ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

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

Author	Reviewer	Audit Date	Version
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Contents

1. Executive Summary

An energy survey of St Peter's Church, Hersham was undertaken by ESOS Energy Ltd to provide advice to the church on how it can be more energy efficient and provide a sustainable and comfortable environment to support its continued use.

St Peter's Church, Hersham is a Victorian church dating from 1887, constructed of brick.

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						
Radiator maintenance, clean and flush system	7% 5,250	£107	Unknown		List A	0.94
Install magnetic particle filter	Reduces maintenance		£400		List B	
Install reflective radiator foil	2% 1,500	£31	£30	1	List A	0.27
Purchase a temperature datalogger	5% 3,750	£77	£50	1	None	0.67
Install an instantaneous water heater	200	£31	£200	7	List B	0.04
Draughtproofing works	2% 1,500	£31	£200	7	Faculty	0.27
Purchase some heated cushions	N/A	N/A	Unknown		None	
Install Air to Air heat pump, in Sedgebeer Room for creche use	5,000	£780	£3,500	5	Faculty	1.05
MEDIUM TERM						
Install LED lighting	4,000	£624	£5,000	8	Faculty	0.84
Install solar photovoltaic panels on south aisle roof	4,000	£624	£5,200	8.5	Faculty	0.84
LONG TERM						
Replace heating system with Air to Air Heat Pump system	60,000	Greater cost at current rates	£40,000 currently		Faculty	10.8

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

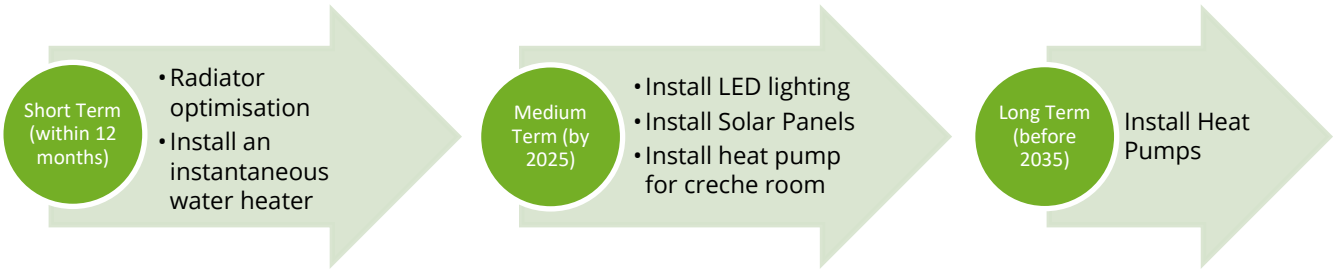
Based on current contracted prices of 15.593p/kWh and 2.0497p/kWh for electricity and mains gas respectively.

If all short and medium term measures were implemented this would save the church around £2,300 per year in operating costs and reduce its carbon footprint by 4.9 tonnes (29%).

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 Church, Hersham 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 Peter's Church, Hersham, Burwood Road, KT12 4AA was completed on the 14th September 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 Malcolm Reid, Treasurer, Andrew Strong, Church Warden, Mark, Building maintenance.

St Peter's Church, Hersham	
Church Code	617140
Gross Internal Floor Area	520m^2
Volume	3,960m^3
Heat requirement	130kW
Listed Status	Grade II

The church is typically used for 21 hours per week for the following activities:

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	5 hours per week	95
Church Meetings and Groups	6 hours per week	
Community Use	6 hours per week	
Occasional Offices	10 weddings 25 funerals	100 100

4. Energy Procurement Review

Energy consumption information for gas and electricity has been supplied by St Peter's Church, Hersham and have been reviewed against the current market rates for energy.

The current electricity rates are:

Single / Blended Rate	15.593p/kWh	Below current market rates
Standing Charge	unknown	N/A

The current gas rates are:

Single / Blended Rate	2.0497p/kWh	Below current market rates
Standing Charge	unknown	N/A

The gas contract will be renewed shortly

When the current contracts expire, there will be opportunities to gain cost savings from improved procurement of the energy supplies at this site using a group purchasing scheme.

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, Charity Buying Group and 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.

VAT data has not been provided.

