Energy Audit of St Mary and St John, Cowley (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 John, Cowley.

The report was prepared following a site audit conducted by Marisa Maitland, Sustain on 22nd January 2014. She was accompanied by Alan Baker, Parish Administrator.

A summary of recommendations is made in Section 9.0 of this report.

The findings of this report in no way negate the PCC of St Mary and St John 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 John in Cowley is the local parish church serving the community. It is located in the city of Oxford and dates back to 1883.

2.1 Listed Status

St Mary and St John 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 720m^2.

From discussions on site during the audit it has been established that the typical usage of the church is 146 hours per month.

	Description	Average Monthly Use
Church Use	2 or 3 services per week	146 hours/month
Community Use	Children's group, choir practise	
Administration	n/a	
Catering and Events	Concerts, coffee mornings, lunch club.	
TOTAL		**1752 hours/year**

The average congregation size is dependent on the service and is approximately 70 for the main Sunday 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 19.26tCO_2e per year.

The annual energy consumption has been taken from the energy data provided from 19 November 2012 to 18 November 2013. These may include the use of estimated readings where actual readings have not been taken.

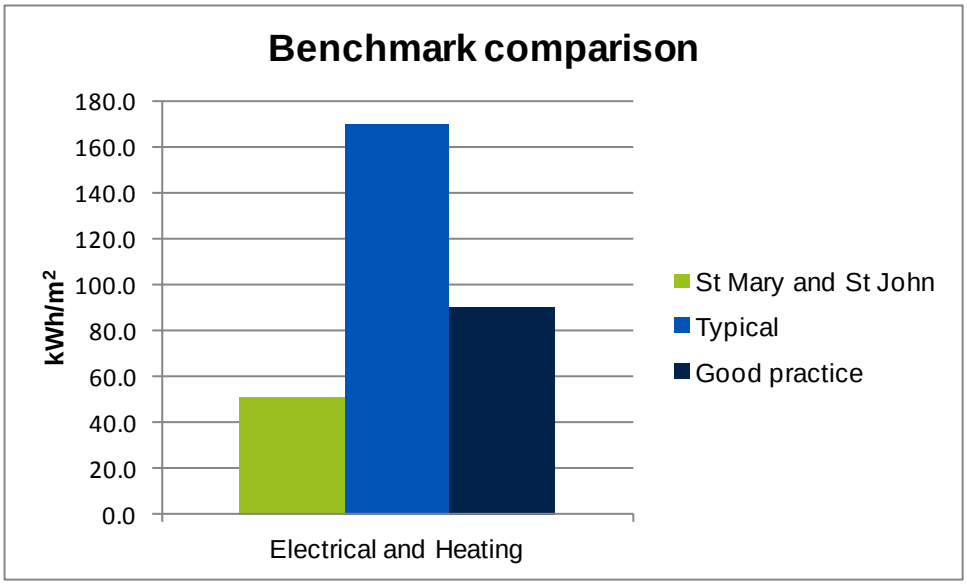
	kWh/year	Cost/kWh	Total £	Total CO_2e (tonnes)
Electricity	36,687	£0.1139	£4,178	19.26

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

In comparison with national benchmarks[1] St Mary and St John's consumes less electricity 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.

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

	kWh/m^2 St Mary and St John	kWh/m^2 benchmark (typical)	kWh/m^2 benchmark (good)
Electrical and Heating	51	170	90



All energy bills werechecked to ensure that the VAT rate of 5%, due to the charitable status of PCC's, 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 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.

There was a large amount of spot lights in the ceiling of the church, which have a significant warm up and cool down time with an orange colour rendering during that period, which indicates the lamps are Sodium based. These types of lamps have a higher wattage compared to many other alternatives available on the market today. During the site visit it was not possible to ascertain the exact wattage of the lamps being used, so an assumption that each is 150W has been used and that there are 30 lamps in the building.

Location	Existing Fitting	Recommended New Fitting	Example Source
Main body of the church, including nave and aisles	High bay spot lighting – assumed 150W SONs	50W LED flood – warm white	http://www.deslamps.co.uk/50-watt-warm-white-led-flood-light-p-8954.html

If all of the above lamps are changed we estimate this to **cost £3,600** but **save £600** per year therefore providing a payback in 6 years. 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.

