sustain

Energy Audit of St Mary & St Berin, Berinsfield

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 & St Berin, Berinsfield.

The report was prepared following a site audit conducted by Emily Guilding, Sustain on 29th January 2014.

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 Mary & St Berin 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 Mary & St Berin is the local parish church serving the community. It is located in Berinsfield, Oxfordshire and was built in the 1960's.

2.1 Listed Status

St May & St Berin is not of listed status. This has been taken into account when determining the recommendations for energy saving measures and renewable energy within this building. The building is split into two sections– the original half of the building which is the church and the newer extension which functions as a community hall.

2.2 Size

The approximate internal area of the church is measured as 210m^2.

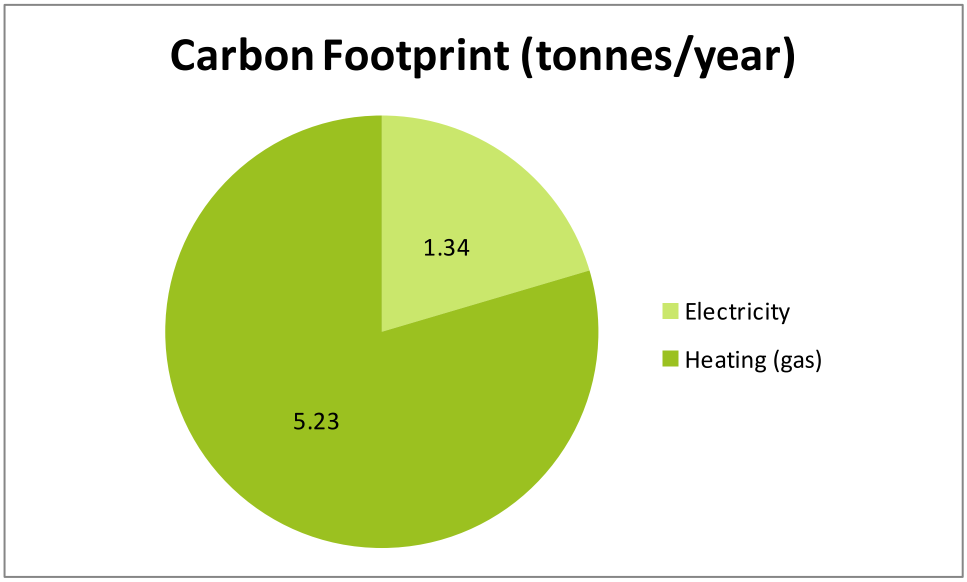
From discussions on site during the audit it has been established that the typical usage of the church is for 1170 hours per annum.

	Description	Average Use
Church Use	1 Sunday service per week	8 hours/month
Community Use	Parties, coffee and lunch clubs, W.I. Brownies, craft and art clubs	1074 hours/year
Administration	n/a	
Catering and Events	n/a	
TOTAL		**1170 hours/year**

The average congregation size is varies between 15-20 people.

2.3 Current Energy Usage

Annual energy bills for the church have been provided and examined. These show that the current carbon footprint of the church is 6.58tCO_2e per year.



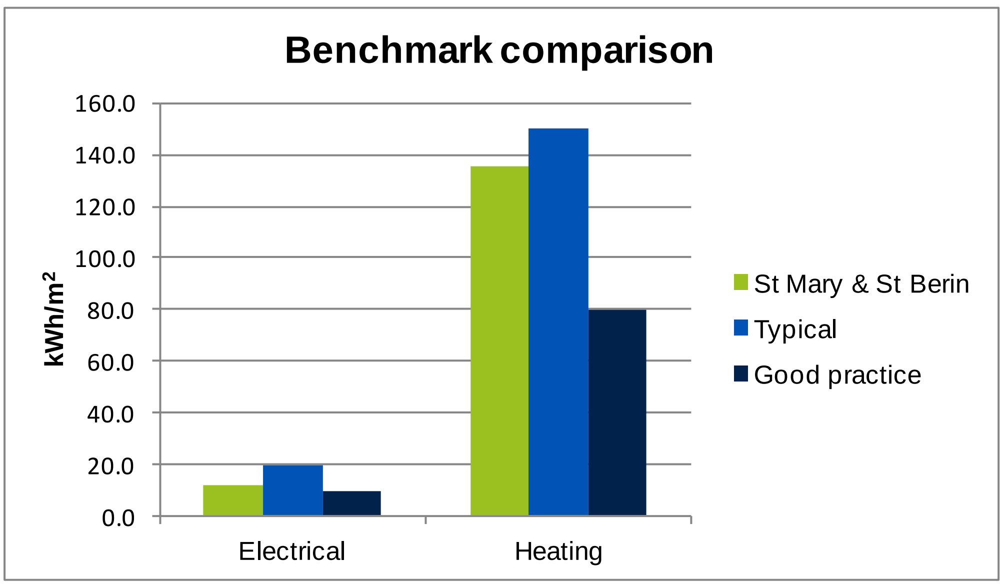
The annual energy consumption has been taken from the energy bills provided from November 2012 – October 2013. These may include the use of estimated readings where actual readings have not been taken.

