sustain

Energy Audit of St Andrew's, Cumnor

January 2014

Table of Contents

1.0 Introduction

This report has been prepared to detail the energy saving measures and renewable energy generation potential that exist at St Andrew's church, Cumnor.

The report was prepared following a site audit conducted by Emily Guilding, Sustain on 15th January 2014. She was accompanied by John Blackie.

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 Andrew'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: fionadanks@trustforoxfordshire.org.uk or www.trustforoxfordshire.org.uk .

.

2.0 Church Details

St Andrew's is the local parish church serving the community. It is located in the parish of Cumnor, Oxford and was built in 1961.

2.1 Listed Status

St Andrew's is not of a listed status. This 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 149m^2.

From discussions on site during the audit it has been established that the typical annual usage of the church is 1116 hours

	Description	Average Monthly Use
Church Use	1 service per week	8 hours/month
Community Use	Art, upholstery and dance classes. Table tennis, choral singing practice, youth club, toddler group	85 hours/month
Administration	n/a	
Catering and Events	n/a	
TOTAL USE		**1116 hours/year**

The average congregation size is 35-40.

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 2.79tCO_2e per year.

The annual energy consumption has been taken from the energy bills provided from November 2012 – October 2013 and use pro-rated data where there is missing data. These may include the use of estimated readings where actual readings have not been taken. All of the bills provided were estimated – it would be worth supplying a regular meter reading to ensuire the correct charges are being applied.

	kWh/year	Cost/kWh	Total £	Total CO_2e (tonnes)
Electricity	5,317	10.83p	£576	2.79

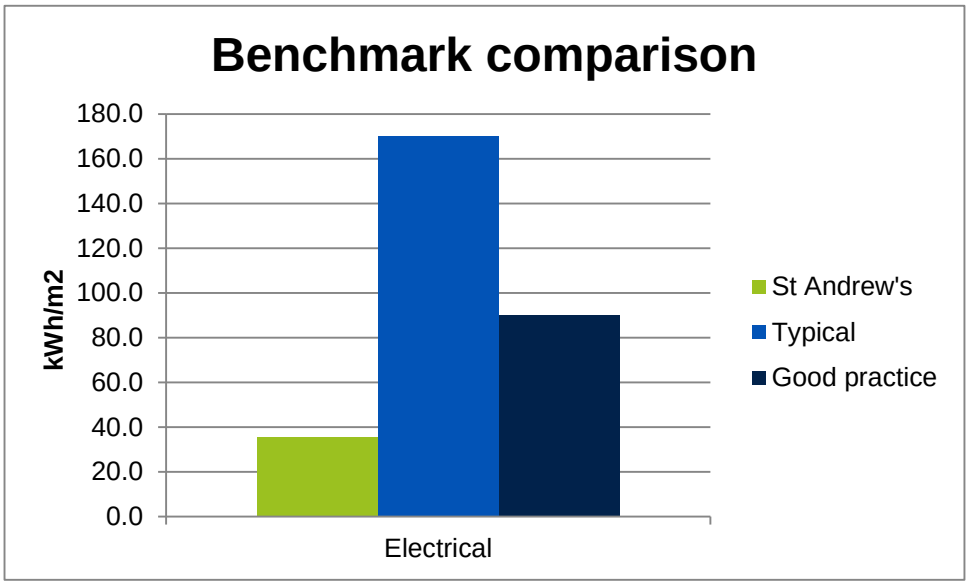
Note: The above costs are for the energy only and do not include standing charges, VAT etc

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 overall picture below. This shows St Andrew's is consuming

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

less electricity than would be expected for a church of the same 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 Andrew's	kWh/m^2 benchmark (typical)	kWh/m^2 benchmark (good)
Electricity	36	170	90



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 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.

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 electrically heated churches typically makes up the second largest use of electricity 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. Replace as they fail.

Location	Existing Lamp Type	Recommended Lamp Type	Example Source
2 x lights facing alter platform (figure 1)	Incandescent 60W bulb and R80 reflector bulb	15W R80 compact fluorescent reflector spot lamp	http://www.lightbulbworld.co.uk/r80-cfl-reflector-spot-15w-4354-p.asp
Main hall and entrance area (figure 2)	T8 fluorescent 58W tubes with switch-start control gear	T5 high frequency adaptor kits and 28W T5 tubes	http://www.chalmor.co.uk/ReFit-T5

Figure 1.Reflector spot lamp

To upgrade the existing T8 fluorescent tubes the church has two options:

a) Retain the existing fittings and use a retrofit kit to convert the fitting to be able to use T5 or LED tubes, or;
b) Replace the entire fitting with a new high frequency unit.