- 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".

3.1.2 Controls

The lights are currently controlled by switches located around the building. They have a small print out adjacent to the switch panels which describe which lights it switches on and off. 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.

3.2 External Lighting

This church only has minor external lighting to the porch and the like which is controlled by dusk till dawn sensors. There is also some security lighting which is controlled by a movement sensor.

External light fitting

3.3 Small Power

During the site visit no electrical equipment was noted to have been unnecessarily left on. The main small power is in the church office, such as the photocopier and fridge. The photocopier was reportedly sensitive to changes in humidity of the paper.

4.0 Heating System Saving Recommendations

4.1 Electrical heating

The heating in the church is provided in the main body of the church via radiant heaters, and in the church office and vestry by night storage heaters.

The radiant heaters were installed in the church between 5-10 years ago. They were chosen as the church is not extensively used and they were extremely cost effective to install. The heating is currently suitable for the amount that the church is used, however it is not always suitable for prolonged use, and the users can find they become uncomfortably hot on their heads, yet still have cold feet.

The church office and vestry have a number of night storage heaters. The church office is occupied 3-4 days a week, however it is assumed that the NSH are left on for the remainder of the week when the space is not occupied. We recommend that 7 day programmers are installed for each of the NSH to make sure they are only on when the area is being used. The saving calculation is based on the assumption that the NSH are 2.5kWh each and use 7 hours of electricity a day, and are used to heat the office and vestry from October until March.

4.2 Heating recommendations

The desire is to increase the use of the building, by rearranging the rear of the church to move the church office and create a kitchen space, to allow for greater use and flexibility of the church. As such it may need to reconsider the provision of heating to the building.

The church previously had trench heating running through the nave, and the existing trenches are still in place. The pipes within these could be replaced with modern radiators, and additional radiators would need to be installed around the perimeter of the church. If a wet heating system was installed, this could be used with either a new gas boiler, or a biomass boiler.

If the church does carry wish to install a gas heating system, we recommend that they take into account the following:

- If the current system is suitable for a condensing boiler. Condensing boilers work most efficiently 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.
- If the existing boiler is over-sized and could it be reduced.
- Can the heating controls be up-graded to include weather and load compensation

Details on Biomass boilers are covered in section 7.7

5.0 Reconfiguration project

As previously mentioned the church is planning to reconfigure the rear of the nave, and create office space, kitchen and meeting space.

For the new area we would recommend that the church take energy efficiency into account and make the energy use of the new areas as low as possible.

Currently the office is heated separately to the rest of the building from the night storage heaters, and it would make good energy efficiency sense for the heating of the office space to be controlled separately to the main church, be it through electrical heating in the area or zoned heating via a wet central heating system.

The aspiration is for the use of the office space to increase, to allow the church to be open to the public on a regular basis with someone on site in the church to provide a presence and security in the building. With this increase in use of the space, the new office space should be well insulated to decrease on the amount of heating required to keep the temperature whilst it is occupied at a reasonable level.

The appliances used within the kitchen should include low flow aerated taps and depending on what method of water heating is chosen, make sure it can be controlled by a timer that is simple to programme. If white goods, such as fridge and cookers are going to be installed ensure they have the most energy efficiency rating available in the market at the moment, which is currently A+++.

For the building works themselves, where available used responsibly sourced timber, and natural insulation products such as sheep's wool.

6.0 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.

6.1 Roof

The roof is undergoing a programme of replacement to make it waterproof. The roof sections that have already been replaced did not have any insulation included in its renewal. We recommend that it is considered for inclusion for the small sections that remain to be replaced.

6.2 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.

6.3 Floors

There are no opportunities to improve the insulation in the floors at this church.

6.4 Windows

The windows are in good condition, with no broken window panes or gaps between the glass and the abutments witnessed.

6.5 Doors

There a number of doors in the church which would benefit from draught proofing. 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.

