ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Giles' Church, Horsted Keynes
PCC of St Giles Church

Author	Reviewer	Audit Date	Version
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1. Executive Summary

An energy survey of St Giles' Church, Horsted Keynes was undertaken by ESOS Energy to provide advice to the church on how it can be more energy efficient and provide a sustainable and comfortable environment to support its continued use. This audit has been provided in conjunction with 2buy2, the Church of England's Parish Buying scheme provider and is subsidised from Total Gas & Power, the Parish Buying schemes principal energy suppliers.

St Giles' Church, Horsted Keynes dates from the 12th and 13th century, with a north aisle and porch added in 1888. Mains electricity is supplied to the site; heating is by oil.

The church has a number of ways in which it can be more energy efficient and a clear path towards net zero carbon. Our key recommendations have been summarised in the table below and are described in more detail later in this report. It is recommended that this table and the route to net zero carbon diagram below are used as the action plan for the church in implementing these recommendations over the coming years.

Energy and decarbonisation recommendations	Estimated Annual Energy Saving (kWh)	Estimated Annual Cost Saving (£)	Estimated capital cost (£)	Payback (years)	Permission needed	CO2 saving (tonnes of CO2e/yr)
Switch electricity supplier to ones which provide 100% renewable (or green gas) supplies	None	None	Nil	N/A	None	Offset 0.35 tonnes
Purchase a temperature and humidity monitor	N/A	N/A	£80		None	
Draught proofing works	1% 280	£21	£30	1.5	Consult DAC	0.07
Flush and Clean heating system	7% 1,960	£145	£500	3.5	List B	0.53
Add further insulation to boiler room pipework, pumps and valves.	5% 1,400	£104	£200	2	List B	0.38
Install Under Pew convector heaters	28,000 oil ~ 6,400 electricity use	Equivalent (full installation)	£20,000 (full installation)		List B	6.2
Consider registering for Eco Church	The Eco Church programme, which is recommended by the Church of England, helps congregations care for the environment in all aspects of church life. The programme is free; you can, however, make a donation to A Rocha UK towards its costs.					
Create a procurement policy for appliances (and other goods)	Commit to buying only appliances with the new energy efficiency ratings of A, B or C at the lowest when those you currently have reach the end of their useful life. (NB ovens, air conditioners and space or water heaters are still on the older rating scale, so for these, try for A+++.)					

Alternative Options	Estimated Annual Energy Saving (kWh)	Estimated Annual Cost Saving (£)	Estimated capital cost (£)	Payback (years)	Permission needed	CO2 saving (tonnes of CO2e/yr)
Install heated Pew cushions	28,000 oil	Unknown	Unknown		List A	

The church should check any faculty requirements with the DAC Secretary at the Diocese before commencing any works.

Figures in the table are based on current market prices of 32p/kWh for electricity and 80p/litre (7.5p/kWh) for oil. The carbon figures are based on the DEFRA 2022 carbon emission factors of 0.21107 for electricity and 0.27 for oil. Do note that as energy prices increase, payback periods decrease.

2. The Route to Net Zero Carbon

Our Government has committed to move towards Net Zero Carbon – the point at which we have reduced emissions as much as we can and then balanced any residual emissions through removal of carbon from the atmosphere. They have done this as part of a worldwide agreement which aims to limit global warming to well under 2 degrees Celsius, with an aim of keeping it below 1.5 degrees Celsius. This will help protect all of us from the impacts of climate change.

In February 2020, the Church of England's General Synod set its own Net Zero Carbon target. The first stage of this target covers energy used by churches, cathedrals, schools, vicarages, other church buildings, as well as emissions caused by reimbursed transport. The target date is 2030.

This church has a clear route to become net zero by 2030 by undertaking the following steps:

3. Introduction

This report is provided to the PCC of St Giles' Church, Horsted Keynes to give them advice and guidance as to how the church can be improved to be more energy efficient. In doing so the church will also become more cost effective to run and seek to improve the levels of comfort. Where future church development and reordering plans are known, the recommendations in this report have been aligned with them.

An energy survey of the St Giles' Church, Horsted Keynes, Church Lane RH17 7AY was completed on the 26th January 2023 by Dr. Paul Hamley. Paul is an energy auditor with experience of advising churches and small businesses. He is part of the Diocesan Environment Officers Energy Group developing advice for the Church of England and authored the "Assessing Energy Use in Churches" report for Historic England. He is a CIBSE Associate member and a Chartered Scientist, with experience of the faculty process gained from chairing the building committee of a Grade I listed church.

