Energy Efficiency and Zero Carbon Advice

St Peter's, Notting Hill
PCC of St Peter's Church

Author	Reviewer	Date	Version
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Contents

1. Executive Summary

An energy survey of St Peter's 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.

St Peter's is a classically styled church built in 1857. 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)
Purchase temperature datalogger to optimise heating settings	5% 6,500	£335	£50	<1	None	1.2
Change gas supplier to Parish Buying (bulk purchasing)	N/A	£3,300	None	Immediate	None	N/A
Replace immersion tank water heater with instantaneous heater.	5,000	£718	£500	1	List B	1.2
Draughtproofing measures	3% 4,200	£215	£400	2	List B	0.8
Flush and clean boiler systems	7% 9,730	£500	£500	1	List A	1.8
Install Endotherm heat transfer fluid	10% 13,000	£670	£500	1	List A	2.4
Install Magnetic Particle Filters	Long term benefits	£100	£500	5	List A	N/A
Run heating at <55°C return temperature	5% 6,500	£335	None	Immediate	None	1.2
Install further fans to assist in extracting heat from pipes.	Method of obtaining the above	Included in above	£2,000	2	Faculty	Included in above
Install Solar Photovoltaic panels	12,700	£1,825	£18,000	10	Faculty	3.2
Install Air Source Heat Pump (150kW)	Replace 130,000 gas with 52,000 electric	£1,000 more. Improves with efficiency measures	£60,000	-	Faculty	11

Based on current contracted prices of 14.37p/kWh and 5.150p/kWh for electricity and mains gas. **If all measures were implemented this would save the church around £2,500 per year in electricity and almost £1,300 in gas costs.**

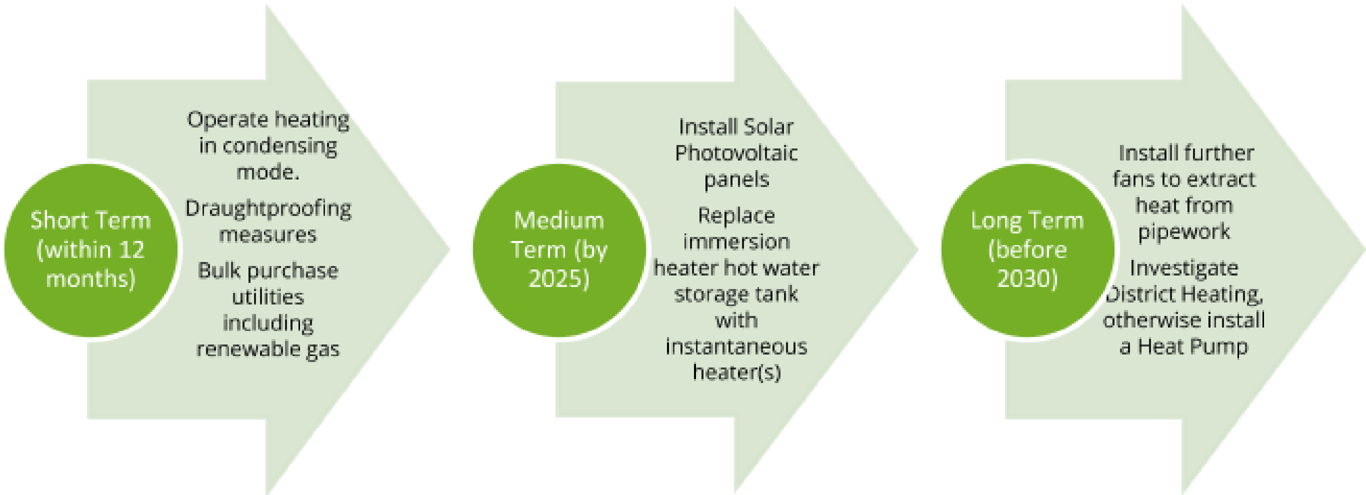
Moving to a bulk purchase tariff for gas could further cut costs from the current rates of 5.150p/kWh (church) and 5.577p/kWh (foyer) to as low as 1.6p/kWh (obtained in July by an inner London church with 80,000kWh annual gas use), see Section 4.

