ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St John’s Church, Walthamstow
PCC of St John’s Church

Author	Reviewer	Audit Date	Version
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Contents

1. Executive Summary

An energy survey of St John's Church, Walthamstow was undertaken by Inspired Efficiency 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.

St John's Church, Walthamstow is a brick built 20th century unlisted church built in 1924.

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 is 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)
Office- heated office chairs (reducing need for portable heaters)	500	£70	£200	3	None	0.12
School office window secondary glazing	1% 820	£16	£10 if plastic sheeting used	<1	None if sheeted	0.15
Window refurbishment where required	2% 1640	£32	£500	15	List A	0.3
Draughtproofing improvements to doors	2% 1640	£32	£100	3	List A	0.3
External Security Lights PIR resetting	400	£56	nil	Immediate	None	0.10
Complete installation of insulation over ceilings and reposition moved insulation	10% 8,200	£164	£3,000 [300M²]	18	Faculty [May be list B due to existing insulation already]	1.51
Install Air Source Heat Pumps to replace boilers [ground floor system]	82,000 gas	£1,600 gas	£17,500 [70kW unit]	25	Faculty	15.1
Install Solar Photovoltaic Panels on roof	44,000 generated	Current electric costs	£65,250	11	Faculty	11, where solar PV powers

		Plus future heat pump costs £6,160 at current cost				heat pumps
Install Air to Air Source Heat Pumps to replace church heating system [for future intensive use]	4,500 electric	£630	£8,250 [33kW unit]	13	Faculty	1.1

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

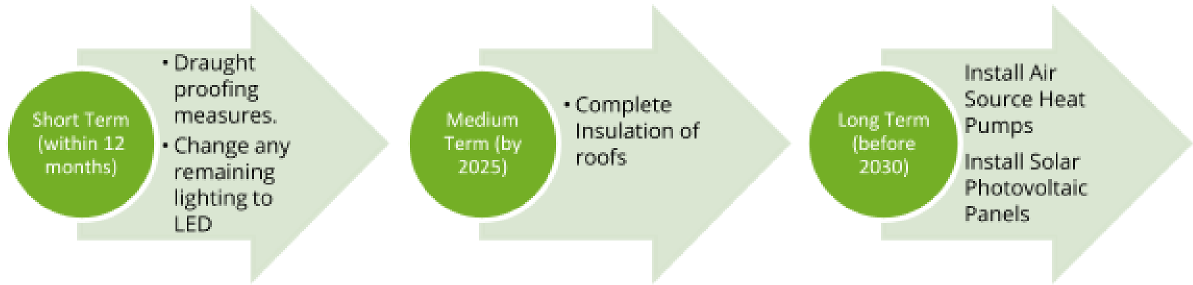
Based on current contracted prices of 14.08p/kWh and 2.0077p/kWh for electricity and mains gas respectively.

If all measures were implemented this would save the church around £4,000 per year in operating costs by eliminating gas charges and generating much electricity on site.

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 2035 by undertaking the following steps:



3. Introduction

This report is provided to the PCC of St John's Church, Walthamstow 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 with improved 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 John's Church, Walthamstow, Brookscroft Road, E17 4LH was completed on the 5th April 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 Rev Kieran Bush, Vicar and Ann, Church Warden.

St John's Church, Walthamstow	
Church Code	608190
Gross Internal Floor Area	1,000 m^2
Listed Status	Unlisted

The church typically used for over 80 hours per week for the following activities

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	4 hours per week	80
Meetings and Church Groups	6 hours per week	50
Community Use	70 hours per week	50 daily
Occasional Offices	Two funerals annually	100

Annual Occupancy Hours: 4,300

Heating hour schedule sum: 4,292

Estimated Footfall: 26,000

4. Energy Procurement Review

Annual energy consumption and cost data for gas and electricity have been supplied by St John's Church, Walthamstow and have been reviewed against the current market rates for energy.

