Energy Audit of St James, Little Milton

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 James, Little Milton.

The report was prepared following a site audit conducted by Emily Guilding, Sustain on 29th January 2014. She was accompanied by church warden Raymond Fergusson.

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 James 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: fionadanks@trustforoxfordshire.org.uk or www.trustforoxfordshire.org.uk.

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2.0 Church Details

St James is the local parish church serving the community. It is located in Little Milton, Oxfordshire and dates back to 1844.

2.1 Listed Status

St James 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 179m^2.

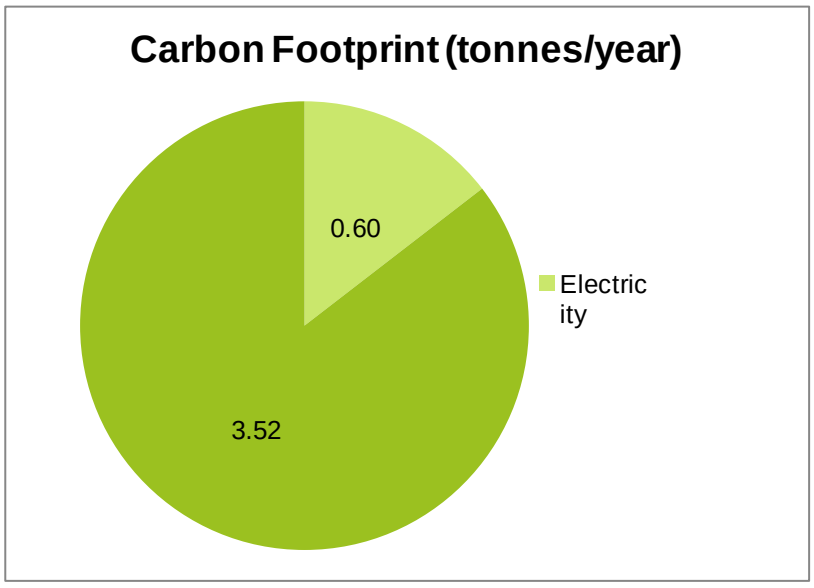
From discussions on site it has been established that the typical usage of the church is for 228 hours a year.

	Description	Average Monthly Use
Church Use	3 or 4 Sunday services per month	18 hours/month
Community Use	n/a	
Administration	n/a	
Catering and Events	Religious festivals	10 hours/year
TOTAL		**228 hours/year**

The average congregation size varies between 6-12 people.

2.3 Current Energy Usage

Annual energy bills for the church have been provided and examined. These show that the carbon footprint of the church from December 2012 – December 2013 was 4.11tCO_2.

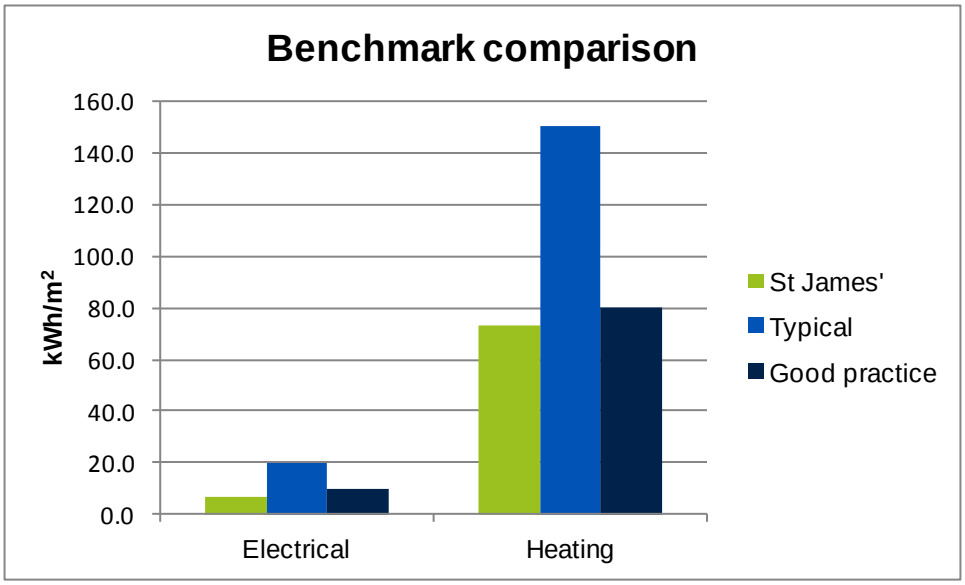


	kWh/year	Cost/kWh	Total £	Total CO_2e (tonnes)
Electricity	1,139	12.40p	£141	0.60
Oil	13,080	5.41p	£708	3.52
TOTAL	**14,219**		**£849**	**4.11**

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

In comparison with national benchmarks[1] St James consumes less heating fuel and electricity than would be expected for a church of this size. This is positive but there will certainly be room for improvement. The main limit to benchmarking is that it does not take into account occupancy hours. The recommendations within this report should help to bring the church further below the expected benchmarks.

	kWh/m^2 St James	kWh/m^2 benchmark (typical)	kWh/m^2 benchmark (good)
Electricity	6	20	10
Heating	73	150	80



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 or tariff. The church is currently on a single rate electricity tariff. Dual tariffs have a cheaper off-peak rate which would likely reduce the electricity bills due to significant weekend use. The church could also use the opportunity of switching suppliers to explore 'green electricity' options.

