ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St James' Church, West Streatham
PCC of St James' Church

Author	Reviewer	Audit Date	Version
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1. Executive Summary

An energy survey of St James' Church, West Streatham 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 James' Church, West Streatham is an Edwardian era church dating from 1905. The entrance foyer facing the main road is a later addition with modern doors and windows.

There is both gas and electricity supplied to the site.

The church has a number of ways in which it can become more energy efficient. Our key recommendations have been summarised in the table below and are described in more detail later in this report. It is recommended that this table is used as the action plan for 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)
SHORT TERM						
Install a timer for control of toilet water heater(s)	900 per unit	£136 per unit	£100	<1	None	
Draughtproofing	1%	£44	< £50	1	List B	
Secondary glazing of office / vestry windows.	1%	£44	£100	2	List B	
Purchase a heated office chair	N/A	N/A	< £300		None	
MEDIUM TERM						
Install solar photovoltaic panels on south west facing roof	27,360	£4,145	£43,500	10.5	Faculty	
Replace gas warm air blower to centre with air to air source heat pump	25,000 gas	£488 Without solar power	£7,200	15	Faculty	
LONG TERM						
Replace boiler to church with air to air source heat pump	125,000 gas	£2,440 Without solar power	£45,000	18.5	Faculty	

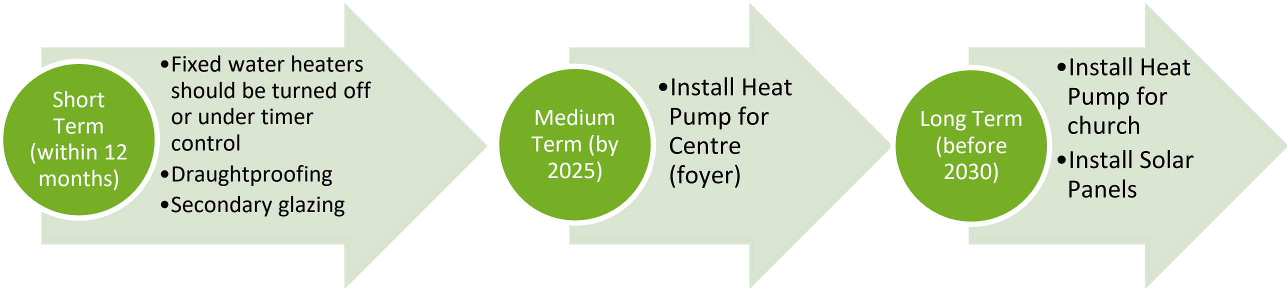
The church should check any faculty requirements with the DAC Secretary at the Diocese before commencing any works.

Based on current contracted prices of 15.1508p/kWh and 1.953p/kWh for electricity and mains gas respectively. **If all measures were implemented this would save the church around £7,700 per year in operating costs.**

2. The Route to Net Zero Carbon

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

This church has a clear route to become net zero by 2030 by undertaking the following steps:



3. Introduction

This report is provided to the PCC of St James' Church, West Streatham 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 improvements in 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 James' Church, West Streatham, 236 Mitcham Lane SW16 6NT was completed on the 9th August 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 Eco Congregation.

The church was represented by Alan Burrows, Church Administrator.

St James' Church, West Streatham	CHURCH
Church Code	637345
Gross Internal Floor Area	600m^2
Volume	4,400m^3
Heat requirement	141kW
Listed Status	unlisted

The church is typically used for 20 hours per for the following activities:

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	4 hours per week	130
Church Meetings and Groups	2 hours per week	5
Community Use	13 hours per week	25. 65 to weekly toddler group
Occasional Offices	4 weddings 4 funerals	100 100

Annual Occupancy Hours: 1,050

Estimated Footfall: 14,200

4. Energy Procurement Review

Energy bills for gas and electricity have been supplied by St James' Church, West Streatham and have been reviewed against the current market rates for energy.

The current electricity rates are:

Single / Blended Rate	15.1508p/kWh	Below current market rates
Standing Charge	41.8393p/day	N/A

Supplier: Total Energies

The current gas rates are:

Single / Blended Rate	1.9530p/kWh	Below current market rates
Standing Charge	368p/day	N/A

Supplier: Total Energies

The current rates are lower than the market rate and should be retained at present.

The church should continue to use a group purchasing scheme such as the Big Church Switch scheme, Charity Buying Group or the Diocese Supported Parish Buying scheme, http://www.parishbuying.org.uk/energy-basket.

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

A review has also been carried out of the taxation and other levies which are being. These are:

VAT	5%	The correct VAT rate is being applied
CCL	not charged	The correct CCL rate is being applied.

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

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

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

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

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

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

5. Energy Usage Details

5.1 Annual Consumption

St James' Church, West Streatham used 7,580 kWh/year of electricity in the calendar year 2021, costing £1,355.

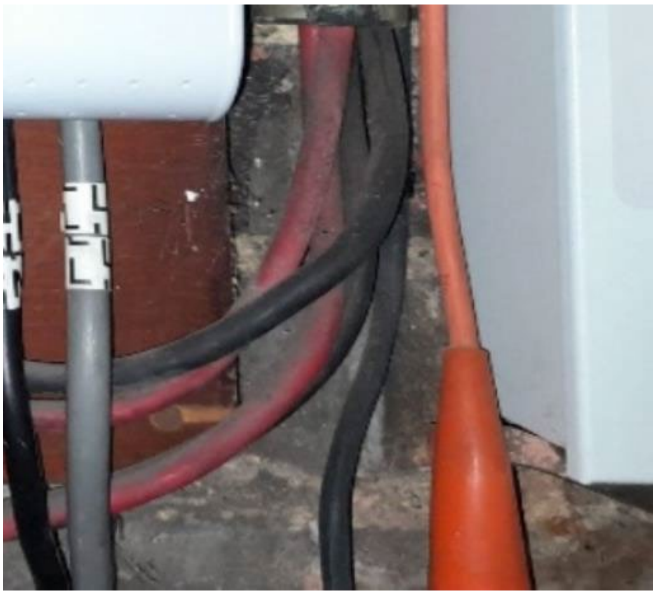
The church used 150,238kWh of gas annually during 2021, costing £4,460.

