ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Peter's Church, Ravenshead
PCC of St Peter's Church

Author	Reviewer	Audit Date	Version
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Contents

1. Executive Summary

An energy survey of St Peter's Church, Ravenshead 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 Peter's Church, Ravenshead was constructed in 1972 of brick. The adjacent hall was constructed in 2015. Electricity only is supplied to the site.

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 suppliers to one which provides a 100% renewable supply	None	None	Nil	N/A	None	Offset 9.8 tonnes
Complete LED lighting installation	50 [Low use of sodium lights]	£15	£400		List B for sodium lights . None for bulbs	0.01
Investigate installing cavity wall insulation in Lounge	8% of room load 50	£15	£1,000		Faculty	0.01
Replace tubular heaters with under pew convector heaters using same wiring if possible.	N/A	N/A	£12,000		List B	
Purchase a heated office chair	N/A	N/A	£300		None	
HALL						
Consider stopping heating in April to allow building to cool naturally in advance of summer	5% of hall load 900	£288	None	Immediate	None	0.2
Install Solar photovoltaic panels	40,000	£12,800	£52,000	4	Faculty	8.4
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+++.)

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

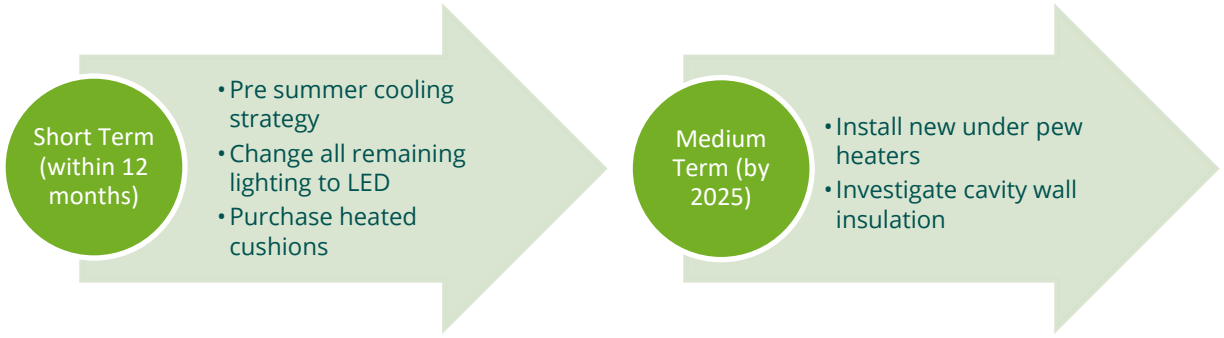
Figures in the table are based on current contracted prices of 34.5744p/kWh (day) and 30.1229p/kWh (evenings/ weekend) for electricity. The carbon figures are based on the DEFRA 2022 carbon emission factors of 0.211 for electricity, 0.18 for gas and 0.27 for oil. Do note that as energy prices increase, 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 Peter's Church, Ravenshead 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 Peter's Church, Ravenshead, Sheepwalk Lane, NG15 9FD was completed on the 7th March 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 Peter's Church, Ravenshead	CHURCH	HALL
Church Code	638038	
Gross Internal Floor Area	420 m^2	270 m^2
Volume	1,770 m^3	950 m^3
Heat requirement	45kW	14kW
Listed Status	Unlisted	
Average Congregation Size	50	

The church is typically used for 7.5 hours per week and the hall for 47 hours for the following activities.

Type of Use	Hours Per Week (Typical)
Services	5 hours per week
Meetings and Groups in Church	1 hour per week
Occasional Offices	6 Weddings 6 Funerals
Hall - Community Use	47 hours per week Daily use between 2 and 10 hours

4. Energy Procurement Review

Energy bills for gas and electricity have been supplied by the church.

The current electricity rates are:

Day Rate	34.5744p/kWh
Night Rate	30.1229p/kWh
Standing Charge	1113.6347p/day
Capacity Charge	94p/kVA

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.

Reported VAT rates are as follows:

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 suppliers 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

5.1 Annual Consumption

St Peter's Church, Ravenshead used 46,461 kWh/year of electricity during 2022, costing £22,022 per year at current rates (including standing charge, capacity charge and VAT).

