ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Mary the Virgin, Mortlake
PCC of St Mary's Church

Author	Reviewer	Audit Date	Version
Paul Hamley	Tamsin Hockett	30th May 2022	1.2

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1. Executive Summary

An energy survey of St Mary the Virgin, Mortlake 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 Mary the Virgin, Mortlake is a Grade II* listed church. Only the tower dates from 1543 with a chancel of 1885. The nave and south aisle date from 1906. The adjoining Vestry Rooms to the north date from 1660 and are included in the listing. [Historic England reference 1357705]. 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 reflective panels behind church radiators	2% 480	£28	£20	<1	List A	0.09
Draughtproofing measures	2% 480	£28	£200	7	List B	0.09
Optimise Vestry Rooms heating system	5%		Zero	Immediate	None	
Improve Vestry Rooms window insulation	10%	£	£10k	Unknown	Faculty	
Install Vestry Rooms roof insulation	10%	£	£430	Unknown	Faculty	
Install LED lighting in church	3,500	£759	£10k	13	Faculty	0.88
MEDIUM TERM						
Install solar photovoltaic panels on south aisle roof	10,500	£2,276	£21,750	10	Faculty	2.66
LONG TERM						
Replace Vestry Rooms boiler with Air Source heat pump	All hall gas		£12,000		Faculty	
Install Air to Air Source Heat Pumps for church	24,000 gas	£1,418	£45,000		Faculty	4.41 gas

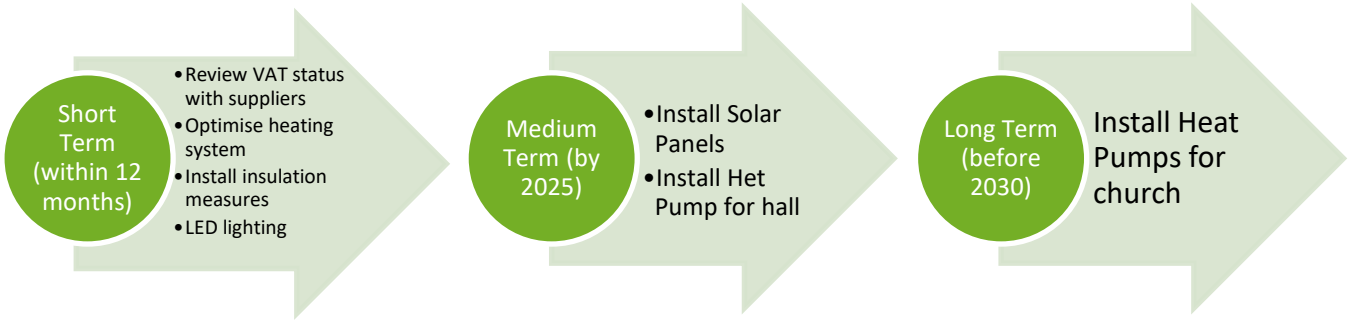
The church should check any faculty requirements with the DAC Secretary at the Diocese before commencing any works. Based on current contracted prices of 21.68p/kWh and 5.91p/kWh for electricity and mains gas respectively.

If all measures were implemented this would save the church around £3,000 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 2035 by undertaking the following steps:



3. Introduction

This report is provided to the PCC of St Mary the Virgin, Mortlake 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 Mary the Virgin, Mortlake, SW14 8JA was completed on the 30th May 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 Greg Kyle, Senior Church Warden.

St Mary the Virgin, Mortlake	CHURCH	Adjacent Vestry Rooms
Church Code	637321	
Gross Internal Floor Area	460m^2	235m^2
Volume	4125m^3	720m^3
Heat requirement	136kW	24kW
Listed Status	Grade II*	Grade II*

The church and adjacent rooms are typically used for 50 hours per week for the following activities, with the church receiving around 16 hours:

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	6 hours per week	70
Church Meetings and Groups	3 hours per week	
Community Use of church	6 hours per week	Nursery group c 20, Kindergarten use church rooms and main church 3 days per week.
Occasional Offices	1 wedding 6 funerals	100 100

Annual Occupancy Hours: 860 + nursery

Estimated Footfall: 17,500

4. Energy Procurement Review

Energy bills for gas and electricity have been supplied by St Mary the Virgin, Mortlake and have been reviewed against the current market rates for energy.