This data has been taken from a list of electricity expenditure provided by the church with customer meter readings.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity - Church	E16UP 15504	EDMI 7-BP Single phase	Yes	Boiler room
Electricity - Church	E16UP 15505	EDMI 7-BP Single phase	Yes	Boiler room
Gas – Church	K06182 14 D6	Elster	Yes	Boiler room

All the meters are AMR connected and as such an annual energy use profile for the site could be obtained from the supplier.

There are additional meters for the adjacent hall and rectory which were not covered by this audit.



5.2 Energy Profiling

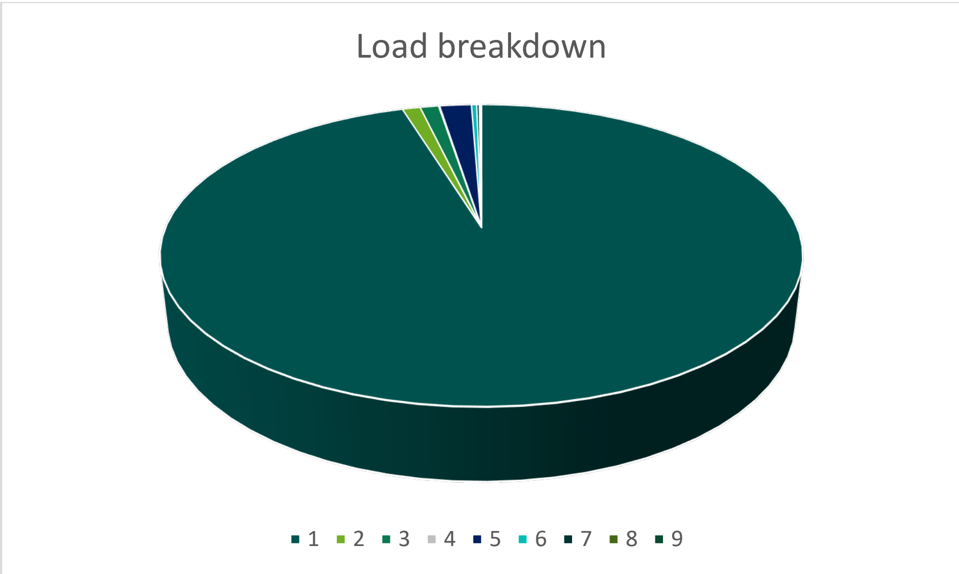
The main energy consuming plant can be summarised as follows:

	Equipment	Power kW	Annual Consumption kWh	Portion
Heating [Gas]	CHURCH Ideal Concord CX100 boiler 125kW input / 100kW output CENTRE (foyer) Goodman hot air blower Gas hob	125 ? 10	125,000 25,000 200	%
Heating [Electric]	Boiler circulation pump Hot air blower fan (300 hours?) Entrance overheat fan heater Portable heater, office x 2 Toilet convector heater Toilet hand drier Kitchen Radiant heaters x 2	0.15 0.3 2 2 x 2 2 3 2 x 2	150 100 50 1000 200 100 100 TOTAL 1,700	0%
Lighting [Internal]	CHURCH 500 hours use Nave, 30 pendant CFL 18W Aisles 6 spotlights LED 5W CENTRE 700 hours 16 fluorescent F58W 8 spotlights LED 5W Entrance 2 x F70W Kitchen 2 x F70W Toilets 5 bulkhead OFFICE 1500 hours/ Vestry / rear entrance 6 x F58W 2 x bulkhead	 540W 30W 928W 40W 140W 140W 200W 348W 80W	 300 1,000 450 TOTAL 1,750	%
Lighting [External]	6 Floodlights, SON 250W (rarely used)	3	100	0%
Hot Water	Toilets: Fixed water heater, Ariston 10 litre, normally on c. 100W heat loss. Kitchen: Fixed water heater, Ariston, under sink, normally off Kitchen: Lincat drinks water heater, normally off Staff toilet: Fixed water heater Heatrae Sadia Hotflo 10, normally on. Kettle Dishwasher, used 3x per week. Short cycle.	3 3 3 3 3 6	1000 100 200 1000 230 470	%

			TOTAL 3,000	
Kitchen	Microwave Warming Cabinet Fridge (on constantly)	1 1 0.1	100 100 300	%
Office	2 workstations Photocopier	0.25 0.5	200 50	
Sound, Music	Sound system 4 hours per week Organ (rarely used)	0.5 0.5	100 10	%
Small Power	Vacuum cleaner	1.5	100	%

Sum of estimates: 7,510kWh

Annual site electricity consumption, 2021: 7,580kWh



KEY *1 Gas heating* *2 electric heating* *3 Lighting internal* *4 Lighting external*

