Energy Audit and Survey Report

Christ Church, Ashford

Ashford Town Parish PCC

Version Control

Author	Reviewer	Date	Version
Paul Hamley	Matt Fulford	28th January 2020	1.0

Contents

1. Executive Summary

An energy survey of Christ Church, Ashford 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. 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.

Christ Church, Ashford is a Grade II listed Victorian church built in 1867 with pitched roofs for the nave, aisles and chancel. There is both gas and electricity supplied to the site.

The church has a number of ways in which is 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 is used as the action plan for the church in implementing these recommendations over the coming years.

Short Term: Energy saving recommendation	Estimated Annual Energy Saving (kWh)	Estimated Annual Cost Saving (£)	Estimated capital cost (£)	Simple Payback (years)	Permission needed	CO2 saving (tonnes of CO2e/year)	£/tonne of CO2
Window repairs **(For Immediate Action)**	1,900	£59	say £10,000	168.14	Faculty	0.41	£24,539.15
Remove radiator cover	N/A (improved comfort)	-	-	-	-	-	-
Door draught proofing measures	1,900	£59	£800	13.45	List B	0.41	£1,963.13
Review church heating with temperature logger and adjust timing accordingly	1,500	£47	£40	0.85	None	0.32	£124.33
Install Endotherm advanced heating fluid into system	2,000	£63	£600	9.58	List A	0.43	£1,398.73
Install solar photovoltaic panels on church hall roof	12,000	£1,570	£14,400	9.17	Faculty	3.69	£3,906.25

Consider installing under pew heaters to replace boiler together with extra radiant heating	Save 38,000kWh of Gas, Use 20,000kWh of Electricity instead	N/A (Switch from Gas to Elec)	£25,000	N/A	Faculty	2.01	£12,437.81

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

Based on contracted market prices of 13.0852p/kWh for electricity and 3.1303p/kWh for mains gas respectively.

If all short and medium term measures were implemented this would save the church £1,800 operating expenditure per year.

Operating costs of electric heating can be equivalent to those of gas, since less preheating is required.

2. Introduction

This report is provided to the PCC of Christ Church, Ashford to provide them with 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 Christ Church, Ashford, Beaver Road, TN23 7SRwas completed on the 9th January 2020 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.

Christ Church, Ashford	606220
Gross Internal Floor Area	430 m^2
Listed Status	Grade II
Typical Congregation Size	50

The church typically used for 11.5 hours per week for the following activities

Services	6 hours per week
Meetings and Church Groups	5 hours per week
Occasional Offfices 4 Weddings, 4 Funerals p.a.	1 hour per week

Church annual use = 600 hours

The adjacent hall is heavily used by several groups, estimated at 40 hours per week.

Heating hours: Church = 480 hours, known boiler timings

Estimated footfall (church only) = 5400 people

NB: only the church has been audited, but relevant suggestions have been made for the adjacent hall.

3. Energy Procurement Review

Energy bills for gas and electricity have been supplied by Christ Church, Ashford and have been reviewed against the current market rates for energy.

The current electricity rates are:

Single / Blended Rate	13.0852p/kWh	In line with current market rates
Standing Charge	13.6982p/day	N/A

The current gas rates are:

Single / Blended Rate	3.1303p/kWh	In line with current market rates
Standing Charge	109p/day	N/A

The above review has highlighted that the current rates being paid are in line or below current market levels and the organisation can be confident it is receiving good rates and should continue with their current procurement practices.

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 for the current meters, listed in Section 4 below. 20% VAT rate was levied on the previous electricity meter D0271917 in January 2019 before it was changed, also for electricity meter K95122822 for the hall before it was changed, and for the new church gas meter M016 K04463 11 D6 for a short period after installation.

This should be checked to ensure that the overpaid amounts have been recovered, if necessary sending the supplier at VAT declaration.

