sustain

Energy Audit of St Clement'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 Clement's Church, Oxford.

The report was prepared following a site audit conducted by Marisa Maitland and Emily Guilding, Sustain on 25th November. They were accompanied by Rev. Bruce Gillingham, Clare Newgass and Raymond Fawcett.

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 Clement'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.

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2.0 Church Details

St Clement's is the local parish church serving the community. It is located in East Oxford and dates back to 1828.

2.1 Listed Status

St Clement'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 was measured as 605m^2.

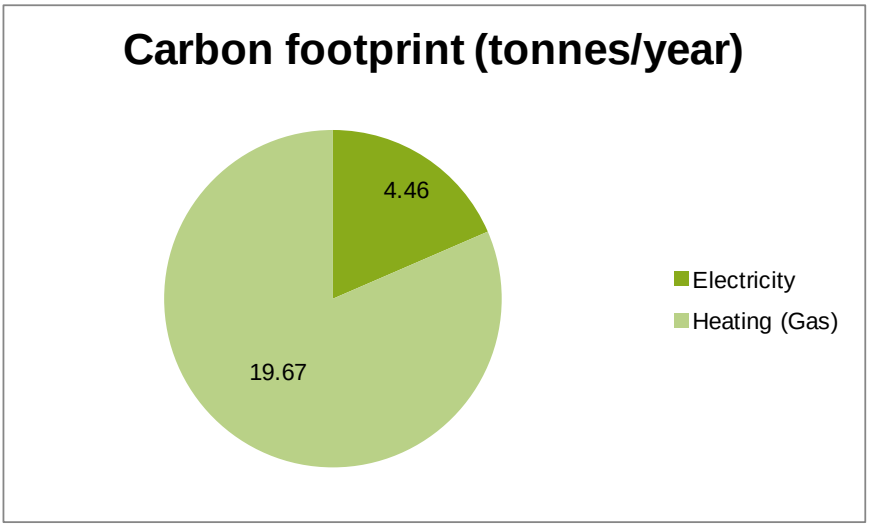
From discussions on site during the audit it has been established that the typical usage of the church is for 30 hours per month.

	Description	Average Monthly Use
Church Use	2 or 3 services per week, Diocesan events	25 hours/month
Community Use	n/a	
Administration	n/a	
Catering and Events	Open days for Art Weeks, 'Open Doors', 'Ride and Stride'; local school visits	5 hours/month
TOTAL		**30 hours/month**

The average congregation size is dependent on the service, and varies between 80 people for the morning service, to 20 people for the afternoon service.

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 24.13tCO_2e per year.



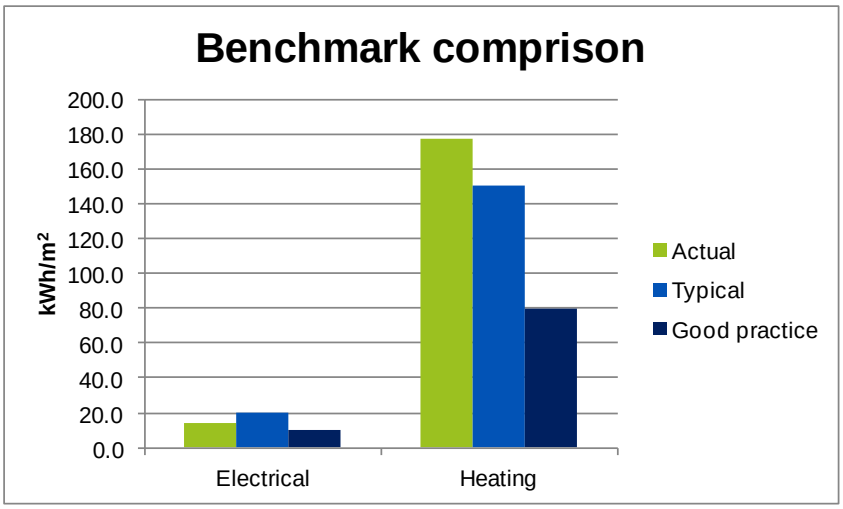
The annual energy consumption has been taken from the electiricty bills provided from 10 October 2012 to 20 September 2013. Gas use is from bills provided from 31 August 2012 to 29 August 2013. These may include the use of estimated readings where actual readings have not been taken. Energy use has been pro rated to cover gaps in data.