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

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 Peter's 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, Kensington Park Road, W11 2PN was completed on the 20th October 2020 by 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, and has been an assessor for Eco Congregation.

St Peter's	
Church Code	623266
Gross Internal Floor Area (includes balconies)	920 m^2
Listed Status	Grade II*

The church typically used for 50 hours per week for the following activities

Type of Use	Hours Per Week (Typical)
Services	11 hours per week
Community Use	39 hours per week

Occupancy Hours 2,600 hours

4. Energy Procurement Review

Energy bills for gas and electricity have been supplied by St Peter's and have been reviewed against the current market rates for energy.

The current electricity rates are:

Single / Blended Rate	14.37p/kWh	In line with current market rates
Standing Charge	26.41p/day	N/A

The current gas rates are:

Single / Blended Rate	5.150p/kWh (church) 5.577p/kWh (Kitchen & foyer)	Above current market rates
Standing Charge	24.96p/day	N/A

The current electricity supplier, Ecotricity offers 100% renewable electricity, which is to be commended. The gas rate (Opus Energy) is extremely high.

The above review has highlighted that there are opportunities to gain cost savings from improved procurement of the energy supplies at this site. We would therefore recommend that the church obtains a quotation for its gas and electricity supplies from the Diocese Supported parish buying scheme, http://www.parishbuying.org.uk/energy-basket. This scheme only offers 100% renewable energy and therefore it 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% for electricity 20% for gas	The correct VAT rate is being applied for electricity. The VAT on the gas is 20%. As the organisation is understood to be a charity it therefore should be benefiting from only be charged a 5% VAT rate. A VAT declaration should be sent to the gas supplier to adjust this.
Climate Change Levy	Charged when VAT rate is 20%	As the organisation is being charged the wrong VAT rate they are also being charged CCL which should not be applied as they are a charitable organisation. Sending the supplier a VAT declaration will remove this charge.

The above review has highlighted that VAT and CCL are being charged on the gas invoices. The church is a charity and therefore can claim VAT exemption status. As such the PCC of St Peter's should send the supplier at VAT declaration confirming this and check all supplies on other sites. 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

St Peter's uses 20,000 kWh/year of electricity, costing in the region of £2,800 per year, and an estimated 139,000kWh/year of gas costing in the region of £7,350.

This data has been taken from the Energy Footprint Tool entry for electricity and the annual energy invoices provided by the suppliers of the site for gas. The church gas figure has been adjusted up to 365 days and the three month data for the kitchen and foyer boiler gas use estimated for a year.

St Peter's has one electricity meter, and two gas meters serving the site, one for each boiler.

Utility	Meter Serial	Type	Pulsed output
Electricity – whole site	L090A 15867	London Electric board	No
Gas – Church	M016 K02411 16 D6	BK G10M	Yes Elster IN-Z61 output
Gas – Kitchen & foyer	G4 K12181 16 01	BK G4M	Yes Elster IN-Z61 output

It is recommended that the church consider asking their suppliers to install a smart electricity meter so that the usage can be monitored more closely, and the patterns of usage reviewed against the times the building is used.