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

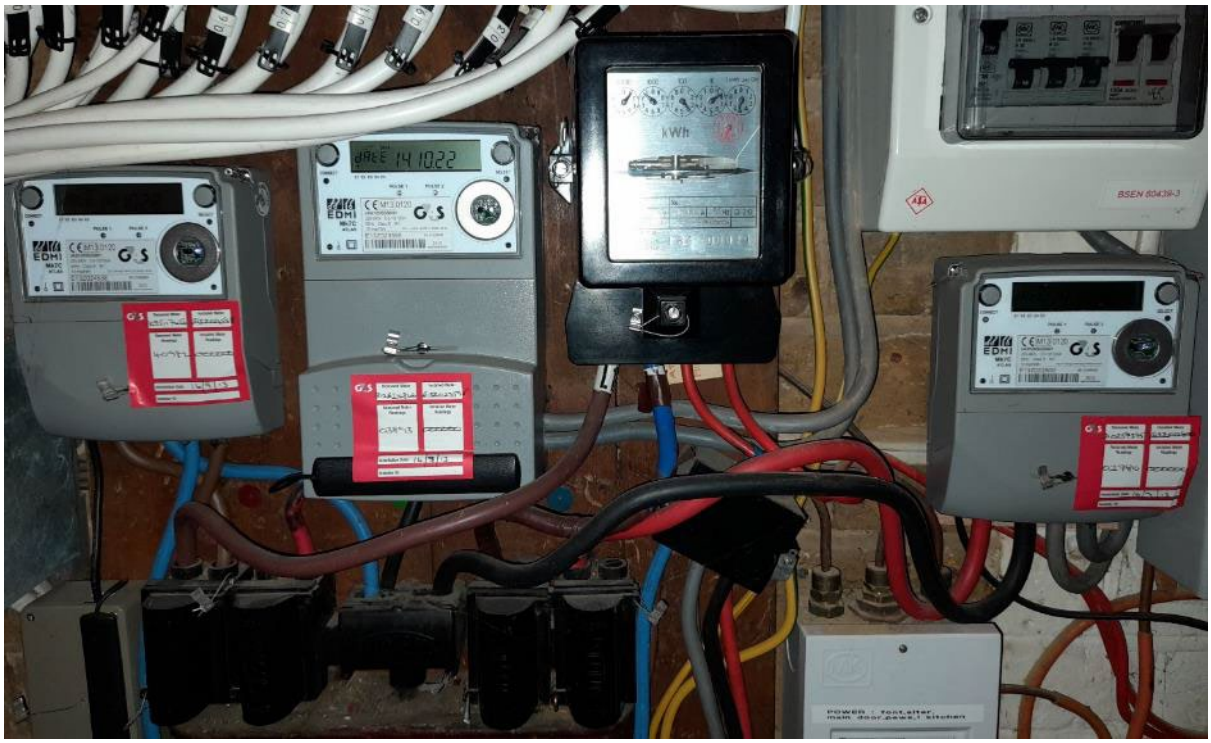
5. Energy Usage Details

5.1 Annual Consumption

St Peter's Church, Hersham used 16,900kWh/year of electricity during 2021, costing £2,400 for the year. Gas use for the church is estimated at around 75,000kWh from the total expenditure of £1,665 for the year and the previous rate charged if 1.7905p/kWh. Standing charge and VAT rates have not been provided.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Kitchen (possibly including kitchen heating)	E13Z 024538	EDMI Atlas Mk7D Single phase	Yes	Electrical cupboard, rear of north aisle No.1 of 4 in image below
Electricity - Lighting	E13Z 022800	EDMI Atlas Mk7D Single phase	Yes	As above No. 2 of 4
Electricity – organ (a)	LB 300029	Single phase	No	As above No. 3 of 4
Electricity – creche heating	E13Z 023595	EDMI Atlas Mk7D Single phase	Yes	As above No. 4 of 4
Gas – Church	K03524 16 D6		Yes	Boiler room

a) The consumption data for the organ fits what is expected for a 1kW machine used for a couple of hours weekly until mid 2021; 205kWh annually. Thereafter there is a high consumption of 11,230kWh for the year from mid 2021. This suggests that another circuit may have been connected to this meter.



