ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

All Saint's Church, Laleham
PCC of All Saint's Church

Author	Reviewer	Audit Date	Version
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1. Executive Summary

An energy survey of All Saint's Church, Laleham was undertaken by ESOS Energy Ltd 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.

All Saint's Church, Laleham dates from the Norman period, but rebuilding and extensions from the 16th and 17th centuries present brick facades.

There is both gas and electricity supplied to the site.

The building has a number of ways in which it can become 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 is used as the action plan for 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)
SHORT TERM						
Draughtproofing works	2%, 870	£43	£50	1	List B	0.15
Window repair	5%, 2,200	£107	£500	5	Faculty	0.4
Install reflective radiator panels	2%, 870	£43	£50	1	List A	0.15
MEDIUM TERM						
Install chandelier mounted radiant heating	43,500 gas 9,000 electricity use	£370	£18,000	48	Faculty	5.9
OR						
Install replacement Condensing gas boiler	20% from efficiency increase 8,700	£430	Unknown	Unknown	Faculty	1.5

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

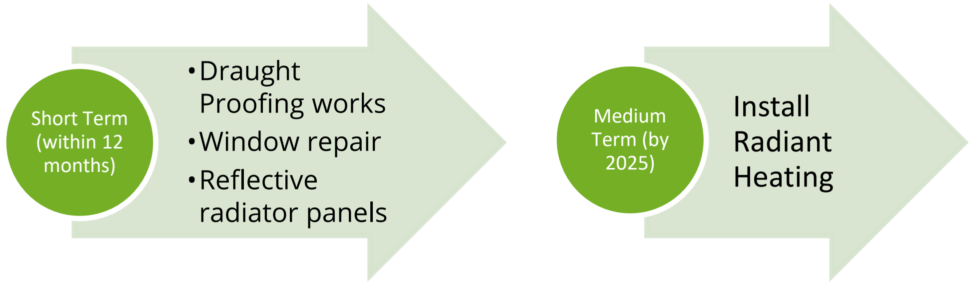
Based on current contracted prices of 20.9p/kWh and 4.941p/kWh (hall) for electricity and mains gas respectively.

If all measures were implemented this would save around £110 per year in operating costs.

2. The Route to Net Zero Carbon

The General Synod of the Church of England has indicated that the Church of England should be Net Zero Carbon by 2030. Every church, cathedral, church school and vicarage will therefore need to convert to be a net zero building in the next 10 years.

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 All Saint's Church, Laleham to give them advice and guidance as to how the buildings can be improved to be more energy efficient. In doing so the buildings will also become more cost effective to run with improvements in the levels of comfort.

An energy survey of the All Saint's Church, Laleham, TW18 1RZ was completed on the 10th November 2022 by Dr. Paul Hamley. Paul is an energy auditor with experience of advising churches and small businesses. He is part of the Church Energy Advisors Network developing advice for the Church of England and authored the "Assessing Energy Use in Churches" report for Historic England. He is a CIBSE affiliate member and a Chartered Scientist, with experience of the faculty process gained from chairing the building committee of a Grade I listed church and has been an assessor for EcoCongregation.

The church was represented by Deborah Bull, Church Administrator, and Ian Dibben.

All Saint's Church, Laleham	
Church Code	623272
Gross Internal Floor Area	200m^2
Volume	1,140m^3
Heat requirement	38kW
Listed Status	Grade I

The church is typically used for 9 hours per week for the following activities:

Type of Use	***Hours Per Week (Typical)***	***Average Number of Attendees***
Church Services	5 hours per week	40
Church Meetings and Groups	2 hours per week	
Community use	Termly school visits	
Occasional Offices	15 weddings + funerals annually	

4. Energy Procurement Review

Summed energy and gas use data has been supplied by the church covering the last four years.

The current electricity rates are:

Single Rate	20.9p/kWh
Standing Charge	28.63p/day

The current gas rates are:

Hall Rate	4.941p/kWh
Standing Charge	Zero

We would recommend that the church looks into 100% renewable tariffs and obtains quotations for its gas and electricity supplies from group purchasing schemes such as the Big Church Switch scheme, Charity Buying Group and the diocese Supported Parish Buying scheme, http://www.parishbuying.org.uk/energy-basket.

These scheme offers 100% renewable electricity and a proportion of renewable gas and therefore are an important part of the process of making churches more sustainable.

VAT information has not been supplied.

Whenever monthly electricity consumption exceeds 1,000kWh, or gas consumption exceeds 4,397kWh (52,000kWh per annum), 20% VAT is charged unless the customer has submitted a VAT declaration form. This should always be done when changing supplier.