5.1 Energy Profiling

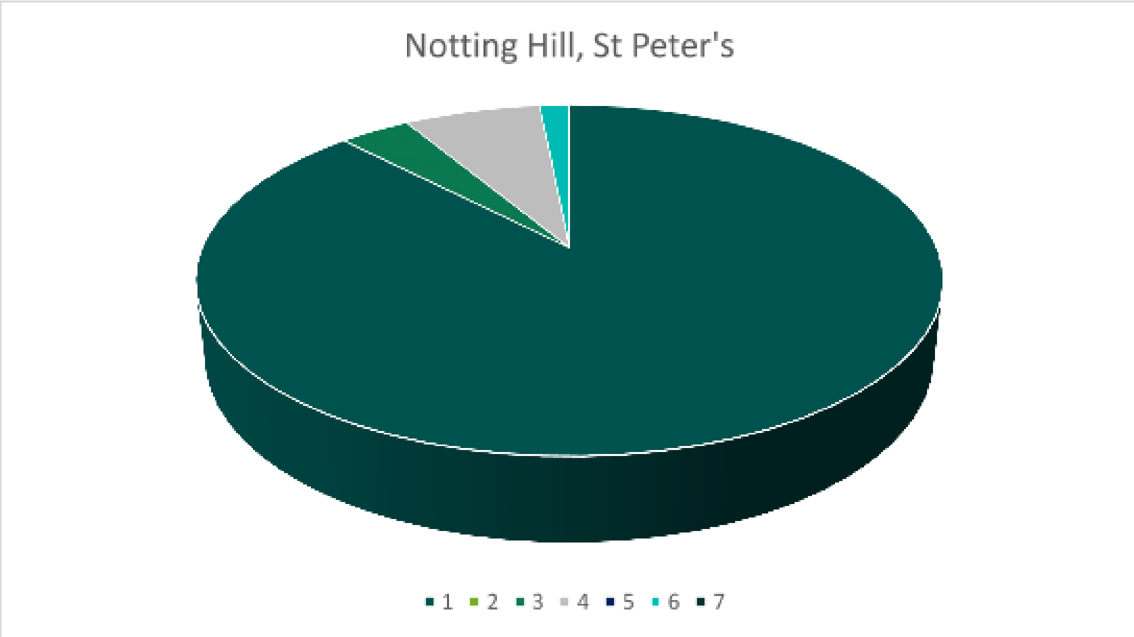
The main energy consuming plant can be summarised as follows:

Service	Description	Estimated Annual Use kWh	Estimated Proportion of Usage
Lighting	All LED (installed 2018), CFL or fluorescent tubes. Several low voltage recessed bulbs. Total estimated 4.3kW	11,180	7%
Heating	180kW boiler (church) 30kW boiler (kitchen/foyer areas)	139,000	87%
Electric Heating	1.5kW portable heater in vestry Occasional use, say 50 hours	75	0.05%
Hot Water	Zip Aquapoint 3kW Immersion heater Heat loss (when on constantly) about 600W	5,200	3.2% Other water heating

	2kW fixed urn – regular use daily Industrial dishwasher FAGOR F1-30B, 3.45kW Used each Sunday and events Kettle	200 200 150	0.3%
Other Small Power	2 fridges, Vacuum cleaning; 1.5kW; 150kW PA System 1kW	900 150 1,300	1.5%%
Organ	2kW, 1 hour use per week	100	0.06%

Sum of estimated use 19,455kWh

Annual Electricity use (EFT report) 20,057kWh



KEY 1 Gas Heating 2 Electric Heating (minimal) 3 Hot Water 4 Lighting

5 External Lighting (zero) 6 Small Power 7 Organ

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 (which has mostly been converted to LED already). There is an opportunity to save further electricity through changes to water heating.

5.2 Energy Benchmarking

In comparison to national benchmarks[1] for church energy use St Peter's uses 19% less electricity and 3% less heating energy than average for a church of this size. The lower electricity use is due to installation of LED lighting.

	Size (m^2 GIA)	Annual Energy Usage (kWh)	Actual kWh/m^2	Benchmark kWh/m^2	Variance from Benchmark
St Peter's (elec)	920	20,057	21.8	27	-19.3%
St Peter's (gas)	920	139,000	151	156	-3.2%
TOTAL	920	159,000	172.8	183	-6.6%

