ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Pauls Church
PCC of St Pauls

THE CHURCH OF ENGLAND

Author	Reviewer	Date	Version
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1. Executive Summary

An energy survey of St Pauls Church 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 Pauls Church is a 1973 build. It has original UFH on oil boilers which have now been replaced for gas boilers. There is both gas and electricity supplied to the site.

The church has a number of ways in which it can be more energy efficient. 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 are used as the action plan for the church in implementing these recommendations over the coming years.

Energy saving recommendation	Estimated Annual Energy Saving (kWh)	Estimated Annual Cost Saving (£)	Estimated capital cost (£)	Payback (years)	Permission needed	CO2 saving (tonnes of CO2e/year)
Consider installing Electric Vehicle Charging Points	0	N/A	£2,875	0.00	Faculty	-
Insulate exposed pipework and fittings in plantrooms	4,127	£413	£1,438	3.48	List A (None)	0.76
Install a Solar PV array to roof of building (assumed 100% of energy generated used in building)	9,165	£2,750	£16,133	5.87	Faculty	2.32
Inject cavity wall insulation into walls	6,604	£660	£9,660	14.63	Consult DAC	1.22
Install an Air Source Heat Pump into the building to replace existing heating system	57,784	£825	£36,800	44.58	Faculty	8.96
Install suspended ceilings to internal areas with insulation above	8,255	£825	£47,610	57.68	Faculty	1.52
Replace windows	12,382	£1,238	£90,850	73.37	Faculty	2.29

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

Based on current capped market prices of 30p/kWh and 10p/kWh for electricity and mains gas respectively.

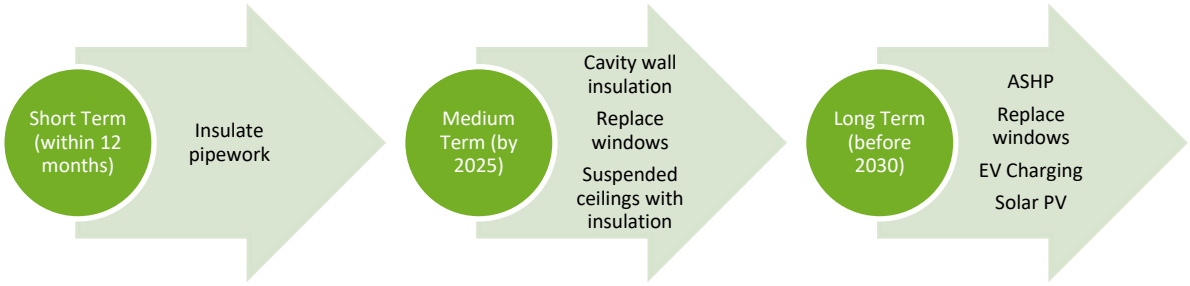
If all measures were implemented this would save the church £6,712 per year and reduce its carbon footprint by 17.07 tonnes (96%).

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 Pauls Church 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 Pauls Church, St Pauls Drive, Swindon, SN3 5BY was completed on the 26th of September 2022 by Matt Fulford. Matt is a highly experienced energy auditor with over 15 years' experience in sustainability and energy matters in the built environment. He is a chartered surveyor with RICS and a CIBSE Low Carbon Energy Assessor. He is a Member of the DAC in the Diocese of Gloucester and advises hundreds of churches on energy matters.

St Pauls Church	
Church Code	605157
Gross Internal Floor Area	832 m^2
Listed Status	Unlisted

The church and church halls are typically used for 67 hours per week for the following activities:

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	2 hours per week	60
Meetings and Church Groups	20 hours per week (between the two halls)	
PreSchool	45 hour per week	

There is additional usage over and above these times for festivals, weddings, funerals and the like.

4. Energy Usage Details

St Pauls Church uses 10,047 kWh/year of electricity, costing £3,014.10 per year, and 82,548 kWh/year of gas, costing £8,254.80. The total carbon emissions associated with this energy use are 18 CO_2e tonnes/year.

