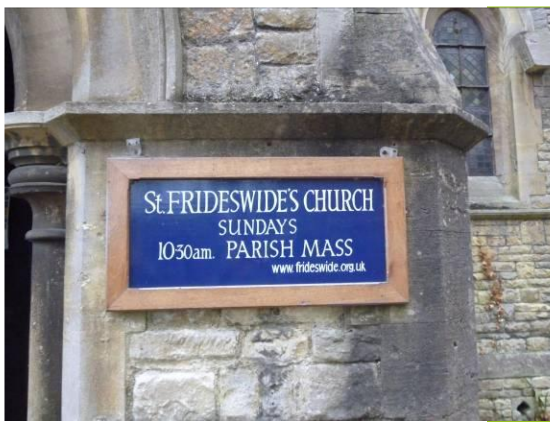

Energy Audit of St Frideswide's Church, Oxford

November 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 Frideswide's Church, Oxford.

The report was prepared following a site audit conducted by Marisa Maitland and Emily Guilding, Sustain on 25th November 2013. They were accompanied by Anne James, the Church Warden.

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 Frideswide's 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, Natalie Merry.

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

2.0 Church Details

St Frideswide's Church in Oxford is the local parish church serving the community. It is located in Osney, West Oxford and dates back to 1872.

2.1 Listed Status

St Frideswide's is of 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

The approximate internal area of the church is 230m^2 as taken from sMeasure.

From discussions on site during the audit it has been established that the typical usage of the church is 32 hours per month. The average congregation size is approximately 25 people.

	Description	Average Monthly Use
Church Use	1 service per week, church meetings	22 hours/month
Community Use	Community groups	10 hours/month
Administration	n/a	
Catering and Events	n/a	
TOTAL		**32 hours/month**

2.3 Current Energy Usage

Annual energy use for the church has been taken from sMeasure. This data shows that from 18 Nov 2012 to 17 Nov 2013 the carbon footprint of the church was 3.77tCO_2e.

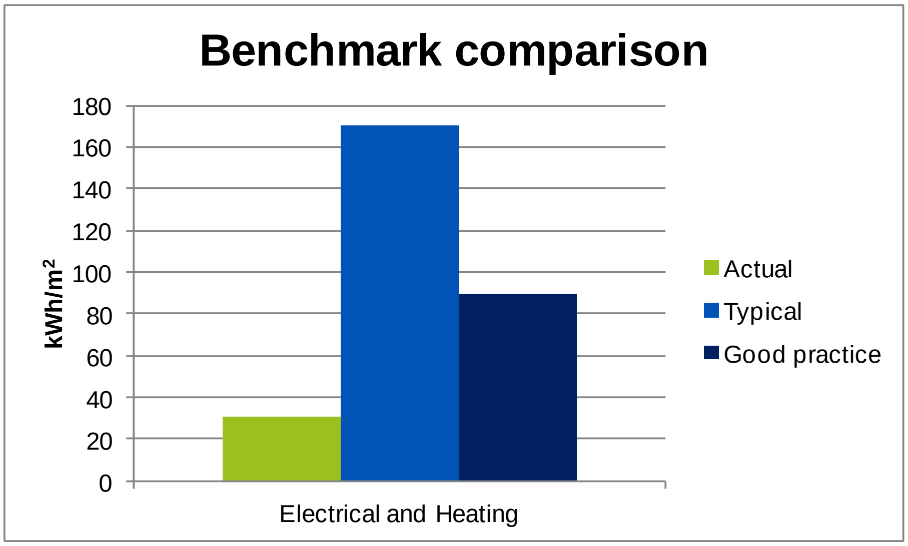
	kWh/year	Cost/kWh	Total £	Total CO_2e (tonnes)
Electricity	7,181	12p	£850.07	3.77
TOTAL	7,181		**£850.07**	

Note: The above costs are for the energy only and do not include standing charges and VAT. The cost per kWh shown is the average off peak and peak cost over the year.

In comparison with national benchmarks[1] St Frideswide's consumes less energy than would be expected for a church of this size. Whilst this is very commendable, it is likely in part due to the low usage of the buildings and as the buildings usage is anticipated to increase the recommendations within this report should help to bring the church further below the expected benchmarks.

	kWh/m^2 actual	kWh/m^2 benchmark (typical)	kWh/m^2 benchmark (good)
Electricity and Heating	31	170	90

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



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.

The electricity bills for the last year are all estimated. The billed estimated peak meter reading on 31st October is higher than the meter reading taken on the day of the audit on the 25th November. We recommend the church provides actual readings to their supplier to ensure they are being billed for actual use.

