sustain

Energy Audit of St Matthew's, Harwell (I)

February 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 Matthew's, Harwell.

The report was prepared following a site audit conducted by Marisa Maitland, Sustain on 4th February 2014. She was accompanied by Mel Gibson.

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 Matthew'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 Matthew's in Harwell is the local parish church serving the community. It is located in South Oxfordshire and dates back to mid 11th century, with a modern extension added in the 1970's.

2.1 Listed Status

St Matthew's is of a Grade I 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 375m^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	22 hours/month
Community Use	Children's group, meetings	7 hours/month
Administration	n/a	
Catering and Events	Concerts	1 hours/month
TOTAL		**360 hours/year**

The average congregation size is dependent on the service, and varies between 6 people at the 8am service, to 95 people at the 11 am 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 16.16tCO_2e per year.

The annual energy consumption has been taken from the energy bills provided from 31 December 2012 to 30 Dec 2013. These may include the use of estimated readings where actual readings have not been taken.

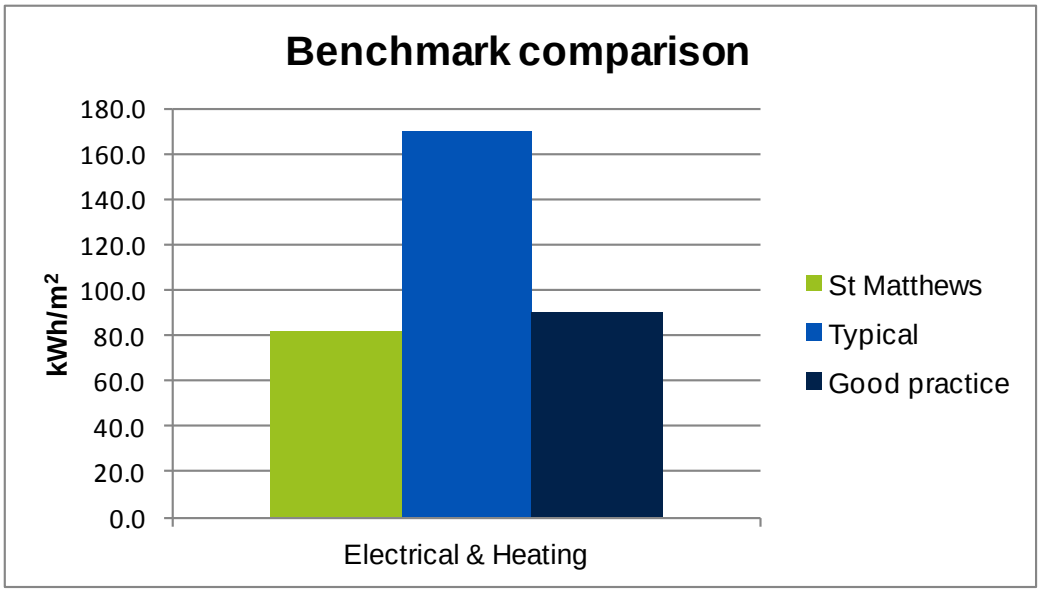
	kWh/year	Cost/kWh	Total £	Total CO_2e (tonnes)
Electricity and Heating	30,772	£0.0933	£2,871	16.16

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

In comparison with national benchmarks[1] St Matthew's consumes about the same amount of electricity than a good practise church which is good, but there is still room for improvements and a focus on reducing the electricity consumption is therefore advisable. The recommendations within this report should help to bring the church within the expected benchmarks.

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

	kWh/m^2	kWh/m^2 benchmark (typical)	kWh/m^2 benchmark (good)
Electricity and heating	82	170	90



All energy bills should apply the VAT rate of 5% due to the charitable status of PCC's and this should be checked to ensure that it 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 it is recommended that the following improvements are made.

3.1.1 Replace bulbs/lamps within existing fittings

The following lights can simply have a new low energy bulb fitted to them to generate an energy saving.

Location	Existing Lamp Type	Recommended Lamp Type	Example Source
Nave	70W metal halide down lights	9W LED G12 fitting	http://www.lightrabbit.co.uk/9-watt-g12-led-bulb-45x-smd-5050-80w-equivalent.html

If all of the above lamps are changed we estimate this to **cost £494** but **save £41** per year therefore providing a payback in 12 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.

Internal lighting – metal halide down lights.

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".
- If the light is suitable for use with dimmers.

3.1.2 Controls

The lights are currently controlled by switches located in the tower. In order that those using the building only turn on the lights they need at that time it is advised that a simple use of red and green dots can be helpful to indicate which lights are required for general use of the church.