This data has been taken from the church's submissiong to the Energy Footprinting Tool. St Pauls Church has one main electricity meter, serial number E10BG31123. There is one gas meter serving the site.

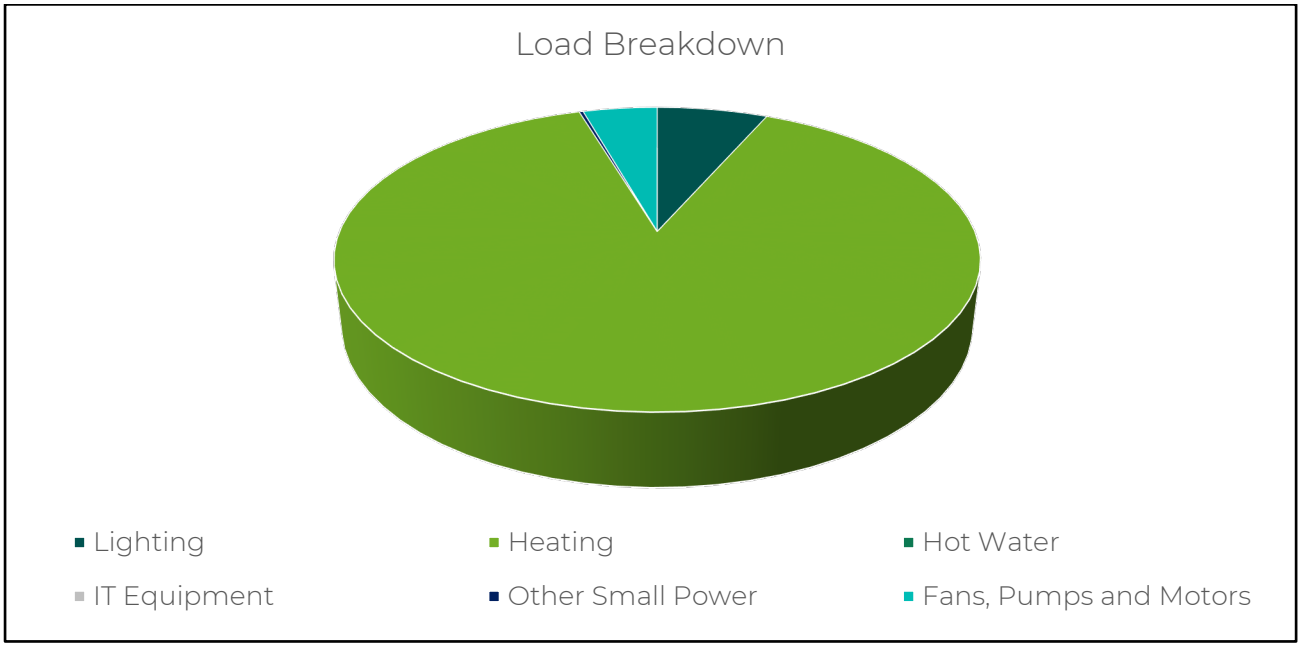
Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	E10BG31123	EDMI Atlas Mk10D	Full AMR Connected	Off boiler room
Gas – Church	NOT SEEN			

All the meters are AMR connected and as such energy profile for the entire energy usage should be possible. It is recommended that the church consider asking their suppliers for access to their smart meter data so that the usage can be monitored more closely, and the patterns of usage reviewed against the times the building is used.

4.1 Energy Profiling

The main energy consuming plant can be summarised as follows:

Service	Description	Estimated Proportion of Usage
Lighting	All LED fittings throughout	7%
Heating	Gas fired boilers serving a mix of older radiators throughout the building	89%
Hot Water	Electric point of use hot water heaters to WC's	0%
Other Small Power	Office, kitchen and cleaning appliances etc.	4%



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 lighting.

4.2 Energy Benchmarking

In comparison to national benchmarks for church energy use St Pauls Church uses 40% less electricity and 34% less heating energy than would be expected for a church of this size.