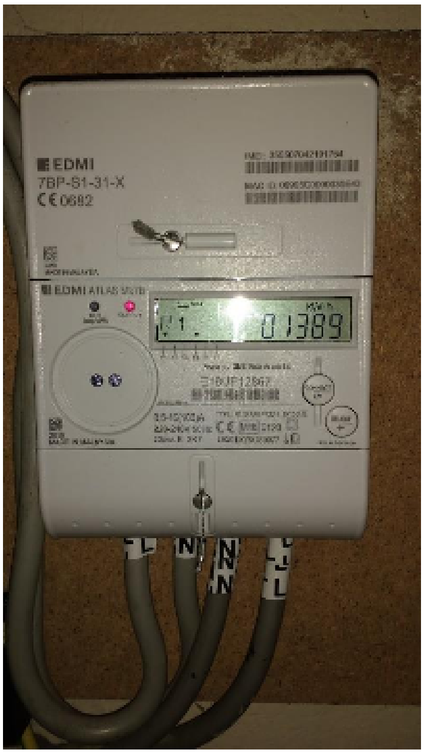
4. Energy Usage Details

4.1 Annual Consumption

Christ Church, Ashford uses 1,426kWh/year of electricity, costing in the region of £240 per year, and 36,000kWh/year of gas costing £1,600.

This data has been taken from the annual energy invoices provided by the suppliers of the site.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	E18UP12867	EDMI 7BP-S1-31-X	Yes	Rear of north aisle on west wall
Electricity – Hall	E18UP12912			
Gas – Church	M016 K04463 11 D6			Outside in box attached to north wall
Gas - Hall	K08733 18 D6			



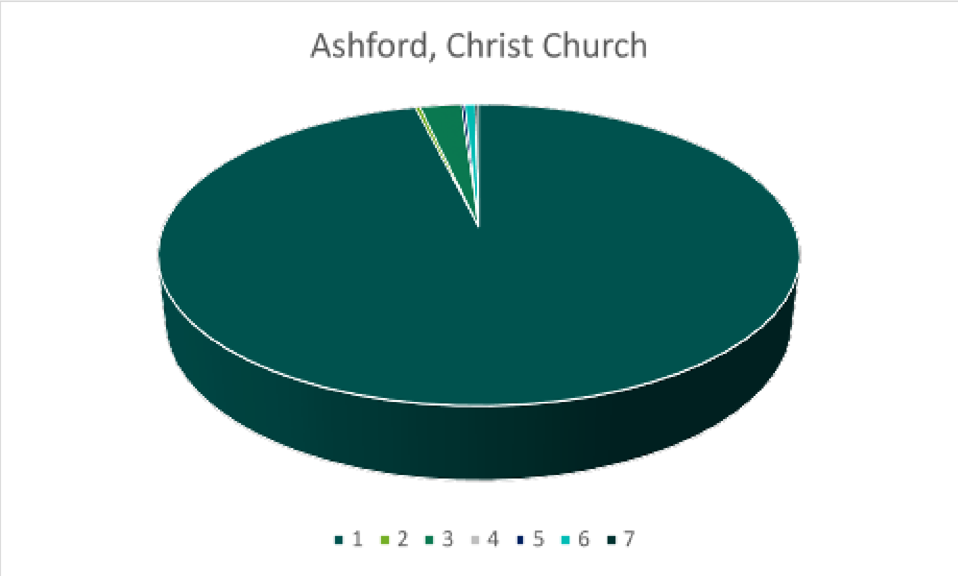
All the meters are AMR connected and as such an energy profile for the annual energy usage should be possible.

4.2 Energy Profiling

The main energy use within the church can be estimated as follows (known figures in bold):

Service	Description	Power	Annual Use/ kWh	Estimated Proportion of Usage %
Gas heating	Keston C90 boiler 400 hours use if always at full power 480 heating hours, average output 74.6kW	90kW	35,829	95.7%
Boiler pump	480 hours use	100W	48	0.1%
Lighting Nave Chancel Aisles Porch Vestry	**ALL LED** 16 clerestory level spotlights ~20W 2 spotlights ~20W 4 floodlights ~50W 4 spotlights #20W 10 pendant lanterns ~10W 2 spotlights ~20W 1 CFL ~20W 1 fluorescent T8 ~50W 1 pendant CFL, ~25W **TOTAL** LED lighting installed during 2019, estimate 6 months of use and 6 months of use for previous lighting	700W	200 730	2.6%
Heating [Electric]	2 x Claudgen heaters over south porch inner doors	2x2kW	60	0.2%
Hot Water	Kettle, 10 boils per week	3kW	78	0.2%
Other Small Power	Sound system Vacuum cleaner	1kW 1.5kW	150 78	0.6%
Organ	Organ	1kW	80	0.2%