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

5.2 Energy Profiling

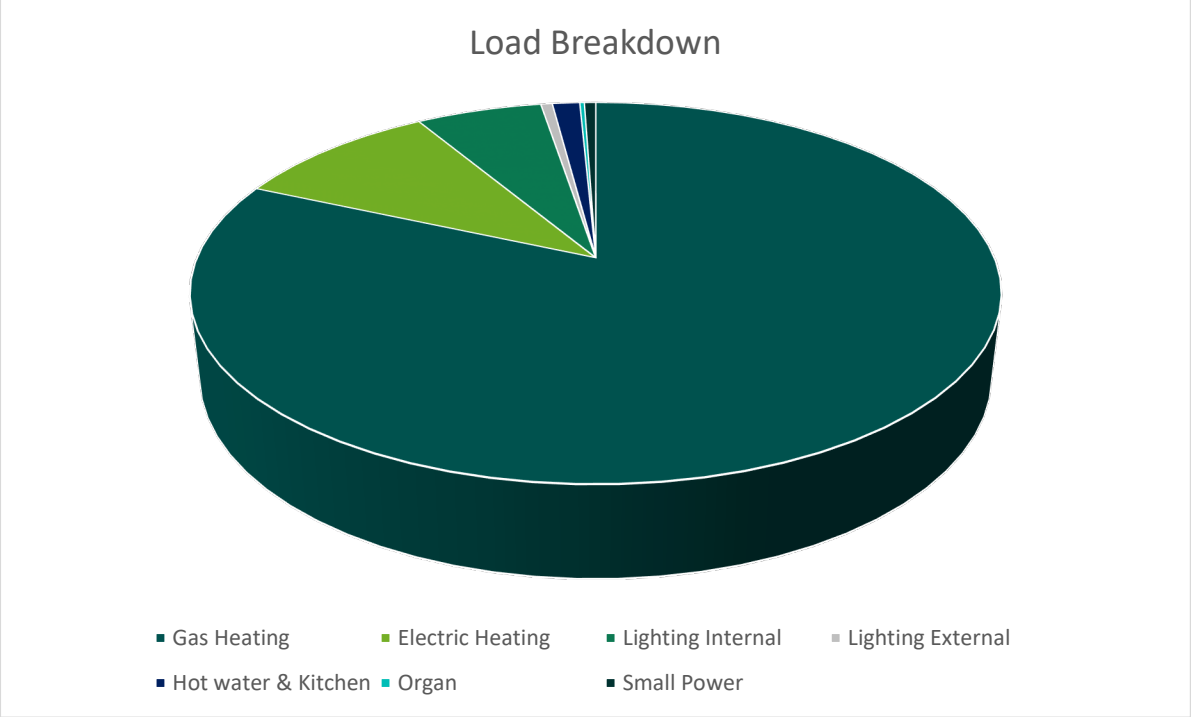
The main energy consuming plant can be summarised as follows.

	Equipment	Power kW	Annual Consumption kWh	Portion
Heating [Gas]	CHURCH MHG Alucon 85kW output, installed 2021	88	75,000	81%
Heating [Electric]	Violet Sedgebeer Room: 2 plinth heaters under seating, + 1 wall mounted convector Kitchen: 1 plinth heater Porch: overdoor convector Ringing room: 1 wall mounted + 2 portable convectors	TOTAL 20	9,000	10%
Lighting [Internal]	CHURCH 1,100 hours use 176 lamps listed Ringing room: 2 incandescent, 1 bulkhead Corridor: various tungsten and halogen bulkhead fittings Vestry: 2 LED	10,875W 160W 300W 12W	5,500	6%
Lighting [External]	Floodlights [LED] have now been switched off	100W	500 (in 2021)	0.5%
Hot Water & Kitchen	Fixed water heater, Heatrae Sadia c 25 litres, under kitchen unit (normally turned OFF) ~100W heat loss) Kettle Urn Mini Fridge (normally OFF)	3 3 2 50W	TOTAL 1,200	1.3%
Organ	Organ	1	200	0.2%
Small Power	Vacuum cleaner Sound system Projector, screens (c 100 hrs annually)	1.5	500	0.5%

Reported in spreadsheet columns C+D lighting, floodlights, kitchen: 7,208kWh

Reported in spreadsheet columns F+G creche (heating), organ: 9,692kWh

Annual site electricity consumption, 2021: 16,900kWh



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

5.3 Energy Benchmarking

In comparison to national benchmarks[1] for church energy use St Peter's Church, Hersham uses 71% more electricity and 3% less heating energy than is average for a church of this size.

Use of electric heating for the creche / Violet Sedgebeer Room and the recent increase of consumption of the organ meter, plus a large installation of non LED lighting are responsible.