5 Hot water *6 Kitchen* *7 Office* *8 Sound, music* *9 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 hot water.

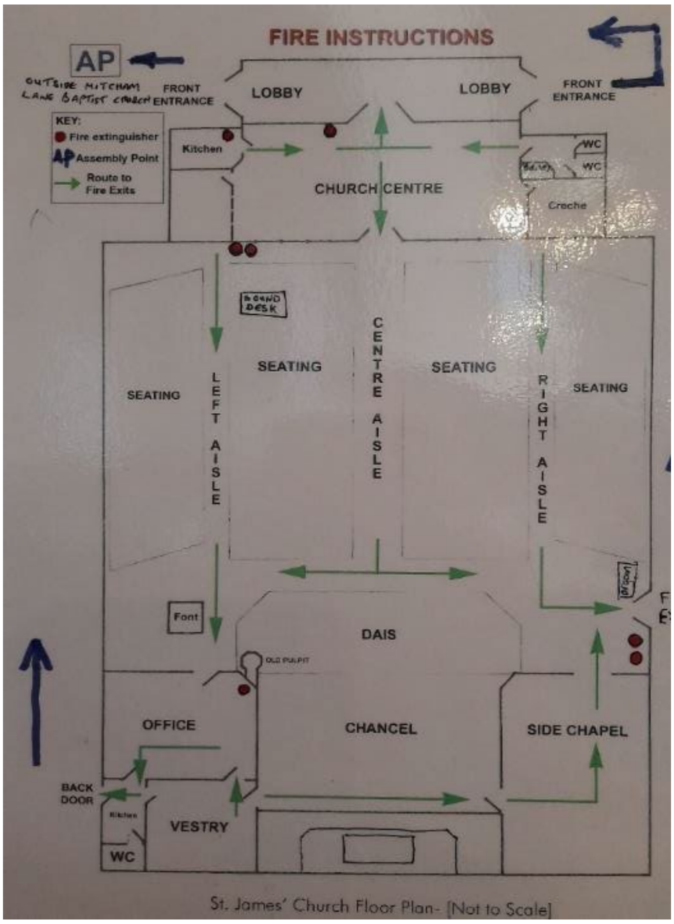
5.3 Energy Benchmarking

In comparison to national benchmarks for church energy use St James' Church, West Streatham uses 33% less electricity and 69% more heating energy than is average for a church of this size.

Electricity is probably a result of lower than average hours of use and mostly low energy lighting. High gas use stems from a relatively inefficient boiler and poor heat emitters which results in a very long heat up time and resulting decision to run the heating constantly.

	Size (m^2 GIA)	Annual Energy Usage (kWh)	Actual kWh/m^2	Benchmark kWh/m^2	Variance from Benchmark
St James' Church, West Streatham (elec)	600	7,580	12.6	19	-33%
St James' Church, West Streatham (gas)	600	150,200	250	148	+69%
TOTAL	600	157,780	263	167	+57%

There is currently no benchmark data available which takes hours of use and footfall into account. [1] CofE Shrinking the Footprint – Energy Audit 2013.



6. Efficient / Low Carbon Heating Strategy

6.1 Reducing Environmental Impact

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 carbon emissions of around the same level as mains gas but the carbon emissions associated with electricity are reducing rapidly as the UK builds more renewable energy and decommissions its remaining coal fired power stations. Mains gas does have some potential to reduce its carbon content through the use of 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 plan to increase building efficiency and become less carbon intensive. One way to achieve this is to consider a transition to electrical heating where this also represents a more efficient and comfortable solution for churches.

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

If the gas boiler is repaired or replaced, then long term, the boiler will need to be made hydrogen ready. 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. Where electric heating can be obtained at similar or lower operating cost, this is recommended.

6.2 Current Heating System

The church is heated by a Concord CX100 gas boiler of 125kW input and 100kW output (80% efficiency when new). This supplies two cast iron radiators on each side of the building which are recessed into the brickwork, plus two fan assisted radiators, with a further (not recessed) cast iron radiator in the chapel. Also on the heating circuit are two small cast iron radiators.

The church is reported as being very slow to heat up, taking one or two days. This is not surprising given that half of the radiators are recessed into the walls, with the result that half of the radiant heat output is lost and convection is not helped. There are no heat emitters in the chancel or the centre of the nave or around the pillars.

The office has subsidiary heat provided by portable electric heaters, with only the small cast iron radiator above providing central heating.

The bay at the ecclesiastical west of the nave has been partitioned to form an area known as the Church Centre. This is heated by a Goodman hot air blower of unknown power. Consumption data has been estimated based on the reported hours of use of this part of the building and its size.

Finally, the entrance foyer which is an addition to the 1905 building has an overdoor electric curtain heater.

6.3 Site Heat Demand

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

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

Insulation Factors

Condition	Factor kW/m^3
Poorly insulated with open or broken windows, draughty doors (add 5%)	0.034
Poorly insulated (assume no interventions)	0.033
Some insulating features	Estimate value
Well insulated	0.022
Insulated to 2010 regulations	0.013

Area	Volume m³	Insulation Factor kW/m³	Heat Required (Space heating) kW
Body of church Nave, aisles, chancel, chapel	3,500	0.033	115
Church centre	535	0.03	16
Entrance area	75	0.033	2.5
Office area	300	0.033	10

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

The site uses around 150,000kWh of gas yearly. The church is estimated to be in use for 500 hours and the centre, with boiler powers of 125kW and about 25kW (?) respectively.

Area	Estimated split kWh	Boiler power kW	Annual heat hours	Area use hours	Cost per hour
Church	125,000	125	1,000	500	£2.44
Hall	25,000	25	1,000	700	£0.48

Cost per hour = Boiler power kW x gas price p/kWh

[Useful for comparison between different heating methods when the total number of hours is either uncertain, or may change with modified building use].

The hall figures above assume some pre heating takes place. It this is known not to be the case and the heater only runs for the occupied hours during the heating season, more of the total in the estimated split column can be added to the main boiler.

6.4 Energy Saving Options – Main Church

During the audit, various options for the PCC to consider were discussed.

The hours of use of the main church itself at around 7 to 8 per week are currently low.

This would often result in a recommendation to install under pew electric convector heaters [2 or 3 per regularly used pew at ~ £350 each]. However, it is understood that pews may be removed in the medium to long term.

The church is too wide for heating by wall mounted radiant panels.

If pews are removed and use is expected to be still low, overhead radiant heaters are suggested.

This could be either chandelier mounted glowing elements or non-glowing far infra-red radiant rings. They produce 1kW of heat for every 1kW of electricity used.

If it is proposed to increase hours of use of the main church (beyond 20 per week, ideally beyond 30) then the running costs of electric "direct" heating become prohibitively high.

In this circumstance a heat pump system is recommended.