The church is a charity and therefore can claim VAT exemption status.

Excess VAT paid can be reclaimed for the past three years.

VAT declarations are available from the suppliers website and can usually be found by typing the suppliers name followed by "VAT Declaration Certificate" into most website search engines.

A detailed explanation is available here: https:// perfect-clarity.com/vat-on-church-utility-bills/#:~:text=There%20is%20no%20VAT%20chargeable%20on%20Church%20water%20bill

5. Energy Usage Details

5.1 Annual Consumption

All Saint’s Church, Laleham used the following amounts of energy;

Year	2019	2020	2021	2022
Electricity	3,370	2,737	3,141	3,100 est’d
Gas	46,670	31,725	41,256	

Utility	Meter Serial	Type	Pulsed output	Location
Electricity	E17UP 25663	EDMI Atlas Mk7B3 phase	Yes	Inside tower door
Gas	1080369 S	UGI Imperial cubic feet	No	Tower, first floor adjacent to boiler

Having an AMR connected gas meter fitted would allow an annual energy use profile for the site gas use to be obtained from the supplier. This should be available for electricity use.

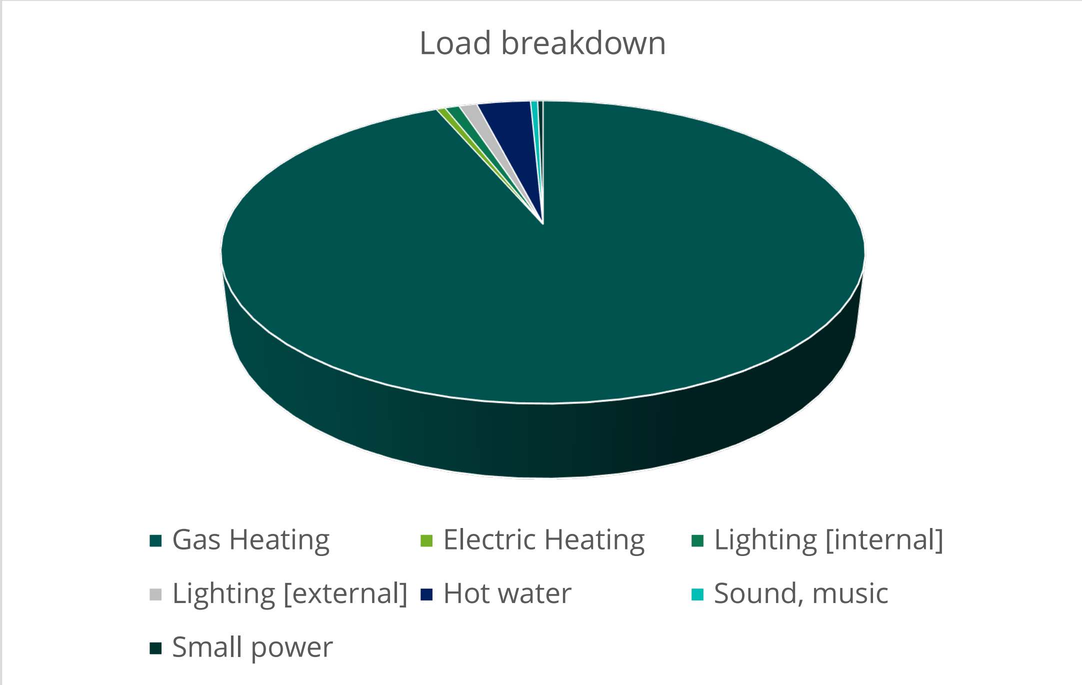
5.2 Energy Profiling

The main energy consuming plant can be summarised as follows:

	Equipment	Power kW	Annual Consumption kWh	Percentage
Heating [Gas]	Hamworthy UR 365 boiler 430 hours use	101	43,500	93.5%
Heating [Electric]	Boiler circulation pump BN Thermic 2kW blower over entrance door Kitchen & Toilets; 4 extraction fans	0.3 2 *0.8*	150 50 50 TOTAL 250	0.5%
Lighting [Internal]	500 hours use All LED lighting, recently installed	870W	400	0.9%
Lighting [External]	Floodlights, 3 LED	300W	500	1.1%
Hot Water	Heatrae Sadia Multipoint 10litre water heater. Normally OFF. Est 5 hours use per week Coffee machine Est. 5 hours per week Urn Kettle	3 2 2 3	750 400 150 200 TOTAL 1,500	3.2%
Sound, music	Electric organ Sound desk	0.5 1	50 150	0.4%
Small Power	Projector TV screen Vacuum cleaner	0.5 0.2 1.5	75 25 50 TOTAL 150	0.3%

Sum of estimates: 3,000kWh

Average Annual electricity consumption: 3,000kWh



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

In comparison to national benchmarks for church energy use All Saint's Church, Laleham uses 7% more electricity and 50% more heating energy than would be expected for a church of this size. It should be noted that the national benchmarks do not make any specific adjustment for the amount of time the church is used and the usage of this church will therefore affect how it performs against this benchmark.