	kWh/year	Cost p/kWh	Total £	Total CO_2e (tonnes)
Electricity	8,500	11	£899	4.46
Heating (Gas)	106,900	4.20	£4,485	19.67
TOTAL	**115,400**		**£5,384**	**24.13**

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

In comparison with national benchmarks[1] St Clement's consumes more gas than would be expected for a typical church of this size but less electricity. A focus on reducing the gas consumption is therefore advisable and the recommendations within this report should help to bring the church within the expected benchmarks.

	kWh/m^2 actual	kWh/m^2 benchmark (typical)	kWh/m^2 benchmark (good)
Electricity	14	20	10
Gas	177	150	80



The church is signed up to sMeasure but not yet using the website. It requires monthly meter readings to be entered into the simple website. This will help the church estimate its future costs of energy and report on its carbon.

[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 now being correctly applied at this church.

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 bulbs/lamps within existing fittings

The following lights can simply be replaced with a low energy bulb to generate an energy saving. CFLs have not been specified due to the concern that a faulty one flickering at a lower frequency could trigger a photosensitive epileptic fit in a congregation member. Research carried out in 2008 by the Scientific Committee on Emerging and Newly Identified Health Risk on Light Sensitivity[2] concluded that CFLs do not trigger epileptic fits, however the suitability of CFLs at St Clement's is for the church to decide.

Location	Existing Lamp Type	Recommended Lamp Type	Example Source
11 chandeliers each with 5 bulbs	70W halogen bulbs	6W LED bulb	http://www.directtradesupplies.co.uk/ledbulb-6-32w-b22-ww-philips-19266400-ledb6wb22nd.html?utm_source=GoogleShopping&origin=GoogleShoppingPaid&gclid=CIKmk5qfl7sCFUkUwwodNGcAXA
4 on central pillar plinth either side of nave aisle and 8 in crèche	50W GU10 halogen spots	5W GU10 LED	http://www.screwfix.com/p/lap-gu10-led-lamp-with-reflector-330lm-5w/36891
3 on pillars facing alter	100W R80 reflector lamp	10W R80 LED	http://www.convertabulb.co.uk/product/r80-led-smd-light-bulb/

[2] http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenihr_o_019.pdf

If all of the lamps are changed we estimate this to **cost £835** and **save £165** per year therefore providing a payback in 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.

3.1.2 Controls

The lights are currently controlled by switches located near the side entrance. These are labelled making it easier for building users to only turn on the lights they need.

3.2 External Lighting

The church has 6 x 70W SON-i lamps around edge of church and 5 more along the driveway plus 2 ceramic metal halide flood lights next to the front and side entrance doors. These lamps are considered to be efficient therefore do not require replacing. The external lights are controlled by PIR and daylight controls.

3.3 Mains Supply

The church has an incoming three phase mains electrical supply and a supply voltage of 243V. The voltage can be reduced to around 220V quite safely and without affecting the performance of any of the electrical equipment. 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 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 electrical appliances such as a PA system and electric keyboard were present. These were switched off at the time of the audit and this good energy practice should continue.

4.0 Heating System Saving Recommendations

4.1 Boiler

The church heating is provided by 2 Strebel condensing, modulating boilers. These were installed in 2005 and are serviced annually.

4.2 Pipework and Distribution

The pipework within the boiler room would benefit from additional lagging to the exposed valves. Not only will this help to save energy through reduced heat loss but will also provide better protection against burst pipes.

4.3 Radiators and other heat emitters

The heating within the church is supplied via old cast iron radiators. Several more recent twin fin radiators are in the narthex/ante room/kitchen area. These are fitted on external walls and would benefit from having reflective radiator panels fitted behind them. These panels ensure the heat is not absorbed by the wall and is reflected into the room. These more modern radiators could also be fitted with thermostatic radiator valves which would give greater control over the heating in this space.

The water circulating within the heating system was drawn off and inspected. It was found that it is clear which indicates that there is no corrosion within the system. The presence of air within the system was also tested at the time of the visit and found not to be present.

4.4 Controls and Frost Protection

The heating system is controlled by an ATAG programmer. The programmer is set at 10℃ for frost protection and increased to 18.5℃ for services. The times set for 18.5℃ matches the reported occupancy of the building and is sensibly used.