The existing radiator network is clearly inadequate at present and is unsuited to the low (45°C) water temperatures supplied by air to water [ASHP] and ground source heat pumps [GSHP].

Either of these systems would require new, much larger radiators.

A better solution would be to employ Air to Air Heat Pump(s) [AASHP]- an external unit, or units supplying refrigerant to internal fan units. The internal units could directly replace the existing radiators, although it would be helpful to add extra positions, possibly on top of the centre false roof and at each end of the aisles. With a non-listed building, there are options of installing individual, small external units serving one or more internal units, or one or two large "master" external units with consequently longer pipework runs serving a network of internal units.

AASHP units are a mature technology for office heating, are beginning to enter the domestic market and have been installed in a small number of churches (and some halls). The large volume of churches results in a long heat up time – exactly as for gas fired space heating systems, so unlike radiant electric systems they are not suited to meetings at short notice.

As a result, some installers have been reluctant to install them in larger churches – this is a developing area with recent research from Historic England.

- Future low hours – overhead radiant heating
- Future medium to high hours – Air to Air heat pumps

6.5 Heating Regime

The main church is currently heated "constantly" during the heating season (under thermostat control), because the heat up time is so long – 24 to 48 hours. This is probably due to insufficient radiator surface area and output. It may also indicate problems with blocked radiators which should be investigated (are they evenly hot to the touch?).

2.9.2 Church Boiler

The Church Boiler is located in the basement and is very old! Technically, it needs to be replaced, but this needs to be included in a much (much!) larger strategy for heating system for the whole church.

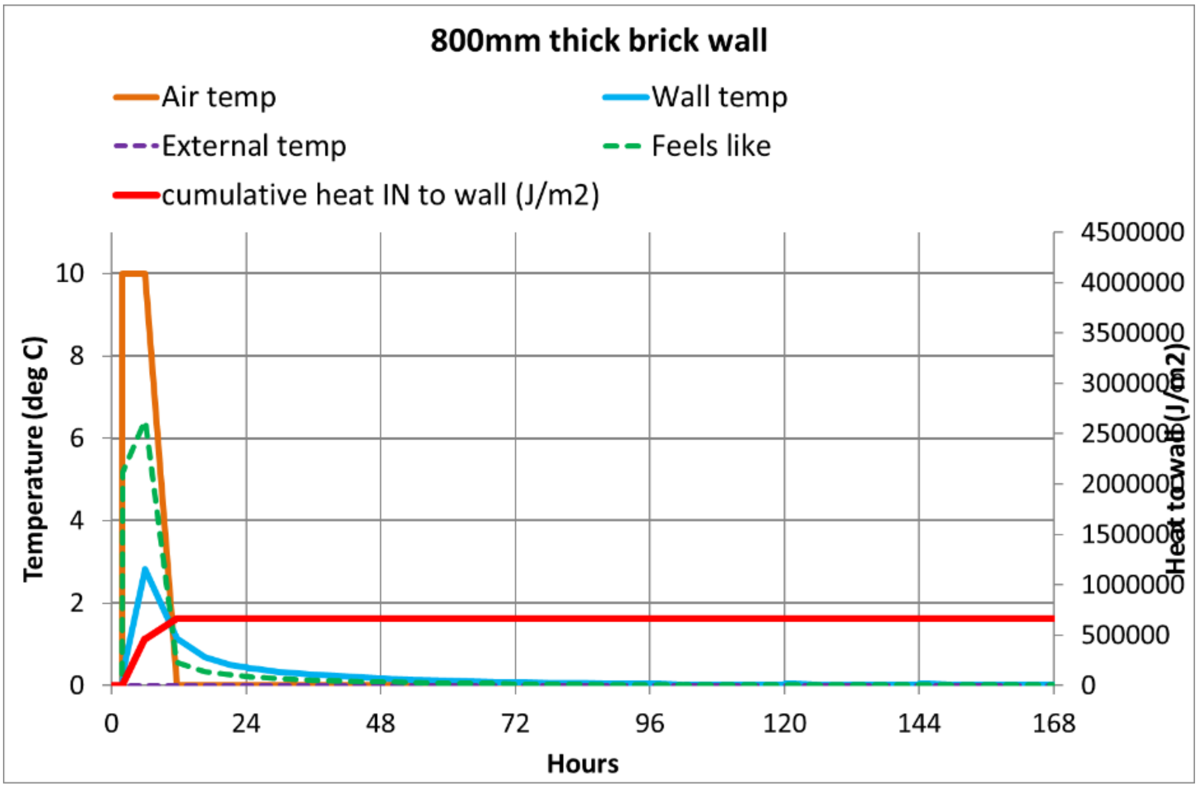
The boiler control is located in the cupboard in the Church Office. This was replaced in 2013/2014 and, for cost purposes, is a "make do" unit. As a result, it should only be relied upon for 'On' and 'Off' settings. Anything else is, at best, unpredictable, i.e. there is no timer feature.

Generally speaking, the heating is [ON] continuously in the winter months, and [OFF] during the summer. Due to the high ceiling and stonework, the church auditorium can take 1-2 <u>days</u> to heat in winter months. Conversely, with the heating off, the auditorium can get cold in 1-2 hours!

Constant heating, or background heating is not normally recommended; the graphs below which were circulated to the Church Energy Advisor's Network show that there is a much greater cumulative heat loss, compared to the loss from one (weekly) heating event.