The current electricity rates are:

Single / Blended Rate	21.68p/kWh	Below current market rates
Standing Charge	30.10p/day	N/A

Supplier: Octopus Energy

The current gas rates are:

Single / Blended Rate	5.91p/kWh	Below current market rates
Standing Charge	29.14	N/A

Supplier: Octopus Energy

When the current contracts expire, there will be opportunities to gain cost savings from procurement of the energy supplies at this site using a group purchasing scheme. The current rates are lower than the market rate and should be retained at present.

We would therefore recommend that the church looks into 100% renewable tariffs and obtains quotations for its gas and electricity supplies from group purchasing schemes such as the Big Church Switch scheme, 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 applied to the bills. These are:

VAT	20%	Applied to electricity when over 1,000kWh per month and regularly to gas. The organisation is understood to be a charity and therefore should be benefiting from only be charged a 5% VAT rate. A VAT declaration should be sent to the supplier to adjust this.
CCL	charged	Charged as above

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 Mary the Virgin, Mortlake used 7,223kWh/year of electricity in the year from November 2020, costing in the region of £1,340 per year, and 23,587kWh/year of gas over the same period, costing £1,285.

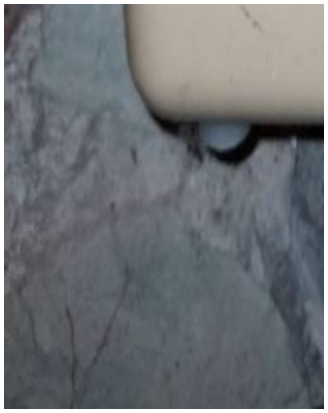
This data has been taken from the annual energy invoices provided by the suppliers of the site.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity - Church	K92A 01151	EDF Three Phase	No	Porch electrical cupboard
Gas – Church	R025 U13107 94 D6	MDU 25W	No	Basement of Tower, wall mounted
Gas – Vestry Rooms	2839052 S	UGI meters	No	Basement of Tower, wall mounted

None of the meters are AMR connected,

Installing SMART meters will allow for accurate monthly metering and also an annual energy use profile for the site could be obtained from the supplier.

Three phases of power are supplied.



Church and church rooms (right) gas meters.

5.2 Energy Profiling

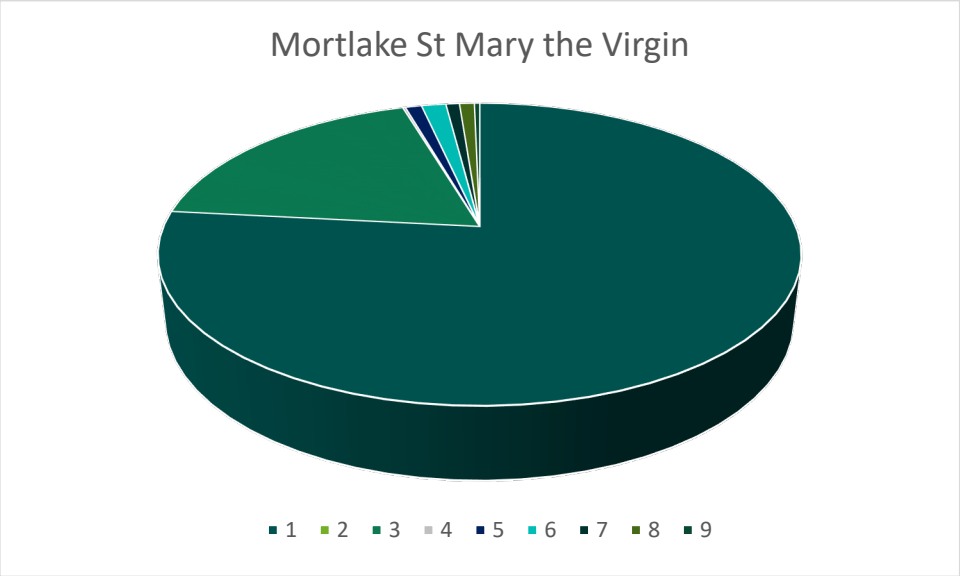
The main energy consuming plant can be summarised as follows:

Church Rooms items are italicised

	Equipment	Power kW	Annual Consumption kWh	Portion
Heating [Gas]	CHURCH Ideal Evomax boiler, 500 hours HALL Worcester Greenstar 30CDi boiler	48 30	24,000 Not reported	%
Heating [Electric]	Nil normally (convector heaters in store, used when boiler failed)			0%
Lighting [Internal]	CHURCH 400 hours use 110 halogen spotlights, 100W each 10 downlights, 100W each HALL 40 hours/week use *17 LEDs x 7W* *18 CFLs x 20W* *Kitchen 7 Halogen GU10 x 50W*	 12kW *120W* *360W* *350W* *Total 830W*	 4,300 1,450	 % %
Lighting [External]	3 security lights	0.15	50	0%
Hot Water	Mostly supplied by combination boiler *Kettle*	 *3*	 *300*	 %
Kitchen	*Microwave* *Fridge (on constantly)* *Electric cooker and hob (low use)*	*1* *0.1* *3*	*100* *300* *50*	%
Office	*2 workstations, daily use 0800-1300* *Photocopier used regularly for newsletters for three churches*	*2 x 0.1* *0.5*	*200* *50*	
Sound, Music	Sound system Organ	0.5 1	75 200	%
Small Power	Vacuum cleaner	1.5	100	%

Sum of estimates: 7,200kWh

Annual site electricity consumption, 2020: 7,223kWh



KEY *1 Gas heating* *2 electric heating (zero)* *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 lighting.

5.3 Energy Benchmarking

In comparison to national benchmarks for church energy use St Mary the Virgin, Mortlake uses 44% less electricity and 65% less heating energy than is 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 Mary the Virgin, Mortlake (elec)	Site 675	7,223	10.7	19	-44%
St Mary the Virgin, Mortlake (gas)	Church 460	23,587	51.3	145	-65%
TOTAL	**460**	**30,810**	**67**	**164**	**-59%**

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

The church has a modern parquet floor and is seated with movable benches. Lighting is installed at high level. The wall between the adjacent vestry rooms building to the north has been removed and the rooms on first and ground floor level extended into what was the north aisle, with glass screening at first floor level and opening panels on the ground floor.

6. Efficient / Low Carbon Heating Strategy

There are only three radiators in the church, two standard cast iron units at the west end of the nave and this early example in the chancel which has heritage value. {Clements, Jeakes & Co, 51 Great Russell St London). This influences future heating options.

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.

6.2 Forward Planning

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 boilers are 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.

6.3 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	Estimated value
Well insulated	0.022
Insulated to 2010 regulations	0.013

Area	Volume m^3	Insulation Factor kW/m^3	Heat Required (Space heating) kW
Church	4125	0.0033	136
Hall Solid walls, single glazed	720	0.0033	24
Hall, with added roof insulation and secondary glazing [20% improvement]	720	0.0026	19

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

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 Management of Heating System

The hall boiler was found to be set at a flow temperature of 73°C. For optimal performance, a condensing boiler requires a return temperature of 55°C or below. This should be measured on the input pipe and the output temperature adjusted downwards. The boiler can then recover 5 to 7% extra heat from the flue gases when they are able to condense on a heat exchanger.

The operation of the Honeywell controller was explained to the warden.

The heating is set to operate for 55 hours per week during the heating season, corresponding to the hours of use of the two rooms by the nursery and kindergarten, plus Saturday room hire use and Sunday church use. Savings are most likely to be made at the beginning and end of the heating season by reducing the number of hours (or thermostat setting) and allowing the building to cool in May, so it is cool before the summer.

7.2 Temperature Datalogger

Purchase of a temperature datalogger will allow an accurate understanding to be built up of the temperatures in the church rooms and church itself and inform when heating should be switched on and off, and thermocouple adjustment.

Suitable equipment includes the Lascar Easylog EL-USB-1 or similar products from other manufacturers.

7.12 Radiator Reflective Panels

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 installation of reflective foil behind the three radiators in church; this will lower the amount of heat being absorbed by the walls.