To decide which the most appropriate option, the age and condition of the existing fittings need to be assessed. If they are more than 10 years old and/or in poor or damaged condition it is likely to be more cost-effective to completely renew the fittings rather than convert them.

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. If light fittings are to be changed this should be carried out by a qualified electrical contractor and advice on the requirement of a faculty should be sought.

If all of the above lamps are changed we estimate this to **cost £164** (cost of lamps and the adaptor kit for replacing the fluorescent tubes) but **save £35** per year therefore providing a payback in 4.6 years.

.

Figure 2. Fluorescent tube

3.1.2 Controls

The internal lights are controlled by manual switches. These are deemed appropriate for purpose and no changes are recommended

3.2 External Lighting

The church's external lighting consists of 2 manually controlled low energy lights plus 3 tungsten halogen security lights. The security lights are movement and daylight sensor controlled. It is not known the wattage of these bulbs but it is likely they can be replaced with a lower energy replacement when they fail

Location	Existing Fitting	Recommended Lamp Type	Example Source
External security lights x 3 (figure 3)	Tungsten halogen lamp	Energy saving linear halogen lamp	http://www.lyco.co.uk/energy-saving-halogen-78mm-linear-r7s.html

Figure 3. Security lights

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.

4.0 Heating System Saving Recommendations

4.1 Heating

The church heating is provided by wall mounted dimplex electric convector heaters, estimated 2 kW (figure 4). There are 5 heaters in the main hall, 1 in each of the 3 toilets and 1 in hall way. There is also a wall mounted radiant heater for the pianist.

Figure 4. Radiant heater

This heating provides adequate heat to the church but they would like to know if there is a more cost effective way to provide the heating and whether better control can be achieved.

There are several options that are available to the church: centralise the electrical heating control (section 4.1.1); install a gas boiler and central heating system (section 4.1.2) or; install an air source heat pump (section 6.6). The advantages and disadvantages of each option is covered in the sections below, the church will need to use this information to decide on the best option.

4.1.1 Heating controls

The heaters have a centralised timeclock but in the past it has been found difficult to control the heating effectively due to the many different groups using the building throughout the week. The heaters are now controlled individually and each heater is switched on manually half an hour before a service or class and turned off/down as required.

If the church wants central control over the heating a Dimplex 4-zone wall mounted programmer system would provide the flexibility of complete system control from the convenience of a single point. Each zone in the system can be individually configured with a custom 7 day time programme, allowing complete flexibility over system design

This will provide a central control meaning use can be monitored and managed more easily but will require weekly setting. Compatibility with the current electric heaters would need to be checked.

4.1.2 Gas heating

The houses nearby are reportedly heated by gas. Therefore, the church could consider installing a gas boiler and central heating system. At around 4p per kWh gas is a cheaper and lower carbon heating fuel than electricity but significant capital would be required to install a boiler and wet heating system. It would also depend on getting a connection to the

mains gas which is thought to be in the locality. A gas heating system would be low maintenance, requiring only an annual service.

The church would require a gas boiler which could be located in the store room and a wet distribution system via radiators around the church. Initial calculations assume a 23kW boiler would be required. Based on an assumed number of heating hours, heating using gas would cost approximately £236 per year compared to £483 for the electrical heating. An estimated cost for a high efficiency gas fired condensing boiler, controls, distribution pipework with 10 2.3kW radiators is £12,250 (this does not include the cost of mains gas connection). This gives a payback period of 49 years.

The church should ensure that the system specification provides good controls and maximum efficiency with individually controlled radiators, well lagged pipework and connections and an antifreeze based inhibitor put in the system which reduces the need for boiler frost protection. Fan assisted convector radiators may well suited in order to distribute warmth around the space, although the noise levels of the fans should be checked.

See section 6.6 for air source heating option.

5.0 Building Fabric

Given the unlisted nature of this church there are a number of areas noted below where improvements can be made to the building fabric which will result in reduced amount of energy consumed and improved levels of comfort being achieved.

5.1 Roof

The loft space is insulated with up to 200mm of insulation. This is deemed adequate.

5.2 Walls

The thermal properties of the timber clad walls could be improved by installing internal wall insulation. Internal wall insulation is done by fitting rigid insulation boards to the wall, or by building a stud wall filled in with mineral wool fibre. Wall insulation will reduce heating costs as less energy will be required to maintain the same levels of heating in the building.

Internal wall insulation is disruptive as it would require the internal walls to be redecorated, the skirting and electricity sockets to be moved to accommodate the additional depth of the wall on the inside of the building. It will also mean that the internal floor area is reduced slightly.

Further advice from the DAC would need to be sought as it would change the appearance of the church. Any problems with penetrating or rising damp should be fixed first.