The current electricity rates are:

Single / Blended Rate (including standing charge)	14.08p/kWh	Below current market rates

The current gas rates are:

Single / Blended Rate	2.0077p/kWh	Below current market rates
Standing Charge	268p/day	N/A

The church uses the Parish Buying group purchasing scheme which offers 100% renewable electricity and a proportion of renewable gas. This is an important part of the process of making churches more sustainable.

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 / reduced % rate charged	The correct CCL rate is being applied.

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

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

Whenever utility suppliers are changed, a VAT declaration should be sent.

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.

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

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

5. Energy Usage Review

St John's Church, Walthamstow has one electricity meter and one gas meter serving the whole site. Monthly consumption and cost data have been supplied for 2020 and 2021, both years affected by coronavirus restrictions. The church has estimated a combined "normal" year energy consumption of 110,000kWh. The 2020 and 2021 figures allow a split to be estimated of 25% electricity and 75% gas use. The right hand column estimates annual costs based on "normal" pre coronavirus consumption and current rates per kWh.

Utility	Annual use/ kWh	2020 use/kWh	2021 use/kWh	"Normal" Cost at current rates
Electricity	28,000	15,070	17,700	£3,940
Gas	82,000	55,035	72,700	£2,756

Meter Information

Utility	Meter Serial	Type	Pulsed output	Location
Electricity	210022260	EDMI Atlas Mk10D 3 phase 100A	Yes	Church office, north transept first floor
Gas	E025 K00347 17 D6	Elster Themis Bk-G16E	Yes	External cabinet To NW of church next to wall

All the meters are AMR connected and as such energy profile for the entire energy usage should be obtainable from the supplier.

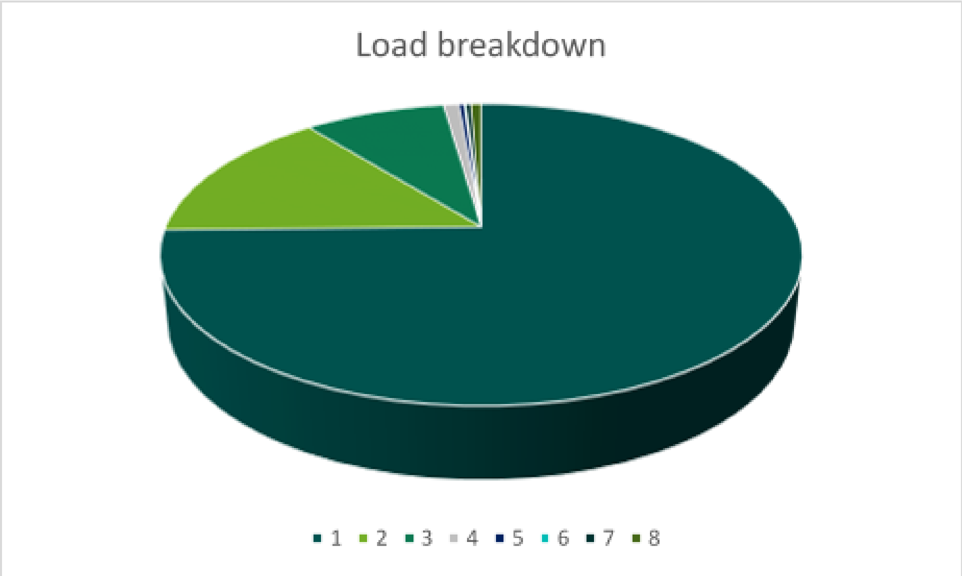
5.1 Energy Profiling

The main energy consuming plant can be summarised as follows:

Service	Description	Power kW	Annual Consumption kWh	Estimated Proportion of Usage
Gas Heating	Two Vaillant EcoTec Plus 637 boilers, each feeding separate circuits on ground floor Heating schedule sums to 4292 hours. Average load 19kW Viking Series 90 blown air system supplying lobby and inner ground floor hall	74	82,000 Not in use	74.5%
Electric Heating	Church (First floor, west nave) Wall mounted Infra Red (glowing) radiant heaters. 22 elements Est. 90 hours use Chancel / East Hall Wall mounted Infra Red (glowing) radiant heaters. 11 elements Sycamore Room Wall mounted Infra Red (glowing) radiant heaters. 10 elements Church Office (North Transept) 4 x wall mounted Dimplex convector heaters x 1200W Portable convector heater Toilet wall mounted heaters (5) TOTAL	66 33 30 4.8 3 10	6,000 7,500 500 1,000 300 700 16,000	14.5%
Lighting internal	14 x mercury vapour 20 x fluorescent 8 x pendant LED large 6 x pendant LED small 14 x square with 4 x 50cm tubes 8 x uplights 10 x various CFL 20 x bulkhead lights TOTAL (full load) 4,300 occupancy hours, at 1/3 load	 100W 70W 50W 25W 35W 30W 25W 40W 6.5kW	9,300	8.5%

Lighting external	2 X LEDs, PIR control, entrance 2 x uplights	100W 100W	800 200	0.9%
Hot Water	Kettles. Kitchen in light use Dishwasher. Used monthly	3 3	300 50	0.3%
Kitchens	Hob Cooker Microwave	3 3 1	75 25 15	0.1%
Offices	Church Office Workstations Printer School office Workstations Printer	 100 500 100 500	 100 20 200 10	0.3%
Small Power	Vacuum cleaner Sound system	1.5 1	500 200	0.6%

Annual electricity use estimated at 28,000kWh



KEY 1 Gas heating 2 Electric heating 3 Lighting internal 4 Lighting external

5 Hot water 6 Kitchen 7 Offices 8 Small power

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.

5.2 Energy Benchmarking

In comparison to national benchmarks for church energy use[1] St John's Church, Walthamstow uses 4% more electricity and 47% less heating energy than average 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 John's Church, Walthamstow (electricity	1000	28,000	28	27	+4%
St John's Church, Walthamstow (gas)	1000	82,000	82	156	-47%
TOTAL	9,913	110,000	110	183	-40%

[1] CofE Shrinking the Footprint – Energy Audit 2013

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 often uses gas as its primary fuel, a fossil fuels with high carbon emissions and little opportunity to decarbonise in the future. Electricity currently has a carbon emissions 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 bio gas 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 set out a plan to increase energy efficiency and reduce the carbon footprint. One way to achieve this is to consider a transition to electrical heating where this represents a more efficient and comfortable solution for churches.

6.2 Heating Performance

Two Vaillant Eco Tec Plus 637 boilers are installed. Each boiler has a maximum output of 37kW. It has been suggested to the church that their total capacity of 74kW is too small. The church has a usable floor area of 1,000m^2 over two floors. Churches of 300-600m^2 are often heated by boilers of 50 to 70kW capacity.

The boiler timing chart shows that boilers are in service for 4,292 hours annually. The gas use figures (pre coronavirus data) suggest an annual use of 82,000kWh. This corresponds to an average output of 19kW – which shows the boilers are not working at maximum capacity.

Lack of warmth may be due to:

A] The boilers not being able to reach their maximum capacity and thus not burning as much gas as they theoretically can. [If this is the case then they are malfunctioning and this should be detected by and addressed through annual servicing].

B] Inefficiencies in the system. This could have a variety of causes:

- Poor circulation (sludge in pipes or valves)
- Radiator valves turned down too far
- Radiators being too small, or not enough for the space.

[One boiler is fitted with a magnetic particle filter, to trap magnetic sludge. This unit should be emptied during the annual servicing.]

Heat Demand Calculations

Using the Centre for Sustainable Energy model "Estimating the heat demand of a hypothetical Community Building":

Demand (kW) = Volume of heated space x Insulation factor.

Poorly insulated building	0.033
Good insulation levels	0.022
Constructed to 2010 regulations	0.013

The ground floor only is heated by gas. The entire western end of the floor is covered by the floor inserted above to create the church space, so is reasonably insulated from above, whereas the east end including the chancel area is not, and the roof sections at this end are uninsulated.

This suggests a value of 0.028 should be used.

Ground floor

The volume of the ground floor is around 3,200m^3, including the higher chancel section.