Total Annual Consumption 2019: **1,426kWh**



KEY 1 Gas Heating 2 Electric Heating and pumps 3 Lighting

5 Hot water 6 Small power 7 Organ

4.3 Energy Benchmarking

In comparison to national benchmarks for Church energy use Christ Church, Ashford uses considerably less electricity and heating energy than would be expected for a church of this size.

This is partly due to the recent installation of LED lighting, but is also influenced by community events being held in the adjacent hall, rather than in the church as is sometimes the case.

	Size (m^2 GIA)	Christ Church, Ashford use kWh/m^2	Typical Church use kWh/m^2	Efficient Church Use kWh/m^2	Variance from Typical
Christ Church, Ashford (elec)	430	3.3	20	10	16%
Christ Church, Ashford (heating fuel)	430	83	150	80	55%
TOTAL	430	87	170	90	51%

There is currently no benchmark data which takes hours of use and footfall into account.

[1] CofE Shrinking the Footprint – Energy Audit 2013

5. Energy Saving Recommendation (Heating)

5.1 Heating System and Strategy

The church currently uses gas fired central heating to heat the church. The boiler, a Keston C90 of 90kW input, 80kW output and operated with 72°C flow temperature was installed in 2008.

The timer controls are set to deliver 480 heating hours annually from late September to late April:

Mon, Tue, Wed	07:00 – 09:30
Thu	07:00 – 12:00
Fri, Sat	07:00 – 09:30
Sun	05:00 – 10:00

The church is in regular use on Mondays, Thursdays and Sundays. It might be possible to reduce heating times on days when the church is not used, but at the expense of longer times when it is.

The system is reported to work well and provides adequate thermal comfort into the church. Given that the system is successful and not overly wasteful of energy we would recommend that this system is continued with and consideration is given to the following improvements.

If a gas boiler is to be retained, then long term, the boiler will need to be made hydrogen ready. Hydrogen is due to be added to the gas grid over the next five year period. If plans to decarbonise the gas grid are implemented; the hydrogen mix will eventually exceed 20% and a hydrogen compatible boiler (and piping) will be required. The transition will be overseen by the regulatory bodies in a similar way to that between town gas and North Sea gas.

If the church use pattern is likely to see the need for it to be heated at short notice or for short periods, changing to electrical heating which delivers heat rapidly and close to the occupants is recommended. Electrical heating would also allow the south aisle glassed area, below, to be heated independently. Section 7 considers electric heating options.

Seating in the south aisle chapel, separated by glass screens.

In addition to the central heating, two fan heaters are situated above the south entrance porch.

5.2 Boiler Timing Optimisation

Experiments in the Diocese of Lichfield at over 50 churches have established that hot water radiator heating can be optimised by being switched off 45 minutes before the end of the service.

Purchasing of a temperature datalogger will allow the time for the church to heat (in different weather conditions) to be understood, as well as the time to switch off to be optimised. This would require someone with a computer to plug in the device and download the readings.

A suitable model retailing for around £40 is https://www.lascarelectronics.com/easylog-data-logger-el-usb-1/

Controls are located opposite the boiler

5.3 Covered Radiator

This radiator is unable to radiate and has limited ability to convect. The presence of a portable electric heater, bottom right, suggests that this seating area is not considered warm enough. The audit took place on a Thursday morning, when the church was open for coffee and cake. At 10:00, when the heating had been on for three hours, temperatures were: Floor 14.0-14.5^oC, ceiling 14.8^oC, north wall 12.6^oC, pews13.9-14,5^oC, font 13.2^oC, radiators 53, 54^oC.