1 Energy Audit report 2012/13; Church of England Shrinking the Footprint: Data for large churches (>649m^2)

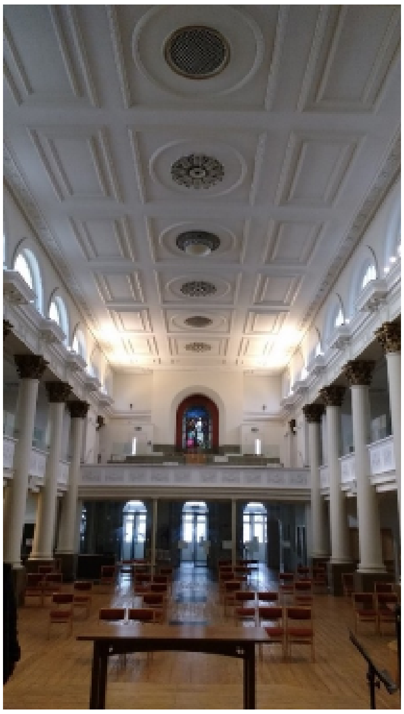
6. Efficient / Low Carbon Heating Strategy

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 future. Electricity currently has a carbon emission 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 it 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'.

The high hours of use of the building mean that conversion to electric heating would incur greater operating costs but use of a heat pump will only require about one third of the electricity compared to direct electric heating. The high hours of use of the building appear compatible with a heat pump, which delivers relatively constant, gentle heat (they are not suitable to provide heating from cold once or twice a week).

Another option would be connection to a District Heating Network. Although there is none locally and none proposed at present it is worthwhile being informed about Westminster Council's plans as they have heat networks under development. Also there is a nearby residential block in the street to the north which may offer the possibility of forming a heating network. Both a heat pump and district heating (Section 10.3) would continue to use the existing pipe network, but to increase the heat transfer from pipework to space, use of a heat transfer fluid (Section 7.4) and installing extra fans are recommended (Section 7.6).

Reducing the need for heat by building efficiency measures is a prerequisite for heat pump installation; these measures are described in Section 8.



The church has moveable seating. The marble wall panels and high (10m) moulded ceiling do not offer any opportunities for installation of radiant infra red heating panels, except perhaps under the aisle ceilings, although this would not provide a solution for the centre of the church, so space heating is to be continued with.

7. Improving the Existing Heating System

As the existing heating system is being retained it is recommended that measures are taken to improve the efficiency of the existing heating system, this should include the following:

7.1 Condensing Boiler Operating Mode

ZONE A, Church (Sanctuary)

The church is heated by a Hamworthy Heating Purewell Variheat 180kW condensing boiler.

This is understood to be operated from 18:00 to 04:30 and 07:30 to 08:30. It is recommended that of a temperature datalogger is used to inform optimisation of heating times. The three hour period from 04:30 to 07:30 will result in cooling; it would seem to be more efficient to heat for one period, which could be of shorter duration e.g. midnight to 10:00.

Annual consumption is around 130,000kWh; this equates to 722 hours operating on full power although it is likely that part of the time is below maximum power and it is run for about 1,300 hours annually, corresponding to the number of hours the church is open during the coldest six months.

With a boiler of this size, considerable savings can be made by running it in condensing mode. It is unclear whether this is currently the case. Purchase of a temperature monitor would allow for this measurement to be made (simply placing the device on the incoming return water pipe near to the boiler inlet).

Reducing the incoming return water temperature allows the exhaust gases to condense, releasing heat which is otherwise warming the atmosphere. This is then transferred into the water, so less gas is used. To achieve this the water output temperature may need to be reduced. The system will now need to be run for longer to deliver the same amount of total heat; but it will be using less gas (i) because it is heating the water to 60°C rather than 80°C and (ii) some of the heat is being supplied by heat recovery from the exhaust.

Addition of heat transfer fluid (Section 7.4 – simple and low cost) and addition of extra fans transferring heat from the pipes will also lower return temperature.

