# Energy Audit of St Mary's, Charlbury (I)

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 Mary's, Charlbury.

The report was prepared following a site audit conducted by Marisa Maitland, Sustain on 7th January 2014. She was accompanied by Scott Grant and Brian Morley.

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'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 Mary's, Charlbury is the local parish church serving the community. It is located in North Oxfordshire and dates back to mid 14th century.

## 2.1 Listed Status

St Mary'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

The approximate internal area of the church was measured as 880m$^2$ from the floor plan of the church.

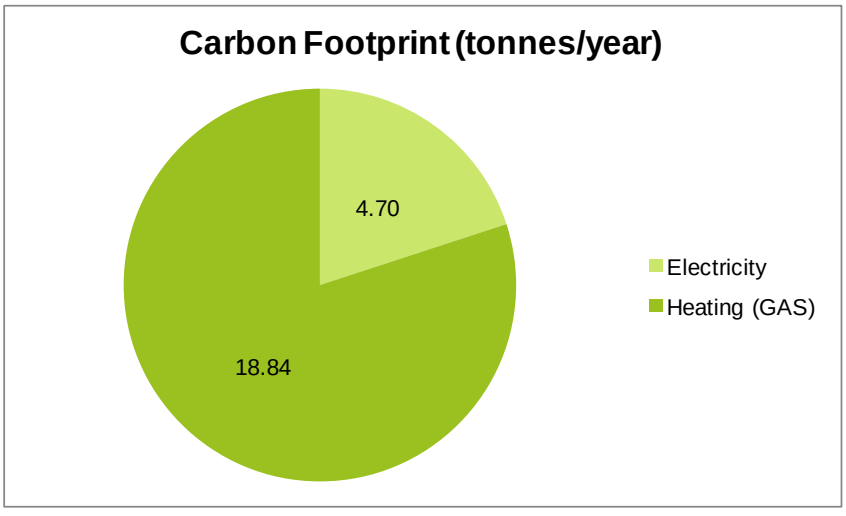
From discussions on site during the audit it has been established that the typical usage of the church is for 35 hours per month.

| | Description | Average Monthly Use |
|---|---|---|
| **Church Use** | 3 or 4 services per week | 25 hours/month |
| **Community Use** | Concerts and other events | 2 hours/ month |
| **Administration** | n/a | |
| **Catering and Events** | Font Cafe | 8 hours/month |
| **TOTAL** | | **420 hours/year** |

The average congregation size is dependent on the service, and is an average of 80 people at the family 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 23.55t$CO_2$e per year.