	Size (m^2 GIA)	Annual Energy Usage (kWh)	Actual kWh/m^2	Benchmark kWh/m^2	Variance from Benchmark
St Peter's Church, Hersham (elec)	520	16,900	32.5	19	+71%
St Peter's Church, Hersham (gas)	520	75,000	144	148	-3%
TOTAL	520	91,900	177	167	+6%

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. Mains gas does have some potential to reduce its carbon content through the use of bio gas and hydrogen but these are less developed solutions and will be unable to deliver 'zero carbon mains gas'.

It is therefore important to review and set out a plan to make energy use more efficient and 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.

Electricity currently has carbon emissions of around the same level as mains gas but the carbon emissions associated with electricity are reducing rapidly as the UK builds more renewable energy and decommissions its remaining oil and coal fired power stations.

The church is heated by a gas fired boiler. This has been installed recently following a flood which rendered the previous boiler inoperable. The radiator network consisting of eleven cast iron radiators requires cleaning and maintenance of the valves. The church is recommended to optimise understanding, control and use of the present system but with a view to its eventual replacement, probably by a heat pump.

The Violet Sedgebeer Room and the kitchen are heated by electric convector heaters and there is an overdoor heater fitted in the porch. The ringing room in the tower has further electric heaters, fixed and portable. The use of electric heating by the creche appears to be partly responsible for a high electricity use.

6,2 Decarbonisation Options

The various options for a decarbonised heating solution have been reviewed in the table below.

Decarbonisation Heating Solution	Viable
Air to Water Source Heat Pump	No – unsuited to current heating pipework and heat emitters
Air to Air Source Heat Pump	Potential for future installation for church. Recommended installation in the short term to replace the direct electric heaters in the Violet Sedgebeer Room (for creche use, etc)
Water Source Heat Pump	No – no water source locally
Ground Source Heat Pump	No – significant archaeology
Under Pew Electric Heating Panels	No - 48 pews and medium hours of use render this option to be of high capital and operational expense
Electric Panel Heaters (to provide supplemental heating only)	No – not required
Over door air heater (to provide supplemental heat only to provide a warm welcome at the door)	Already installed

Overhead Infra-Red Heaters	No – visual intrusion to the church would do harm, also least preferred heating source due to comfort issues
Heated chair cushions	Potential as top up heat for the elderly

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 m^3	Insulation Factor kW/m^3	Heat Required (Space heating) kW
Church main area	3,730	0.033	123
Kitchen and Violet Sedgebeer room	230	0.033	7.5

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

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7. Improve the Existing Heating System

In the years before the replacement of the existing heating system it is recommended that measures are taken to improve the efficiency of the existing heating system, this should include:

7.1 Clean the Existing Heating System

The new boiler is separated from the radiator network by a heat exchanger.

Problems reported with radiator valves not working suggest sludge is present in the system.

The radiator valves were described as in poor condition by a heating engineer engaged to dissemble and clean the valves.

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 – or allow shorter hours of operation, saving money.

7.2 Magnetic Particle Filter

A small filter of this type is fitted under the boiler itself but there does not appear to be one on the radiator circuit. Fitting one would help prevent further problems with radiator valves.

7.3 Radiator Reflective Panels

Some 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 giving it out 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. It is recommended that these panels are installed behind all radiators on external walls 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.

7.4 Control of Heating System

The system is reported as being able to heat the building from cold to about 18 degrees in 90 minutes. It may be possible to reduce this following cleaning of radiator valves and flushing the system. Purchase of a temperature datalogger will allow the heating time to be accurately measured and optimised.

Following this, the existing timer control should be reset. Alternatively, installation of a networked remote control system (such as “Hive” or “Nest”) could be introduced, which would allow the heating to be switched on and off without attending the building.

It should be noted that the system will only produce cost savings when the person programming it is familiar with how it works and can set the parameters appropriately.

8. Future Heating Options

8.1 Options Overview

The church is currently seated using 48 pews in the nave and aisles.

Fitting of under pew heaters for a relatively large congregation of up to 60 per service would be expensive, and operating costs would be higher than a heat pump. [70 heaters at £350 = £24,500].

Air to Air heat pumps deliver 4 to 5 kW of heat for every kW if electricity used. Air to air heat pumps, with internal fan heaters should be considered for when the existing heating system requires replacement (Section 8.3).

8.2 Heated Cushions

It is recommended that the church consider purchasing some heated cushions which would be suitable for very small services, so not requiring use of the main heating, or as a "top up" for cold weather for use by the elderly.