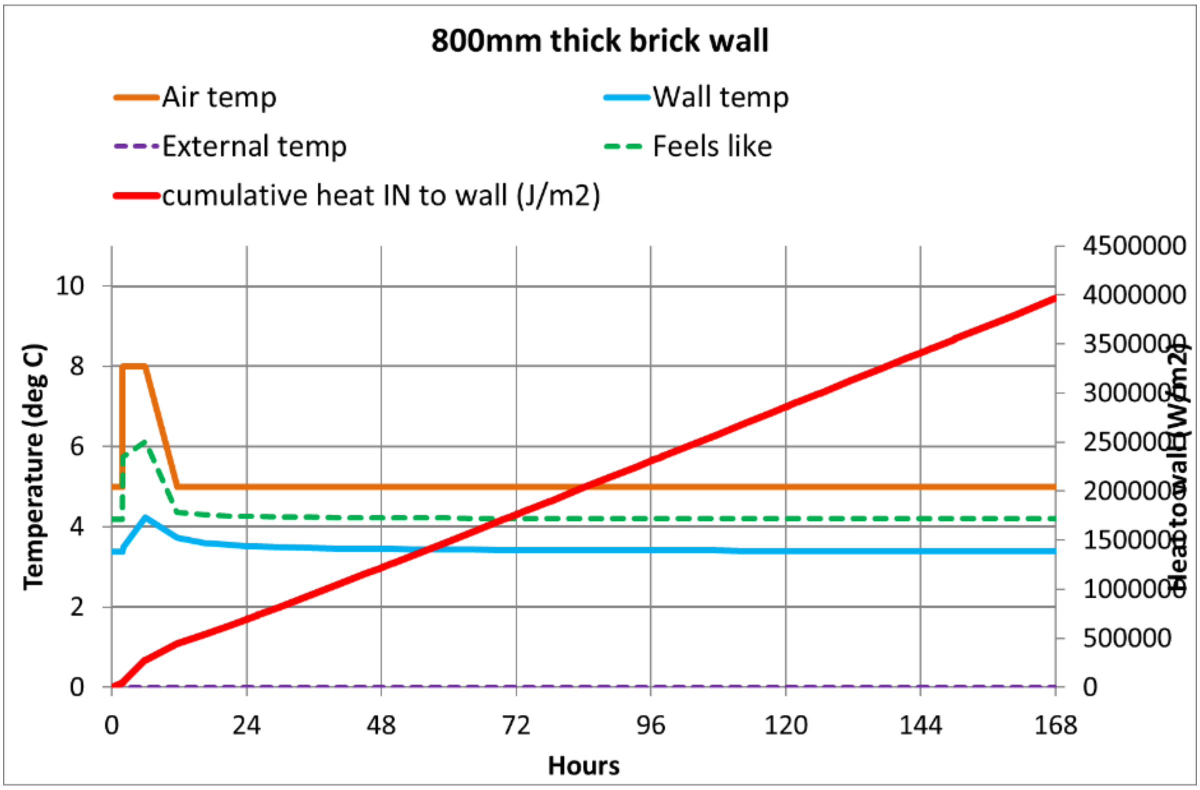
The current church hours of use are not sufficient to justify continuous heating, but it is understood to be a necessity.

This issue is a driver for either system replacement or complete refurbishment.



Above, one heating episode

Below, background heating



paper by James Sheehan https://www.cibsejournal.com/general/tidings-of-comfort-and-joy-cost-efficient-church-heating/

7. Renew the Existing Heating System

7.1 Refurbishment of Central Heating System

If a heat pump system is not technically viable or affordable as a mid to long term solution, and the hours of use of the building are too high for a direct electric radiant system to be affordable, then complete refurbishment of the heating system is the choice. If pews are to be removed, installation of a high efficiency condensing boiler is the remaining option.

This will increase efficiency from 80% to around 93% - however it is likely that an installer will specify a boiler of higher power than present (given the shortfall between boiler output and the heat loss model).

The current boiler delivers 100kW of heat – there is little which could be done to reduce the heat loss requirement of the building (ceiling, wall and window insulation are not cost effective for low hours of use). Replacing a 125kW input / 100kW output boiler with a modern high efficiency condensing boiler (100kW input, 93 to 95kW output) alongside replacement of the cast iron radiators or adding further supplementary fan assisted radiators to significantly increase (double?) the heat output would be necessary.

7.2 Replace the Existing Boiler for a High Efficiency Condensing Boiler

The existing gas boiler within the church is now around 30 years old and as such is reaching the end of its serviceable life. Boiler efficiencies have also improved since this boiler was originally installed and therefore replacing the boiler for a new, high efficiency, Low NOx gas condensing boiler will deliver gas savings through more efficient combustion and heat transfer in any new boiler.

Installing a new gas boiler now will lock the church into a gas / fossil fuel based solution for the lifetime of the new boiler (around 20 years) and therefore an important decision needs to be made as to whether the PCC is seeking to transition to a net zero carbon position within that period and therefore should consider installing a heat pump technology in lieu of a gas boiler. The options for a heat pump are covered in section 6 of this report.

A replacement gas boiler can be undertaken by a competent mechanical engineering company and it would make sense to install new Variable Speed Drive pumps and undertake the pipework insulation as part of these works. The heating system could also be flushed clean and refilled with inhibitor and advanced heating fluids (such as endotherm) on completion to maximise the efficiencies.

7.3 Install Variable Speed Drive (VSD) boiler pump

A new boiler should be fitted with a variable speed drive units which can automatically vary the power they use depending on the conditions at that particular moment in time, for example, how much heat is required into the heating system. Under varying conditions the pumps will only need to operate at part power and can consume less energy in doing so.

The installation of variable speed units will require the removal of the existing pump and the installation of a new unit with integration back into the controls system. As such this should be carried out by a competent mechanical engineer.

7.4 Insulate exposed pipework and fittings around boilers

The pipework within the boiler room has been left uninsulated. These exposed areas of pipework contribute significantly to wasted heat loss from the system. The exposed hot surfaces also represent a health and safety risk of burns for those working in the area.

It is recommended that these areas of expose pipework and fittings are insulated with bespoke made flexible insulation jackets. These wrap around the various elements but can be removed and then replaced for any servicing activities.

7.5 Radiator Reflective Panels

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

7.6 Clean the Existing Heating System

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.

7.7 Magnetic Particle Filter

A filter should be installed to catch magnetic sludge which circulates in central heating systems. It reduces boiler efficiency and can cause blockages in radiators. These units should be emptied and cleaned During the annual service.