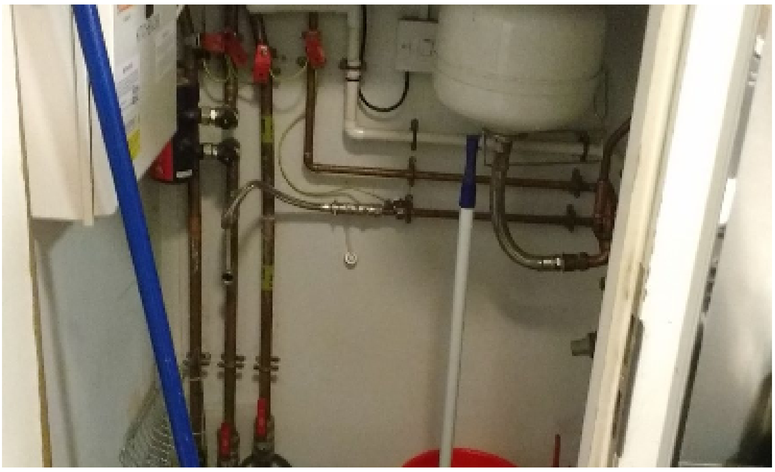
ZONE B, Kitchen & Foyer

These areas are heated by a Baxi Megaflo domestic type boiler of around 30kW, installed in 2017.

This is operated from 07:30 to 11:30 and 15:00-18:00 daily with extra on Monday evening equalling 52 hours per week. Only partial gas bill data was available for this boiler.

The temperature space setting was at 24°C which is high – reducing this by two degrees would bring considerable (5 to 10%) savings.

Such boilers usually have an "Eco" setting which sets the temperature to allow them to operate in condensing mode and this should be selected.



7.2 Clean the Existing Heating System

Neither system appears to be fitted with a magnetic particle filter, thus allowing magnetic sludge to circulate. This will prevent the proper and efficient operation of the system by reducing the ability of the boiler to heat up the water and reducing the output of the radiators. It is similar to how scale build up can adversely affect kettles and showers.

It is strongly recommended that the heating system is cleaned to remove this 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.

7.3 Install a Magnetic Particle Filter

To protect against the above, magnetic particle filters, similar to the one shown below should be fitted.

7.4 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 is 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.

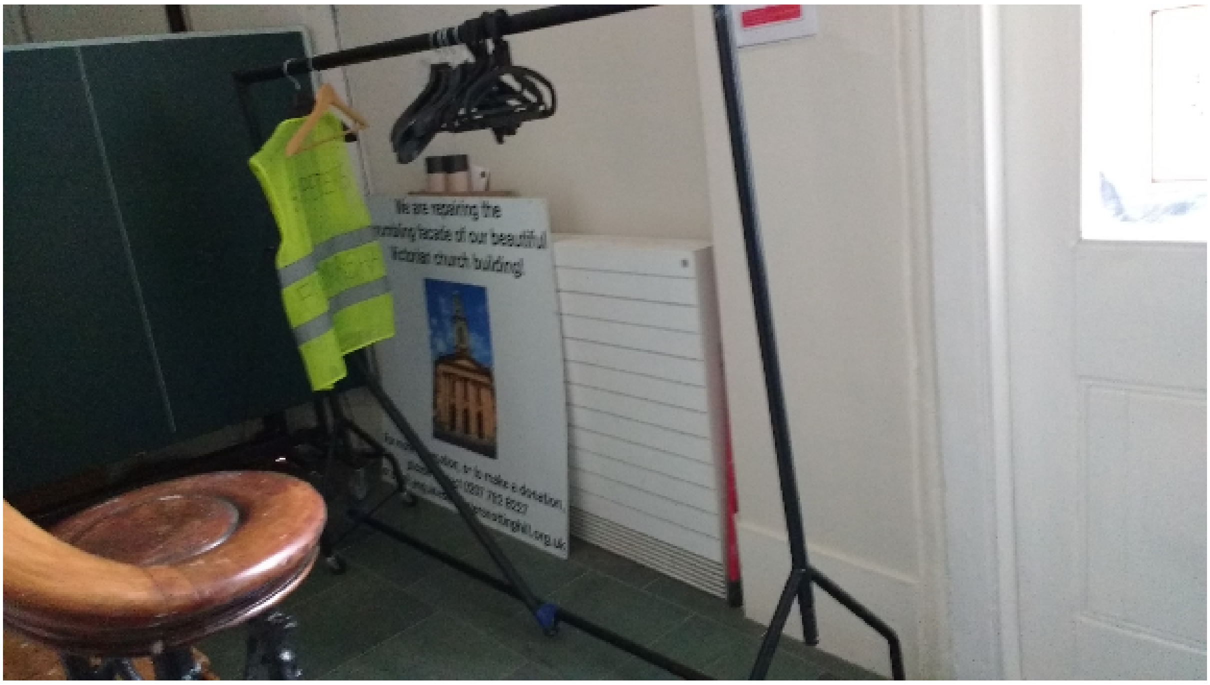
Endotherm can be self-installed, by someone who is familiar with the system and competent to depressurise and repressurise it.