The South door in the Nave, opposite the main entrance door, has a large gap at the base of it. It appears that this door is not often used, so something simple and very inexpensive such as a sausage shaped draught proof excluder placed at the base of the door will reduce the draughts entering. Alternatively a more permanent solution would be to install a brush strip along the bottom of the door.

The other door that would benefit from draught proofing is the external door into the vestry. We recommend draught proofing using the Quattro seal method suitable for historic buildings is installed (www.quattroseal.com). In addition we would recommend the installation of a brush strip along the bottom of the door.

South door, with gap at the bottom

Vestry door

7.0 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.

7.1 Solar Photovoltaics

The church has previously looked into the potential to install photovoltaic (PV) panels on the roof of the church to provide them with renewable electricity. There is a large south facing roof over the nave, however this is extremely visible. Currently PV installation on Grade II listed churches is only allowed if there is a small amount of the panels visible, however as the whole array would be visible, planning at the moment might not be granted. However it is worth making a request to the DAC to confirm this, especially as the array will not be facing the road.

Aerial view of the church

Ideally a solar PV system should face between south east and south west, and be free of shade. For best performance the panels should be angled at 30 to 40 degrees – although they 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 at least a 6kWp installation with a yield of approximately 5,100 kWh. The size of the installation could be reduced in line with the available church funds. 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. This means the church will be paid for the electricity generated by the solar panels and the electricity that is not used and exported back to the National Grid. The export rate is currently 4.64p per kWh of electricity exported. The generation rate is dependent on the church's EPC rating. If this rating is A-D the higher FIT rate is applicable (currently 13.5p/kWh). If the rating is E-G, the lower rate is applicable (currently 6.85p/kWh). The calculation has assumed an EPC rating of E or below as it would be unlikely that the churches will gain an EPC band D, even with energy efficiency improvements.

The church could expect to pay off the initial investment within 14 years. However this would be variable depending on the exact make and model of the PV units being considered and the amount of electricity generated and exported.

Be aware that in the quotes you have received already for the installation of PV on the church have assumed that you will be receiving the higher rate of the Feed in Tariff at 13.5p/kWh based on the assumption that the will achieve an EPC rating of A-D which is unlikely. Therefore the payback periods in the quotations are liable to increase.

7.2 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.

7.3 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.

7.4 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.

7.5 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.

7.6 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.

7.7 Biomass

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.

The installation of a biomass boiler would be worth the church considering. This would provide a heating system that would meet its requirements with an increased occupancy and is more cost and carbon effective than using an electric heating system.

Biomass biolers 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. A new external boiler house and fuel store is likely to cost between £10,000-£20,000, however if there is any space due to be released following the reconfiguration, this could be used as a boiler house.

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.

8.0 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.

8.1 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).

8.2 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

8.3 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

8.4 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.

9.0 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 (tCO2e)**	**To be actioned by**
Measure	£0	The savings depend on how much energy wastage there is currently. This saving is based on 2% of energy consumption a year saved -£125	0.58	
Calculate and monitor	£0			
Communicate	£0			
Housekeeping	£0			
Label light switches	£10	£42 if assume lighting is 10% of energy use and 10% saved by shortening running hours due to labelling.	0.19	
7 day programmer for the night storage heaters	Unknown – you will need to talk with an electrician to find a programmer to fit with the current heaters.	£622	2.87	
Draught proofing on doors	£195	£84	0.39	

Long Term Improvement Measures				
Description	**Estimated Cost**	**Estimated £ Saving per year**	**Estimated Carbon Savings per year (tCO2e)**	**To be actioned by**
Replace current lights with LED fittings	£3,600	£600	2.76	
Install PV panels on the roof	£9,000	£640	2.68	
Investigate the installation of a gas boiler and heating system.	£20,000-£40,000 (dependant on extent of distribution and radiator work required)	-	-	
Investigate biomass boiler and central heating option	Biomass boiler approx £5,000 - £11,000 plus cost of installation, distribution system, radiators and boiler/fuel store.	Depending on fuel type used, biomass is marginally more expensive than gas	-	

10.0 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