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

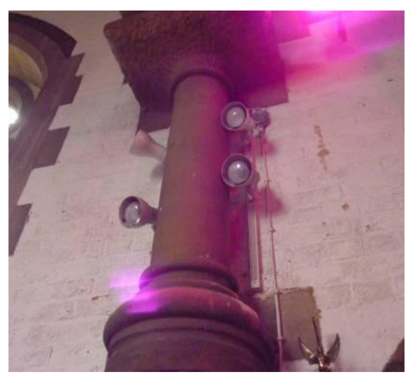
The energy used for the internal lighting within electrically heated churches typically makes up the second largest use of electricity and therefore savings made to this area can result in significant overall reductions to energy usage.

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 church is already replacing old bulbs with new more efficient replacements as they come to the end of their life. We advise they continue with this programme of replacements using the following bulbs which can be fitted in the existing light fitting and generate an energy saving.

Location	Existing Lamp Type	Recommended Lamp Type	Example Source
12 x nave and vestry ceiling pendant fittings	150W incandescent lamp	20W CFL	http://www.wickes.co.uk/philips-tornado-bc-20w/invt/205212/
22 x on wall mounted brackets	100W R80 incandescent reflector lamp	20W R80 CFL or 10W R80 LED	http://www.bltdirect.com/energy-saving-reflector-lamp-r80-20w-es-warm-white-100w-alternative-1 http://www.convertabulb.co.uk/product/r80-led-smd-light-bulb/

If all of the above lamps are changed this is estimated to **cost £318** but **save £192** per year therefore providing a payback in less than 2 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.

3.1.2 Controls

The lights are currently controlled by manual switches. 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 to describe which light it switches on and off.

3.2 External Lighting

This church has minor external lighting which is a mixture of ceramic metal halide and CFL lamps. The lighting is controlled by dawn to dusk and movement sensors. This is the best method for control and efficiency.

3.3 Mains Supply

The church has an incoming three phase mains electrical supply and a supply voltage of 246V. The voltage can be reduced to around 220V quite safely and without affecting the performance of any of the electrical equipment by installing a power Perfector unit (http://www.powerperfector.com). Reducing the voltage will not only produce an energy saving but will also help to protect any lighting and sound equipment from problems associated with high voltage which can shorten their life. However, given the presence of electrical heating and the high capital costs of installing voltage optimisation on a three phase supply such a solution is not recommended at this church.

3.4 Small Power

During the site visit it was noted that a few small electrical appliances such as electric fan heaters and lamps were present. These were switched off and this good energy practice should continue.

4.0 Heating System Saving Recommendations

4.1 Heating

The church heating is provided by 10 electric radiant heaters plus a few additional plug-in electric heaters. They are normally turned on 1 hour before the start of a service and switched off at the end of the service. These form the biggest electricity use of the building.

For a church with low occupancy hours radiant heaters are often the best form of heating as they provide instant warmth as required. However, at St Frideswide's the heaters do not provide adequate heating, their height makes them difficult to service so some are now longer working and they are not aesthetically pleasing. Therefore, the church would like to upgrade to a better heating system so that a comfortable, useable space can be provided for community use.

In order to do this considerable investment into upgrading the heating system is required. There are several options which could be appropriate at this church depending on the future usage, available funds, system suitability and DAC guidelines. These are: improve electrical heating (section 4.1.1), install gas fired boiler and central heating system (section 4.1.2) or install biomass boiler (section 6.7). All approaches would require further investigation and consultation with the DAC.

4.1.1 Upgrade electric heating

Improving the electrical heating requires the lowest capital investment but has the highest carbon and fuel costs. This may be the best option if the church does not plan to significantly increase its occupancy hours.

The nave area would be best served by fitting additional wall mounted electric convector heaters. These should be installed at a low level near the congregation seating. These should be thermostatically and individually controlled so can be used as and when required. The convection action will distribute the warm air around the space at ground level helping to provide a warmer, more useable space in conjunction with the existing radiant heaters. Attention should be given to the noise levels of convector heaters at the various operating speeds. The Dimplex Saletto range of heaters provide a low profile and discreet heating solution.

The choir stalls would be best served by under pew heaters such as the dimplex 500W SCH5. These should be wired into individual switched fused spurs with a neon indicator so that the heater to each pew can be switched off individually.

4.1.2 Install gas fired boiler and central heating system

The church has already received a quote from Dunphys to install a gas fired boiler and central heating system at a cost of £50,000. This does not include the cost of connecting the church to a mains gas supply.

Gas is the cheapest heating fuel available to the church and the system would require little maintenance. If the church decides to go down this route they should ensure that the system specification provides 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.

The boiler would be located in the cupboard next to the toilets in the modern extension. Installing this system would likely mean that a dehumidifier for the organ will not need to be purchased.

See also renewable options for heating in section 6.0.