8. Future Heating Options

8.1 Options overview

The low hours of use of the church itself of around 16 hours per week is too low for technical success of an Air Source Heat Pump supplying radiators, and too low to justify the capital costs of a Ground Source Heat Pump.

The Vestry Rooms have regular higher hours of use and would be appropriate for installation of an Air Source Heat Pump. The boiler, a Worcester Greenstar 30CDi of 30kW is relatively recent and should offer an efficiency of around 92%.

The following options were discussed during the audit:

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

- Under Pew mounted convector heaters – this is often the preferred solution for churches with low hours of use which wish to retain fixed bench seating. The church is currently seated using moveable modern open backed pews which would make this difficult. [Only regularly used pews have to be fitted. With a larger installation, only pews in use need the heaters switched on. Alternatively, the whole array can be run to preheat the building in very cold weather].

- Chandelier Mounted Radiant IR Quartz heaters – not recommended; normally suspended from arch centres which do not align well with the seating areas. Visual glow from elements and localised hot spots.

- Radiant IR roof mounted panels – not recommended, the roof is high (11m). The beams are spaced too closely to insert panels between them.
- Wall IR roof mounted panels – not recommended, walls are too far from the nave centre and only the south aisle wall could be used.

8.3 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.

An Air to Air Heat Pump (requiring fan heaters to replace some of the existing radiators) is suggested.

Air to water Source – the low hours of use of the church, around 16 per week are insufficient for this technology. Also, a new installation of large radiators would be required; the existing three are insufficient.

Ground Source, comments as above, plus it would require a borehole.

Air to Air Source Heat Pump – this requires an external unit (as do all heat pumps), which would be connected to a network of internal fan units which could provide heating or cooling. The existing underfloor heating pipe trenches would provide a pipework route and could possibly be used to house some small output fan units (which would require a particular manufacturer's product to fit). Other fan heaters would be required above ground, for instance in the present radiator locations at the west end of the nave.

8.4 Heat Pump Overview

As the hours of 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 around 55°C (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 50°C 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 radiators, or life expired / poorly sited units and spaces heated intermittently.

St Mary the Virgin, Mortlake only has three radiators in the church and it is likely that the radiator plus 3 inch pipe system would not be suitable for use with either type of heat pump delivering warm water to radiators, as the heat emitter area is too small.

8.5 Replace Vestry Rooms Boiler with a Heat Pump

Air 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. The vestry rooms have a regular and high weekly hours of use, so their use is appropriate.

If the heating power is the same as the current boiler, a 30kW output Air Source Heat Pump operating at CoP 2.5 requires 12kW of electricity.

Heating hours for the church rooms are 55 per week during the heating season:

Current costs per hour for gas (assumes boiler operates at full power, which it will when warming the building from cold)

Gas boiler costs	30kW x 5.91p/kWh = 177p/hour
ASHP costs	12kW x 21.68p/kWh = 260p/hour

At current rates, ASHP costs are higher. However, they will reduce if solar power is installed, and ASHP systems can be configured to provide summer cooling.

8.6 Air to Air Source Heat Pumps for Church Use

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 4 to 5 times the amount of heat which they consume in electricity. They may be suitable for churches which have no pews and no, few or poor radiators.

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.

The south aisle and south nave roofs of the Grade II* listed building are both visible. The north nave roof is angled at 20 degrees and may provide a suitable location for a medium sized solar PV array which could power the church rooms and regularly used office.

The majority of electricity will still be required from the grid.

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.

The units below supply an office area of 660m^2, which is similar to the total of the main church (460m^2) plus Vestry Rooms (235m^2) areas. The CoP of this 2012 installed plant 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.