3,200 x 0.028 = 89.6kW

The chancel section has both central heating and radiant heating (11 elements). If the radiant heating supplies around 20kW of heat; 70kW is required from the central heating – the current boilers are of the appropriate capacity provided the system is all functioning correctly.

Church Office

The church office, situated in the first floor of the north transept is a high room with approximate dimensions 6m x 6m x 7m (height) = 250m^3.

250 x 0.033 = 8.25kW

The room is fitted with four 1,200W convector heaters mounted on the walls at about 2m height.

The heaters will deliver a maximum of 4.8kW, but the heat rises to the ceiling and cools before it has an effect. Heating the *whole* of the large volume requires more energy – most of which will end up heating air rather than people. A solution is proposed in Section 6.3.2.

6.3 Heating Strategy

Whilst there are plans to add hydrogen to the network, and "green" gas from anerobic 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.

Some 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.

The church should develop a boiler replacement plan, by obtaining detailed quotations for the options presented in this report. If feasible, boiler replacement can occur as part of the adjacent housing scheme construction project. Otherwise, replacement independent of the development can occur when the boilers require replacement (domestic sized units tend to require costly repair at around ten years of age), or before if gas costs continue to rise faster than electricity costs.

6.3.1 Ground Floor rooms

The regular use and daily heating pattern of the rooms is compatible with the use of a heat pump, connected to the existing radiator network. In some areas, larger or more radiators may be required, but this issue could also be addressed by running the system constantly.

An Air Source pump will deliver 2 to 2.5 times the amount of heat which it consumes in electricity, whereas a Ground Source pump will deliver around four times more heat than electricity used.

Air Source pumps could be located in the area outside of the boiler room wall, between the church walls and the boundary wall, which is about 1.5m high and would provide visual screening of the plant (below). The buildings opposite are commercial and the church is located on a busy main road, so pump noise will be minimal.

The church is planning to develop a piece of land on its perimeter into a housing scheme, which will be constructed incorporating renewable technology. It is recommended that the church discusses with the developer and architect whether:

i) The residential building heating system (heat pump) could also serve the church ground floor radiator network.
ii) A separate heat pump for the church radiator network be installed as part of the works to lower project cost.