If it is possible to remove the wooden cover temporarily and experiment with the seating arrangement, this area could be made warmer.

5.4 Endotherm Advanced Heating Fluid

In order to improve the efficiency of the heating system further it is recommended that an advanced heating fluid (http://www.endotherm.co.uk/) is added to the heating system.

This fluid in in addition to, and complements any existing inhibitors in the heating system and is added in a similar way. The fluid works to improve the ability of the boiler to transfer heat into the heating system and for the radiators and other heating elements to give out their heat into the rooms. It does this by reducing the surface tension of the water and increasing its capacity to transfer and hold heat. Case studies have demonstrated that the addition of this fluid into heating systems reduces heating energy consumptions by over 10% as well as helping the building heat up quicker.

Endotherm can be self-installed.

6. Alternative Heating Systems

A church with low hours of use per week will always fall back to "base" temperature between heating events (it may take around 24 hours for the temperature to fall). A system which can heat rapidly, without sending most of the heat to the ceiling first, and in addition can be configured to heat small areas independently for small services or midweek meetings will be more efficient than one which seeks to heat up the whole volume.

6.1 Under Pew heating

A future option to replace gas fired space heating is to install under pew electric heating. Although electricity is currently more expensive that gas per kWh, this form of heating requires little preheating time and delivers heat directly to the congregation. There are three sets of eleven pews with a further nine in the south aisle separate area.

Heaters with an output of 300-400W seem to be more suitable than 500W models according to reports from different churches.

Two heaters per pew require 84 heaters, giving an output of 33.6kW (at 400W). Costs per heater are in the range £140-180, totalling around £15,000.

Two most popular under pew heaters within churches are BN Thermic PH30 heaters (http://www.bnthermic.co.uk/products/convection-heaters/ph/) or similar from http://www.electricheatingsolutions.co.uk/Content/PewHeating. A further type are "Cooltouch" fabric covered heaters. https://www.cooltouchheaters.co.uk/

All cabling should be in armoured cable or FP200 Gold when above ground.

The under pew (see photo below) and panel heaters have been recently installed at St Andrews Church, Chedworth, Gloucestershire, GL54 4AJ. The church is open in daylight hours so can be viewed at any time.

6.2 Use of Electric Radiant Panels for Heating Specific Areas only

The under pew heater described above will deliver around 33kW of heat. The current boiler delivers 80kW, which involves slowly raising the temperature of water, which then heats air which circulates up to the ceiling. Under pew heating at close distance to people is relatively instantaneous and therefore more efficient, so a smaller power in kW can deliver a similar comfort effect. However, in order to heat those areas of the church away from the pews, such as the chancel, font area and the seating area in the south west corner, it is suggested to use some radiant heating.

It is suggested that under pew heaters are installed *before removal* of the central heating system. Operating with under pew only (with the CH boiler as back up) will indicate whether further electric heating panels are required.

To avoid having to heat up the entire church building for these smaller mid-week services it is recommended that the PCC consider installing electrical panel heaters in this area on a time delay switch and remove the existing radiators.

Suitable electric panel heaters would be far infrared panels such as https://www.warm4less.com/product/63/1200-watt-platinum-white- . These can be purchased widely and fitted by any competent electrician. It is recommended that they are fitted with a time delay switch such as https://www.danlers.co.uk/time-lag-switches/77-products/time-lag-switches/multi-selectable-time-lag-switch/159-tlsw-ms so they can not be left on accidently after use.

Panels are available in colours from some manufacturers, including bespoke stone colours to blend in, or even with printed patterns or pictures, e.g. https://www.suryaheating.co.uk/custom-image-heating-panels.html

Another option would be to use radiant (glowing) heating elements – these normally look unsightly when hung from ceilings or attached to walls but have been successfully deployed in churches hung from chandeliers, where they can be combined with lighting if desired.

The image below is from St Catherine's, Faversham, which is heated solely by chandelier mounted radiant heaters.