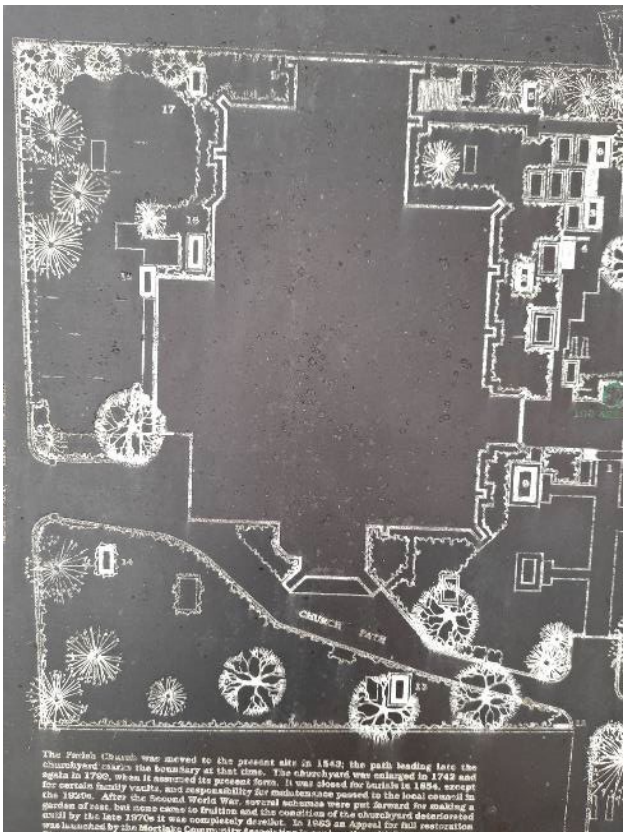
The church has a network of underfloor heating ducts where the current finned pipe heaters are located. This could be used to run the heat pump refrigerant pipework and possibly install some internal fan units (although the dimensions of the duct may need to be increased).

Floor ducts, above, contain two three inch heating pipes.

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. Potential locations include (1) the north side of the chancel, partly hidden by the buttress at the NE corner of the north aisle (and with some extra planting)

Potential location (1) is to the left of the tree in the background.

Potential location (2) is the east end of the south aisle where there is a recessed area 70cm below the churchyard (which has probably been raised by three centuries of burials). This area is not very visible and is screened by the south aisle, trees, and tombs. There is an existing green metal shed for garden tools in the area). A further small area of land, currently planted, could be used. The map indicated locations of trees and tombs.



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).

Operating cost to deliver 24,000kWh of heat (as at present) with grid electricity at 21.68p/kWh

24,000 / CoP 4 x 21.68p/kWh = £1,300, which is similar to current gas expenditure.

Generation of solar power on site would reduce operating costs – although the small size of solar array which can be accommodated means mostly grid electricity would be required.

Quotations for Heat Pumps should be obtained (including enough information to allow calculation of operating costs) and compared with capital and operating costs for a high efficiency replacement boiler.

9. 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.

9.1 New LED Lighting

The lighting makes up a relatively large overall energy proportion of the electricity used within the church, and the church is lit entirely by a large number of inefficient halogen fittings.

There are 40 spotlights and 10 downlights in the nave and a further 30 (south aisle), 30 (chancel) and 8 (north transept). 120 lights at about 100W each gives a load of 12kW. The lights are only used for church services and few other occasions; even with low hours of use they account for over half of electricity consumption.

Many of the lights are at high level and will require changing professionally. Those in the nave are carried in luminaires which also include a downlight, which may require replacing the whole unit. The church uses a dimming system and is aware that compatible LED lights are required.

A full professional relighting scheme is likely to cost in excess of £10k. Costs may be considerably less if LED lamps which are compatible with the dimming system and existing luminaires can be sourced.

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/

9.2 Power Management Settings on Computers

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

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 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 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.

10. Energy Saving Recommendations – Building Fabric

10.1 Draught Proof External Doors

There are a number of external doors in the church. These have the original historic timber doors on them, but these do not all close tightly against the stone surround and hence a large amount of cold air can enter the church around the side and base of these 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

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. Other traditional methods such as using hessian or felt pads tacked to the door could be used and keeping the door maintained in a good condition is important.

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.

10.2 Windows

The five clerestory windows of the south nave each have an opening panel. The western three light window in the south aisle has an opening panel whose leadwork is bent into a "W" shape, which may be as a result of rust to the metal frame. Any rust should be treated, especially if there is any water entering.

Black Plasticene is useful for filling gaps and is easy to remove later to allow the window to be opened.

10.3 Secondary Glazing

The windows of the Church rooms are single glazed with metal frames. The office has wooden framed sash windows. As these are regularly used areas, they will benefit from secondary glazing which can save 10% of energy bills.