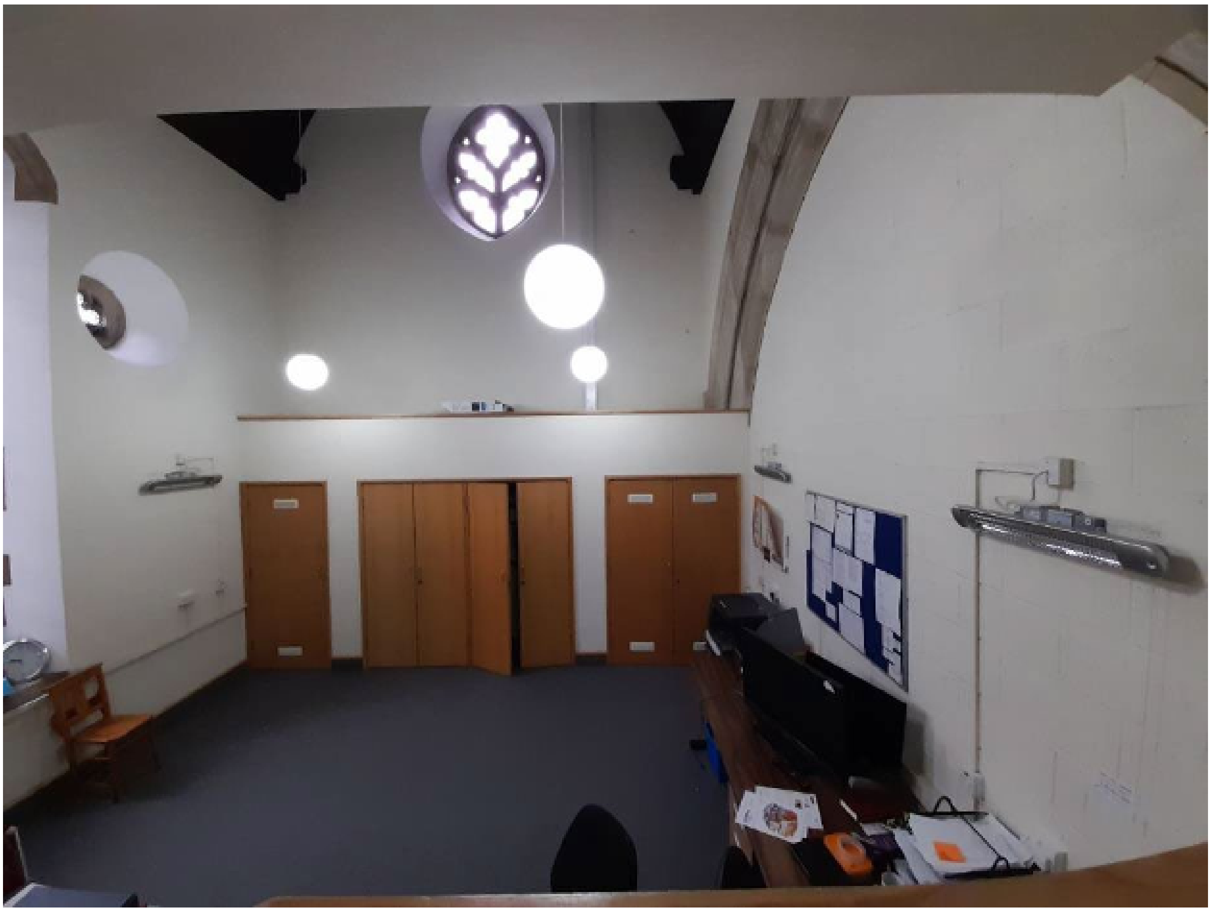
6.3.2 Church Office

This is a large volume to heat to accommodate one or two people with a 7.6m high ceiling.

The wall mounted convector heaters do not provide heat where it is required.

Installing radiant heaters on the walls would only work if they were focussed on the places where staff were sitting.

It is recommended that the church investigate buying heated office chairs for the staff.



6.3.3 First Floor, Church area

Currently heated by wall mounted radiant infra-red (glowing) heaters. This is ideal for a space which is used occasionally, and it allows small areas of the building to be heated individually for meetings of short duration which may occur at short notice.

If this church area moves to being a regularly used space, then the cost of direct electric heating will increase proportionally to the duration of use.

In this scenario, it is recommended that Air to Air Source Heat Pumps are installed in the long term. These give four to five times the amount of heat in kW which they consume in electricity.

Internal units (similar to fan assisted radiators) would be required, with external units which could be located in the valleys between the nave and aisle roofs. This would locate the external units above the arches and columns. Ceiling suspended units could then be located on the higher side of the aisle ceilings, with further units around the perimeter.

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 Clean the Existing Heating System

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

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

7.2 Magnetic Particle Filter

One magnetic particle filter is fitted, serving one of the two radiator networks, but the adjacent system is not fitted. It is recommended that a second should be added to protect the other system.

7.3 Reflective Radiator Panels

The church ground floor is heated by radiators served from the two boilers. Some radiators are located on 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 give out the heat 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 such as www.heatkeeper.co.uk. 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. Energy Saving Recommendations

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

8.1 Completion of LED Lighting

The lighting makes up a relatively large overall energy proportion of the electricity used within the church. The church itself appears to be lit by relatively inefficient mercury vapour lamps which are often rated at 100W. These should be replaced by new LED bulbs and luminaires.

Much of the lower floor is lit by fluorescent tubes of 70W. When these require replacement, the complete unit should be replaced by suitable LED lighting.

Much of the pendant lights are LED units. Uplight bulbs can be replaced at low cost by church staff with LED bulbs. This could be carried out by competent members of the churches internal team, very cost effectively and would be a List A item so no permissions would be required.