St Giles' Church, Horsted Keynes	
Church Code	610162
Gross Internal Floor Area	275 m^2
Volume	1,700 m^3
Heat requirement	56 kW
Listed Status	Grade I
Average Congregation Size	60 (over 3 services)

The church typically used for 7.5 hours per week for the following activities

Type of Use	Hours Per Week (Typical)
Services	3 hours per week
Meetings and Church Groups	0.5 hours per week
Community Use	2 hours per week (school)
Occasional Offices	3 Weddings 15 Funerals

4. Energy Procurement Review

Energy bills for electricity have been supplied for the period October 2021 to October 2022.

The electricity rates listed below applied to 31/12/2022.

Single Rate	15.50p/kWh
Standing Charge	25.00p/day

The electricity is supplied by EDF, and is not purchased on a renewable tariff.

Going onto a renewable tariff is an important part of the process of taking churches towards net zero. The church is therefore encouraged to consider procuring its electricity from suppliers that offer 100% renewable electricity, and in some cases 'green' or 'carbon neutral' gas.
Parish Buying, the Charity Buying Group and Big Clean Switch provide group purchasing schemes which are usually cheaper than individual contracts.

A review has also been carried out of the taxation and other levies which are being applied to the bills. These are:

VAT	5%	The correct VAT rate is being applied.
CCL	not charged	The correct CCL rate is being applied.

The above review confirmed that the correct taxation and levy rates are being charged.

The church is a charity and therefore can claim VAT exemption status. This should always be done when changing supplier. VAT declarations are available from the supplier's website and can usually be found by typing the suppliers name followed by "VAT Declaration Certificate" into most website search engines.

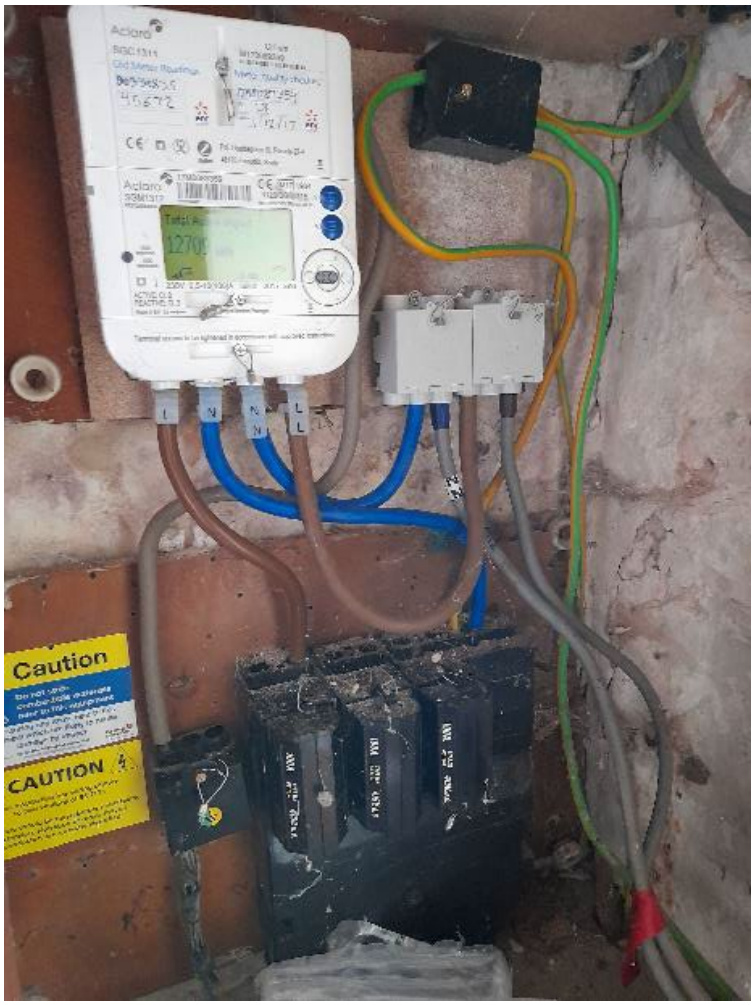
5. Energy Usage Details

St Giles' Church, Horsted Keynes used 1,656kWh/year of electricity from 14/10/2021 to 15/10/2022, costing £340 per year, and 27,870kWh/year of oil [2,600 litres], costing £2,080. The total carbon emissions associated with this energy use are 7.87 CO_2e tonnes/year.