7.8 Data and Dataloggers

It is recommended that a temperature datalogger is purchased so understanding can be developed of the heating and cooling time of the building. The device can be used to generate heating and cooling curves which should be of use to specifying a heat pump system.

A suitable device is the Easylog USB-1 or equivalent, costing around £50.

7.9 Discontinue with Background Heating Strategy

As discussed earlier, the aim of any central heating refurbishment / replacement should be to increase the heating rate so that the building can be heated for an event much more quickly and the heating is then only operated for the preheating period (6 hours?) and the event itself.

The boiler should be turned off 45 minutes before the end of each service or event – the radiators store heat and will continue to radiate. This is based on datalogger recordings from over 50 churches in the Diocese of Lichfield.

8. Future Heating Options – Main Church

The following options were discussed during the audit:

8.1 Direct Electrical heating methods: 1kW of heat supplied per kW of electricity.

Under pew heaters – ideal for infrequently used churches.

Chandelier Mounted Radiant IR Quartz heaters – these are normally suspended from arch centres. There is a visual glow from the elements and localised hot spots.

Radiant IR roof mounted panels – not recommended, the beams are spaced too closely to insert panels between them.

Wall IR roof mounted panels – not recommended, the walls are too far from the nave centre.

8.2 Radiant Chandelier Mounted Heaters

There are six arch positions which correspond to the seated area.

Each hexagonal chandelier is fitted with 6 x 1kW heaters.

36kW of heating is less than the space heating, but instead of warm air rising from the radiators to the ceiling, then partially cooling, heat is supplied directly.

Installed cost would be in the reqion of £500 per heater; £18.000

8.3 Install Electric Under Pew Heaters

Should the church decide to retain pew seating, this is the recommended solution for low hours of use.

The church is currently seated using 43 pews in the nave and aisles. If these are to be retained, under pew heating is a straightforward solution which can be applied to all pews, or just a selected number if a congregation is normally small.

The 3m length pews (No: 38) have two central support under the seat and are open underneath.

The 2m length pews (No: 5) have one central support.

A maximum installation would be:

124 x BN65 650W 91cm length heaters.

Maximum output of 80kW

Installed costs (2018 data) of £42,284.

Operating costs: heating for around 1/3 of 500 hours of use = 170 heating hours

80kW x 170 = 13,600kWh. At current rate of 15.1508p/kWh, annual cost = £2,060.

Note that not all positions need to be filled – this will depend on normal congregation size. Clearly a partial installation will save capital cost. The units can be used to preheat the space during midwinter, but only as required in the less cold months.

Each unit should be fitted with a switch so it can be turned off from underneath the seat.

The output is lower than the figure calculated by model for space heating, 110kW – but the model assumes that heat circulates around the whole building – heat from radiators begins by rising to the ceiling. Heat supplied directly to the congregation does not have to fill the volume of the church first.

System advantages include:

- Individual switching of each unit – useful for small meetings
- The ability to run all units to preheat the building when it is very cold.

For replacement, two most popular under pew heaters within churches are BN Thermic PH65 heaters (http://www.bnthermic.co.uk/products/convection-heaters/ph/) which are used for the above calculations, or similar from http://www.electricheatingsolutions.co.uk/Content/PewHeating.

All cabling should be in armoured cable or FP200 Gold when above ground. Each pew heater to be switched with a neon indicated fused spur located underneath the pew seat.

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

8.4 Heat Pumps: delivering more kWh of heat than electricity used

The efficiency advantages of heat pumps mean that in some circumstances they can work out at equivalent or cheaper operating cost than gas despite the higher cost of electricity per kWh. This effect is increased if electricity is generated on site by solar power.

Air Source – a new installation of large radiators would be required the existing items are insufficient.

Ground Source, as above, plus would require boreholes.

Air to Air Source Heat Pump – this requires an external unit (as do all heat pumps), but would be connected to a network of internal fan units which could provide heating or cooling.

It is recommended that the church obtain detailed quotations from several installers.

8.5 Heat Pump Overview

Heat Pumps are a low carbon method of creating heat.

As the hours if use of a building increase, so do heating costs.

Electrically operated heat pumps can provide between 2.5 times and 5 times the amount of heat in kW which they consume in electricity (This is termed the Coefficient of Performance, CoP). They are compatible with underfloor heating, which typically runs at fairly low water temperatures, but not with high temperature heating systems. When replacing gas boilers directly, sometimes larger radiators are required, or fan assisted radiators, or running the system for longer periods to achieve the same temperature (but at less power input).

With electricity prices now only three times more per kWh than gas (it was about four times), heat pumps are becoming steadily more cost effective. Refrigeration technology is mature and reliable; the units appear to offer lower maintenance costs compared to gas boilers.

Heat pumps generally deliver water at 45 to 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 Source systems deliver between 2.5 and 3 times the amount of heat in kWh to water that they consume.

Ground Source systems are more efficient (since the average ground temperature is higher than the average air temperature), but require either a borehole, or extensive trench digging.

Ground Source Heat Pumps supplying water at around 50ºC are more efficient than their Air Source equivalent. Where a site has a daily requirement for heat (and thus high daily expenditure), the lower operating costs of a ground source pump outweigh the higher capital costs.

Air to Air systems deliver warm air through indoor fan units and have a CoP rating of up to 5 and they can also provide cooling. The latter would be suitable where there are no or few radiators, or life expired / poorly sited units and spaces heated intermittently.

Some of the extra electricity required to run heat pumps can be obtained from solar PV panels. Some types of heat pump can provide cooling – solar powered cooling in summer is very efficient. Electricity will still be required from the grid for evening or winter use.

8.6 Air to Air Source Heat Pumps Overview

Air to Air Source heat pumps require internal fan units, blowing warm air, connected to external units – they do not require radiators. Systems provide summer cooling as well as winter heating and can deliver up to 4 to 5 times the amount of heat which they consume in electricity.