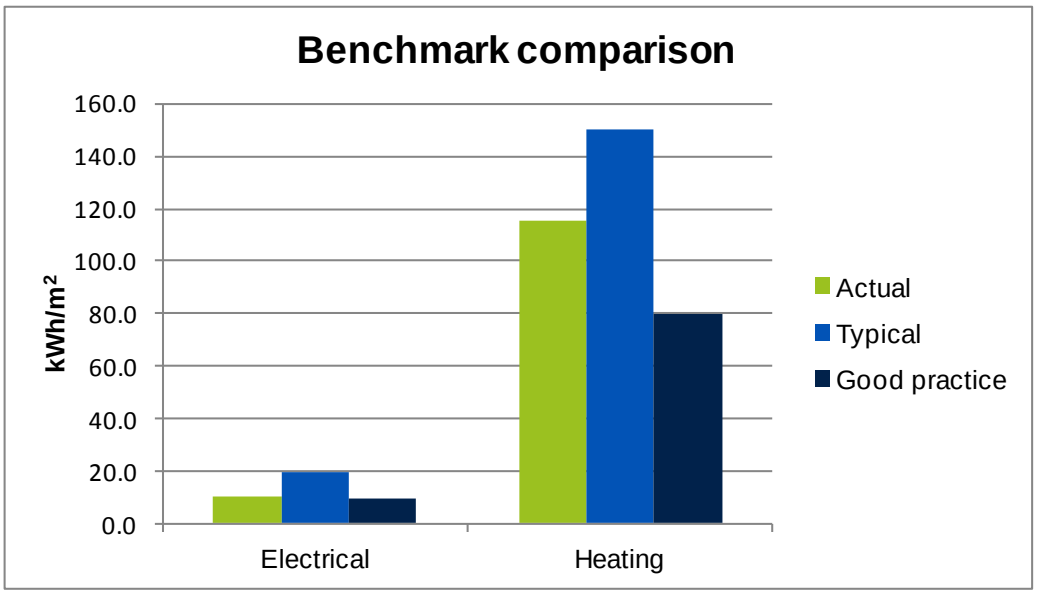

The annual energy consumption has been taken from the energy bills provided from October 2012 for a 12 month period.

| | kWh/year | Cost/kWh | Total £ | Total $CO_2e$ (tonnes) |
|---|---|---|---|---|
| **Electricity** | 8,959 | £0.1051 | £942 | 4.70 |
| **Gas** | 102,402 | £0.0490 | £5,017 | 18.84 |
| **TOTAL** | **111,361** | | **£5,959** | **23.55** |

*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's consumes more gas than would be expected for a church of this size but average electricity. A focus on reducing the gas consumption is therefore advisable and the recommendations within this report should help to bring the church within the expected benchmarks.

| | kWh/m$^2$ St Mary's | kWh/m$^2$ benchmark (typical) | kWh/m$^2$ benchmark (good) |
|---|---|---|---|
| **Electricity** | 10 | 20 | 10 |
| **Gas** | 115 | 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

St Mary's have recently joined the Parish Buying scheme, which will lead to lower costs of energy. We 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.

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

# 3.0 Electrical Saving Recommendations

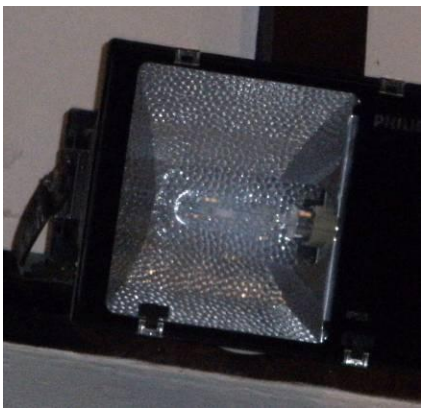
## 3.1 Internal Lighting

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.

There are approximately 32 flood lights installed at ceiling level throughout the church. These appear to use a high pressure sodium lamps, which are likely to have a high wattage. During the visit, it was not possible to ascertain the exact wattage or lamp fitting to be able to recommend a more energy efficient replacement.

Based on the assumption that each of the lamps is at least 150W, they could be replaced with LED lamps, which would only need to be 40W equivalent to give a similar amount of light. The cost savings from reducing the overall wattage of those lamps would lead to a saving of £311 per year. The cost of the new lamps will depend if the current fittings can be used, and the lamps only replaced, or if new fittings will be required as well.



Sodium flood lamps

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.

### 3.1.1 Controls

The lights are currently controlled by switches which are well labelled.

In order that those using the building only turn on the lights they need at that time it is advised that each switch is labelled to describe which light it switches on and off. A simple use of red and green dots can be helpful to indicate which lights are required for general visiting.

Lighting switches

## 3.2 External Lighting

This church only has minor external lighting to the porch. This lamp is controlled by a PIR movement sensor, which controls 3 flood lights. Currently only one of the flood lights is working, which provides adequate lighting, and the church should consider if all the lights are required.

We also recommend that the church consider the installation of a daylight sensor to control the porch light, so that it only comes on when the natural daylight has reduced beyond a certain level. This will avoid any unnecessary usage of the lamp when it is not required to light the porch.