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

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 have a new low energy bulb fitted to them to generate an energy saving.

Location	Existing Lamp Type	Recommended Lamp Type	Example Source
3 x chandelier bulbs in chancel (figure 1)	60W incandescent bulbs	15W compact fluorescent lamps	http://www.screwfix.com/p/sylvania-mini-lynx-gls-compact-fluorescent-lamp-bc-810lm-15w/56221
8 x nave lamps (figure 2)	Unable to confirm type, estimate 240W halogen linear R7S 118mm	160W energy saving halogen 118mm linear R7S	http://www.lyco.co.uk/energy-saving-halogen-118mm-linear-r7s.html

Figure 1: Chancel chandelier

Figure 2: Nave lighting

If all of the above lamps are changed we estimate this will **cost £30** but **save £22** per year therefore providing a payback in 1.4 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 by the south aisle door. These are suitable for purpose and no change is recommended.

3.2 External Lighting

This church only has minor external lighting to the porch and the churchyard gate. These are suitable for purpose and no change is recommended.

4.0 Heating System Saving Recommendations

4.1 Boiler

The heating at the church is currently provided by a Vanguard Ideal standard 606 oil fired boiler (figure 3). The boiler is over 30 years old and is coming to the end of its life. The church would like to know what the options are for its replacement.

Figure 3: Existing boiler

The church could consider a biomass boiler (see section 6.7), electric heating (see section 4.4) or a modern high efficiency oil boiler.

Initial calculations assume a 80kW boiler would be required which, based on an assumed number of heating hours, would heat the church for approximately £435 per year. A high efficiency condensing oil fired boiler would cost around £4320. Additional to this would be the cost of controls and upgrade to the current distribution system – which would depend on whether the current pipework and radiators are suitable.

When considering a boiler replacement it is worth taking into account the following;

- If the system is suitable for a condensing boiler. Condensing boilers are most efficient 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. Also, if the current pipework is old and liable to have dirt in the system a non-condensing boiler would be better suited as the larger boiler pipework will be less susceptible to blockages.
- If a dual burner boiler is to be used, so in Spring and Autumn only half the boiler will fire
- Can the heating controls be up-graded to include weather and load compensation
- Can the existing distribution pipework be utilised or does it need replacing. Ensure pipework, valves and joins in all external/non-heated areas are well lagged to reduce heat loss.
- Can the system be filled with an antifreeze based inhibitor such as X500 from Sentinel. This prevents the water in the system from freezing so boiler frost protection is not required.

4.2 Pipework and Distribution

Within the body of the church the heating is distributed via four radiators. Without knowing the size of the current boiler it is unknown whether the radiators match the boiler output. It is unlikely they do which could partially explain the difficulty in heating the church effectively. If the boiler is replaced the radiator output should match the boiler output. It may be worthwhile installing fan convectors to help distribute the heat effectively around the space, although noise levels from the fans should be checked.

There are several actions that can be implemented to will ensure the current hating distribution is as effective as possible:

- Bleed the system to check for corrosion and sludge. If any is present it is recommended that the system is emptied, power flushed and refilled with a suitable inhibitor. This will improve

the performance of the boiler by reducing energy use and allow the building to be heated quicker and more effectively.

- Check for air within the system. If there is any in the system this will be reducing the effectiveness of the heating system and it is recommended that the church undertakes regular bleeding of air from the system. This should be carried out when the boiler and circulating pump are on and should be scheduled in each year a few weeks after the heating has been turned on.

- There is a central trench with cast iron pipework running along it which provides heat to the church (figure 4). In order to reduce unnecessary heat loss it is recommended that a flexible reflective insulation sheet should be tucked beneath the pipes and run up the sides of the trench to reflect as much heat into the church and to avoid heating the ground beneath. Such flexible insulation sheets can be obtained from DIY stores and are more typically used as a reflective sheet placed behind radiators.

Figure 4: Trench pipework

4.3 Controls and Frost Protection

The heating system is controlled by a manual switch located in the vestry. There used to be a timeclock but this was removed as it was found difficult to control. The church warden switches the boiler on at 8pm the night before a service to give a 12 hour warm up time. This seems like an excessive amount of time and could be a reflection of the inadequacy of the current system. A new boiler and heating system should mean the warm up time can be reduced. A simple 7 day programmer should be installed to allow the heating to be set to come on just a few hours before the service.

4.4 Electric heating

The church could consider installing electric pew heaters to either supplement the existing heating system or to replace the boiler once it comes to the end of its life. Although electricity is a high cost and carbon intensive fuel, because this is a low use church which is not looking to expand its community use, it may be a sensible option. However, it should be noted that it may not provide adequate heat for the bigger religious festivals or for school use, when the whole church needs to be heated. Electric heating would be used to heat a small area of the church and only used for the duration of the service removing the need for the long warm up time. Electric heaters are easy to install and fairly low cost with minimal maintenance costs.