Four of the small units below supply one floor of an office of area 160m^2, giving a heating capacity of 21kW for an electrical load of around 1.5kW. The larger units supply 75kW to 500m^2 over three floors. The CoP is between 3.2 and 3.9 depending on the type of internal unit chosen.

There are a wide variety of internal units for ceiling, high wall and low wall mounting.

External units would need to be found locations which were non viewable or hidden in some way, but need to be well ventilated for this method to be viable. Hedge planting has been used to hide oil tanks at some churches. The side of the building away from Welham Road is the least visible location.

8.7 Air to Air Source Heat Pumps Costs

Pumps to supply 100kW of heat (with capital cost estimated at £450 per kW output: £45,000) would deliver the same amount of heat annually as the current system.

Costs may be less if direct connections through the wall between external and internal units can be used, minimising piping costs.

The units would require 1,000 hours of operation at full power to deliver the same amount of heat, 100,000kWh annually.

Operating at a Coefficient of Performance of 4, an 100kW heat output requires 25kW of electricity supply. It is believed that two phases of power are presently supplied, giving a maximum of 46kW.

25kW x 1,000 hours = 25,000kWh electricity used annually.

At current costs of 15.1508p/kWh, annual cost = £3,788

8.8 Cost Comparison

Item	Power output kW	Power input kW	Operating cost	Capital Cost
Current gas boiler	100	125	£2,440 + maintenance	N/A
Replacement gas boiler plus new radiators and some pipework	93	100	£1,953 + maintenance	Unknown
Under Pew Heaters (maximum 124 units)	80	80	£2,060	£42,284
Air to Air Source Heat Pump system	100	25	£3,788	£45,000

8.9 Underfloor Heating

The church parquet floor is in need of repair with many loose blocks.

If the church wished to consider installing underfloor heating, the need to renew the flooring anyway would fit, but the current use pattern of the building is too low to justify it.

This is a constant / semi constant heating technology which requires >1 day for heat up. It is not suitable for once / twice a week building use, it is suited to a building in regular daily use.

There is a £1000 / m^2 guide price for installation

9. Future Heating Options – Entrance Area, Office

9.1 Entrance Area – Church Centre

This is currently heated by a Goodman direct air blower, of unknown power rating. It is estimated to use around 25,000kWh annually.

Replacement could be by Air to Air source heat pumps

Two small units, one placed at each end of the area with external units outside the walls are suggested.

The area may be completely remodelled; a separately heated zone is recommended.

The location of the current heater with a single output would be a more difficult location in which to install a heat pump, requiring long pipework runs.

9.2 Office

If the main church was converted to heat pump, this area should have a separate small heat pump installed for independent heating.

In the short term, a heated office chair is recommended to supplement the central heating; these can be obtained for around double the cost of an ergonomic swivel chair.

10. Energy Saving Recommendations - Equipment

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.

10.1 Fixed Water Heaters

There are four fixed water heaters

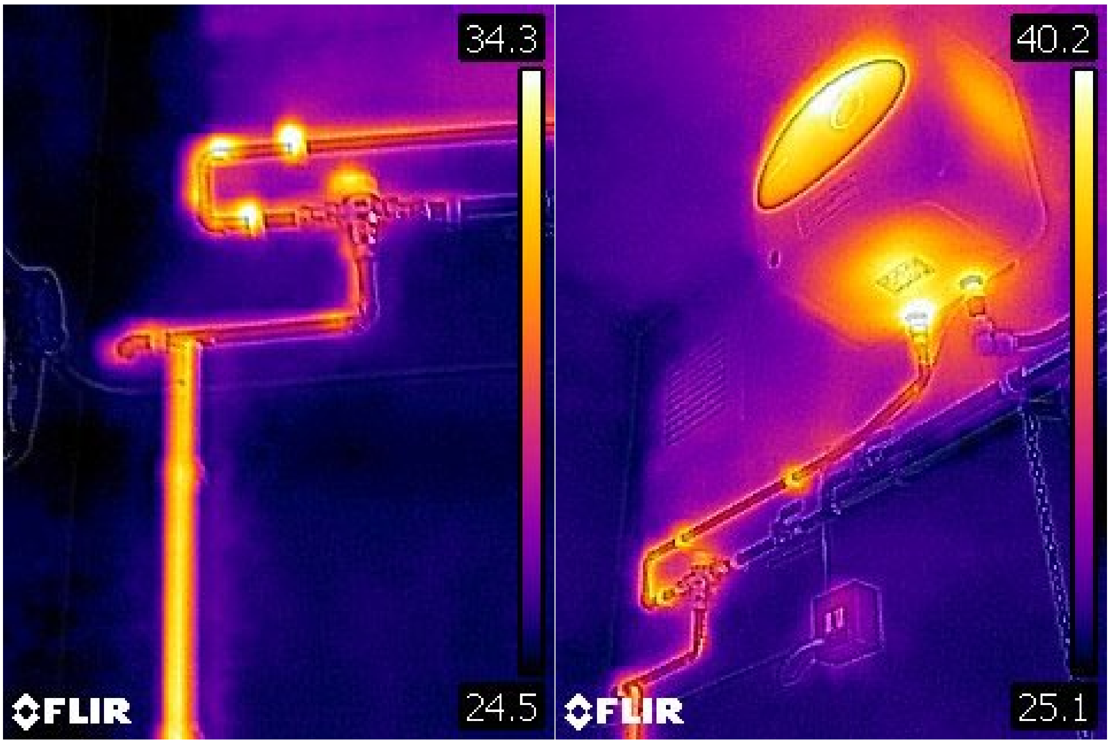
A] Main toilets, wall mounted, Ariston (normally on)

B] Kitchen , under sink, Ariston (normally off)

C] Kitchen drinks, Lincat (normally off)

D] Staff toilet, wall mounted, Heatrae Sadia Hotflo 10 (normally on).