5.3 Floors

As the floor is solid concrete there is no opportunity for insulation. Fitting carpet will improve the thermal comfort of the space; however this may not be practical due to the varied functions of this church.

5.4 Windows

The windows are single glazed; upgrading these to double glazed units will reduce heat loss of the church.

5.5 Doors

The external doors had adequate draught proofing. However the double entrance doors did not seem to be easily closed and were left ajar during the visit. If this is a common problem this will be causing heat loss so the church may want to replace these with more welcoming partially glazed doors.

6.0 Renewable Energy Feasibility

The below reviews the viability of renewable technologies at St Andrew's 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 with providing specific costs for either a feasibility study or installation at the church depending on the requirements.

6.1 Solar Photovoltaics

The roof (figure 5) is orientated south and would make a suitable location for a solar photovoltaic (PV) array. The timber trussed, felt covered roof is thought to be of sound structure and it is not shaded. The shallow pitch will keep the visibility of the panels to a minimum. The cable routes could run down to the distribution board located in the kitchen, where there is space for an inverter if required. It is likely the distribution board would need updating, which would be an additional cost.

Ideally a solar PV system should face between south east and south west, and be free of shade. For best performance it should be angled at 30 to 40 degrees – although it will still catch a reasonable level of sunlight at angles of 20 – 50 degrees. Solar panels can be fairly heavy, so the 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.

Figure 5. Aerial image of church

An initial assessment indicates that there would be space for an 8kWp installation with a yield of approximately 6,800 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 D or higher the higher FIT rate is applicable (currently 13.5p/kWh). If it is below D, the lower rate is applicable (currently 6.85p/kWh). The calculation has assumed an EPC rating of D and above.

The church could expect to pay off the initial investment within 9 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.

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

There is no suitable space for a ground source heat pump so this system is not recommended for this church.

6.6 Air Source Heat Pump

Air source heat pumps could be a heating option at this church. Air source heat pumps are most effective in well insulated buildings with long occupancy hours. Such a system could be designed to be an air to air system with several either wall or ceiling mounted fan coil units using heat pumps to discretely distribute the hot air within the main body of the church.

An air source heat pump (ASHP) is usually placed outside at the side or back of a building, and takes heat from the air and boosts it to a higher temperature using a heat pump. This heat is then used to heat warm air convectors (in an air to air system). They are a low carbon from of heating and require very little maintenance.

The pumps needs electricity to run, but the idea is that it uses less electrical energy than the heat it produces. For every unit of electricity used by the pump, you get between two and three units of heat – making this an efficient way to heat a building. Cheaper dual electricity tariffs can be used to lower the cost of electricity to power the heat pump. Alternatively if solar photovoltaic panels are in place this free electricity source can be used.

An estimated cost for such a system would be £12,324 (for the units and estimated installation cost); this is for 3 x 8.5kW heat pumps such as the Mitsubishi Ecodan W85. It is calculated these would use £161 of electricity over a year therefore the payback period for the system would be about 38 years, but this does depend on how efficiently the system works and specification of heat pumps.

6.7 Biomass

Biomass boilers burn logs, wood chips, wood pellets or other forms of biomass. Installation of a biomass boiler and central heating system, along with the necessary fuel store and boiler house would be cost prohibitive for this church and the lifetime of the boiler might not be realised if the building fails.

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 based either on indicative quotations for this church specifically, previous similar quotes, or generic price information and include an allowance for labour. It is recommended that prior to engaging with any capital works, competitive quotations are obtained from suitably qualified contractors. We have not included a factor to account energy price rises or inflation which would make the payback periods more favourable. As the sequence of implementation of the measures is unknown the savings are independent rather than cumulative.

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 - £12	0.056	
Calculate and monitor	£0			
Communicate	£0			
Housekeeping	£0			
Replace alter platform lamps	£12	£6	0.031	
Replace fluorescent tubes	£152	£29	0.141	
Replace halogen security lights	£6	£9	0.046	

Medium Term Improvement Measures				
Description	**Estimated Cost**	**Estimated Saving per year**	**Estimated Carbon Savings per year (tCO2e)**	**To be actioned by**
Double glazing	£3,000	£40	0.195	
Central heating controller	£259	£60	0.293	

Long Term Improvement Measures				
Description	**Estimated Cost**	**Estimated Saving per year**	**Estimated Carbon Savings per year (kgCO2e)**	**To be actioned by**
Internal wall insulation	To be determined at the time of the works, but in the region of £15,000	£115	0.558	
Solar PV panels	£12,000	£184	0.893	
Gas boiler and central heating	£12,250	£248	1.254	
Air source heat pumps	£12,324	£322	1.562	

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