There are a vast number of specifications of LED lights on the market but it is recommended that any LED light should come with branded chips and drivers and offer a 5 year warranty. An example of such a range of fittings is available from http://www.qvisled.com/

8.2 Lighting Controls (Internal)

There are several entrance areas, corridors, stairwells and toilets which would benefit from presence detectors controlling the lighting. Some of these areas are only used occasionally and for a short amount of time and as such, the light does not need to remain on constantly. There are also spaces which benefit from a good amount of natural daylight coming in through the windows where artificial lighting is not required for much of the year during the day.

It is recommended that a motion sensor is installed on these specific lighting circuits so that the lights come on only when movement is detected in the space and turn off approximately two minutes after the last movement has been detected (note that the duration of the time lag after which the light goes off needs to be consider alongside the type of light that is fitted. LED lights are much more suited to being switched off after only a short duration than some fluorescent lights). These movement sensors (commonly called PIRs) also have light sensors integrated into them so they can be used to make sure that the light does not come on if there is already sufficient daylight in the space.

Where lighting is changed, e.g. from fluorescent to LED, this would be an ideal time to install presence detectors to control the new lights.

Your existing electrician or any NICEIC registered electrical contractor can install PIR sensors onto existing lighting circuits. This can be carried out without significant disruption to the use of the space.

8.3 External Lighting Controls

The PIR controls on one of the external security floodlights is wrongly adjusted such that the light was observed to be on continuously during the day. The unit did not appear to have any hand adjustable control dial on the outside (from ground level inspection).

There should be a manual relating to this light which would assist in rectifying the issue.

Alternatively, the electrician who installed the item should be able to assist.

8.4 Power Management Settings on Computers

All computers can be shut down or put into a hibernate mode but this is often not done by users during the day and tends to be limited to an end of day shut down only. This tends to be due to the multi-function process that is required to do this. It is therefore recommended that all computer workstations are set to go into hibernate mode after a short period of time of not being used.

This can be set on the computers by going into the Power Options settings on the computers control panel and adjusting the times on the 'change when computer sleeps' option. It is recommended that computers should turn off their display after 2 minutes and put the computer to sleep after 5minutes. Putting the computer to sleep will not loose any unsaved work but will require the user to power up the computer again when returning to their desk. Having shorter hibernate modes not along helps to save energy but also improves security by reducing the time that computers are left on but unsupervised.

8.5 Draught Proof External Doors

There are a number of external doors in the church. These should be kept in good repair and sources of draughts addressed as they result in continuous losses of heat from the building.

It is recommended that the draughtproofing around doors are improved where daylight can be seen under or around, or draughts felt, by the addition of draught strips. For an unlisted building, this could be achieved in a number of ways.

Simple E or P cross section self-adhesive polymer strips can be used to close gaps. Brush strips can be fitted to lower edges, and in cases where water can enter under doors, rubber upstands fitted to the floor.

For timber doors that close onto a stone surround more traditional solutions such brush draught strips rebated into the edge of the door by a skilled joiner.

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

The door to the right is the regularly used entrance to the nursery on the north side, and would need either a brush strip fitted underneath, or a rubber upstand in the flooring to form a waterproof seal.

8.6 Windows and Secondary Glazing

The windows of the building are singled glazed with metal frames. There are some fairly large areas of glazing, particularly in the chancel, but the total percentage of glazing to overall building surface area is small. Installing secondary glazing is expensive, and is only cost effective where a building is used regularly and thus there is a constant loss of heat.

Rooms which are particularly cold, or in heavy use should be addressed.

The School Office has a very large window (right), approximately 3m wide x 1.5m, which is immediately adjacent to desks. Some of the small panes are cracked or broken, leading to draughts and these should be repaired. This window should be considered for internal secondary glazing. A short term solution is to install "seasonal" plastic glazing film – this would not be an easy task as the window is larger than most sheets, so some intermediate battens would be required.

It was noted there were some broken panels in this window, e.g. the top right of the third lower light from the left.

The opening windows to the aisle rooms (e.g. the dining room. Lounge) are operated by a screw mechanism. Some of these are in need of maintenance to ensure that they will close easily and securely. Where a window is jammed or draughty, a temporary solution which will close gaps is to use black plasticene.