	Size (m^2 GIA)	All Saint's Church, Laleham use kWh	All Saint's Church, Laleham use kWh/m^2	Typical Church Use kWh/m^2	Variance from Typical
All Saint's Church, Laleham (electricity)	200	3,000	15	14	+7%
All Saint's Church, Laleham (gas heating)	200	43,500	217	145	+50%
TOTAL	200	46,500	232	159	+46%

6. Efficient / Low Carbon Heating Strategy

6.1 Overview

The building is visible all around and located next to a main road. There is limited scope for solar panels, but the low hours of use and consequent low electricity use mean there is limited viability for installing an array.

Lighting is all LED and the seating is by comfortable upholsterd chairs.

6.2 Reducing Environmental Impact

The energy used for heating a building typically makes up the majority 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 future. 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 coal fired power stations. Mains gas does have some potential to reduce its carbon content through the use of biogas and hydrogen but these are less developed solutions and will be unable to deliver 'zero carbon mains gas'.

It is therefore important to review and plan to increase building efficiency and become less carbon intensive. One way to achieve this is to consider a transition to electrical heating where this also represents a more efficient and comfortable solution for churches.

6.3 Forward Planning

Whilst there are plans to add hydrogen to the network, and "green" gas from anaerobic digestion; some suppliers offering up to 20% "green gas" tariffs, the majority of the gas supply will continue to be fossil fuel for the next decade. The economics of hydrogen production and the need to replace some pipework make full decarbonisation of gas unlikely.

The church should develop a boiler replacement plan, by obtaining detailed quotations for the options presented in this report. Where electric heating can be obtained at similar or lower operating cost, this is recommended.

6.4 Site Heat Demand

The Centre for Sustainable Energy model[2] can be used to estimate heat load for the building.

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

Insulation Factors

Condition	Factor kW/m^3
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

Building	Volume m^3	Insulation Factor kW/m^3	Heat Required (Space heating) kW
Church	1,140	0.03	38

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

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, this should include:

7.1 Radiator Reflective Panels

The hall is heated by radiators served from the boiler. These radiators are located on the external, uninsulated walls and have no reflective or insulated surfaces directly behind them at present. They therefore lose much of their heat into the masonry of the wall behind the radiator rather than giving it out into the body of the church.

In order to improve the insulation directly behind the radiators, a reflective panel can be installed. This helps to make sure more of the heat from the radiator goes into the space and requires less overall heating from the boiler to achieve the set point. There are a wide variety of reflective panels for installing behind radiators on the market. It is recommended that these panels are installed behind all radiators within the building.

The installation of radiator panels can be carried out by anybody competent in basic DIY and does not require the radiators to be removed.

8. Future Heating Options

8.1 Options Comparison

The current hours of use of the church are low, at around 9 per week.

This is considered too low for an Air to Water heat pump system, because the defrost cycle which needs to run in cold weather extracts heat back from the building to melt the ice. This only works if the system is run for long enough to store enough heat in the building – which means running the system for much longer than the building is in use for.

With no pews, the options are an Air-to-Air heat pump system (which may also have a similar drawback), chandelier mounted radiant quartz heaters, similar radiant "ring" heaters or a replacement gas boiler.

The church is visible on all sides and does not possess either large buttresses or a sunken boiler room which could be used to house the external units of an air source heat pump. If the church wishes to consider a heat pump system (rather than overhead radiant); it is encouraged to research the system recently installed at St Andrews in the Wardrobe, Diocese of London where the external units have been located in the tower. All Saints may have room in the tower at second floor level for the necessary plant. At first floor level in the tower, the Carillion mechanism, clock weights and stored chairs all preclude the open atmospheric ventilation which a heat pump would require. A further consideration is the need to install pipework for refrigerant, and find locations for the internal floor mounted fan units which would be required.

The (present) low hours of building use plus likely installation difficulties do not favour a heat an air to water pump. An overhead radiant system would need to be carefully considered on aesthetic grounds. An air-to-air heat pump may provide some solution but would equally need careful consideration of the aesthetically acceptable location of the external units. This would leave installing a replacement gas boiler as the remaining option – if chosen, a very careful and considered justification would be required to gain faculty permission that would have to show due regard to the Net Zero Carbon guidance. This may include having a gas supply contract providing renewable gas (from anaerobic digestion). Churches can offset their emissions by schemes such as that offered by Climate Stewards or similar.

