Energy Audit of St Peters Church, Stoke Lyne

December 2013

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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 Peter's Church, Stoke Lyne.

The report was prepared following a site audit conducted by Emily Guilding, Sustain on 12th December 2013. She was accompanied by Church Warden Chris Poole.

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 Peter'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 .

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2.0 Church Details

St Peter's is the local parish church serving the community. It is located in Stoke Lyne, Oxfordshire and dates back to the 12th century.

2.1 Listed Status

St Peter's 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 260m^2.

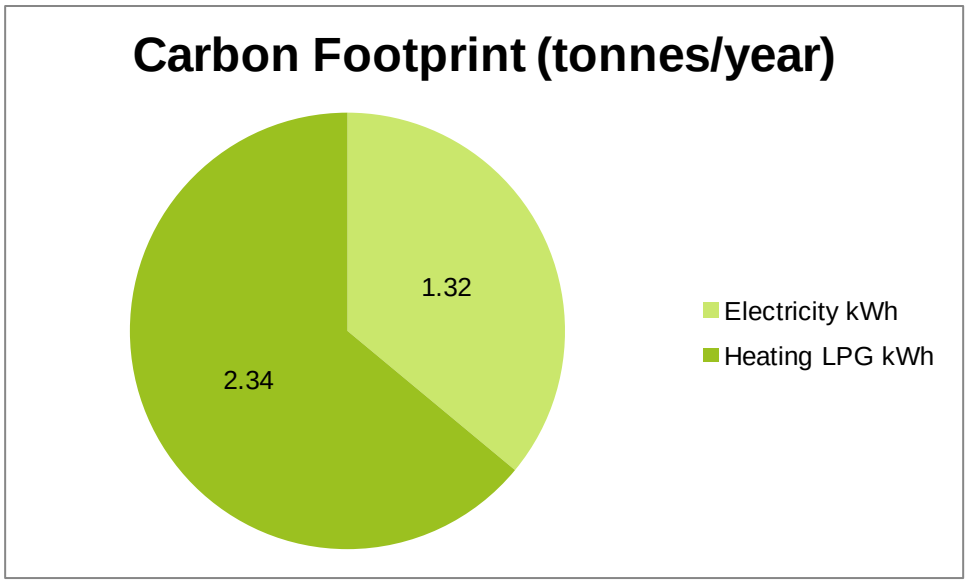
From discussions on site during the audit it has been established that the typical usage of the church is for 140 hours per annum.

	Description	Average Monthly Use
Church Use	Church services	8 hours/month
Community Use	Children's playgroup, church/PCC meetings, W.I. meetings, fitness groups, occasional village events	3 hours/month
Administration	n/a	n/a
Catering and Events		n/a
Total annual use		**140 hours/year**

The average congregation size is between 12-14 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 3.66tCO_2e per year.



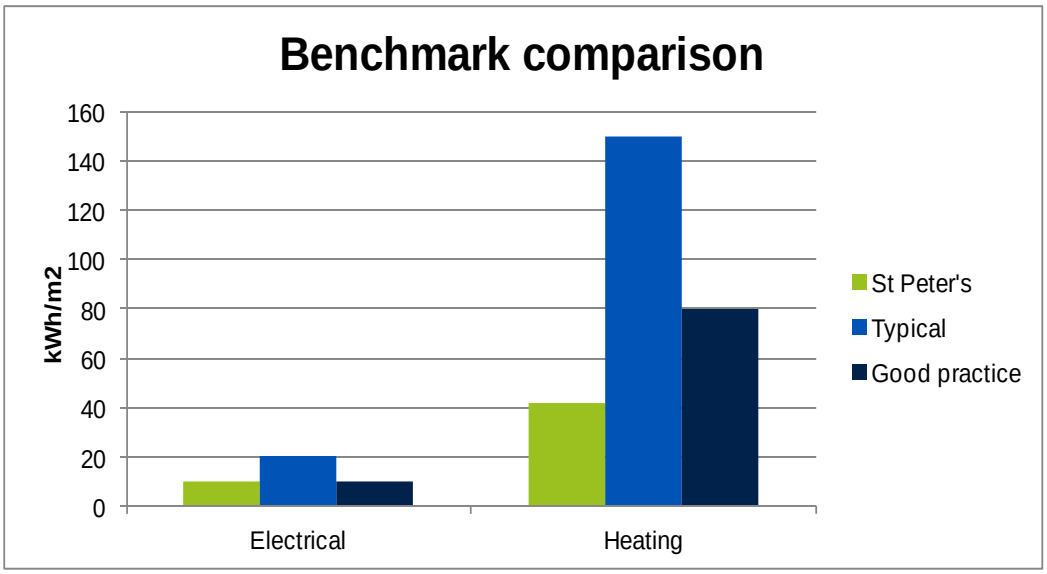
The annual energy consumption has been taken from the electricity and LPG bills provided between November 2012 – October 2013. These may include the use of estimated readings where actual readings have not been taken.