	kWh/year	Cost/kWh	Total £	Total CO_2e (tonnes)
Electricity	1,342	11.86p	£306	1.34
Gas	28,437	4.21p	£1,196	5.23
TOTAL	**30,995**		**£1,502**	**6.58**

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

In comparison with national benchmarks[1] St Mary & St Berin consumes slightly less gas and electricity than would be expected for a church of this size. The recommendations within this report should help to bring the church further below the expected benchmarks.

	kWh/m^2 St Mary & St Berin	kWh/m^2 benchmark (typical)	kWh/m^2 benchmark (good)
Electricity	12	20	10
Gas	135	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.

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

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 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
6 in hall and 8 in church (figure 1)	R125 reflector spot 150W	75W Eco reflector spot lamp	http://www.tlc-direct.co.uk/Products/LAHR8070ES.html

Figure 1: Lighting in hall

If all of the above lamps are changed we estimate this to **cost £25** but **save £104** per year therefore providing a payback in 0.2 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.

Alternatively if the church wishes to invest in energy efficient lighting, an LED lighting system could be fitted. This would require new fittings and re-wiring.

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 Replace existing fittings with new low energy fittings

Due to the nature of the existing fitting the following light would require the fitting to be replaced to create a low energy light source.

Location	Existing Fitting	Recommended New Fitting	Example Source
Kitchen (figure 2)	T12 4ft tube	T5 high frequency adaptor kits and 35W T5 tubes	http://www.chalmor.co.uk/ReFit-T5

To upgrade the existing T12 fluorescent tube the church has two options:

a) Retain the existing fittings and use a retrofit kit to convert the fitting to use T5 or LED tubes, or;
b) Replace the entire fitting with a new high frequency unit, costing between £100-150

Figure 2. Kitchen fluorescent tube

To decide on 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.

If the existing fitting is retained and a retrofit kit used to convert it, this will **cost £40** but **save £2** per year therefore providing a payback in 15 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.

3.2 Controls

The lights are currently controlled by a bank of switches, these are suitable for purpose no change is recommended.

4.0 Heating System Saving Recommendations

4.1 Boiler

The heating at the church is provided by 2 Valiant ecoTEC plus gas fired boilers. These are each 28kW in size and installed 4 years ago. These were last serviced in October 2012 so another service should be organised soon.

4.2 Pipework and Distribution

The heating within the church is supplied via a mixture of fan convectors and panel radiators.

The panel radiators in the entrance hall, vestry and toilets provide adequate heat to these areas.

Figure 3. Fan convector

The boiler pipework in the kitchen is unlagged and as this space is not frequently occupied could be lagged to save energy.

There are 8 fan convectors in total - 4 original and 2 newer units in the church and 2 original units in the hall (figure 3). Fan convectors are normally the best type of heat emitters in this type of building as the fans help distribute the warm air around the large space. However, the temperature and speed of the air from these convectors is very low and struggles to adequately heat the church and hall. It is difficult to identify exactly what the problem is without a detailed investigation of the heating system. It could be a number of factors which are explored below. The ideal course of action would be to employ a heating engineer to investigate the issues in depth and identify a solution.

- Preliminary calculations suggest the boilers could be undersized for the building which could go some way to explaining the inadequate heating provision.
- The output of the fan convectors is unknown but it may be the case that they are less than the boiler output, particularly in the hall.
- The fan convector air filters should be cleaned as they can become blocked with dust, reducing the effectiveness. These can be removed and gently tapped to remove most of the accumulated dust and either vacuumed clean or washed in lukewarm water with detergent. Rinse in clean water and allow to dry naturally before replacement. For more information on fan convector maintenance download the manual.
- Bleed the system to check for corrosion and sludge. There is Sentinel X100 corrosion inhibitor already in the system but the concentration should be checked during the service. If any corrosion or sludge is present in the system 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. It will also improve the performance of units with small hot water elements such as fan convector heaters.
- 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.

- Check the following points on the fan convectors: Check thermostat operation where fitted (change set point to maximum); check integrity of wiring; check coil vented; check hot water to unit; check thermostat bulb in airstream.
- Checking flow temperature setting on the boiler.
- Check how the boiler flow temperature is controlled – it is via the thermostat or the flow temperature alone or the difference between the flow and return temperature.