Light switches and labeling

3.2 External Lighting

This church only has minor external lighting to the porch and the like and the recommendations of alternative bulbs/fittings have been made below.

Location	Existing Fitting	Recommended New Fitting	Example Source
Porch	100W incandescent	11W CLF	http://www.tlc-direct.co.uk/Products/LALEC11BC.html

If the above lamp is changed we estimate this to **cost £3** but **save £3** per year therefore providing a payback in 1 year. Changing the light fittings should be carried out by a qualified electrical contractor and advice on the requirement of a faculty should be sought.

The other external lights are controlled by a movement and daylight sensor.

Porch light

4.0 Heating System Saving Recommendations

4.1 Electric Heating

The heating at the church is currently provided by a number of electric bar radiant heaters which are located around building. They range from 2kW, 3kW and 4kW in output depending on their size, and provide a total of 68kW of heat when they are all on. These heaters were installed in 1997, but have proved expensive to run for long periods of time.

Radiant heater in the church

The heaters are controlled manually and are put on at 10am for the 11am service on a Sunday. The control has an automatic run time of 2 hours, after which it shuts off. There is a Danfoss 851 programmer but this is not used. The heaters are also controlled by a thermostat located at the front of the nave, so when the internal temperature reaches 16^{o}C the heaters reduce their output to half power.

Night Storage Heater in the office

The heating in the extension is supplied by night storage heaters in the office and point of use electrical heaters in the room below. The heaters in the office are left on each day, as the printer paper otherwise becomes damp and the printer will not work.. The church office is only in used on a Wednesday and Thursday and on Sundays for crèche.

4.2 Heating recommendations

The current heating system is not meeting the requirements of the church and is found to be expensive to run, especially during very cold weather. Also the current system is not very flexible in terms of allowing heating to different areas of the church for smaller areas to be used.

If the church is considering a full review of the heating system at St Matthew's, there are a number of options open to them to replace the current system.

There is gas on-site and this could be reinstated as the main heating fuel at the church, with a wet distribution system with radiators around the church and in the extension. With an efficient boiler and distribution system the running cost for the same heat output in the church will be cheaper than the current system. However, there will be the initial capital cost to take into account to install a wet heating distribution system. The cost of a new gas system is likely to be between £35,000 - £50,000 depending on the specification of the system.

A biomass boiler would be a low carbon option to a gas boiler. The distribution of the heating could be the same as the gas boiler, via a wet radiator system. The cost to run the biomass boiler would be slightly higher as the cost for biomass is approximately 5 p/kWh at

the moment, where as gas is 3.5p/kWh. However biomass is a renewable fuel source, and should have lower carbon emission dependent on the location of the fuel source.
For more information about biomass please see section 6.0.

If the pews are retained, another option is to replace the radiant heaters with more modern electrical heating. One of the more efficient options is to provide heating directly to the congregations members using heaters such as the Dimplex SCH5 attached to the pews. These heaters are 550W and cost £55 per heater, with the cost of labour being additional.

4.3 Office heating

The heating in the office is kept on to ensure that the paper used in the printer does not get damp. If the paper is damp then the printer will not work properly which causes issues. However, the cost of running the heating in the office when it is not occupied (Mon, Tue, Fri and Sat) is in the order of £450 a year. This cost has been calculated based on the assumption that there are two night storage heaters, which are drawing 3.4kW of power for 7 hours a day, at a flat rate of 9.3p/kWh for 4 days a week, 6 months of the year.

This is a significant on-going cost to the church at just over 15% of the total energy spend per year. We recommend that the church consider a more sustainable and cost effective way of storing the paper, from low cost options such as air tight containers containing bicarbonate of soda to absorb any moisture from the air, to heated cabinets.

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

There is no opportunity to insulate the floor at this church. If there floor were to be replaced in the near future, then this would be a perfect opportunity to insulate the floor.

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

There is a lobby that has been installed on the inside of the South door. This provides a good barrier to reduce draughts entering the church when congregation members and visitors are coming into the building.

The door closing mechanism on the inner porch door is no longer strong enough to keep the door closed shut. This will be leading to draughts entering into the church from the main entrance doors. The closing mechanism can be simply replaced to ensure that the door does not open and cause draughts.

It is estimated that up to 15% of heat generated can be lost through draughts and gaps in doors and windows, so anything to reduce these draughts that is simple and quick to install should be considered.