It is not possible or desirable to change the window(s) as the building carries listed status. Given the windows to these area(s) are relatively small and have a more simple surround they would be suitable to have secondary glazing installed.

The introduction of secondary glazing would considerably reduce the heat loss through the existing windows and improve both thermal comfort and noise levels from the adjacent main road as well as providing added security.

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.

10.4 Seasonal Glazing

Prior to installing secondary glazing, a cost effective solution is to use "seasonal" double glazing film. This adheres to the frames and gives a similar effect by trapping a 2 to 3 inch layer of air. (Installing this is a two person process).

10.5 Loft Insulation

The loft of the hipped roof of the church rooms was not inspected. 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 current standard 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.

Ceiling insulation for an area of 45m^2 would cost approximately £430.

11. Saving Recommendations (Water)

11.1 Tap Flow Regulators

With young children present regularly, it is advised to fit tap flow restrictors. 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.

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.

11.2 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/

12. Renewable Energy Potential

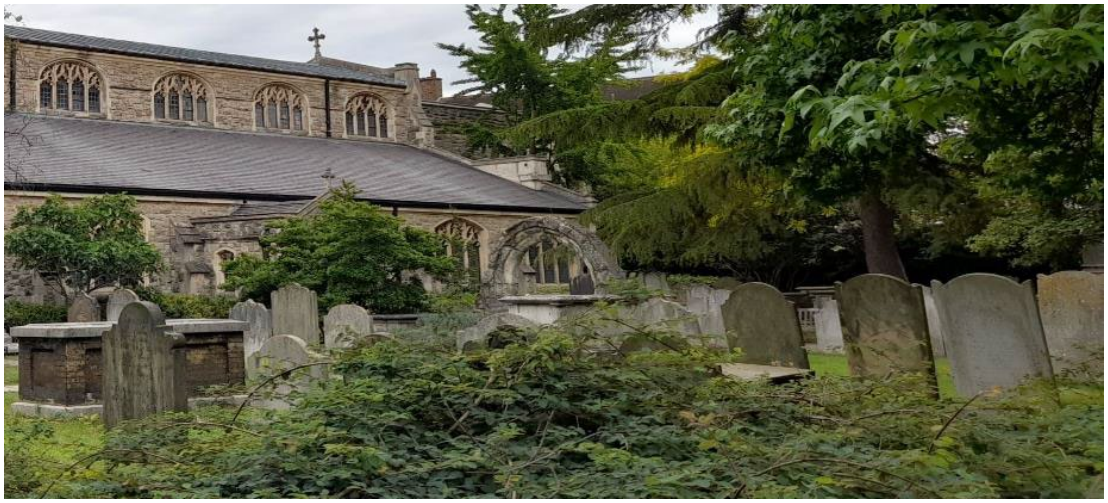
The potential for the generation of renewable energy on site has been reviewed and the viability noted.

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	Yes for church rooms
Ground Source Heat Pump	No
Air to Air Source Heat Pump	Yes for church

12.1 Solar Photovoltaic Panels

Most of the roof is visible from the ground, the south aisle slopes at around 45 degrees and the nave at around 20 degrees and can be seen from Church Path.

The north side of the nave roof may offer a site, this also is not viewable from Mortlake High Street and is mostly obscured by trees and the roof of the Vestry Rooms building. Neither of these would provide shading as they are to the north. Despite the negative angle of the north roof, it is worth engaging with solar PV providers as current panels are efficient in overcast light and do not need direct sunlight to generate.



The nave roof offers an area of around 100m^2. This could generate 0.15kWpeak/m^2 giving a 15kWpeak system. A 1kWpeak system can generate up to 1000kWh annually.

The angle of the church roof is approximately 20^o. A panel on a north facing slope at this angle can generate 70% of the optimum amount.

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 Aisle	100	15	0 degrees / 20^0 0.7	1	10,500

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 (around 7,200kWh). If no heat pumps are installed, the system should be sized appropriately for current electricity consumption.

If heat pumps were installed, this would require extra power. The extra production over the existing electricity use would then go to reducing heat pump operating costs.

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 15 kWpeak system would cost £21,750.

13. 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 .

14. 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.