For a 180kW system, approximately 14litres of the fluid are suggested.

7.5 Radiators

Radiators should be kept free of obstructions which impede airflow and prevent them radiating.

If this area is ever used to dry wet coats, it may be helpful to install a portable (domestic type) dehumidifier.



7.6 Additional Heat Delivery Fans

Currently, heating is delivered by gas fired space heating. There are no radiators in the church; heat is emitted by pipework in ducts along the centre of the floor and sides of the building at ground level and in the balconies. The ground floor pipework is built into wooden ducts; there is one electric fan each side to assist in extracting heat from the pipes situated inside wooden panelling and operated as required by a local switch.

Installation of further fans could assist in increasing the draw of heat from the pipework and this would also help to ensure that the return pipe water temperature is below 55°C. Below this temperature, waste heat can be recovered from the boiler exhaust gas making the system more efficient.

An alternative to installing further fans nearby (and increasing the length of the boxed in section) could be to add an installation in the store room under the chancel area, with new ducting bringing warm air up into the front of the church.

8. Energy Saving Recommendations

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

8.1 New LED Lighting

The lighting was mostly changed to LED lighting in 2018.

There are still some T5 fluorescent tubes (probably 85cm length) of about 40W each. These can be changed for LED lighting strips when due.

8.2 Timers for Water Heaters

The 100 litre immersion heater tank located in the kitchen boiler cupboard is rated to 3kW. This is the peak output, used when heating a tank of cold water. It needs to maintain a temperature above 55°C to prevent legionella, so if the tank is run constantly it will always be losing heat. The heat used annually for tanks of this size is known; corresponding to an average energy requirement of 600W, using 5,200kWh annually.

It is recommended that the unit be run off a timer in the short term, so that it is turned off from when bookings are complete and overnight.

It is recommended that the heater is fitted with a 24 hour/7 day timeclock to replace the fused spur switch. An example of such a unit would be a TimeGuard FST77. They should be set up with times to match the times that the building is occupied and 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.

Long term, the tank should be replaced by an immediate water heater located at the point of need.

This avoids any waste of energy keeping a tank of water warm, and the amount of hot water required is always delivered. [With a tank, only the first half of the volume can be obtained hot; when it is half emptied it is now half full of cold water, so the tank either delivers lukewarm water for the second portion, or it is sized at double the actual requirement – so you are always paying to keep half a tank of water hot which can never be used].

8.3 Draught Proof External Doors

The three pairs of original wooden doors should be kept well maintained to exclude draughts, as should the fire doors.