This data has beendirectly supplied by the church.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Site	E14ML16604	EDMI Atlas Mk10 Three Phase	Yes	Hall, plant room
Electricity Submeters Hall lighting Hall sockets Church Unlabelled (external lights?)	Not numbered	Unknown		Hall, plant room

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

5.2 Energy Profiling

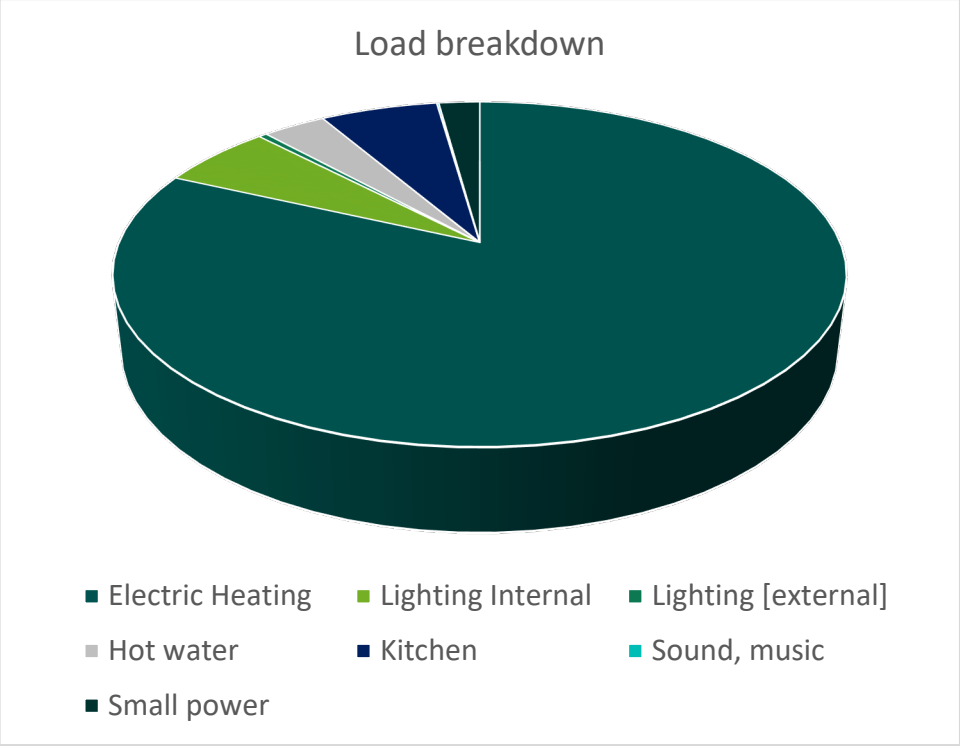
The main energy consuming plant can be summarised as follows:

	Equipment	Power kW	Annual Consumption kWh	Proportion
Heating [Electric]	CHURCH (14 hours per winter Sunday) Under pew tube heaters, 34 Wall mounted radiant quartz, 6 elements Wall mounted convectors, 8 x 2.9kW OFFICE 2 portable convector heaters [15 hours / week] TOILETS 2 hand driers HALL Air to Water Heat Pump, 15kW output estimated (2,900 hours; 1/3)	17 9 24 2 x 3 2 x 1 6	7,000 3,900 8,000 CHURCH 18,900 1,500 100 HALL 17,500 TOTAL 38,000	82%
Lighting [Internal]	Church 380 hours use SON sodium floodlights 4 x 250W LED spotlights 3 x 20W 2 x 10W Lounge 8 x LED diffuser 25W Entrance & foyer 7 bulkhead Office, sacristy, vestry 5 x incandescent Hall 2,500 hours use Kitchen Fluorescent 8 T5 x 35W Foyer, toilets, corridor 26 LED Meeting rooms recessed LED panels Store room 4 T5 x 35W	1000W 60W 20W 200W 200W 300W 280W 130W 700W 140W	570 2,200 TOTAL 2,770	6%
Lighting [External]	Car park lighting, LED floodlights	400W	200	0.4%
Hot Water (electric)	CHURCH Heatrae Sadia Multipoint 30: 30 litre wall mounted (normally OFF, low use) HALL Large Lincat heater Small Lincat heater	3 3 3	150 600 300	

	Commercial dishwasher (weekend use only)	5	500 TOTAL 1,550	3.3%
Kitchen	Oven, hob Warming oven Extraction fan Microwave oven Fridge x 3 Freezer x 2	7 1 0.2 1.5 0.4 0.4	350 50 10 50 1,200 1,200 TOTAL 2,860	6.1%
Sound, Music	Organ	0.5	50	0.1%
Small Power	Vacuum cleaner Router (on constantly) Workstation	1.5 100W 200W	100 800 100	2.2%