# 4.0 Heating System Saving Recommendations

## 4.1 Boiler

The heating at the church is currently provided by a three gas boilers. The main boiler is 128 kW in size and was installed in 1989. The other two boilers were installed when the church was re-ordered in the1990s.

The main Lochinvar boiler is responsible for heating the majority of the church which includes the nave, chancel, North and South aisles. One of the other smaller Vaillant boilers provides heating to the enclosed Memorial Chapel and the other Vaillant boiler the vestry and hot water to the kitchen.

The church is looking to replace the main boiler in the near future. When replacing boilers we recommend you take into consideration the following:

Boiler in the Memorial Chapel

- If the current system is suitable for a condensing boiler. Condensing boilers work most efficiently at lower flower temperatures, so if the heating system is not designed to work at a lower temperature the efficiency from a condensing boiler would not be noticeable. Also, if the current heating system is old and liable to have dirt in the system a non-condensing boiler would be better suited as the larger pipework will be less susceptible to blockages.
- If a dual burner boiler can be used, so in Spring and Autumn only half the boiler will fire.
- If the existing boiler is over-sized and could it be reduced.
- Can the heating controls be up-graded to include weather and load compensation

## 4.2 Pipework and Distribution

The pipework within the boiler room is copper and requires additional lagging to the pipes. Not only will this help to save energy through reduced heat loss but will also provide better protection against burst pipes. Within the body of the church the pipework is distributed via copper pipes.

The water circulating within the heating system was reported to be drawn off and inspected. It is found that the water within the heating system is clear which indicates that the system has got adequate corrosion inhibitor within it.

The radiators are also bled on a regular basis. When air is in the system it will be reducing the effectiveness of the heating system and it is recommended that the church continues to undertake 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.

## 4.3 Radiators and other heat emitters

The heating within the church is supplied via a mix of radiators and trench heating vents.

There are a large number of radiators along the external walls of the side aisle, and these are controlled by TRVs. It was noted however that the TRVs were set to different heating

levels. We recommend that these are all checked and set to 3 again, unless there is any requirement for them to be set any higher.

We also recommend that the trench heating grills are cleaned, as they were extremely dusty and dirty which will be significantly reducing the effectiveness of the radiators

Radiators in the nave

Trench heating in church floor

There are a number of radiators on external walls which will benefit from radiator panels behind them. These panels reflect the heat from the radiator back into the room, rather than being absorbed into the stone wall. These are a low cost measure and simple to fit. The installation of the radiator panels will need to by checked with the DAC.

## 4.4 Controls and Frost Protection

The heating system is controlled by three programmers. Two of the programmers are located in the bathroom in the vestry area and are Honeywell controllers and the other programmer is adjacent to the boiler in the Memorial Chapel, which is a Dunfoss controller. The Honeywell programmers were reported to be set for the heating to come on twice a day during the week and longer on Sundays. The boiler for the Memorial Chapel was reported to only come on when the space is used on Sundays and Thursdays.

We recommend that the settings to the heating a reconsidered to check if it is necessary for the building to be heated every day during the winter, when it is only in use a number of times a week.

For the main boiler, there is no thermostat; the boiler heating demand is controlled by the flow and return temperatures, which appeared to be set at 68$^{o}$C and 60$^{o}$C respectively.

The building is protected against frost by a frost stat located in bathroom in the vestry area, however this was broken. The dial on the front of the stat had previously been removed and stuck back on, but this was still loose and it was not clear what temperature it was set too. It would appear that the frost stat is set incorrectly which will either cause the gas boilers to fire too often if the stat is set too high, or lead to the potential of damage if it is set too low and the internal temperature drops too low. We recommend that a new frost stat is installed.

However, it is not unusual for over 30% of the heat energy used in churches to be used to protect the heating system itself from frost damage. As an alternative to firing the boiler to warm up the water to prevent it from freezing the system can instead be filled with an antifreeze based inhibitor such as X500 from Sentinel and the frost stat removed.

## 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 were no opportunities to install any insulation in the floor at the church.