This data has been taken from the annual energy invoices provided by the electricity supplier and a total for the annual gas consumption provided by the church together with one bill.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	17M0089359	Acloro 3 phase cable, one phase connected	Yes	Cupboard, upper vestry steps

The meters is AMR connected and as such energy profile for the entire energy usage could be obtained from the supplier.



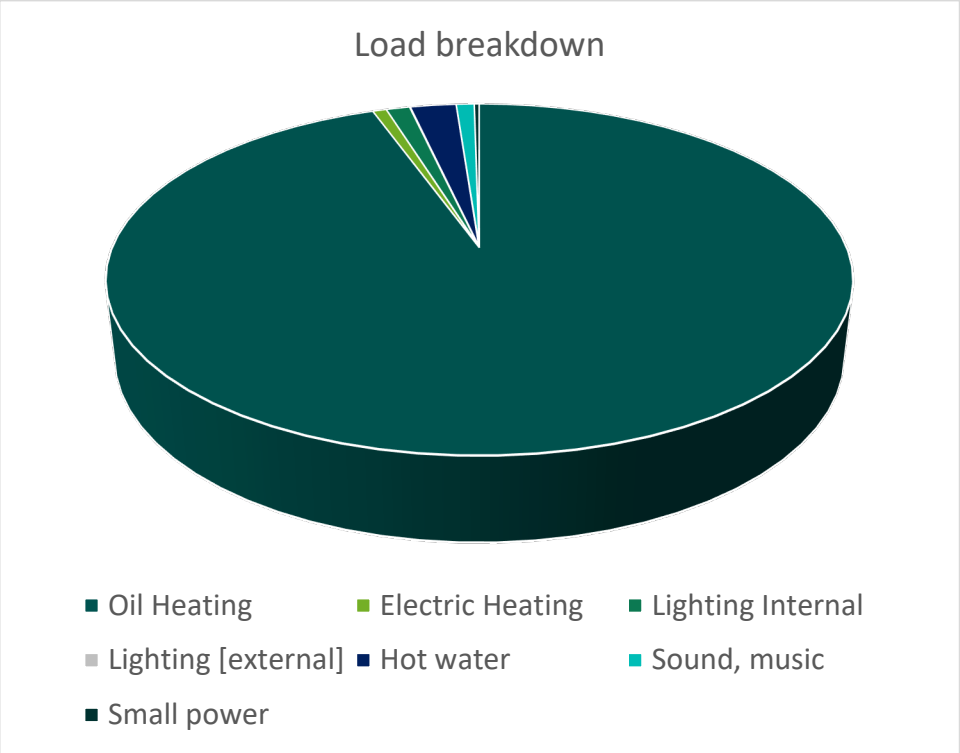
5.1 Energy Profiling

The main energy consuming plant can be summarised as follows:

	Equipment	Power kW	Annual Consumption kWh	Portion
Heating [Oil]	Thermecon 5240/300 boiler [350 hours operation]	79	28,000	94.4%
Heating [Electric]	Boiler circulation pumps Upper vestry fan heater	250W 3	90 120	0.7%
Lighting [Internal]	375 hours use PAR 38 Spotlights 5 x 100W LED Spotlights 23 x 15W Other LED 14 Bulkhead 3 x 28W Strip light 20W	 500W 265W 110W 84W 140W	 TOTAL 360	 1.2%
Lighting [External]	Security lights		20	0.07%
Hot Water (electric)	Instantaneous tap in kitchenette Wall mounted Zip Hydroboil unit in kitchen, normally turned off	5 3	400 300	2.4%
Sound, Music	Sound system Organ	0.5 1	175 100	0.9%
Small Power	Vacuum cleaner Photocopier	1.5 0.5	50 25	0.25%

Sum of electricity use estimates (church only): 1,640kWh

Annual church electricity consumption, 2021-2022: 1,656kW



As can been seen from this data, the heating makes up by far the largest proportion of the energy usage on site. The other significant load is hot water.

The church is seated by fixed pews. Three arches separate the nave from the north aisle. Suspension of chandelier mounted radiant heating units from arch centres would only serve the central seating area. The front (east) arch does not cover any seating.