7. Energy Saving Measures (Building Fabric)

7.1 Draught Proofing to Doors

There are a number of external doors in the building including under the tower, the south porch and to the vestry. These have the original historic timber doors on them, but these do not close tightly against the stone surround and hence an amount of cold air is coming into the church around the side and base of these doors.

Where a timber door closes against a timber frame it is recommended that draught proofing is fitted. A product called QuattroSeal (see link below) is often used in heritage environments to provide appropriate draught proofing.
http://www.theenergysavers.co.uk/application/files/1714/7197/4194/National_Trust_Case_Study.pdf. Note this cannot be used where the timber door closes directly against a stone surround.

The tower and porch doors both close against stone with the wooden door set into a substantial recess, (see below) which offers the opportunity for some form of draught exclusion to be added, either between door and stonework, or door and wooden frame.

The porch door leads to inner doors which are covered with a mix of felt and leather strips around the edges – this system appears to fill the gaps but probably needs some maintenance to keep weather tight.

The inner glass doors to the tower cannot easily be made airtight due to their shape and the clearances provided.   Other simple measures such as using a small fridge magnet painted black over the large keyhole or the use of 'sausage dog' type draught excluders at the base of little used doors can prove to be very effective. Doors should be reviewed in daylight and gaps where the light shines through sealed or filled in whatever the most appropriate way is for the specific door.

South porch doors, external and internal (right)

West tower internal glass doors, these would be very difficult to make airtight.

7.2 Closed Door Policy

The entry doors under the tower should be kept closed in cold or windy weather and only the south porch used. The inner doors should be quickly closed behind the congregation by your friendly welcome team (one of which probably gets to stand in the porch area!).

7.3 Windows

There are several windows in a poor state of repair where damage, probably from corrosion has distorted the framework to the extent that large gaps are appearing in the window structure.

This will lead to significant loss of heat from the building, with constant draughts, and to ingress of rain and moisture causing further problems.