	kWh/year	Cost/kWh	Total £	Total CO_2e (tonnes)
Electricity	2,511	£0.1373	£345	1.32
Heating (LPG)	10,899	£0.0936	£1,021	2.34
TOTAL	**13,410**		**£1,365**	**3.66**

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

In comparison with national benchmarks[1] St Peter's is consuming less electricity and heating fuel than would be expected for a church of the same size. This is positive but the benchmark figure does not take into account occupancy hours. There will certainly be room for improvement and the recommendations within this report should help to bring the church further below the expected benchmarks.

	kWh/m^2 St Peter's	kWh/m^2 benchmark (typical)	kWh/m^2 benchmark (good)
Electricity	10	20	10
Heating	42	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.

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

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 as the majority of the church use is at weekends, would likely reduce the church's bills. 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. This should be done as the old lamps fail. The church's low occupancy hours mean that the paybacks are long, however, if the use of the church increases so will the energy savings.

Location	Existing Lamp Type	Recommend Lamp Type	Example Source
12 internal high level flood lights - (figure 1)	Unable to confirm bulb type but estimate is 150W high pressure sodium SON-E	40W LED corn light	http://www.lampshoponline.com/60w-led-corn-light-mh-son-replacement-ges-e40-cap/
7 internal spot lights located around church at high level (figure 2)	60W R80 screw cap spot lights	15W compact reflector R80 lamps	http://www.tlc-direct.co.uk/Products/MGR8015ES.html
6 internal lights around church including ones facing into chancel (figure 3)	120W halogen linear R7S 78mm lamps	70W energy saving halogen 78mm linear R7S	http://www.lyco.co.uk/energy-saving-halogen-78mm-linear-r7s.html

Figure 1. High pressure sodium lights

Figure 2. R80 spot lights

Figure 3. Halogen linear lamps

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 Replace existing fittings with new low energy fittings

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

Location	Existing Fitting	Recommended New Fitting	Example Source
2 fluorescent tubes in Kitchen (figure 4)	5ft T12 fluorescent tubes	T5 high frequency adaptor kits and 35W T5 tubes	http://www.chalmor.co.uk/ReFit-T5

To upgrade the existing T12 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.

Figure 4. Kitchen fluorescent tube

To decide which the most appropriate option is 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.

Changing the light fittings should be carried out by a qualified electrical contractor and advice on the requirement of a faculty should be sought.

3.1.3 Controls

The lights are currently controlled by a bank of labelled switches (figure 6).

Figure 6. Labelled light switches

3.2 External Lighting

The church's external lighting consists of 5 manually controlled low energy lights plus 1 security light controlled by a sensor. These are deemed appropriate for purpose and no changes are recommended.

4.0 Heating System Saving Recommendations

4.1 Heating system

The heating in the main body of the church is currently provided by 6 LPG DRU Kamara powered flue gas wall heaters (figure 7). There are 4 7kW heaters and 2 recently installed 16kW heaters (total 60kW). These are controlled by individual programmers. The heaters are programmed to come on at 7.15am Sunday morning, giving 2 hours of warm up time before the Sunday service. The thermostat is set to 22°C but this temperature is not reached. It is estimated that the internal temperature gets up to about 14°C for the service.

LPG is an expensive fuel at about 9p per kWh but due to the rural location of the church other options are limited.

The church wants to increase its community use but is reluctant to do so until it can be adequately heated. It is a large space which due to infrequent use and its traditional build is difficult to heat to an acceptable temperature. To achieve this is ultimately going to use more energy and will require investment. There are two appropriate options to achieve this: install supplementary electrical heating (section 4.1.1) and; install a biomass boiler and wet heating system (section 6.7). The advantages and disadvantages of each option is covered in the sections below, the church will need to use this information to decide which the best option is.

The church is considering screening off the Lady Chapel and using it for its regular weekly service. This will provide a smaller space that will be easier to heat to an adequate temperature.

Figure 7. LPG heater

4.1.1 Install supplementary electric heating

The church heating is currently provided by 6 LPG heaters. As these are not providing satisfactory heating the church may want to consider supplementing it with modern slim line heaters such as the Dimplex 500W SCH5 heater. These could be fitted either on the back of the pew in front or under the pew seats. These heat the person sitting in the pew directly. 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. Electrical heaters are generally easy to install and fairly low cost with minimal maintenance costs.

Alternatively wall mounted radiant heaters such as the Dimplex Quartz 3kW heater could be installed. These are often an appropriate heating method in a large building with low

occupancy such a church. Radiant heaters are turned on as required and provide instant heat. They heat the occupants rather than attempting to heat the whole space. They warm the occupants sat in the direct line of the heaters so these should be directed to where the main congregation sit. These heaters can sometimes have the unsatisfactory effect of heating heads and leaving feet cold. It should be noted that wall mounted radiant heaters are not currently favoured by the DAC.