6. Efficient / Low Carbon Heating Strategy

6.1 Overview

The energy used for heating a church typically makes up around 80% to 90% of the overall energy consumption. Heating also often uses gas or oil as its primary fuel. These are fossil fuels with high carbon emissions and little opportunity to decarbonise in the near future. Mains gas does have some potential to reduce its carbon content through the use of bio gas and hydrogen, but these are less developed solutions and will be unable to deliver 'zero carbon mains gas' in the foreseeable future.

It is therefore important to review and set out a plan to make heating more efficient and less carbon intensive. One way to achieve this is to consider a transition to electrical heating where this also represents an efficient and comfortable solution for churches. Electricity currently has carbon emissions of around the same level as mains gas, but the carbon emissions associated with electricity are reducing rapidly as the UK builds more renewable energy and decommissions its remaining oil and coal-fired power stations.

6.2 Present Heating System

The church is currently heated by a Thermecon S240/300 oil fired boiler of 79kW output which was installed in 2000. This is now at the end of its serviceable life and should be expected to require replacement in the next few years. The boilers provide heating to seven cast iron column radiators, (two in the chancel) and one pressed steel radiator in the Lady Chapel (north transept).

The church makes use of fixed wooden pews.

The church is used for the main Sunday for service and the typical congregation size is 35 with 12 attending the earlier service and 10 on Wednesday mornings .

6.3 Future Heating Options

The various options for a decarbonised heating solution are summarised in the table below and discussed in more detail after.

Decarbonisation Heating Solution	Viable
Air to Water Source Heat Pump	No – unsuited to current heating pipework and heat emitters, low hours of building use
Air to Air Source Heat Pump	No – low hours of building use
Water Source Heat Pump	No – no water source locally
Ground Source Heat Pump	No – significant archaeology, low hours of building use
Under Pew Electric Heating Panels	Yes
Electric Panel Heaters (to provide supplemental heating only)	No – no suitable locations
Over Door Air Heater (to provide a supplemental warm welcome at the door only)	No – architecture around door would not permit unit to be fixed
Overhead Infra-Red Heaters	No – visual intrusion to the church would do harm, least preferred heating source due to comfort. Poor alignment of arches with seating locations
Heated Chair Cushions	Yes -alternative option

Heat Pumps

- Low hours of use (below 8 hours per week on average) preclude the use of heat pumps. (There would not be enough heat stored in the building to operate the defrost cycle in winter, unless the heating was run for many more hours than the church is used.
- Also, lack of adequate radiator provision does not allow for heat pump installation – only 5 cast iron radiators are fitted in the nave, plus one 1m long (small) pressed steel unit. The church wishes to retain the pews; the radiators are fitted closely in between pews and removal of several pews would be required to install larger, fan assisted radiators which would be necessary to work with water at 50°C.

Radiant Heating

- Overhead radiant heating by quartz elements mounted on chandeliers and suspended from arch centres would be unsuitable as only two of the three arches align with seating, and this is only above the central area. The reach of the heating (about 4m) would be insufficient for most of the seating positions. The same applies to infra-red heating discs which emit no visible radiation (such as those manufactured by the Herschel company).
- Overhead radiant infra-red rectangular ceiling mounted panels cannot be accommodated as the beam spacing is too narrow.
- Wall mounted (angled) infra-red heaters are not visually desirable in the nave and aisle, but would be an alternative to under pew heating. One of these units could be used to heat the altar area if desired, a suitable location high on the wall which is not visible from the body of the church may be possible. Another alternative would be an infra-red panel heater located on the east wall low down behind the high altar (only worthwhile if the priest spends enough time in this location).

Pew based heating

- Under pew heaters are recommended for a church which has low hours of use, is intending to keep pews and is unsuited to heat pump installation. Another option would be longitudinal heated cushions on pews. An example of these is available from Kovo Schidt (Another church recently received a quotation of £8k for 27 cushions of about 2m length).

The recommendation is therefore that the church consider pew based heating solutions as described below.

6.4 Install Electric Under Pew Heaters

Electric under pew heaters provide a high level of thermal comfort to people sat in the pews. They are not installed to try and heat the entire air volume of the church, instead thermal comfort is achieved through a flow of warm air rising past the person in the pew. This means that the heaters should be installed under the entire length of all the pews that are likely to be used.

These heaters warm up almost instantly and a flow of warm air over the pew area is created within around 15 minutes of their being turned on. This significantly reduces the amount of preheating required before each use of the building and can make electric heating cost competitive with gas. It is important that this reduced 'on time' is properly reflected in any comparisons with other types of heating.