It is not unusual for over 30% of the heat energy used in churches to be used to protect the heating system itself from frost damage. As an alternative to firing the boiler to warm up the water to prevent it from freezing the system can instead be filled with an antifreeze based inhibitor such as X500 from Sentinel. It is recommended that for best results the system is flushed and cleaned before re-filling with a Glycol based inhibitor. This means the heat will not need to be left at 10℃ for frost protection. Depending on the quantity of inhibitor added to the system, it will offer protection between -4 and -20℃.

As the building is infrequently used in the week; it would be more economical to only heat it when required. If week day occupancy increases this may need to be reconsidered.

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 aisle and the internal barrelled ceiling of this area. This void was accessed during the audit and it is fully boarded and presents an opportunity for loft insulation. It is believed that the lower side ceilings of the East and West aisles have already been insulated but this should be checked. By installing insulation in the loft space, the church would reduce the heat loss through the ceiling and improve the comfort in the church,

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 floors beneath the pews are timber boards and there appeared to be a small void beneath these. This void could be insulated and the joints to the boards should be filled and sealed as to prevent cold draughts rising up from the floor. 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

Strips of carpet could be laid over the wooden floor boards in-between the pews to improve the thermal comfort of the space. Carpet provides a warmer surface which can help achieve a greater perceived sense of warmth. Carpet should be hessian (not rubber) backed and if fixed in place, tacks should be used rather than glue.

5.4 Windows

There were several panes of glass missing from the windows. Work to replace these is planned and should be done as quickly as possible to reduce heat loss.

Secondary glazing is not an option due to DAC guidelines.

5.5 Doors

The external door in the crèche would benefit from draught proofing to prevent cold draughts. A suitable system for this in these types of buildings is Quattro seal (http://www.quattroseal.com/). A heavy curtain hanging in front of the door will also help stop draughts.

The entrance door to the South porch is often left open as the congregation arrives, during this time a lot of the heat in the church escapes. A solution to reduce this would be to fit a glazed door to the porch entrance. This can stay closed whilst the main door is open so maintaining a welcoming entrance whilst reducing heat loss. The South porch door would also benefit from a key hole cover.

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 nave roof is orientated south east and would make a suitable location for a solar photovoltaic (PV) array. The coverings to the roof are slate tiles. Re-roofing works are planned which may be the best time for integrating solar PV. There is space for the inverters in the electrical cupboard. The availability of distribution board spare ways of a suitable capacity would need to be checked.

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.

An initial assessment indicates that there would be space for a 7kWp installation with a yield of approximately 5,950 kWh. 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 18 years. However this would be variable depending on the exact make and model of the PV units being considered.

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 suited to very well insulated buildings, without mains gas and with long occupancy hours. They are also unlikely to be approved by the DAC therefore not deemed appropriate for this site.

6.7 Biomass

The church has a mains gas connection and gas heating system already in place; therefore it would not make economical sense to consider a biomass heating system.

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 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**	**To be actioned by**
Replace halogen chandelier bulbs with LEDs	£679	£134/year	
Replace halogen spot lights with LEDs	£120	£21/year	
Replace R80 reflector lamps with LEDs	£36	£10/year	
Draught proof crèche door and fit key hole cover on main door	£125	£22/year	
Add Glycol inhibitor to heating system	£288	£244/year	

Medium Term Improvement Measures			
Description	**Estimated Cost**	**Estimated Saving**	**To be actioned by**
Install loft insulation over nave ceiling	£3,000	£449/year	
Install radiator panels in narthex/ante room/kitchen area	£20	£4/year	
Install TRVs on radiators in narthex/ante room/kitchen area	£40	£11	
Install boiler room valve insulation	£245	£40	
Replace missing window panes	Further investigation required	Improved comfort	
Add carpet strips in-between pews.	Further investigation required	Improved comfort	

Long Term Improvement Measures			
Description	**Estimated Cost**	**Estimated Saving**	**To be actioned by**
Install glazed door to South porch	Further investigation required	£224 and improved comfort	
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	
Commission solar panel feasibility study for SE nave roof	£14,000	Approximately £800/year. Payback of around 18 years.	

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