The cost of heating the church electrically depends on the amount the heaters are used but at 13p per kWh, electricity is more cost and carbon intensive than LPG. The use of the electric heaters should be carefully controlled and only used to supplement the existing LPG heaters when absolutely necessary.

See also Biomass 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 loft space in the church 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 externally no improvement recommendations have been made in this regard.

5.3 Floors

The timber floorboards under the pews (figure 8) 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.

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.

Figure 8. Floor boards

5.4 Windows

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

5.5 Doors

The church has an enclosed porch with an external door. If the porch and church entrance doors are left open as the congregation arrives for a service it may be worthwhile installing a hot air curtain over the internal door to prevent cold air entering the church (an air curtain should not be necessary if either the porch or church entrance door remains closed before a service).

An air curtain is a device used for separating two spaces from each other. The most common configuration for air curtains is a downward-facing blower fan mounted over an opening, blowing air across the surface of the opening (see figure 9). Air curtains can come with, or without heaters to heat the air. It helps keep out outside air, reducing infiltration though the opening. They can also be used to avoid cold draughts by mixing in warm air heated by the air curtain. The fan must be powerful enough to generate a jet of air that can reach the floor.

This will help to reduce heat loss and cold air entering the building just prior to a service and reduce the need for longer warm up times. The air curtain must go across the full width of the door way to be effective. It is likely that the DAC will need to be consulted before installing this measure. There are many manufactures of air curtains, and Dimplex have a large range. You will need to employ an electrician to carry out the installation.

Figure 9. Example of an air curtain in a church

6.0 Renewable Energy Feasibility

The below reviews the viability of renewable technologies at St Peter's Church and indicates if it would be possible for each of the technologies to be installed.

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

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

6.1 Solar Photovoltaics

The current planning guidance does not support solar photovoltaic (PV) arrays on Grade II* buildings where the panels would be visible. The visibility of a PV installation on St Peter's Church roof means it would not be suitable.

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

A biomass boiler and wet heating system could be a suitable heating option for the church. 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 there is 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 will need to be cleaned and ash removed about once a month.

Biomass is a zero carbon fuel and depending on the fuel used costs about around 5p per kWh. The cost of the installation of the boiler would need to be obtained from specialist installers due the specific requirements of the church. A biomass boiler can cost between £5,000 to £11,000, however the cost of the installation, distribution system, radiators and boiler room would all also need to be included. As these costs are specific to the church we are not able to provide an estimate as the parameters are wide ranging. Capital costs are high but if the hours of use of the church increases this will strengthen the case for investment.

The cost of heating the church using biomass depends on the boiler and distribution system efficiency. Based on a biomass heating system running at 85% efficiency, the cost to produce the same heat output as currently would be approximately £572 (based on 5p/kWh but does depend on biomass fuel used) compared to £1,020 for LPG. To calculate the system payback a feasibility study would need to be completed to give the total cost.

The site appears to have suitable access for fuel deliveries. A new external boiler house and fuel store costing between £10,000-£20,000 would need to be built. A possible location for this would be on the north side of the church out of view of the main entrance (figure 10). The new structure would need to be in keeping with the adjacent building.

The system could be eligible for the Renewable Heat Incentive (depending on fuel used). 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.

Figure 10. Possible location for fuel store and boiler house

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 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 indicative only based on our experience and are not specific to this church. The savings are based on occupancy hours given therefore may change depending on occupancy and heating hours of the church.

Short Term Improvement Measures			
Description	**Estimated Cost**	**Estimated Saving**	**To be actioned by**
Measure	£0	Low for this church but there will be a small saving	
Calculate and monitor	£0		
Communicate	£0		
Housekeeping	£0		
Replace high pressure sodium lamps once existing lamps fail	£912	£25/year (36 year payback)	
Replace R80 spot lights	£64	£6/year (10 year payback)	
Replace halogen linear lamps	£13	£6/year (2 year payback)	
Replace T12 fluorescent tubes	£38	£2/year (21 year payback)	

Medium Term Improvement Measures			
Description	**Estimated Cost**	**Estimated Saving**	**To be actioned by**
Consider installing air curtain	£1400	£51/year and improved comfort (27 year payback)	
Insulate under floor boards	Depends on type of insulation used but likely to be in the region of £500	£20 and improved comfort (£23 year payback)	

Long Term Improvement Measures			
Description	**Estimated Cost**	**Estimated Saving**	**To be actioned by**
Consider supplementary electrical heating	Approximately £50 per pew heater and £350 per Quartz	Improved comfort	

	heater plus installation costs		
Commission feasibility study for biomass heating system	Biomass boiler approx £5,000 - £11,000 plus cost of installation, distribution system, radiators and boiler/fuel store.	Difficult to quantify as depends on occupancy hours of church. Biomass heating per kWh is lower cost than electricity or LPG to run.	

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