Energy Audit of St Stephen's, Clanfield (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 Stephen's, Clanfield.

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

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 Stephen'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.

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 Stephen's in Clanfield is the local parish church serving the community. It is located in Oxfordshire and dates back to1209.

2.1 Listed Status

St Stephen's 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 193m^2.

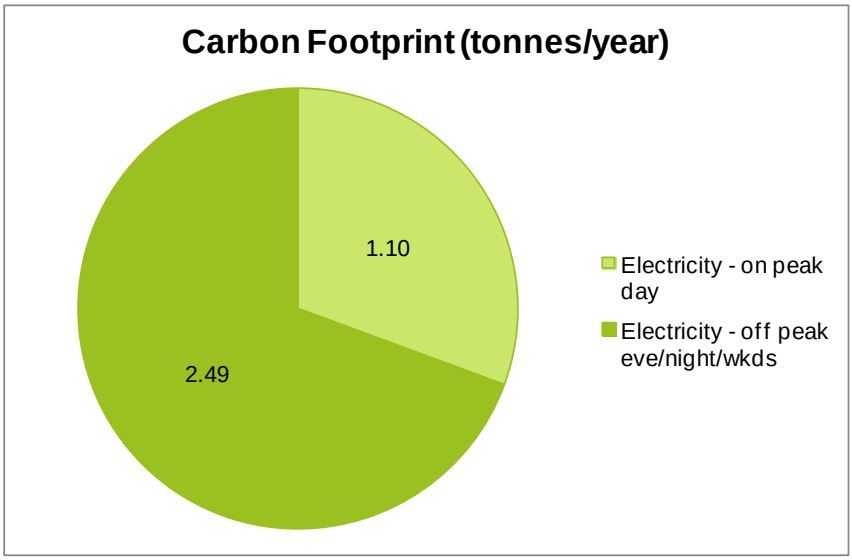
From the churches application form and discussions on site during the audit it has been established that the typical usage of the church is for 19 hours per month.

	Description	Average Monthly Use
Church Use	Sunday Church services	11 hours/month
Community Use	n/a	
Administration	n/a	
Catering and Events	Concerts	8 hours/month
TOTAL		**19 hours/month**

The average congregation size is 20 people.

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 3.59 tCO_2e per year.



The annual energy consumption has been taken from the energy bills provided from 26 September 2012 to 24 September 2013. These may include the use of estimated readings where actual readings have not been taken.

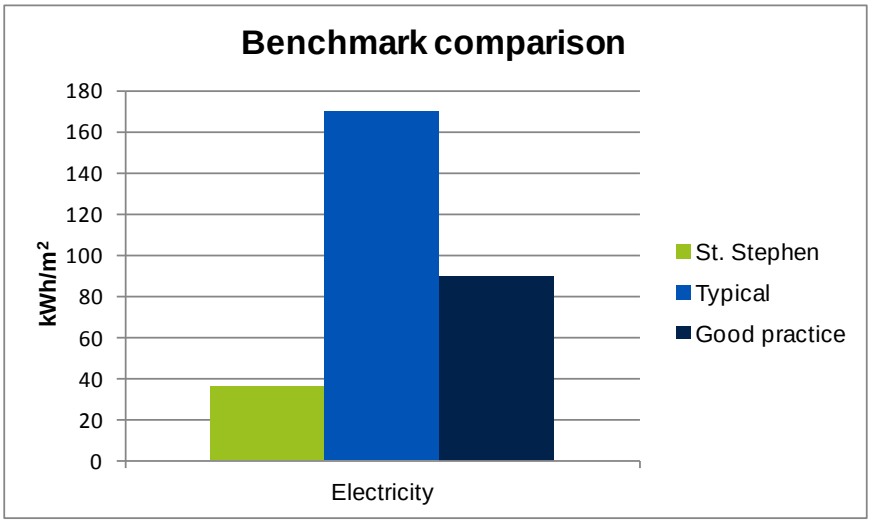
	kWh/year	Cost/kWh	Total cost/year	Total CO_2e (tonnes)
Electricity - on peak day	2,093	£0.12	£249	1.10
Electricity - off peak eve/night/wkds	4,744	£0.10	£485	2.49
TOTAL	**6,837**	**-**	**£734**	**3.59**

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 Stephen's is consuming less electricity than would be expected for a church of the same 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.

Energy consumption in kWh/m^2

	St. Stephen's	Typical	Good practice
Electricity	35	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.

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 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 we found that the lighting at the moment is adequate given the usage of the building. We advocate that when lamps are required to be replaced due to lamp fitting failing that they are replaced with more efficient alternatives (usually LED lamps). This process has started already with the installation of two LED flood lights in the chancel.

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.

- 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".

3.1.1 Controls

The lights are currently controlled by 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. A simple use of red and green dots can be helpful to indicate which lights are required for general visiting.