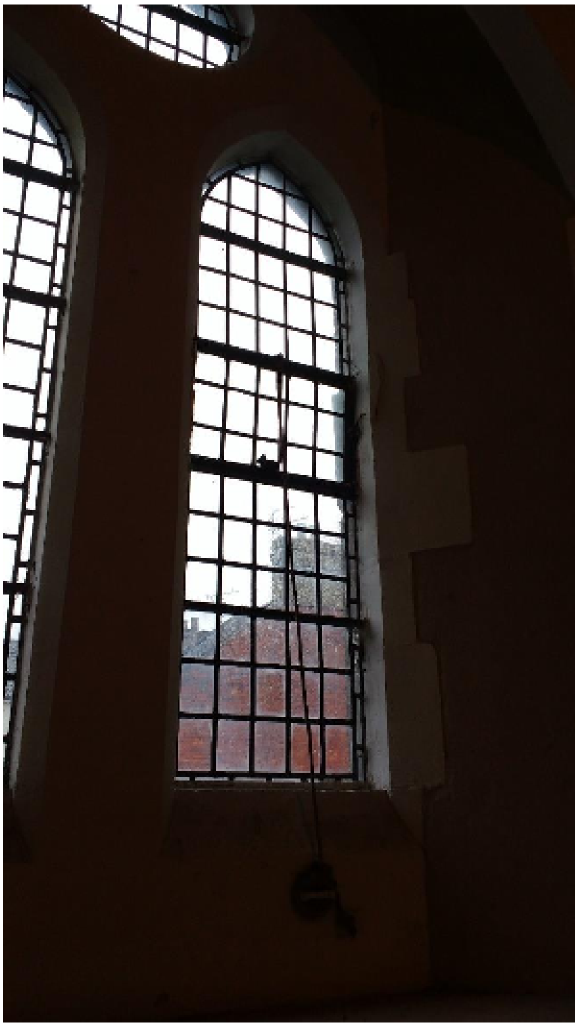
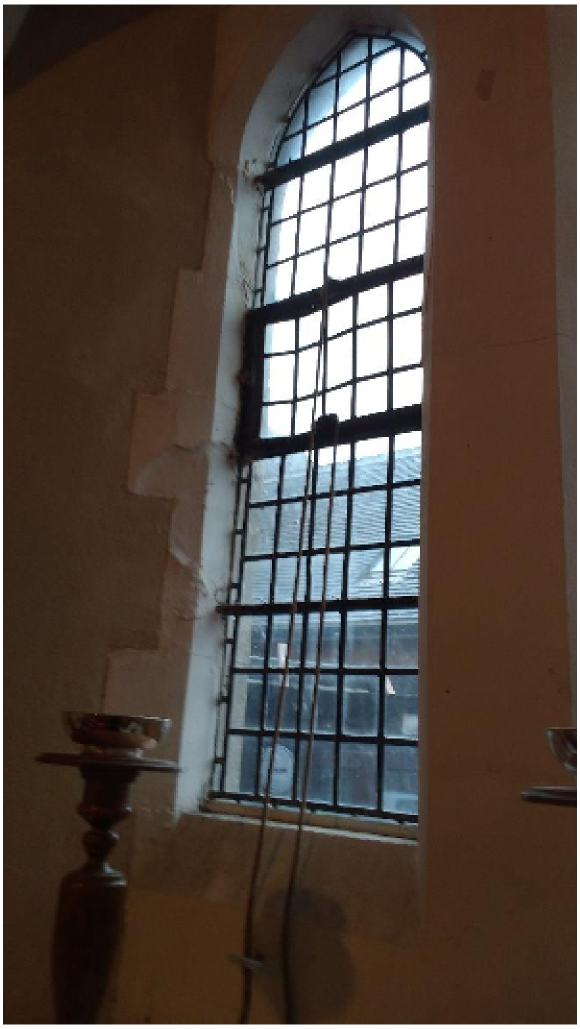
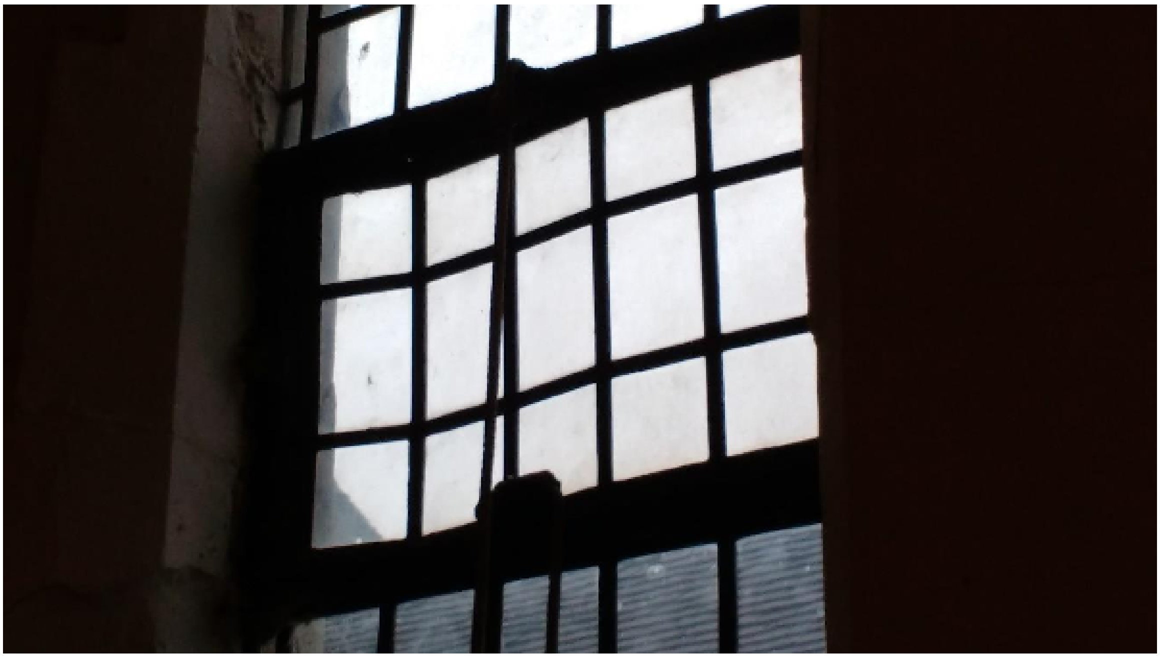
If there are draughts caused by small cracks or hopper windows not shutting correctly, a temporary solution is to use black plasticine to fill gaps. However, many of the areas of damage are too great for this to work, Care should be exercised where there is already broken glass, as seen below.