Modern slim line electrical heaters such as the Dimplex 500W SCH5 could be fitted on the pews, either underneath (out of sight) or on the back of the pew in front. These provide direct heat to the person sitting in the pew. The heaters should be wired into individual switched fused spurs with a neon indicator so that the heater to each pew can be switched off individually. They should be fitted in the most frequently used pews and only turned on when the pew is occupied.

There are already two electric heaters in the bell tower. Timers should be fitted to these to allow programming as required.

See also renewable options for heating in section 6.7.

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 accessible roof void in which to install 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 no improvement recommendations have been made in this regard.

5.3 Floors

It was reported that the timber floorboards under the pews (figure 5) have a void beneath them. These boards could be lifted, insulation added beneath them and then the boards replaced. This could include sealing the joints to prevent cold draughts from rising up from the floor and would result in significant comfort improvements. Prior to doing this, you would need to consult with the inspecting architect to ensure that there will still be adequate ventilation under the boards to avoid wet and dry rot. A breathable insulating material that has been treated with vermin repellent should be used. Options include mineral wool, dry cellulose (recycled newspapers) or sheep wool.

Figure 5:Timber floorboards

Laying strips of carpet in-between the pews will also help to improve comfort by reducing draughts and cold transfer from the floor. Carpet should be hessian (not rubber) backed and if fixed in place, tacks should be used rather than glue.

5.4 Windows

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

5.5 Doors

The vestry and bell tower door have gaps around them which will be creating draughts (figure 6). 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. Draught proofing doors is a simple and quick measure to install.

Figure 6: Bell tower door

The edges of the doors can be sealed using the Quattro seal method (www.quattroseal.com) which is suitable for historic buildings. The product is recognised by English Heritage for listed buildings as it is fully reversible which makes it ideal to be used in churches. The doors would also benefit from a keyhole cover – a simple magnet can be used to do this if a metal surround is present.

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 specific costs for either a feasibility study or installation at your church depending on what your requirements are.

6.1 Solar Photovoltaics

Solar PV systems generate electricity from the solar radiation of the sun. Any electricity that is being generated can be used within the building or fed back to the National Grid. 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. Solar panels need to be hidden from view on listed buildings; therefore, as St James has no suitable hidden south facing pitches, they are not recommended.

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

When the time comes to replace the existing oil boiler you may want to consider a biomass fuelled boiler. Biomass is a lower carbon heating fuel than oil and at 4-6p/kWh has a similar or lower running costs.

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

They are fed with wood chips or pellets from a large hopper sited nearby. If you've got space, manufacturers recommend a hopper that's big enough to hold a year's supply of fuel. This minimises transport and delivery costs for fuel, as well as work for the owner. The boiler would require slightly more maintenance than a gas boiler so a service and maintenance contract should be put in place. Ash will need to be removed about once a month.

A new external boiler house and fuel store would need to be built adjacent to the church in a style in-keeping with the church. Ideally this would be within 30 meters of the delivery truck to pneumatically deliver wood pellets. The means it would have to be to the east of the chancel which is not ideal as would be very visible. It is likely to be more preferable to be located to the north side of the tower. In this case, the fuel would need to be bought in bags and hand loaded into the fuel store.

The system would likely be eligible for the Renewable Heat Incentive so the church would be paid for every kWh of heat produced; the rate is currently 8.6p/kWh (small commercial biomass, tier 1).

A biomass boiler can cost from £5,000 to £11,000 however the cost of the installation, distribution system, radiators, fuel store 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. The total cost of the installation would need to be obtained from installers due the specific requirements of the church and is dependent on whether the existing pipework and radiators can be used.

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.

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 to help users 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 (tonnes)**	**To be actioned by**
Measure Calculate and monitor Communicate Housekeeping	£0	£15	0.08	
Replace chancel chandelier lamps	£12	£4	0.02	
Replace nave lamps	£18	£18	0.08	
Draughtproof doors	£300	£28	0.14	

Medium Term Improvement Measures				
Description	**Estimated Cost**	**Estimated £Saving per year**	**Estimated Carbon Savings per year (tonnes)**	**To be actioned by**
Insulate central trench	£150	£14	0.07	
Flush heating system and add corrosion inhibitor if required	£375	£57	0.28	
Insulate floor	£1,200	£35	0.18	

Long Term Improvement Measures				
Description	**Estimated Cost**	**Estimated £ Saving per year**	**Estimated Carbon Savings per year (tonnes)**	**To be actioned by**
Electric heating	£500	Depends on number of services heating is required for, but based on assumed number of heating hours - £383	0.37	
Biomass boiler	Biomass boiler approx £5,000 - £11,000 plus cost of installation, distribution system, radiators and boiler/fuel store	Biomass running costs depends on fuel used. Based on last year's heating use would be in region of £354	3.2	
Oil boiler	£4-5,000 plus controls, radiator and pipework costs	£273	1.35	

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.