	Size (m^2 GIA)	Annual Energy Usage (kWh)	Actual kWh/m^2	Benchmark kWh/m^2	Variance from Benchmark
St Pauls Church (elec)	832	10,047	12.08	20.00	-40%
St Pauls Church (gas)	832	82,548	99.22	150.00	-34%
TOTAL	832	92,595	111.29	170.00	-35%

5. Efficient / Low Carbon Heating Strategy

The energy used for heating a church typically makes up around 80% to 90% of the overall energy consumption. Putting in place a heating strategy that is energy efficient and low carbon is, therefore, of the highest priority

The Church of England is in the process of reviewing its heating guidelines. The process has already established some principles for heating that can help churches as they seek an acceptable combination of comfort, conservation, affordability, and environmental care. The principles can be found at https://www.churchofengland.org/sites/default/files/2020-04/CBC%20Heating%20guidance%20principles%20FINAL%20issued.pdf

As the principles make clear, every church's strategy will be unique to it, informed by many factors, including the nature of its usage, the system it's starting from, the conservation needs of the building, and the resources available. The strategies in this audit are designed specifically for your church.

Our recommendations on heating generally fall within three major areas. Firstly, for all churches we make recommendations that will help to reduce energy wastage and, as a starting point, to optimise the system that you already have

Secondly, we recommend options for many churches that focus on heating people rather than the full volume of the church. Some of the changes that can help with this will be 'soft' changes – others will relate to the heating system itself.

Finally, we make recommendations about moving away from fossil fuels. Moves away from fossil fuels are key to cutting emissions. For most churches, this will involve moving from gas, oil or LPG to electricity. Electricity currently creates carbon emissions around the same level as mains gas, but the carbon emissions associated with it are reducing rapidly as the UK builds more renewable energy and decommissions its remaining oil and coal fired power stations. 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'. Some local areas may also be considering the option of district heating networks.

While moving away from fossil fuels may not always be possible, as the principles state, "churches should be expected to have at least carefully considered the option of moving away from fossil-fuel based heating (gas and oil boilers) towards electric-based heating." And if such options are not viable now, the churches "can try to be ready for a future retro-fit when technology and the grid has progressed."

This church has already completed many energy efficiency measures and has changed all its lighting to LED and has modern gas boilers. In order to make the building more energy efficient and move towards zero carbon more substantial measures, which would involve the refurbishment of the space, are now required. This would first include the improvement of the thermal fabric of the church with cavity wall insulation being installed into the wall and all the existing single glazed windows being replaced with double glazed units. Within the building the most effective way of insulating the roof space and refurbishing the appearance of the space would be to install a suspended ceiling grid into the rooms with insulation directly above. This would also create a small ceiling void into which air-to-air source heat pump units could be

installed (identical to air conditioning units but used to heat rather than cool) which would provide the decarbonised heating solution for this more modern church building.

6. Energy Saving Recommendations

There are several measures that can be taken to reduce the amount of energy used within the church.

6.1 Insulation of Pipework and Fittings

The pipework within the boiler room has most 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.

A free survey and quotation for the supply and installation of insulation of pipework fittings can be arranged through ESOS Energy Ltd (contact Adrian Newton 0117 9309689, adrian@esos-energy.com).

6.2 Replace windows

The windows on the building are single glazed with metal casements and as such are poor in terms of thermal quality. In addition, many of the openings do not close well against the frames and excessive cold air is being let into the space.

The introduction of new double-glazed units would reduce the heat loss from the building and improve thermal comfort. This measure would be costly and disruptive to install but could be considered as part of a refurbishment programme. The use of high-quality windows will also reduce external noise transfer and provide added security. To enhance heat ingress in particularly cold areas, double glazing with low emissivity (Low-E) glass could be selected as this allows more solar gain than standard double glazing.

It is therefore recommended to replace these windows with new double-glazed windows with wooden/aluminium/uPVC casements set into the existing surrounds. It is suggested that any window installation is undertaken by a FENSA Approved Installer www.fensa.org.uk

6.3 Cavity Wall Insulation

The church is constructed with a cavity wall method, and the inspection of the wall showed no signs that insulation has been added. Prior to the early 1990's, building regulations did not require walls to be fully insulated and therefore it is likely that there is no insulation present. It could, however, be added through injection into the cavity walls.