4.3 Controls and Frost Protection

The heating system is controlled by a Honeywell programmer (figure 4) located in the kitchen. It is set according to the weekly schedule by the user of the hall. The heating is set to come on 1 hour before use to warm up.

Figure 4. Heating programmer

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 hall extension has a suspended ceiling and existing levels of insulation are unknown. This should be investigated and if it is found lacking then insulation can be installed using specific suspended ceiling insulation such as Go Green Insulations insulated ceiling tiles. This insulation system consists of an 'Encapsulated Insulation Pad' to provide a clean and fibre-free insulation solution for suspended ceilings. The system is designed to provide maximum energy efficiency with the lowest possible weight to reduce stress on the suspended ceiling.

The church section of the building has a pitched ceiling without a loft space. If the roof is replaced in the future, insulation should be added at this time.

5.2 Walls

The church is not listed and is of solid wall construction (figure 5). Solid wall insulation could be installed to improve the thermal properties of the building. We advise that internal wall insulation would be preferable over external insulation if the external appearance of the building wishes to be retained. Generally internal wall insulation is the cheaper option of the two, but is more 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. Further advice from the DAC would need to be sought as it would change the appearance of the church.

The construction of the hall extension indicates a cavity wall (figure 5). It was built in 1978 so the cavity may have been filled upon construction but there is no indication or knowledge of it being filled retrospectively. The presence of a cavity should be checked and filled if empty.

Figure 5. Extension – left; church - right

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 through-out the church are single-glazed. The church is already investigating secondary glazing for the two large church windows (figure 6). They may wish to extend this to include the 6 windows in the hall extension and kitchen.

Figure 6. Church windows

5.5 Doors

The external doors are adequately draught proofed and no change required.

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

The roof (figure 7) is orientated south west and would make a suitable location for a solar photovoltaic (PV) array. The tiled roof is thought to be of sound structure and it is not shaded. It is likely the distribution board would need updating, which would be an additional cost.

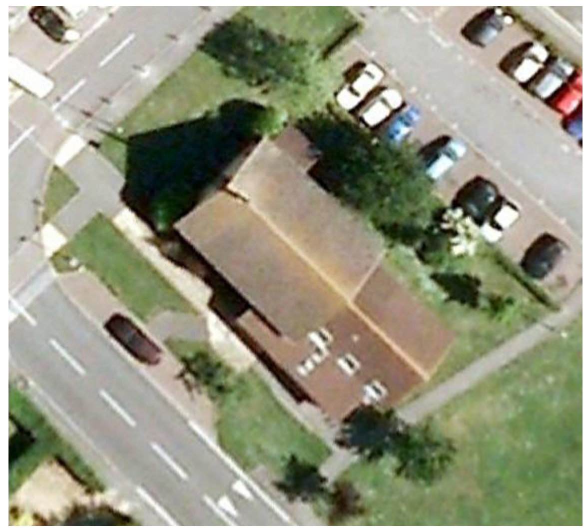


Figure 7. Aerial view of church

Ideally a solar PV system should face between south east and south west, and be free of shade. For best performance 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.

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 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

Given the church has a mains gas connection and new boilers 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

Given the church has a mains gas connection and 2 new boilers it is not recommended that any consideration is given to the feasibility of biomass heating within this building at this time.

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**	**To be actioned by**
Measure				
Calculate and monitor	£0	£30	0.13	
Communicate				
Housekeeping				
Replace lighting	£25	£104	0.46	
Replace kitchen light	£40	£2	0.01	
Insulate boiler pipework	£50	£7	0.07	
Clean fan convector filters	£0	£18	0.08	

Medium Term Improvement Measures				
Description	**Estimated Cost**	**Estimated £Saving per year**	**Estimated Carbon Savings per year**	**To be actioned by**
Heating engineer system investigation	Estimate £150	Depends on outcome of investigation	Depends on outcome of investigation	
Secondary glazing	£2500	£144	0.63	
Hall extension cavity wall insulation	To be determined at the time of the works. Approx £500	£60	0.26	
Hall ceiling insulation	£320	£48	0.21	

Long Term Improvement Measures				
Description	**Estimated Cost**	**Estimated £ Saving per year**	**Estimated Carbon Savings per year**	**To be actioned by**
Internal wall insulation	To be determined at the time of the works. Approx £150-m^2 (including moving skirting, rads, sockets, redecorating)	£144	0.78	
Solar PV panels	£12,000	£203 plus Feed-in tariff payments	0.34	

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