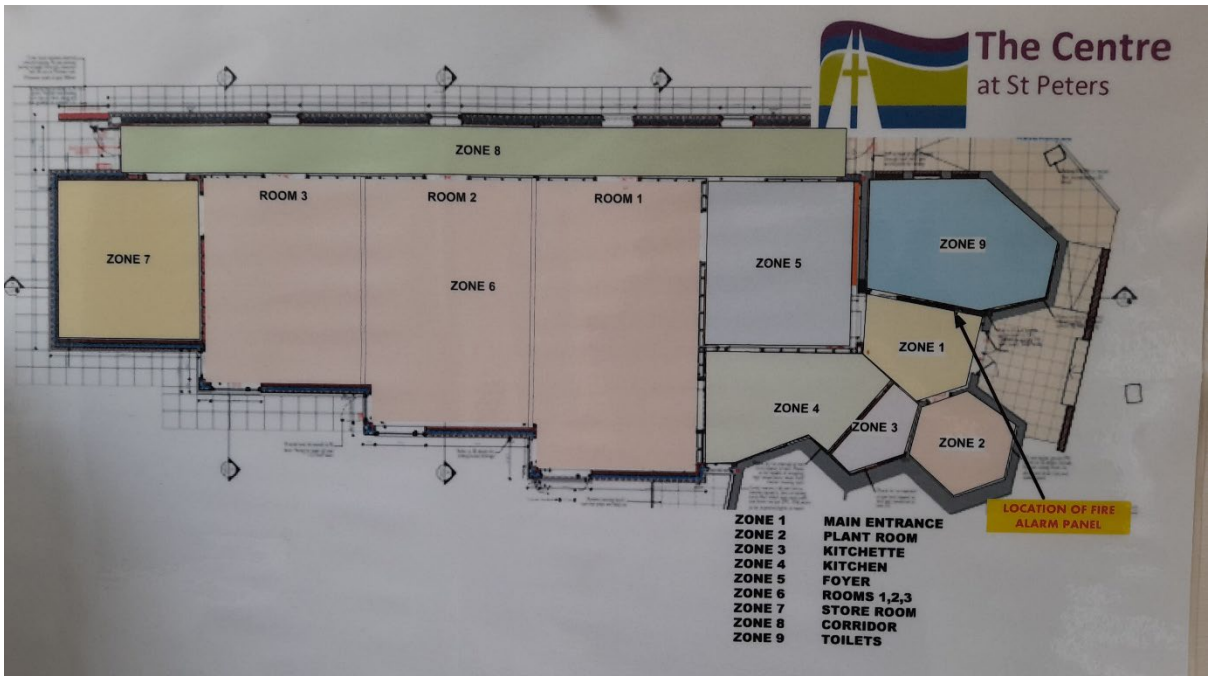
Sum of estimates: 46,430 kWh

Annual electricity use (2022), 46,461kWh

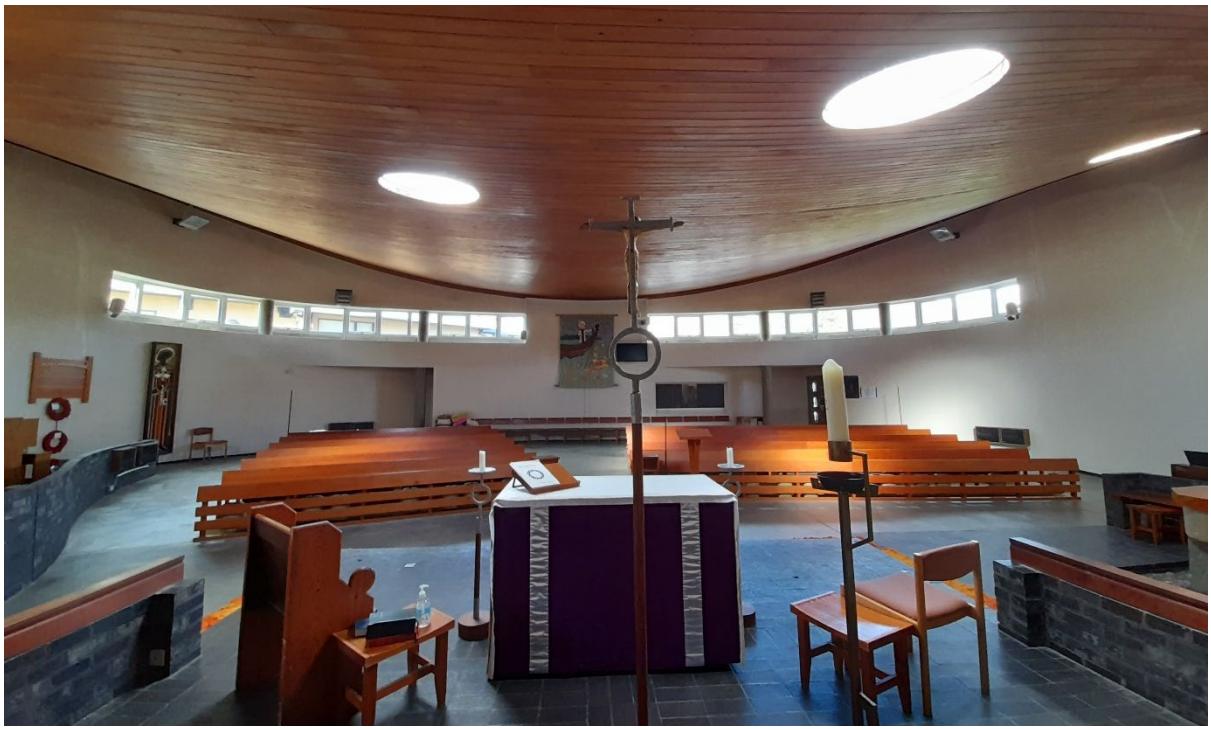


As can been seen from this data, the heating makes up by far the largest proportion of the energy usage on site. The other significant loads are lighting and hot water.

Church to the left, Church Centre to the right.



Plan of church with sacristy, office, vestry above. The church roof is to an unusual design which drains to the centre.



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 Systems

The church is currently heated electrically by a combination of under pew tubular heaters below all seating positions, two subsidiary wall mounted radiant quartz heaters and eight wall mounted convectors in four pairs.

The tubular heaters are thought to date from building construction and are reported to provide insufficient heat. They are of the type where the element is surrounded by the tube, and heat transfer to then air is poor. Radiant heat is only provided to the congregation's lower legs.

The office is provided with portable convector heaters. A dehumidifier is sometimes required, there has been some water ingress from the flat section of the roof, as can be seen below, where paint has begun to detach from the surfaces.

The hall, constructed in 2015 is supplied by an Air to Water Heat Pump system located on the roof at the NE corner of the building. This is reported as running constantly (it is presumed that the output is modulated according to the internal temperature).

6.3 Future Heating Options

The low hours of use of the church count against installing a heat pump system. [Air source heat pumps operate a defrost cycle in cold weather, using heat from inside the building. If there are insufficient hours of operation, there is not enough heat stored inside for this to work. The building needs to be in use / system run for sufficient hours, more than the 7 hours per week current use]. If the building were to enter into more regular use, an Air to Air Heat Pump system using small external units each serving one or two internal emitters seems the most suitable.

If the Lounge is to be used regularly, a small AASHP system should be considered.

Otherwise, with less than ten hours use per week, the church sanctuary heating could be improved by direct replacement of the tubular heaters with under pew convector heaters.

The church could purchase and install one unit to ascertain the level of improvement to comfort, and to assess the power rating required for new units.