It is recommended that cavity wall insulation is considered and added to the walls where appropriate. A survey to check the width of the cavity, exposure of the wall and condition of the cavity has been carried out to confirm that there is a clear and unfiled cavity and this should be checked by a CIGA-approved installer who will then be able to provide you with a quotation to undertake the works. Installing cavity wall insulation will help to reduce heat loss and improve the comfort of the space but needs to be considered alongside other control measures such as TRV's or room sensors to ensure that the space does not overheat because of the additional insulation.

A free survey and quotation for the supply and installation of insulation to the loft spaces can be arranged through ESOS Energy Ltd (contact Adrian Newton 0117 9309689, adrian@esos-energy.com).

6.4 Insulation to Roof

It is recommended that suspended ceilings are installed to the internal areas with insulation above.

In cases where there is little insulation in the ceiling and sufficient ceiling height, it is recommended that a new suspended ceiling grid be installed beneath with insulation being added directly above to prevent heat loss, to reduce the heated volume of the building and create a more comfortable environment for the occupants.

The ceiling of a room is the largest contributing area to heat loss from a building as heat rises. The insulation of such spaces can therefore have a dramatic impact on both the efficiency of the heating system and the temperature of the space below. Insulation measures such as this also need to be combined with control measures such as TRV's or room sensors to ensure that the space does not overheat because of the additional insulation. The insulation is usually fitted in the form of bags or pads sized to the same dimensions of the ceiling tile and therefore it maintains access into the ceiling through the easy removal of ceiling tiles as required.

7. Other Recommendations

7.1 Electric Vehicle Charging Points

The church has a car park at the front which serves the church and the frequently used church hall. To make a visible statement on the churches mission of stewardship and to facilitate more sustainable transport choices by those visiting the church and/or using the hall, the church may wish to consider installing an electric vehicle charging point, probably on the side of the church hall to allow visitors to charge their electric cars.

Installing a unit such as a Rolec Securi-Charge http://www.rolecserv.com/ev-charging/news/view/Robust-EV-Charging-With-Rolecs-SecuriCharge-EV-Wall-Unit-Coin-Token-PAYG would allow the organisation control over who is allowed to use the unit with a key operated system. Or given the type of use of the building and control over the usage of the car park as a whole a simple 32 amp type 2 wall pod type charger may be most suitable and these are widely available through many suppliers such as http://www.rolecserv.com/ev-charging/product/EV-Charging-Points-For-The-Home.