Most are now familiar with the concept of heated seats within cars and the same solution is also used in some outdoor venues such as alfresco dining and sports stadiums. These provide a heated cushion to sit on and the direct warmth from the contact areas provides a degree of comfort even when the surrounding space is cold. This can be a useful solution for churches which only have chairs (having removed pews) and/or for small congregations where there are few other alternatives.

There are a variety of heated seat cushions on the market some of which are directly plugged into a power socket (similar to an electric blanket) and others which have battery pack which can be charged and then connected to a seat pad which makes them more flexible and avoids trailing leads. The more advanced products have a pressure sensor which means heat is only provided when someone is sat upon the cushion. Heated pads for 'benches' can also be used to heat a pew or could even be adapted to form a heated kneeler for the communion rail.

A case study of a church using heated cushions is available at https://www.churchofengland.org/about/environment-and-climate-change/towards-net-zero-carbon-case-studies/marown-church-tries-new

8.3 Air to Air Heat Pumps

The church is recommended to consider this technology in the future for heating the body of the church when the new boiler eventually requires replacement - or sooner, if gas prices increase significantly compared to electricity prices per kWh.

At present, the heating in the Violet Sedgebeer room is provided by two plinth heaters under a boxed in pew (below) and one wall mounted convector. These provide 1kW of heat for each 1kW of electricity. If the winter use of this room is to be high, then it is recommended that an Air to Air heat pump system is fitted. This would (probably) involve a wall mounted internal unit on the external wall, or on the internal wall where the current wall heater is, connected directly to

an external unit placed in the least conspicuous place. This might be on the flat roof of the south aisle, nearby.

The room in question is located in the west end of the south aisle, with the two light windows on the right. There is a parapet to the low angle roof above. An alternative location for an AASHP external unit would be at ground level in the corner to the right, perhaps disguised by planting.

For this room, a 7.5kW output unit would be needed, with a capital cost around £3,500.

Air to Air source heat pumps work by having an external unit which sucks air throughout it and extracts the heat from the air. It concentrates this heat and puts it into a refrigeration gas (in the same way as a fridge or freezer works). This refrigeration gas is then piped inside the building in a small pipe where is it then allowed to expand in an internal unit with a fan. This heat is then blown out into the space. This system is identical to an air conditioning system but it works in reverse to heat the space. As warm air is blown into the space this type of system can heat spaces from cold relatively quickly. Air to Air Source heat pumps provide around 4.5 units of heat for every 1 unit of electricity used in the heat pump (it therefore has a Coefficient of Performance (CoP) of 4.5)

The heat load model in Section 6.3 indicates a 120 kW output heat pump would be required, currently the boiler has an 85kW output which appears adequate. Using the lower value would require longer hours of operation to deliver the same amount of heat, but at lower capital cost.

ASHPs require the installation of external units which look like air conditioning modules in well ventilated external locations. These external units will need an electricity supply and pipework running from them to the heating system. They will also need a drain nearby as the back of the units can build up moisture, condensing and sometimes freezing on the coils. The larger units do create some low level noise and therefore the location and baffling of the units may need to be considered carefully.

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

Internal units come in a variety of styles. The most appropriate internal units for most churches are a floor mounted units which looks very similar to a fan convector heater. They can be painted to blend in/camouflage them.

FTXM-R - Wall mount air conditioning unit

Attractive, wall mounted design with perfect indoor air quality. 2 area motion detection sensor: air flow is sent to a zone other than where the person is located at that moment; if no people are detected, the unit will automatically switch over to the energy-efficient setting.

FVXM - Floor Mount Air Conditioning Unit

Designed to fit rooms of any size and shape, it blends well with the interior due to the new design which incorporates more flowing lines and softer edges. These units are ideal when it is not possible to fit a high level wall mount unit for aesthetic or practical reasons.

They are suitable for a wide range of applications including domestic, small to medium offices and commercial uses.

All these units do have a fan element within them and therefore a small amount of fan noise is emitted. This tends to be less than a fan convector heater on a boiler based system as is similar to the noise from a fridge or freezer. Air conditioning units are commonplace in hotel rooms so the noise is low enough to be suitable for sleeping environments.

A case study of a church which has installed such a solution is available at [5. Air-source heat pumps at Hethel Church - All Saints Church, Hethel - A Church Near You]

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.