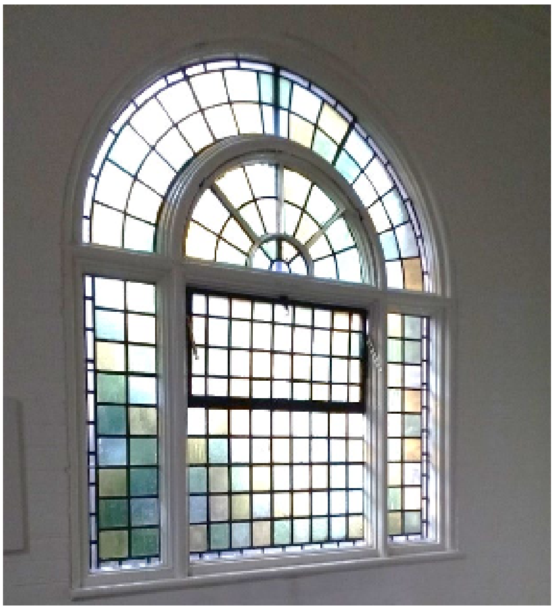
It is recommended that the draughtproofing around the door is improved and draught strips are added. This could be achieved in a number of ways:

For timber doors that close onto a timber frame 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

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

8.4 Draught Proof Windows

Hopper windows such as those in the room above the vestry can be a source of draughts. Any damage to the frame such as rust or misalignment should be repaired quickly as it allows water ingress and further deterioration). Small gaps causing draughts can be filled reversibly over the winter using black plasticine. This is cheap, easily removable and recommended by Historic England.



The sash window in the vestry has either dropped (see right photo at top of window) or the frame is distorted, allowing a gap and draughts. Whilst this can be sealed temporarily using plasticine, repair by a sash window maintenance company is recommended

8.5 Secondary Glazing

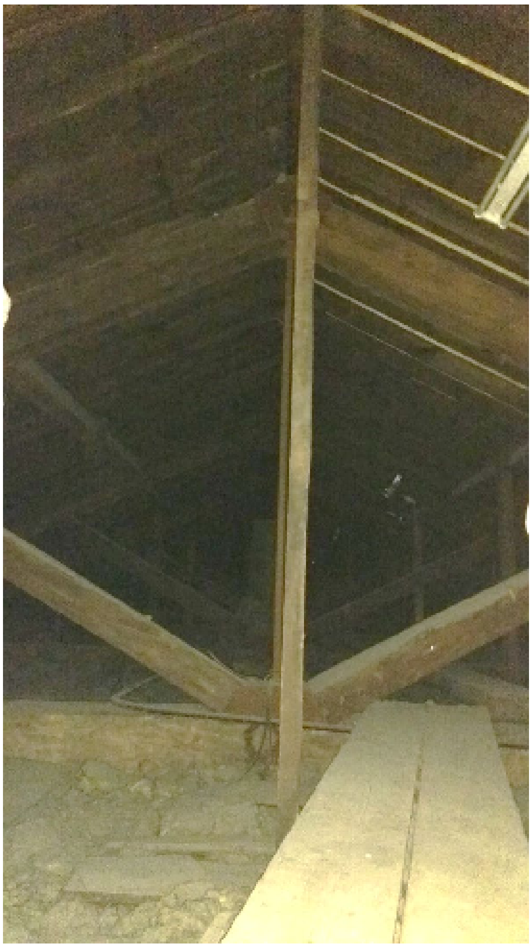
It might be possible to install secondary double glazing outside of the clerestory windows. Double glazing can only be recommended to churches that have very high hours of use

It is not possible or desirable to change the windows as the building carries listed status. However the introduction of secondary glazing would considerably reduce the heat loss through the existing windows and improve both thermal comfort and noise levels.

Any possible installation would need to be carefully specified, and companies such as https://www.selectaglaze.co.uk/heritage-listed-buildings or https://www.stormwindows.co.uk/ can provide very discrete and appropriate systems for all types of spaces.

8.6 Roof Insulation

The loft void above the ceiling was inspected as part of this audit and found to have some insulation present. In all cases where there is 100mm or less of insulation within accessible roof spaces it is recommended that insulation be added up to the recommended level of 270mm 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. Addition of insulation becomes worthwhile for a frequently used building, in this case 50 hours per week.

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. Where a church has toilets and is regularly used by the community, especially children, tap 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.