8.7 Insulation to Roof

The loft void above the ceilings were inspected as part of this audit and found to have little or no insulation present. There is no insulation above either of the aisle ceilings. The west 2/3 of the nave ceiling (above the church, but not above the chancel east room) has insulation. In places this has been pulled back to allow lighting replacement. As can be seen from the images, there is comprehensive boarding across the centre (of each of the three roofs) giving access for installation.

In all cases where there is 100mm or less of insulation within accessible roof spaces it is recommended that insulation be added to prevent heat loss and create a more comfortable environment for the occupants of the building.

The ceiling/roof of a building 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. This is worthwhile as the whole building is in regular daily use, and thus the costs would be recovered. It would also enhance the financial case for installing heat pumps.

9. Saving Recommendations (Water)

9.1 Tap Flow Regulators

The over provision of water for hand washing is not only a source of excessive water use, but in the case of hot water, it is also a source of wasted energy in the heating that has to go into providing the hot water. For buildings which are regularly used by children, flow regulators are recommended.

The flow rate of the taps can be easily regulated by fitting flow regulators within the taps. It is recommended that flow regulators such as those manufactured by neoperl (http://www.neoperl.net/en/) are fitted into all the viable hand wash basin taps to save on both water and heating of the hot water.

These regulators can be self-installed or by any good facilities staff.

9.2 Detergents for Cold Water Hand washing

Use of cold water for hand washing can be just as effective as using hot.

https://www.nhs.uk/news/lifestyle-and-exercise/cold-water-just-as-good-as-hot-for-handwashing/

10. Other Recommendations

10.1 Electric Vehicle Charging Points

The church has a car park to the front of it which serves the church and the frequently used church halls. In order to make a visible statement on the churches mission of stewardship and to facilitate more sustainable transport choices by those both visiting the church and 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 car.

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.

Because of the parish office within the building the church as be considered as a place of work and as such installation grants are available through the work place 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.

11. 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
Battery Storage	Yes
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 Source Heat Pump	Yes
Ground Source Heat Pump	Yes

11.1 Solar Photovoltaic Panels

As an unlisted building, it should be possible to install solar panels on the roof. The south face of the south aisle is visible, but not particularly so, with the vicarage and school playing fields behind on this side of the site. The nave and north aisle south facing roofs are not visible, being in the valleys. These, particularly the upper half of the nave roof offer a good location.

This would have to be confirmed with your architect as to suitability for extra weight and wind loading on the roof structure.

The roofs offer a useful area of around 300m^2, considering two areas of 30m length x 5m drop over the nave and south aisle roofs. Installers should be asked if the more shaded aspect of the north aisle roof offers a potential site for the most recent and efficient type of panel.

300m^2 could generate 0.15kWpeak/m^2 giving a 45kWpeak system. A 1kWpeak system can generate up to 1000kWh annually, giving a total annual generation of around 45,000kWh. Orientation factor (roof slope and angle from south) is 0.98.

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

$= 300m^2 \times 0.15kWp/m^2 \times 1000kWh/kWp \times 0.96 \times 1$

$= 44,100kWh$

This much larger than the church's annual recent electricity use (28,000kWh), but if a heat pump is installed, all the power generated can be used in winter. In summer, a heat pump system can be configured to provide cooling. If a heat pump is installed, solar power greatly enhances its viability, as the pump can run whenever the sun shines.

Electricity requirements of a heat pump are estimated at 20,500kWh (GSHP) or 32,800kWh (ASHP), which suggests that installing a large solar array would provide most of the church electricity needs with a heat pump, this would create a zero carbon building.

Detailed figures from various potential suppliers of solar and heat pump technology will be required to confirm these initial estimates.

The Smart Export Guarantee pays about 5p/kWh for electricity generated and exported to the grid (the Feed in Tariff having ended). A solar PV system should be sized so that the majority of the power produced is used on site. This would be the case if a heat pump is installed if the pump also provides summer cooling. During the winter there would be no excess power produced with all solar output going to the heat pump and lighting. Grid electricity will be required for evening heating and lighting in winter.