3.2 External Lighting

This church only has minor external lighting, one external flood and bollards for the pathway, which are controlled by movement sensors (PIR) and dusk-till-dawn sensors to make sure the lights are only activated when it is dark and there is someone present. The lamps and fittings used for this are suitable. As with the internal lamps and fittings, as and when these need to be replaced we would recommend they are replaced with LEDs which are lower wattage.

3.3 Small Power

During the site visit we found that the hot water heater, located under the washing up sink remains on all the time. We understand that hot water is only used on a Sunday morning for washing up after the church services and not at any other time. Therefore the tank of water in the heater is being kept hot all week just for the Sunday morning. This will use more energy than just turning it on at the start of the service and off when the hot water is no longer required (because of losses from the tank throughout the week). We recommend the water heater is only turned on for use on a Sunday morning and turned off at all other times.

4.0 Heating System Saving Recommendations

4.1 Heat emitters

The heating within the church is supplied via 13 radiant heaters with a maximum output at 4.5kW. These heaters have 3 different radiant heating bars which can be controlled separately. There are 7 of these heaters in the main church, 3 in the North aisle, 2 in the Chancel and 1 in the bell tower.

There are no plans at the moment for the church to replace their heating system. It is found to be adequate and meets their needs. Given the low usage of the building electric heating is an efficient method of providing heat to the users of the building.

The organ also has a heater which is used to control the humidity within the organ. We were unable to inspect this on the day of the visit, but we recommend that it is checked that this is controlled by a humidistat to make sure it is providing the right kind of environment for the organ and not running continuously if not required.

4.2 Controls

The electric radiant heaters in the church are controlled by individual switches, one for each of the bars on each heater. These are labelled and there is an accompanying map of the church showing where each heater is located.

We recommend that the use of the radiant heaters is matched to the requirements of the building users and their seating arrangement during services. There are likely to be times when not all the heaters are needed and when not all 3 bars on each heater are needed. An example of matching use with requirements could be to leave the heaters in the North aisle off if this space is not being by parishioners during a service. Also just 1 or 2 bars could be used especially at times outside of Winter. Each bar is rated at 1.5kW so turning one off will save 15p per hour.

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 floorboards which are likely to 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, the church 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 in good condition, with no broken window panes or gaps between the glass and the abutments witnessed.

5.5 Doors

The church does not have any barrier at the door to stop warm air escaping and cold draughts entering. This could be a fabric curtain or an air curtain which will continue to act even when the door is opened as the congregation enters. An air curtain is a device used for separating two spaces from each other. 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. 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. 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 example in the photo below is a Dimplex heater. You will need to employ an electrician to carry out the installation.

South door at St Stephen's

Example of an air curtain in a church

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 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 vestry roof is orientated South and is potentially a suitable location for a solar photovoltaic (PV) array. The panels would be hidden from view as they could be located in the valley between chancel and vestry roofs. As this church is Grade II listed, planning permission would only be granted if the panels are barely visible.

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. The proximity and height of the trees to the east of the church and the proximity of the chancel roof would also need to checked to ensure they do not shade the panels. Some PV arrays do not operate when one part of the solar array is shaded whereas others will operate even if this is the case.

Aerial view of 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. 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 1.3kWp installation with a yield of approximately 1,130kWh. 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 15 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. There is a small demand for hot water within the church for the washing up sink and toilet which is currently supplied by a 10 litre electric water heater. This demand is not large enough to justify the installation of a solar hot water system.

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. Also see 6.6 below.

6.6 Air Source Heat Pump

As the church has a relatively new electric heating system rather than a wet heating system, air source heat pumps are not compatible. The low occupancy hours do not justify the cost of installing a wet heating system.

6.7 Biomass

As the church is not connected to gas, biomass would be an option at this site. However, given the low occupancy hours and the fact the church would need to convert from the existing electric heating system to a wet heating system this would not be a cost effective solution at the moment.

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/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 ~ £40.	
Calculate and monitor	£0		
Communicate	£0		
Housekeeping	£0		
Turn off under sink heater during week	£0	£20	
Limit use of north aisle heater	£0	£52	
Careful control of heater use – switch only number of bars on heaters as required.	£0	15p per hour per bar (45p per hour for each 3 bar heater)	
Link organ heater to humidistat	Unknown.	Unknown	

Medium Term Improvement Measures			
Description	**Estimated Cost**	**Estimated Saving/year**	**To be actioned by**
Installation of air curtain	£1,400	Improved comfort. There will also be some saving in heating use e.g. one or more of the radiant heaters at the entrance could be turned off	
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	
Replace lamps and	Depends on current	Depends on current	

or light fittings in nave and chancel as they fail with LEDs	specification and replacement chosen	specification and replacement chosen	

Long Term Improvement Measures			
Description	**Estimated Cost**	**Estimated Saving/year**	**To be actioned by**
Solar photovoltaics	£2000	£134/year	

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