only used on a Sunday and are manually controlled. They are turned on at 7.30am, ready for a 10am service and then switched off again at 12.30pm.

The portable heaters might be providing a stop gap until a more permanent heating solution is installed, however be aware that the cost of running the portable heater is £0.17 per kWh, compared to mains gas at £0.045 per kWh. As such in the long run to use this as a heating solution alone could cost the church over £2,000, compared to £500 if using the same amount of energy from mains gas.

As such we recommend that the church consider a long term heating solution that is not based on the portable gas heaters, but either a mains gas boiler or a biomass boiler. As the church is considering a re-ordering and extension to include kitchen and bathroom facilities, this would be a good time to reconfigure the heating for the church.

There is also an electric heater in the vestry, which is only used on Sundays and is manually controlled.

## 4.2 Gas boiler installation

Due to DAC guidelines it is unlikely that the system can be replaced with similar wall mounted gas radiant heaters. If the church wanted to have mains gas fired heating, a gas boiler and wet radiator system would be the most obvious option.

The church would require a gas boiler which could be located in the vestry and a wet distribution system via radiators around the church. Initial calculations assume a 110kW boiler would be required. An estimated cost for a high efficiency gas fired boiler, controls, distribution pipework is between £35,000- £50,000. Based on an assumed number of heating hours, it would cost approximately £1422 per year to heat the church.

The church should ensure that the system specification includes good controls and maximum efficiency with individually controlled radiators, well lagged pipework and connections and an antifreeze based inhibitor put in the system which reduces the need for boiler frost protection. Fan assisted convector radiators may be well suited in order to distribute warmth around the space, although the noise levels of the fans should be checked.

When considering a boiler replacement it is worth taking into account the following;

- If the system is suitable for a condensing boiler. Condensing boilers are most efficient at lower flower temperatures, so if the heating system is not designed to work at a lower temperature the efficiency from a condensing boiler would not be noticeable.
- If a dual burner boiler can be used, so in Spring and Autumn only half the boiler will fire.
- Can the heating controls be up-graded to include weather and load compensation.

## 4.3 Electric heating

There currently are under pew electric heaters which are not used at all in the church presumably due to the age of the heaters, and the cost running them due to the higher wattage, and have been superseded by the gas radiant heaters.

Under pew heaters

However a lower capital cost option for the church, as compared to installing a wet heating system, would be to replace these heaters with more modern under pew heaters, such as the Dimplex SCH5 (500W) 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.

If the church usage is going to remain static for the medium term, this might be the most cost effective option, as compared to installing a wet central heating system, however if the usage of the building is going to increase the lower cost and lower carbon of gas and biomass heating compared to electrical heating would mean these are better options. The installation of these heaters would also be dependent on the commitment of the church to retain the pews for the medium term.

See biomass heating option in section 6.7.

## 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. If the roof is replaced at a later date then insulation should be seriously considered.

### 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

The pews are on timber raised platforms which potentially have a void beneath them. These boards could be lifted, insulation added beneath them and then the boards replaced including sealing the joints to prevent cold draughts from rising up from the floor and would result in significant comfort improvements. Prior to doing this, you would need to consult with the inspecting architect to ensure that there will still be adequate ventilation under the boards to avoid wet and dry rot.

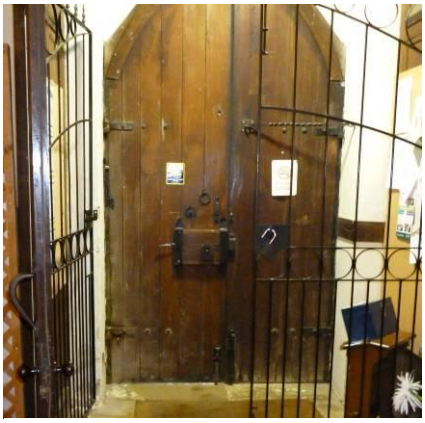
### 5.4 Windows

The windows are generally in good condition besides a few missing panes which should be replaced as soon as possible.

### 5.5 Doors

The main doors to the church are not well fitting and would benefit from some improvements. It is estimated that up to 15% of heat generated can be lost through draughts and gaps in doors and windows, so it is a good idea for this to be reduced where possible and draught proofing doors is a simple and quick measure to install.

By improving the seal on the external doors, the draughts into the building can be minimised. We recommend that the doors are sealed using the Quattro seal method - (www.quattroseal.com). This is recognised by English Heritage for use in listed buildings, as the installation is easily reversible if required.



Main entrance doors

We also recommend that the church install an air curtain in the porch area, as there is no lobby, every time the door is opened, any heat that has been building up in the church is lost and cold air enters. This effect can be reduced by using an air curtain.

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, and Dimplex have a large range. You will need to employ an electrician to carry out the installation.

**Example of an air curtain in a church**

## 5.6 Other

Other draughts, such as where the gas pipe enters the building should also be sealed, to remove the draught created by gaps around the pipe.

## 6.0 Renewable Energy Feasibility

The below reviews the viability of renewable technologies at your 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 church has a single pitched roof, with a south facing slope. However if any photovoltaic panels were installed, they would be clearly visible, and the church would not gain planning permission as the church is Grade II* listed. In addition there are a number of large trees that surround the church would are likely to lead to shading on the panels.

At the moment, given the planning restrictions we would not recommend PV panels at this church.

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. They are suitable for use in urban areas which wind or hydro systems don't tend to be. The 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.

### 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.

## 6.6 Air Source Heat Pump

Air source heat pumps are most effective in very well insulated buildings with long occupancy hours. They are also unlikely to be approved by the DAC therefore not deemed appropriate for this site.

## 6.7 Biomass

As the church will be looking at replacing its heating system, it may wish to consider a biomass boiler and wet heating system option. 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 site appears to have suitable access for fuel deliveries. A new external boiler house and fuel store would need to be built adding to the cost, but this might be able to be added into the extension plans. The new structure would need to be in keeping with the adjacent buildings.

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 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. Also please take into consideration that the more the church is used, the greater the savings will be in the below table, as these are based on current usage times of the church.

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** | **Estimated Carbon Savings per year** | **To be actioned by** |
| Measure | £0 | £40 | 0.18 | |
| Calculate and monitor | £0 | | | |
| Communicate | £0 | | | |
| Housekeeping | £0 | | | |
| Seal up gaps around gas pipe | Approx £20 | £5 | 0.02 | |
| Draught proof the main entrance door | £150 | £26 | 0.12 | |
| Fix broken glazing | Dependant on how many panes to be fixed at one time. | - | - | |

| **Medium Term Improvement Measures** | | | | |
|---|---|---|---|---|
| **Description** | **Estimated Cost** | **Estimated £Saving per year** | **Estimated Carbon Savings per year** | **To be actioned by** |
| Insulate under wooden floor boards | Cost will depend on type of insulation required but likely to be in the region of £15-£25 per $m^2$ | Improved comfort | - | |
| Installation of air | £1,400 | | 0.19 | |

| | | | | |
|---|---|---|---|---|
| curtain | | £40 and Improved comfort. | | |

| **Long Term Improvement Measures** | | | | |
|---|---|---|---|---|
| **Description** | **Estimated Cost** | **Estimated £ Saving per year** | **Estimated Carbon Savings per year** | **To be actioned by** |
| 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. | Difficult to quantify as depends on increasing the use of building. Gas heating per kWh is lower cost than electricity and butane gas bottles. | - | |
| 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. | Difficult to quantify as depends on increasing the use of building. Biomass heating per kWh is lower cost than electricity and butane gas bottles. | - | |

## 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