### 5.4 Windows

The windows are in good condition, with no broken window panes or gaps between the glass and the abutments witnessed. However one of the windows near the main door on the South side had a tendency to blow open in the wind, as was the case on the day of the audit. This is going to be leading to a considerable draught in the building and a waste of heat. We recommend that the fixing for this window is repaired to eliminate this problem.

Faulty window on south side

### 5.5 Doors

The main entrance doors to the church were glazed in 2011, which provides a welcoming feel to the church, without requiring the doors to be open all of the time.

There is however a gap at the bottom of the glazed doors which will be leading to draughts within the church. It is estimated that up to 15% of heat generated can be lost through draughts and gaps in doors and windows, so it is a good idea for this to be reduced where possible and draught proofing doors is a simple and quick measure to install.

Gap on entrance doors

This gap can be sealed using a specifically designed glass door brush, which can be attached along the bottom of the door.

## 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

This church is of Grade I listed status and as such the current planning policies by the DAC restrict the installation of PV panels on such churches where the panels would be visible. If the panels were installed they are likely to be visible from neighbouring houses, and also there is a very large tree on the south side of the church which will cause shade over the roof of the church. Given these restrictions the installation of PV at St Mary's is 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

Although St Mary's church has gas installed, the cost of running a biomass system at the moment is comparable. As the gas boiler is due to be replaced in the near future, it would be worth the church considering if the heat for the church can be supplied from a renewable source.

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. Daily 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, however a new storage area and boiler house would need to be built in the church grounds. The cost of the installation of the boiler would need to be obtained from installers due the specific requirements of the church and the requirement of a storage area. A biomass boiler can cost between £5,000 to £11,000, however the cost of the installation will be specific to this church.

The boiler would require slightly more servicing than a gas boiler so a service and maintenance contract should be put in place. The system would likely to be eligible for the Renewable Heat Incentive. This means the church will be paid for the energy generated by the boiler. The rate depends on size of boiler installed; for a small commercial biomass boiler it is currently 8.6p/kWh.

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** | **To be actioned by** |
| Measure | £0 | The savings depend on how much energy wastage there is currently. A fair estimate is 2-5% of energy consumption a year ~ £170. | 1.75 $tCO_2^e$ | |
| Calculate and monitor | £0 | | | |
| Communicate | £0 | | | |
| Housekeeping | £0 | | | |
| Label light switches | £10 | £5 if assume lighting is 10% of energy use and 10% saved by shortening running hours due to labelling. | 0.02 $tCO_2^e$ | |
| Clean trench radiators | £0 | £40 | 0.14 $tCO_2^e$ | |
| Fix window catch on South side | £50 | £25 | 0.09 $tCO_2^e$ | |
| Replace broken frost stat | £80 | £125 | 0.47 $tCO_2^e$ | |
| Pipework insulation | £60 | £130 | 0.48 $tCO_2^e$ | |
| Draughtproof glass door | £100 | £50 | 0.2 $tCO_2^e$ | |

| Medium Term Improvement Measures | | | | |
|---|---|---|---|---|
| **Description** | **Estimated Cost** | **Estimated £Saving per year** | **Estimated Carbon Savings per year** | **To be actioned by** |
| Radiator reflective panels | £200 | £151 | 0.57 $tCO_2^e$ | |
| Use Gylcol inhibitor in water pipes and remove the froststat | £260 | £200 | 0.75 $tCO_2^e$ | |
| Replace flood lamps | Cost to be determined when lamp type identified. | £300 | 1.55 $tCO_2^e$ | |

| Long Term Improvement Measures | | | | |
|---|---|---|---|---|
| **Description** | **Estimated Cost** | **Estimated Saving per year** | **Estimated Carbon Savings per year (tCO2e)** | **To be actioned by** |
| Biomass boiler | Biomass boiler approx £5k - £11, plus cost of installation and boiler room. | To be calculated as specific to this church. | | |

## 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