The forthcoming EICR should inform the church of the condition of the wiring to the existing heaters, which could be re-used if possible.

Direct replacement of each tubular heater by new convector heaters is possible which would lower costs.

If there are budgetary constraints, only a portion of units could be fitted (e.g. half), although this strategy is likely to result in higher overall costs than for all units being installed at once.

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:

East side, 15 x 650W heaters in equivalent positions

West side, 12 x 650W heaters in equivalent positions

Choir stalls, 7 x 650W heaters in equivalent positions

Cable runs to the pew heaters should utilise either the existing cabling if in good order or follow the existing routes if replacement is necessary. Each pew heater to be switched with a neon indicated fused spur located underneath the pew seat as at present.

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

Capital cost estimate for 34 650W units are £12,000.

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.

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

6.5 Air to Air Source Heat Pumps

A small installation may be considered for the Lounge if it's hours of use rise sufficiently to justify the capital cost (about £2,700 for a 6 kW output unit). Operating costs are 20 to 25% of direct electric heating. If savings of £400 per year are achieved, this gives a 7 year payback.

This level of savings at 80% of an initial £500 bill indicate an annual use of around 1,500kWh at current rates. This is 300 heating hours at 5kW, indicating 6 hours per week use – this rough calculation shows that over this number of hours use per week (and particularly over 10 hours per week use), an air to air heat pump is more economical than "direct" electric heating.

The lounge appears to be used less than this at present.

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. AASHPs 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 up to 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

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

Area	Volume m^3	Insulation Factor kW/m^3	Heat Required (Space heating) kW
Lounge	250	0.025 Double glazed Cavity wall (not insulated ?)	6

Therefore, a heat pump of 6 kW output would be required. (One small external unit, below)

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.

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

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

Internal units come in a variety of styles. The most appropriate internal units for most churches are floor mounted units which look very similar to a fan convector heater.