We would therefore suggest that the following works could be considered:

Install under pew heaters suspended from brackets from the underside of the pew seat as follows:

North aisle, 5 rows with two 650W heaters in each row between uprights

Centre, 9 rows with four 450W heaters in each row between uprights

South Nave, 7 rows with two 650W heaters in each row between uprights

24 x 650W = 15.6kW, capital cost at £341 each = £8,184

36 x 450W = 16.2kW, capital cost at £329 each = £11,844

Maximum Load = 31.8kW Cost estimate = £20,000

- Operating cost for 30 heating weeks x 3 hours per week + 40 hours for school visits + 70 hours for weddings and funerals = 200 hours x 31.8kW x 32p/kWh = £2,035
- This is equivalent to the current spend on oil
- Note that this cost is for a full installation. The church may wish to make a partial installation suited to the average size of the congregation, thus significantly cutting capital cost. Alternatively, except in midwinter, all the units do not need to be on, only those where pews are occupied.

Cable runs to the pew heaters should run along the along the existing routes (all cabling should be in armoured cable or FP200 Gold when above ground) to both rows of pews. Each pew heater to be switched with a neon indicated fused spur located underneath the pew seat.

A case study of a church which has adopted this solution is available at https://www.churchofengland.org/about/environment-and-climate-change/st-andrews-chedworth-electric-heating

Photos of installations are shown below. In addition, several churches have recently installed such systems. If you would like to find out about churches whom you could ask about their experiences, please contact the diocese.

Brown BN Thermic 650W under pew heaters fixed to underside of pew seats for pews which have no solid backs.

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Black 650W Norel under pew heaters fitted to solid pew backs.

6.5 Heated Pew / Seat Cushions

Most are now familiar with the concept of heated seats within cars; the same solution is also used in some outdoor venues such as alfresco dining and sports stadiums. These provide a heated cushion to sit on: the direct warmth from the contact areas provides a degree of comfort even when the surrounding space is cold. This can be a useful solution for churches which only have chairs (having removed pews) and/or for small congregations where there are few other alternatives.

There are a variety of heated seat cushions on the market. Some are directly plugged into a power socket (similar to an electric blanket). Others have battery packs, which can be charged and then connected to a seat pad. This makes them more flexible and avoids trailing leads. The more advanced products have a pressure sensor which means heat is only provided when someone is sitting on the cushion. Heated pads for 'benches' can also be used to heat a pew or could even be adapted to form a heated kneeler for the communion rail.

It is recommended that the church consider using heated cushions to provide heating which would be suitable for smaller services and could be used either in the Lady Chapel or elsewhere in the church. They can also provide an alternative to under pew located convector heaters, but are likely to deliver less heat and so contribute little to warming the air.

If the trial is successful the church may wish to consider installing additional plug sockets at the end of the pews where heated seat cushions are likely to be used to allow for the plug in versions to be used. This electrical work should be considered to be undertaken at the same time as other electrical recommendations such as under pew heating.

A case study of a church using heated cushions is available at https://www.churchofengland.org/about/environment-and-climate-change/towards-net-zero-carbon-case-studies/marown-church-tries-new

6.6 Upgrade to 3 Phase Electricity Supply

To be able to have sufficient electrical power to supply enough energy into an electrical heating system, the church will need to increase the existing electrical supply from single phase 100A supply to a 3 phase 100A supply.

Although a single phase meter is installed, it appears that the supply cable may be three phase. This should be confirmed with your supplier.

The upgrade to the supply has to be carried out by the District Network Operator in the areas.

The DNO in your area is: UK Power Networks www.ukpowernetworks.co.uk

The cost of bringing in a new 3 phase supply can range from £300 to £30,000. The DNO will provide a quotation for free, so it is well worth obtaining a quotation even if plans are not yet certain, so that decisions can be made on a well-informed basis.

7. Improve the Existing Heating System

In the years before the replacement of the existing heating system it is recommended that measures are taken to improve the efficiency of the existing heating system. These should include:

7.1 Clean the Existing Heating System

The water in the heating system within the church was inspected as part of the audit in conjunction with thermal imagery on some elements of the heating system. This has identified that the system has magnetic sludge within it. This is preventing the proper and efficient operation of the system by reducing both the ability of the boiler to heat up the water and the output of the radiators. It is similar to how scale build up can adversely affect kettles and showers.