10. Renewable Energy Potential

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

Renewable Energy Type	Viable
Solar PV	Yes
Battery Storage	Yes
Wind	No
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	Potential
Ground Source Heat Pump	No land
District Heating	Yes, but no current proposals in this area

10.1 Solar Photovoltaic Panels

The church possesses a south facing roof portion which is not visible from the ground, seen below.

These two areas (the lower of which is probably restricted by the shading provided by the adjacent property to being between the downpipes). Half of the roof width is approximately 9m.

The upper portion corresponds to the length of the sanctuary; giving 20m x 4m. The lower portion allows around 10m x 2m, giving a total of 100m2. The roof faces approximately south east.

At 0.15kWpeak per m2, this would give a peak output of 15kW peak.

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

K factor (London latitude) = 1000kWh/kWpeak

135º oriented roof, at 30 degree slope; Orientation factor = 0.94

Overshading factor 0.9 (wall, tower)

This system could be expected to generate around 12,700kWh per year, around 63% of current electricity use.

The installed cost (using 2018 costs at £1,200 per kWpeak) would be around £18,000.

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

10.2 Air Source Heat Pump

An Air Source Heat Pump [ASHP] could be located on the area of flat roof behind the parapet, or possibly next to the adjacent building pictured below. The outside areas at the rear of the church were not visited; there may be an alternative location outside (south east) of the store/corridor area beneath the chancel through which heating pipes run which could be a more convenient location than the roof.

Church heating consumption is currently 130,000kWh delivered by a 180kW boiler [plus at least 9,000kWh for the foyer and kitchen areas]. Efficiency measures (extra ceiling insulation, heat transfer fluid, etc) could reduce heat requirement by up to 20%. A heat pump would deliver water at lower temperature (typically 45-50ºC) but would be in operation for more hours per week. It would be necessary to ensure more efficient transfer of heat from the water pipework, such as installing further fans and possibly a finned radiator, fan and ducting arrangement in the under chancel corridor; the exact needs will require calculation along with the specification for a pump.

A 120kW heat pump system would have a capital cost in the region of £60,000, the smaller power reflecting a more constant use pattern.

Heat pumps work using refrigeration type technology to "upgrade" heat. The Coefficient of Performance (COP) measures how many kW of heat are produced for every kW of electricity needed to run the pump. For an ASHP it is reasonable to expect an average COP of 2.5. With only a small improvement in heat requirement efficiency, needing 120,000kWh of heat annually would require 48,000kWh of electricity. At current costs (14,37p/kWh) this would cost about £6,900p.a.

This should be compared with the current cost for gas (5.150p/kWh) of £6,695, although there is potential to reduce this high rate through bulk purchasing. NB: neither cost includes standing charge or VAT.

10.3 District Heating

District heating offers potential economies through connecting to a local network of heating pipes. There are currently no networks operative or planned in this area of London. It is worthwhile monitoring the situation as the council are developing networks in other areas, and this solution is likely to be encouraged in dense urban areas where appropriate. Westminster City Council, PDHU & Energy department are the relevant authority, https://maps.london.gov.uk/heatmap

It is also worth discussing with the operators of the adjacent flats just to the north in Kensington Park Road to see if they operate a communal heating system with spare capacity which could be linked to the church via the car park. In both cases, the boiler would be replaced by a Heat Interface Unit of equivalent capacity.

11. 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-Jan-2019.pdf .

12. Faculty Requirements

It must be noted that all works intended to be undertaken should be discussed with the DAC at the Diocese.

Throughout this report we have indicated our view on what category of permission may be needed to undertake the work. This is for guidance only and must be checked prior to proceeding as views of different DACs can differ.

Under the new faculty rules;

List A is for more minor work which can be undertaken without the need for consultation and would include changing of light bulbs within existing fittings, repair and maintenance works to heating and electrical systems and repairs to the building which do not affect the historic fabric.

List B is for works which can be undertaken without a faculty but must be consulted on with permission sought from the Archdeacon through the DAC. This includes works of adaptation (but not substantial addition or replacement) of heating and electrical systems and also 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.