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 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

6.6 Heated Office Chair

Positionable office chairs are also available with heating, and this can provide a more efficient way of keeping staff warm than using multiple convector heaters as observed.

6.7 Dehumidifier

Evidence of water penetration through the flat roof interface with windows suggests that installing a portable domestic dehumidifier would also benefit the office environment. It could be used in the vestry and sacristy while the office was in use and run to keep humidity down to 55%. Some models warm the air slightly.

7. 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.

7.1 New LED Lighting

The lighting makes up a relatively small proportion of the electricity used within the church. The majority of the building has had efficient LED lights installed.

The outstanding non LED lighting includes four sodium lights in the church (thought to be 250W each) and incandescent bulbs in the office, sacristy and vestry should be changed to LED lamps.

Changing the sodium lamps to LEDs requires contractors as they are at height – it may be more cost effective to change the whole unit to an LED floodlight.

For the offices, the existing fitting can be made more efficient by simply changing the bulb/lamp within the existing fitting to a new LED bulb/lamp. This could be carried out by competent members of the churches internal team, very cost effectively and, unlike a change of fittings, would be a List A item, so no permissions would be required.

Supply and installation can be undertaken by SavaWatt directly; information is at http://savawatt.com/. The installation does not cause any significant disruption to operations and can be undertaken during normal operating times.

7.2 Timers on Fuse Spurs to Water Heaters

There are various electric hot water heaters and water boilers (for tea-making and the like) located around the church. These only need to heat the water to the required temperature when the building is in occupation but at the moment these heaters are directly wired in without any form of time control.

If these can continue to be managed by “Switch Off When Not In Use” notices, that is sufficient. If hours of use of the kitchen increase with midweek uses, it is recommended that the water heaters are fitted with a 24 hour/7 day timeclock to replace the fused spur switch. They should be set up with times to match the times that the building is occupied. This will prevent the standing losses from the unit wasting energy during periods when the building is not occupied.

Such units can be purchased at any electrical wholesaler and fitted by your existing electrician or any NICEIC registered electrical contractor.

7.3 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 should be carried out 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 room temperature sensors to ensure that the space does not overheat because of the additional insulation.

This should be considered for the lounge if it is to be brought into greater weekly use.

Capital cost estimate: 17m of wall with a large window , 40m^2 of wall area x £25/m^2 = £1,000

The Lounge. Walls to left and at rear of the image are external.

8. Other Recommendations

8.1 Electric Vehicle Charging Points

The church has a car park to the side of it which serves the church and also the frequently used church hall. In order to make a visible statement on the church's 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.

Some units 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 without the need for a key may be most suitable. These are widely available through many suppliers.

Because of the parish office within the building, the church can be considered as a place of work and, as such, installation grants are available through the workplace charging scheme https://www.gov.uk/government/publications/workplace-charging-scheme-guidance-for-applicants-installers-and-manufacturers which will fund 75% of the installation cost up to £500.

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)	Yes
Battery Storage	In future

The hall is in regular daily use with a constant load from the heat pump system. Lighting is LED and low demand, and the church use during the week is mostly limited to part time use of the office. A system sized to power the heat pumps plus the minor lighting load would be suitable.

The following formula calculates annual generation:

Annual Generation (kWh) = Area x 0.15kWp/m^2 x 1000kWh/kWp x Orientation Factor x Overshading Factor.

Roof Section	Useable area / m^2	System Size / kW peak	Orientation factor	Shading factor	Annual Generation, kWh
Hall (south facing)	250	37.5	180 degrees / 35^0 1.0 Optimised on supports	1	37,500
Church	250	37.5	Various, following roof profile 0.8	1	30,000
Total		75			67,500

The size of the roofs have the potential to generate more than the current annual consumption.

This is the maximum likely figure, which may be reduced by factors such as the weight of panels (due to roof strength), access space between panels. The ability of the roof structures to support the extra loads should be discussed with the church's inspecting architect.

Once a decision on future heating for the church and lounge are made (either retain direct electric heating or move to a heat pump system), this will allow a revised annual consumption to be estimated. A solar PV system should be sized for the normal load of the building (A system large enough to provide winter heating needs will be oversized for summer requirements, and little money will be recovered from export to the grid under present arrangements).

A 40kW peak system, generating around 40,000kWh annually would cost in the region of £52,000.

The system should be specified for future addition of a battery, when battery costs reduce as this would extend system usefulness into the evening

Battery storage is not strictly a renewable energy solution, but it does 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 solar PV is no longer generating. It therefore extends the usefulness of the existing solar PV system particularly in this sort of church. This is a new but fast-growing technology with prices expected to fall substantially over the next 2 to 3 years.

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.