8. Renewable Energy Potential

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

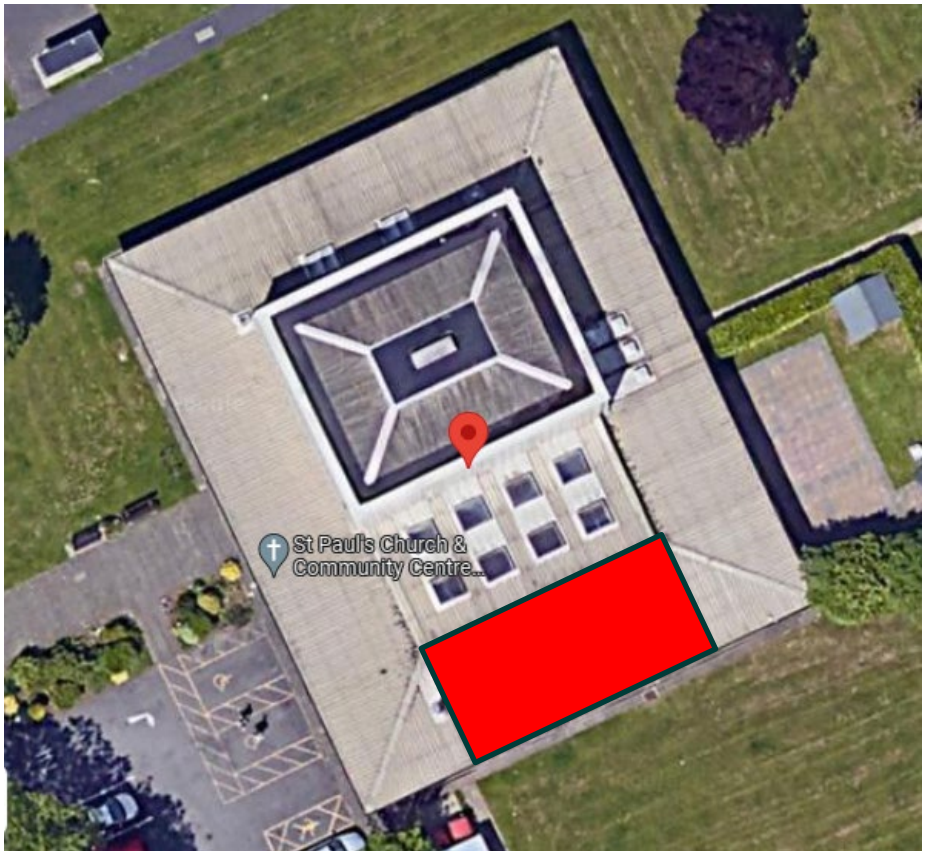
Renewable Energy Type	Viable
Solar PV	Yes – Roof of 65 m^2 facing southerly
Wind	No – no suitable land away from buildings
Battery Storage	Yes – could be combined with PV
Micro-Hydro	No – no water course
Solar Thermal	No – insufficient hot water need
Biomass	No – not enough heating load as well as air quality issues
Air Source Heat Pump	Yes – Move to air-to-air in phases as internal areas are refurbished.
Ground Source Heat Pump	Yes – but high install costs and poor existing heating distribution system would result in this being a very costly solution.

8.1 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.

There is potential for a PV array on the roof. The current arrangements around solar panels mean that to be financially viable the building on which they are mounted needs to consume the

vast majority of the energy that they produce. The church's energy consumption has a regular demand due to the use by the pre-school which would make a PV system quite viable.



8.2 Air Source Heat Pump

Air to Air source heat pumps work by having an external unit which sucks air throughout it and extracts the heat from the air. It concentrates this heat and puts it into a refrigeration gas (in the same way as a fridge or freezer works). This refrigeration gas is then piped inside the building in a small pipe where is it then allowed to expand in an internal unit with a fan. This heat is then blown out into the space. This system is identical to an air conditioning system but it works in reverse to heat the space. As warm air is blown into the space this type of system can heat spaces from cold relatively quickly. Air to Air Source heat pumps provide around 4.5 units of heat for every 1 unit of electricity used in the heat pump (it therefore has a Coefficient of Performance (CoP) of 4.5)

The Centre for Sustainable Energy model[1] can be used to estimate heat load for the building.

Heat Load (kW) = Volume V (m^3) x Insulation Factor

[1] www.cse.org.uk/local-energy/download/estimating-the-heat-demand-of-a-hypothetical-community-building-79

Insulation Factors

Condition	Factor kW/m³
Poorly insulated with open or broken windows, draughty doors (add 5%)	0.034
Poorly insulated (assume no interventions)	0.033
Some insulating features	Estimate value
Well insulated	0.022
Insulated to 2010 regulations	0.013

Area	Volume m³	Insulation Factor kW/m³	Heat Required (Space heating) kW
Church	2,000	0.022	44

Therefore a heat pump of 44kW would be required.

ASHPs require the installation of external units which look like air conditioning modules in well ventilated external locations. These external units will need an electricity supply and pipework running from them to the heating system. They will also need a drain nearby as the back of the units can build up moisture condensing and sometimes freezing on the coils. The larger units do create some low level noise and therefore the location and baffling of the units may need to be considered carefully.

Examples of external units for ASHP comprising of three smaller 3kW units and two larger 10kW units.

The external units for this church could use a number of the smaller units located on the ground around the external walls of the church and/or on the central roof area.

Internal units come in a variety of styles. The most appropriate internal unit for this church is likely to be the ceiling unit fixed flush into a new suspended ceiling system as is common in offices and other similar buildings.