Without excess power production it would not be worth installing a battery due to the expense. However, the system should be configured to accept a battery in the future.

Battery Storage is not strictly a renewable energy solution but provides 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. This is a new but fast-growing technology; costs are expected to fall over the next decade.

Using average 2019 installation costs (£1,450 per kWpeak); a 45kWpeak system would cost £65,250. Large systems may cost less per kWpeak. This does not include cost of any battery.

Sources: Tables H3 & H4, SAP 2009, http://www.bre.co.uk/filelibrary/SAP/2009/SAp-2009_9-90.pdf

11.2 Heat Pump Overview

It is recommended that plans are developed for replacement of the boiler by the end of the decade, with the extra electricity required to run the heat pumps coming from solar PV panels.

This technology uses refrigerant fluid to provide heat in a very efficient manner, extracting heat from the air or ground by boiling refrigerant and recovering the heat when the refrigerant is recompressed.

An outdoor unit draws heat energy by cooling a large amount of flowing air by a small amount (about one degree). The amount of energy required to run the pump is less than that of the heat captured – the ratio is called the Coefficient of Performance (CoP). CoP values of around 4 can be achieved by Ground Source pumps and 2 to 2.5 by Air Source units. This technology does not transfer the heat to water (in a radiator system), but pumps the refrigerant fluid to internal fan units where the heat is recovered, blowing out warm air.

The size of the church ground floor and the building heat demand calculations in Section 6.2 indicates that a heat pump system would have to be deliver between 70kW (current boiler size) and 100kW of heat.

Currently, 82,000kWh of heat is used annually by the boilers.

With an equivalent heat output, the following inputs would be required:

Air Source, CoP 2.5	32,800kWh electricity input
Ground Source, CoP 4.0	20,500kWh electricity input

Ground Source Heat Pumps [GSHP] require either a sufficient area of land to lay subsurface pipes (not enough is available from the car park and small area of grass), or a borehole. Large heat requirements for a small site may make this option unviable if the heat stored in the ground becomes depleted.

Air to Water Source Heat Pumps [ASHP] have COP values between 2 and 3, which are weather dependent. They are least efficient when required to deliver large amounts of heat when the air is cold, so are incompatible with heating a church once a week from cold, but ideal for regularly used buildings.

Heat pumps generally deliver water at around 55ºC (although there are higher temperature ones on the market which require more energy to run); thus are compatible with a building which is regularly used and can be supplied with constant, medium heat, rather than a full power heat up on Sunday mornings.

Air to Air Heat Pumps do not use water radiators, but internal fan units supplied with refrigeration fluid from outside units. They can provide heating and cooling, with heating CoP values of 4 and above, so offer lower operating costs with less capital cost than ground source.

For the church area on the first floor, irregular use and lack of existing radiators will require Air to Air Source Units. This technology is very similar to air conditioning, using refrigerant fluid to provide heat in a very efficient manner, with around four to five times the amount of heat provided as is consumed as electricity in kWh. External units would probably be located on stands on the sides of the roof, accessible from the roof valley walkways. Internal units could be a mixture of ceiling suspended cassettes located on the aisle side of the arches, and low level horizontal units.

Pipework would rise vertically through the ceiling and cross the roof void to access the external units.

Note the costs below are estimates referring to stand alone systems and may be reduced if part of the adjacent proposed housing development.

ASHP (ground floor system)

Capital cost, 70kW output unit: £17,500

100kw output unit, £25,000

Operating cost: 82,000kWh output/COP2.5 = 32,800kWh.

Without solar, x 14p/kWh = £4,592

GSHP (ground floor system)

Capital cost, 70kW output unit £28,000

100kWoutput unit, £40,000

Operating cost: 82,000kWh output/COP4 = 20.500kWh.

Without solar, x 14p/kWh = £2,870

AASHP (Church first floor system)

Capital Cost, 33kW output system @ £250/kW = £8,250

Operating cost, 6,000kWh output/COP 4 = 1,500kWh

Without solar, x 14p/kWh = £210

12. 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-Jul-2020.pdf

13. 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.