8.2 Air to Air Source Heat Pumps

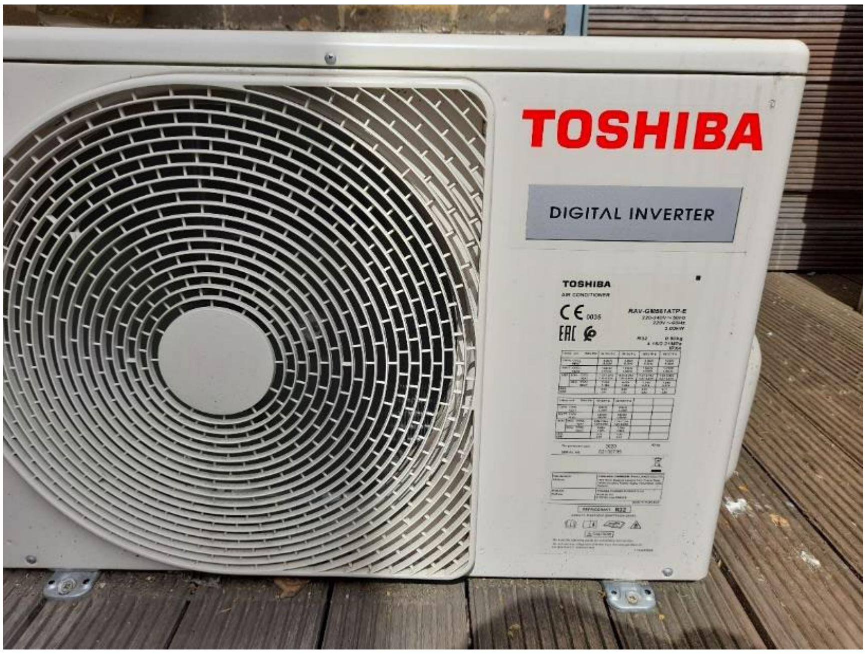
Air-to-Air Source Heat Pumps (AASHP) work by having an external unit which sucks air in and extracts the heat from it. The pumps concentrate this heat and put it into a refrigeration gas (in the same way as a fridge or freezer works). This refrigeration gas is then piped inside the building in a small 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; they therefore have a Coefficient of Performance (CoP) of 4.5.

The Centre for Sustainable Energy model has been used to estimate heat load for the building.

A heat pump system of 38 kW would be required. With no suitable location for external units around the perimeter of the building, this system would only be viable if the plant was located in the tower. This would increase the length of pipework required and the inventory of refrigerant. If the church is expecting / planning to increase hours of use of the building, and a radiant system or replacement gas boiler are undesirable, this is the other option.

AASHPs 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, which condenses and sometimes freezes 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. For this hall, two or three of the small external units (left, below) would be required.

Examples of external units for ASHP comprising of three smaller 3kW units (10kW output each) and two larger 10kW units (37.5kW output each).



Internal units come in a variety of styles, but due to the location of windows and memorials, mostly floor mounted units would be required, with possibly a wall type above the vestry.

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 and similar to the noise from a fridge or freezer. Air conditioning units are commonplace in hotel rooms, indicating that the noise is low enough even 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 Air to Air Source Heat Pumps Costs

Pumps to supply 38kW of heat (with capital cost estimated at £450 per kW output: £17,100) would deliver the same amount of heat annually, 43,500kWh, as the current system.

Operating at a Coefficient of Performance of 4.5, a 38kW heat output requires 8.4kW of electricity supply.

Annual electricity consumption = 43,500kWh/4.5 = 9,667kWh

At current costs of 20.9p/kWh, annual operating cost = £2,020

Present gas costs are 4.941p/kWh x 43,500kWh = £2,149 + VAT

Annual servicing costs for gas will also be avoided, thus lowering the payback period.

Note that gas costs may continue to rise against electricity costs; this will also favour heat pumps.

8.4 Overhead Radiant Electric Heating

In areas where there are no fixed pews on to which heaters could be fitted, an option for heating the people, rather than all the air in the space, is to use overhead infrared heaters. These come in a variety of forms from the traditional that have a visible red-light glow emitted from them, to ceramic units and the more modern 'black heat' units which have no visible light. In most cases the distance from the heater to the people being heated needs to be no more than around 2.5 to 3m, although this varies slightly between heater types (therefore a mounting height of between 3m to 4m is typical). Units mounted outside of their heating range are likely to give poor performance. This form of heating provides heat from above and can leave lower limbs and feet feeling cold; therefore some people find this form of heating less comfortable, especially for longer periods of time. Comfort perceptions tend to improve in spaces where people are standing and more able to move around but reduce in areas where they are sitting in a fixed position for more than around 15 minutes. Some of these units can also have extremely high surface temperatures, and care should be taken not to mount them directly next to historic timbers or fabric that may be impacted by high heat levels.