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 a void between the external pitched roof of the nave roof and the internal barrelled ceiling of this area which could be insulated without affecting the appearance of the church interior. Care would need to be taken in the installation of the insulation to maintain good levels of ventilation to the timber in the roof.

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 choir stalls are on raised timber platforms which are likely to have a void beneath them. The same goes for the wooden floor boards under the congregation seating. 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.

The choir stalls are already fitted with strips of carpet helping to improve comfort. It might be worth considering if the floor in the congregation seating area could also be carpeted to improve thermal comfort. Carpet should be hessian (not rubber) backed and if fixed in place, tacks should be used rather than glue.

5.4 Windows

The windows are generally in good condition, due to the listed and historic nature of the building there is not an opportunity to improve the insulation of the windows.

5.5 Doors

The internal entrance door to the North porch and the external door in the side chapel would benefit from draught proofing in order to reduce cold draughts. Draught proofing using the Quattro seal method suitable for historic buildings is recommended (www.quattroseal.com).

The external door in the vestry had considerable gaps around its edge. This door could either be draught proofed using the method above or alternatively an insulated ply board panel could be fitted across the whole door way. The key hole should also be blocked off to reduce the draught through there as well. This is a fire exit which may affect whether the ply board panel solution would be suitable.

The church may wish to consider the installation of a hot air curtain over the internal North porch entrance door to prevent cold air entering the church when the door is open as the congregation enter for services.

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 drafts 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.

Example of an air curtain in a church

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.

Installing a glazed porch door will also help combat the issue of heat loss during congregation arrival. Keeping the glazed door closed will allow the main entrance door to remain open to welcome the congregation but heat loss will be minimised. We understand that whilst this is a significant investment, a more welcoming entrance and also a warmer church resulting from reducing the amount of cold air entering the building will be of benefit.

6.0 Renewable Energy Feasibility

This section 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 already made an application for a solar PV array however it has been rejected as deemed too visible. It would be worth the church re-applying at a later date as the guidelines for making decisions to install PV may change with time.

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. The church will be paid for the electricity generated by the panels and for excess electricity exported back to the 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. If the hot water of usage of the church changes significantly over time, this may be worth considering in the future.

6.5 Ground Source Heat Pump

The church has unused grounds which could be suitable for a ground source heat pump. However, these often work most effectively with an underfloor heating system in a well insulated building; therefore is not recommended for this site.

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

A biomass boiler and wet heating system may be an alternative to upgrading the electrical heating or installing a gas fired heating system at the church. This would provide low carbon heating with similar running costs per kWh to gas.

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. The boiler would require slightly more maintenance than a gas boiler so a service and maintenance contract should be put in place. The boiler will also need cleaning and ash removed about once a month.

Potential location for biomass external fuel store and boiler house

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. A possible location for this would be the left corner of the car park on the opposite site of the link corridor modern extension (see image). The new structure would need to be in keeping with the adjacent buildings and slightly raised for flood protection.

The system would be eligible for the Renewable Heat Incentive. This means the church will be paid for the energy generated by the boiler. The rate depends on size of boiler installed; for a small commercial biomass boiler it is currently 8.6p/kWh.

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. A new biomass boiler was installed at St Michael and All Angels Church, Withington, Gloucestershire at a cost of £23,000, however the church had an existing wet heating distribution system.

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 difference 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 a number of 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. As use of the building increases the paybacks of the measures will shorten.

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**	**To be actioned by**
Replace incandescent pendant ceiling lamps	£54	£84/year	
Replace R80 reflector lamps	£264	£107/year	
Draught proof side chapel exit door and North porch internal entrance door	£89	£15/year	
Draught proof vestry door	£100	£15/year	

Medium Term Improvement Measures			
Description	**Estimated Cost**	**Estimated Saving**	**To be actioned by**
Install loft insulation	£1200	£105/year	
Install air curtain over North porch internal entrance door	£500	£38/year and improved comfort	
Install glazed porch door	Further investigation required	£38/year and improved comfort	
Insulate wooden floor boards under choir stalls and congregation chairs	Cost will depend on type of insulation required but likely to be in the region of £15-£25 per m^2	Improved comfort	

Long Term Improvement Measures			
Description	**Estimated Cost**	**Estimated Saving**	**To be actioned by**
Improve electrical heating	Approximately £150 per heater plus installation costs	Improved comfort	
Install gas boiler and	£50,000	Difficult to quantify	

central heating system		as depends on increasing the use of building. Gas heating per kWh is lower cost than electrical	
Commission feasibility study for biomass heating system	Biomass boiler approx £5k - £11, plus cost of installation, distribution system, radiators and boiler room.	To be calculated as part of biomass feasibility study	

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