It is recommended that the PCC release money for window repairs.

Many of the windows are in a poor state of repair, with cracked, broken or missing glass at the edges, ironwork which has corroded and deformed due to rust jacking leading to severe deformation, opening sections which will not shut. This is leading to draughts and ingress of moisture and rain which will cause further deterioration to the windows themselves and other fabric. The worst sections are approaching a state where large gaps will open.

If this is not addressed it could lead to a chain reaction of decay.

Actioning these repairs now will enable them to be carried out over the spring / summer to weatherproof the building before next autumn.

Above, possibly in vestry

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	Potential for hall
Battery Storage	Potential for hall
Wind	No – no suitable land away from buildings
Micro-Hydro	No – no water course
Solar Thermal	No – insufficient hot water need
Ground Source Heat Pump	No – archaeology in ground and radiator system
Air Source Heat Pump	No – insufficient hours of use
Biomass	No – not enough heating load as well as air quality issues

8.1 Solar PV potential

As a Grade II listed building, it is unlikely that the church would receive permission to install solar panels on the south facing roof. It could be argued that the south facing elevation is relatively hidden, although the height of the nave roof means it is visible from Beaver Road. The aisle roof is less visible, although partially shaded by the adjacent hall.

The church hall roof, which is also south facing and an unlisted building, offers good potential for a solar photovoltaic installation.

The south facing hall roof may offer a suitable site which appears unshaded by other buildings or trees. It appears to have dimensions of 18m x 5m and to offers an area of around 80m^2. This could generate 0.15kWpeak/m^2 giving a 12kWpeak system. [A roof pitch of 40 degrees and orientation of about 210degrees reduces output to 96%]. A 1kWpeak system in Kent can generate 1000kWh annually, giving a total annual generation of 12,000kWh. This is greater than the church's annual electricity use (1426kWh) and the hall (4782kWh) added – although much of that use will be during the evening and night. Addition of electric heating to the church and/or hall would obviously raise this figure.

The government has advertised a "Smart Export Guarantee" to begin in 2020 which will pay for electricity generated and exported to the grid (the Feed in Tariff having ended). Unlike the government fixed rate Feed in Tariff, the SEG is paid by energy companies and there is a large range of prices offered; some guidance can be found here: https://www.which.co.uk/reviews/solar-panels/article/smart-export-guarantee-explained#much

Using 2018 installation costs for larger systems of £1,200 per kWpeak (average 2018 domestic installation costs were £1,667 per kWpeak); a 12kWpeak system would cost £14,400. This does not include cost of any battery.

One of the issues for churches is that most lighting use is at periods when the electricity is not being generated. Given the low rates offered by the SEG, a battery would be a useful investment.

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 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.

9. Funding Sources

There are a variety of charitable grants for churches undertaking works and a comprehensive list of available grants is available at https://www.parishresources.org.uk/wp-content/uploads/Charitable-Grants-for-Churches-Nov-2019.pdf

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 the replacement of existing boilers so long at the same pipe work, fuel source and flues are used. It can also be used to replace heating controls.

All other works 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.

11. Report Circulation

In addition to the PCC, this report is also sent to:

1. Your DAC secretary and your DEO, because
    - They maybe be able to offer you help and support with implementing your audit
    - They want to look across all the audits in your diocese to learn what the most common recommendations are.
2. Catherine Ross, the officer in the Cathedral and Church Buildings team centrally who leads on the environment, who wants to learn from all the audits across the country. She will be identifying cost-effective actions churches like yours might be able to make.