It is strongly recommended that the heating system is cleaned to remove this sludge from the system. This is done by using a chemical clean and/or power flush procedure in which cleaning chemicals are put into the system, which is then turned on and run through a filter consisting of high-power magnetics to remove the sludge.

The cleaning of a heating system can be carried out by any competent heating engineer and typically increases the efficiency of a system by 10 to 15%. This can dramatically improve comfort for the congregation.

7.2 Add Further Insulation to boiler Room Pipework and Valves

The pipework within the boiler room has the majority of its straight lengths insulated, but the more complex-shaped pipework fittings, such as valves, have been left uninsulated. These exposed areas of pipework contribute significantly to heat loss from the system and make the plant room unnecessarily warm. The exposed hot surfaces also represent a health and safety risk of burns for those working in the area.

It is recommended that these areas of exposed pipework and fittings are insulated with bespoke flexible insulation jackets. These wrap around the various elements but can be removed and then replaced for any servicing activities.

8. Energy Saving Recommendations

In addition to having a revised heating strategy there are also a number of other measures that can be taken to reduce the amount of energy used within the church.

8.1 Draught Proof External Doors

There are a number of external doors in the church. Where doors do not close tightly against the stone surrounds and hence a large amount of cold air is coming into the church around the side and base of these doors.

The vestry door above is proposed to be fitted with a neoprene rubber draught excluder.

There are alternative strategies which may be useful for the main porch door:

For timber doors that close onto a timber frame a product called QuattroSeal is often used in heritage environments to provide appropriate draught proofing.

For timber doors that close onto a stone surround, traditional solutions can be used such as brush draught strips rebated into the edge of the door by a skilled joiner. Other traditional methods such as using hessian or felt pads tacked to the door could also be used. Keeping the door maintained in a good condition is also important.

It is necessary to check with the DAC before undertaking any form of draughtproofing that involves work on the fabric of the door.

Simple measures such as having a 'sausage dog' style draught excluder laid along the base of a door (it needs to be sufficiently heavy to stay in place), using plasticine of the right colour to fill gaps where daylight can be seen, and putting painted fridge magnets over large keyholes can all be simple DIY measures which are effective.

Such measures should be considered carefully around bat conservation needs to ensure that access points bats use are not disturbed. Check your draught excluding plans with the Bat Conservation Trust's free helpline: 0345 1300 228 https://www.bats.org.uk/

9. Renewable Energy Potential

The potential for the generation of renewable energy on site has been reviewed and the viability noted.

Renewable Energy Type	Viable
Solar Photo Voltaic (PV)	No – not sufficient demand, visible roof
Battery Storage	No – no viable solar PV

Now that the Feed in Tariff scheme has come to an end, the installation of solar PV panels in situations where there is not almost full usage of the electricity generated on site is not really viable.

Having reviewed the site it is not considered that there is good viability for any renewables and instead a good clear focus on reducing the energy demand of the building should continue with a targeted approach on reducing the heating energy.

10. Funding Sources

There are a variety of charitable grants for churches undertaking works and a comprehensive list of available grants is available on this Parish Resources page:
https://www.parishresources.org.uk/resources-for-treasurers/funding/

11. Faculty Requirements

It must be noted that all works intended to be undertaken should be discussed with the DAC at the Diocese.

Throughout this report we have indicated our view on what category of permission may be needed to undertake the work. This is for guidance only and must be checked prior to proceeding as views of different DACs can differ.

Under the new faculty rules:

List A is for more minor work which can be undertaken without the need for consultation and would include changing of light bulbs within existing fittings, repair and maintenance works to heating and electrical systems and repairs to the building which do not affect the historic fabric.

List B is for works which can be undertaken without a faculty but must be consulted on with permission sought from the Archdeacon through the DAC. This includes works of adaptation (but not substantial addition or replacement) of heating and electrical systems and also includes the installation of under pew heaters to pews which are made in or after 1850 and are not of historic interest.

All other works, including the like for like replacement of gas and oil boilers will be subject to a full faculty.

Works which affect the external appearance of the church will also require planning permission (but not listed building consent) from the local authority. This includes items such as solar PV installations.

12. Offsetting

12.1 Bats in Churches

The Bat Conservation Trust has a project with the Church Buildings Council Natural England, the Church of England, Historic England and the Churches Conservation Trust to address bat issues: *www.churchofengland.org/resources/churchcare/advice-and-guidance-church-buildings/bats-churches*