Entrance lobby

6.0 Renewable Energy Feasibility

The below reviews the viability of renewable technologies at your church and indicates if it would be possible for each of the technologies to be installed.

More details on the major technologies can be found by going to the following website www.oxford.anglican.org/mission-ministry/environment/resources

Also included in this website is a directory of installers who will be able to help you in providing you with specific costs for either a feasibility study or installation at your church depending on what your requirements are.

6.1 Solar Photovoltaics

The church roof is at a perfect orientation for the installation of photovoltaic panels, however any installation of panels will be highly visible and as such planning permission would not be granted. There is the possibility that the panels could be installed on the roof of the tower where they would not be visible. The suitability of the roof as a location would need to be verified.

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. They are suitable for use in urban areas which wind or hydro systems don't tend to be. The solar PV systems generate electricity from the solar radiation from the sun, and any electricity that is being generated can be used within the building or fed back to the National Grid.

6.2 Micro-Wind

Micro wind units require highly exposed sites and should be located 250m away from buildings. They are not suitable to be located in the curtailage of listed buildings. Given these parameters it is concluded that micro wind generation is unsuitable at this site.

6.3 Micro-Hydro

Hydro electricity is a highly efficient source of renewable energy but requires a flowing body of water with a differential height, this is not present at this site and therefore such an installation would not be feasible.

6.4 Solar Thermal

Solar thermal installations are best suited to heat water for use in washing up, hand washing and bathing. The demand for hot water is very minimal within the church and therefore the use of renewable heat for such a small demand is not recommended.

6.5 Ground Source Heat Pump

Given the church yard has numerous archaeological features with graves and the like it is not recommended that any consideration is given to the feasibility of ground source heating within this building.

6.6 Air Source Heat Pump

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

6.7 Biomass

Biomass boilers burn logs, wood chips, wood pellets or other forms of biomass. The most advanced boilers are fully automatic. They control the amount of fuel and air supplied to the combustion chamber. As a result they are highly efficient and emissions are low.

They are fed with wood chips or pellets from a large hopper sited nearby. If you've got space, manufacturers recommend a hopper that's big enough to hold a year's supply of fuel. This minimises transport and delivery costs for fuel, as well as work for the owner. Maintenance is minimal – although you will need to clean it and remove the ash about once a month.

The site appears to have suitable access for fuel deliveries. A new external boiler house and fuel store would need to be built adding to the cost. A possible location for this would adjacent to the extension.

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. 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 different functions, e.g. open for public during the day, services on a Sunday and midweek or larger public events such as flower displays.

8.0 Summary of Recommendations

This report has made numerous recommendations on improvements that can be carried out to reduce energy and carbon emissions from the operation and use of this church.

These have been summarised here in short, medium and long term measures taking into consideration the payback, capital investment and ease of carrying out each improvement. Also please take into consideration that the more the church is used, the greater the savings will be in the below table, as these are based on current usage times of the church.

These recommendations and this report should be presented to the next available PCC meeting and an action plan developed to implement as many of these actions as possible.

The costs below are indicative only based on our experience and are not specific to this church.

Short Term Improvement Measures				
Description	**Estimated Cost**	**Estimated £ Saving per year**	**Estimated Carbon Savings per year tCO_2e**	**To be actioned by**
Measure	£0	The savings depend on how much energy wastage there is currently. This saving is based on 3% of energy consumption a year saved ~£85	0.48	
Calculate and monitor	£0			
Communicate	£0			
Housekeeping	£0			
Turn of heaters in office for four days a week	£0	£460	2.6	
Label light switches for general use	£10	£14	0.08	
Replace incandescent light bulb in porch with low energy CFL.	£3	£3	0.02	
New closer on inner porch door.	£50	£20	0.12	

Medium Term Improvement Measures				
Description	**Estimated Cost**	**Estimated £Saving per year**	**Estimated Carbon Savings per year tCO_2e**	**To be actioned by**
Replace down light metal halide lamps with LEDs	£494	£41	0.23	

Long Term Improvement Measures				
Description	**Estimated Cost**	**Estimated £ Saving per year**	**Estimated Carbon Savings per year tCO_2e year**	**To be actioned by**
PV panels on the roof of the tower	£2,500	£175	0.74	
Pew heaters	Cost per heater is approx £55 per heating, ex labour	Dependant on number of heaters installed		
New gas heating system	Approx £35,000 - £50,000 for boiler and new distribution system	Dependant on type of system		
New biomass heating system	Approx £5,000-£11,000 for boiler, plus cost of distribution system, boiler house and fuel store.	Dependant on type of system		

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