FUA-A - Under ceiling cassette air conditioning unit

Unique under ceiling cassettes for high rooms with solid ceilings or false ceilings with a shallow void. Suitable for all types of commercial applications.

The FUA-A range provides comfortable heating and cooling even for rooms with high ceilings and has individual louvre control flexibility to suit every room layout.

FTXM-R - Wall mount air conditioning unit

Attractive, wall mounted design with perfect indoor air quality. 2 area motion detection sensor: air flow is sent to a zone other than where the person is located at that moment; if no people are detected, the unit will automatically switch over to the energy-efficient setting.

FVXM - Floor Mount Air Conditioning Unit

Designed to fit rooms of any size and shape, it blends well with the interior due to the new design which incorporates more flowing lines and softer edges. These units are ideal when it is not possible to fit a high level wall mount unit for aesthetic or practical reasons.

They are suitable for a wide range of applications including domestic, small to medium offices and commercial uses.

All these units do have a fan element within them and therefore a small amount of fan noise is emitted. This tends to be less than a fan convector heater on a boiler based system as is similar to the noise from a fridge or freezer. Air conditioning units are commonplace in hotel rooms so the noise is low enough to be suitable for sleeping environments.

A case study of a church which has installed such a solution is available at [5. Air-source heat pumps at Hethel Church - All Saints Church, Hethel - A Church Near You]

8.3 Other renewables

Battery Storage is not strictly a renewable energy solution, but battery storage does however provide a means of storing energy generated from solar PV on site to be able to be used at peak times or later into the day when the PV is no longer generating. It therefore extends the usefulness of the existing PV system particularly in this sort of church. This is a new but fast-growing technology with prices expected to fall substantial over the next 2 to 3 years.

Wind turbines require highly exposed sites and should be located 250m way from buildings as such this site is not suitable for a wind turbine to be installed.

Hydro electricity is a highly efficient source of renewable energy but requires a body of flowing water with a differential height which is not present on this site.

Solar thermal installations are best suited to heat water for use in washing up, hand washing and bathing. There is minimal hot water demand at this church so such an installation would not be viable.

Biomass is an alternative boiler and fuel to oil or gas. It requires wood chips or pellets to be delivered on site, stored, and then fed into a large boiler for burning. While the fuel is not a fossil fuel there are emissions from the burning of wood, and these can be detrimental to local air quality particularly in more built-up areas for all these reasons it is not considered a viable recommendation for this site.

9. 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/

10. 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 Victorian or later in date.

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 and this will be required for items such as PV installations..

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11. Offsetting

As you take action to reduce your emissions, you may also wish to offset those that you cannot yet reduce. If you would like to engage in offsetting, it is important to use a reputable scheme. The Church of England recommends Climate Stewards, which has a simple calculator that can help you to work out how much you would need to offset. https://www.climatestewards.org/

Climate Stewards encourages people to 'reduce what you can and offset the rest' as part of your journey to Net Zero carbon emissions. They provide training and resources to help you understand climate change and its impacts, and to calculate the carbon footprint from your activities including travel, energy, expenditure, and food. Their online carbon calculators for individuals and smaller organisations are free to use, and they provide bespoke carbon footprint audits for larger organisations.

Having reduced as much of your organisation's carbon footprint as you can, there will always be unavoidable emissions from your work and travel. Carbon offsetting allows you to compensate for the negative impact of your carbon emissions by funding projects which take an equivalent amount of CO_2 out of the atmosphere. These either involve locking up ('sequestrating') CO_2 as trees grow or reducing emissions by using low-carbon technology such as fuel-efficient cookstoves or water filters.

Climate Stewards has a close relationship with all their project partners in Ghana, Uganda, Kenya, Tanzania, Nepal and Peru. They work closely with them to design, develop, implement and monitor projects which will not only mitigate carbon, but also bring tangible benefits to the local community - including improved health, savings in time and money previously spent on buying or collecting fuel, and improvements in local biodiversity. Each project is assessed using their Seal of Approval protocol which enables us to assess and monitor carbon mitigation and ensure robust, sustainable, and transparent partnerships.