There are some units on the market that incorporate a large chandelier type unit with both lighting and heating. These tend to be a very large visual intrusion in most churches and for that reason are not seen as appropriate where buildings of historic significance are concerned.

It is particularly important that sight lines to the east window are not obstructed.

The images below are of an installation made during 2018 at St Catherine's, Faversham, where seven chandeliers were suspended from arch centres. Capital costs were around £500 per kW (42kW fitted). The heaters are wired in pairs, allowing two, four or six elements per ring to be used.

However, as All Saints has just one row of columns (having a nave and one aisle), there could only be three arch suspended chandeliers installed.   A better distribution would require suspension from beams or roof, to align the chandeliers with the centre of the aisle and nave. However, this may interfere with the sightline to the east window.

Above, nave looking west (there was once a south aisle, which has been removed and the arches filled).

Below, north aisle. Vestry constructed at end of chapel.

Capital cost – less than 38kW required; 8 rings (three in nave and aisle, one each in Lucan Chapel and chancel). With 750W elements x 48 = 36kW maximum. Approximately £18,000 (using 2018 costs).

36kW x 250 heating hours = 9,000kWh. Operating cost at present rates = £1,881.

8.5 Install an Efficient Condensing Boiler

The current boiler, A Hamworthy Heating UR 365 of 101kW input, 79.2kW output offered an efficiency of only 79% when new. If it is replaced by a gas boiler, this should be a condensing boiler. These should offer an efficiency of 93 to 95% when operated so that the return water temperature is below 55°C. Any new boiler should be hydrogen ready.

- Heating should be turned off 45 minutes before the end of a service or event as the radiators will continue to supply heat.
- Heating should not be run in May and turned off early – allowing the church to cool will give a reservoir of “coolth” in advance of the summer.
- Using heated cushions (see below) would also allow reduction in the number of gas heating hours at each end of the heating season.

8.6 Heated 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 and/or for small congregations where there are few other alternatives.

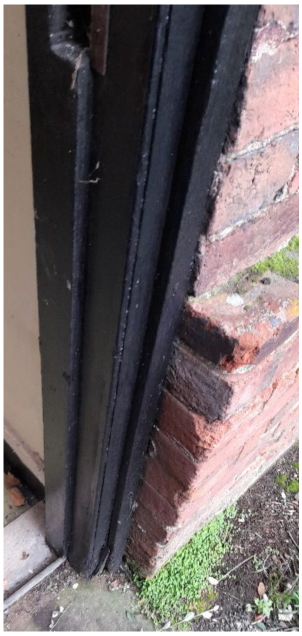
There are a variety of heated seat cushions on the market. Some are directly plugged into a power socket (similar to an electric blanket). Others have battery packs, which can be charged and then connected to a seat pad. This makes them more flexible and avoids trailing leads. The more advanced products 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.

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

9. Energy Saving Recommendations – Building Fabric

9.1 Draught Proof External Doors

The tower door, below, appears to be recent or of 20th century construction. It would benefit from draught strips added to the frame and the metal upstand on the ground.

The main porch door and vestry door both have large open keyholes which could be covered on the inside. In addition, the vestry door could have a weighted “sausage dog” draught excluder.

9.2 Windows


The hopper window above the tower door is rusted and stuck in the open position. As the result is a 5cm gap at the top, a considerable amount of cold air will be constantly entering the building, which may account for around 5% of heating energy use [2,200kWh, £107 annually].

It is recommended that the window unit is removed for restoration and repair. This will probably require a faculty rather than being list B (because something has to be put into the hole to block it, as well as finding a suitable repair company).

10. 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	No, low electricity use, mostly visible roof
Battery Storage	Future potential
Wind	No – no suitable land away from buildings
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 to Water Source Heat Pump	No, hours of use too low
Ground Source Heat Pump	No, as above, plus expensive borehole required
Air to Air Source Heat Pump	Possible

11. Funding Sources

There are a variety of charitable grants for churches undertaking works and a comprehensive list of available grants is available at www.parishresources.org.uk/resources-for-treasurers/funding/

This includes a 77-page guide to funders and their criteria:

https://www.parishresources.org.uk/wp-content/uploads/Charitable-Grants-for-Churches-Jan-2020.pdf .

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