Although tanks are insulated, the copper pipework leading to and from them is not and is a constant source of heat loss of around 100W (incandescent light bulb) and will waste around 900kWh per year, costing £140. The pipework from Unit A was found to be hot (around 45 degrees) even though the building was empty and the facilities had not been used.



It is recommended that a timer is installed so the water is only heated during hours when the building is regularly used. A 24 hour/7 day timeclock should 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 This will prevent the standing losses from the unit wasting energy during periods when the building is not occupied.

Note that a 1 litre tank will only deliver half this volume of hot water. As the water is drawn, it is replaced by cold, so the second half of the tank will be lukewarm.

If the building use pattern is so unpredictable that the timer needs to be altered daily, the church is recommended to replace the whole unit with a point of use water heater immediately in advance of the hot tap. This will then heat only the water actually required.

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

Units B and C in the kitchen are normally turned off as indicated by a notice by the switch.

Unit D in the staff toilet will only be required to produce a small amount of hot water daily, yet also appears to be on constantly. Around 900kWh and £140 could be saved through turning this unit off.

10.2 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/

10.3 New LED Lighting

Changing the 18W Compact Fluorescent Lamps [CFL] in the main church lighting for LED units of similar output (about 7W) would save a modest amount of energy (165W based on 500 hours annual use). This should be done when the lamps require replacement.

When the fluorescent lighting is due for renewal, the whole units (not just the tube) should be changed for LED strip lighting offering the same lumen output. Reductions to around one third of current consumption should be achievable, saving around 700kWh.

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/

10.4 Power Management Settings on Computers

The computers are used by the staff within the parish office.

All computers can be shut down or put into a hibernate mode but this is rarely 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 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 5 minutes. Putting the computer to sleep will not lose 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.

11. Energy Saving Recommendations – Building Fabric

11.1 Draught Proof External Doors

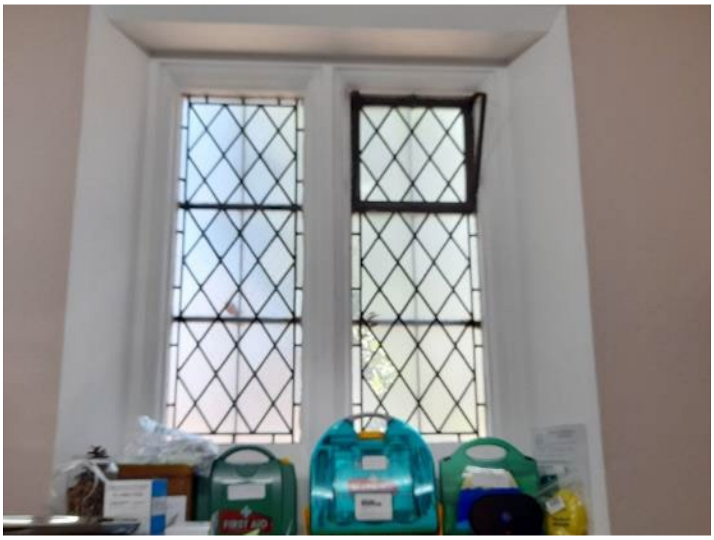
The entrance doors should be kept draught proof. For an unlisted building this can use inexpensive E or P cross section adhesive strip around the edges.

11.2 Windows

Where there are hopper windows these should be kept maintained so that they close properly.

Any rust should be treated; metal expands as rust forms and this leads to distortion and damage to lead, panels not closing leading to further leakage of water and more rusting.

Plasticene can be used to reversibly fill gaps.



11.3 Secondary Glazing

In regularly used areas such as the office and perhaps the vestry, secondary glazing can be installed to reduce heat loss. The hopper window sections would need removal for permanent (glass, framed) secondary glazing installation. At £550/m2, a cost of around £1,200 should be expected for the office.

An inexpensive alternative is to source 2mm polycarbonate sheet which can be cut with a craft knife, and cut panels to cover the part of the window excluding the opening hopper section. If it needed to be removable, this could be affixed using magnetic tape applied to the sheet and window frame.

12. Saving Recommendations (Water)

12.1 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. This is recommended for taps in areas with frequent public use, especially by children.

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.

13. 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	Future potential
Wind	No – no suitable land away from buildings
Micro-Hydro	No – no water course
Solar Thermal	No – insufficient hot water need
Biomass	No – not enough heating load as well as air quality issues
Air Source Heat Pump	No – unsuitable radiator network and low hours of use
Ground Source Heat Pump	No – as above
Air to Air Source Heat Pump	Yes

13.1 Solar Photovoltaic Panels

Most of the roof is visible from the ground, but the south west facing aspect faces the rectory and as an unlisted building appears a viable location for solar panels.

There is limited visibility of the south west facing roof, above, from the road.

The roof offers an areas of around 200m^2. This could generate 0.15kWpeak/m^2 giving a 30kWpeak system. A 1kWpeak system can generate up to 1000kWh annually.

Assuming that the maximum amount of roof space could be, and was used for panels, 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
Church Nave	120	18	210 degrees / 45^0 0.95	1	17,100
Aisle	80	12	210 degrees / 20^o 0.95	0.9	10,260
				TOTAL	27,360

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.

The maximum potential generation is greater than the church centre's annual recent electricity use (7,580kWh in 2021). If heat pumps are not installed, the system should be sized appropriate for current electricity consumption – just the aisle roof would suffice.

If heat pumps were installed, this would require extra power. With a current gas use of 150,000kWh (for the whole site), if heat pumps achieved an average of CoP 4 this would require 37,500kWh of electricity, so there would still be reliance on grid electricity (which should be sourced from a 100% renewable supplier).

Generation of 27,360kWh against a total demand of around 45,000kWh is 60% of average requirements.

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 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.

Using average 2019 installation costs (£1,450 per kWpeak); a 30kWpeak system would cost £43,500.

14. Other Observations

15. Funding Sources

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

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

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

16. 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.