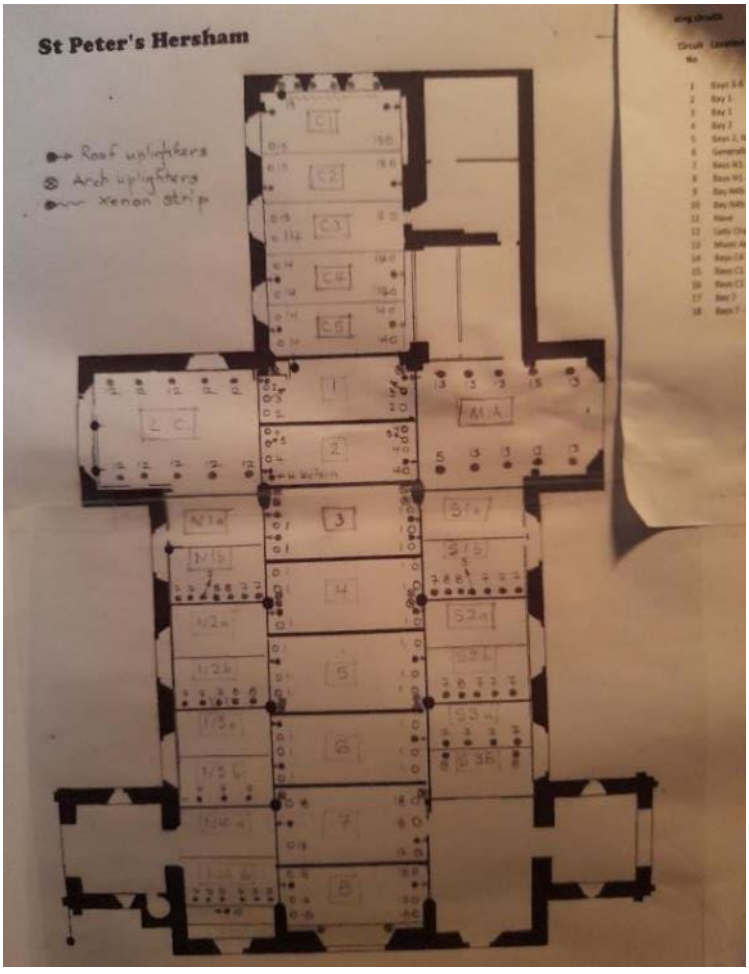
9.1 New LED Lighting

The church is equipped with a large amount of lighting as detailed in the image and list below.

Church Hersham

ıting circuits

Circuit No	Location	Function	No of Lamps	Type
1	Bays 3-6	Nave generally	23	75W 24 Degree 12v AR111 track mounted super spots
2	Bay 1	Dais	3	75W 12V 24 Degree AR111 track mounted super spots-exc
3	Bay 1	Cross	2	75W 12V 24 Degree AR111 track mounted super spots
4	Bay 2	Dais and accent to lectern and pedestal	6	75W 12V 24 Degree AR111 track mounted super spots
5	Bays 2, N1- N4 and S1-S4	Dais accents	5	75W 12V 24 Degree AR111 track mounted super spots
6	Generally	Arch, West window and Nave uplighters	39	Roof: 50W 45Degree 12v surface monuted spots. Arches:
7	Bays N1 - N4 and S1 -S4	Aisle lighting	22	50W 12V 24 degreetrack mounted spots
8	Bays N1 - N4 and S1 -S4	Aisle lighting	9	50W 12V 24 degreetrack mounted spots
9	Bay N4b	West entrance	8	50W 12V 24 degreetrack mounted spots
10	Bay N4b	Notice board	1	50W 12V 24 degreetrack mounted spots
11	Nave	Provision for rugby ball fittings in future	0	Not applicable
12	Lady Chapel	Lady Chapel	10	75W 12V 24 Degree AR111 track mounted super spots
13	Music Area	Music Area	9	75W 12V 24 Degree AR111 track mounted super spots
14	Bays C4 and C5	Chancel next screen	8	75W 12V 24 Degree AR111 track mounted super spots
15	Bays C1 - C3 and reredos	Chancel and Sanctuary	6	75W 12V 24 Degree AR111 track mounted super spots-
16	Bays C1 - C4	Chancel roof uplighters	14	Roof: 50W 45Degree 12v surface monuted spots. Arches
17	Bay 7	War memorial	2	75W 12V 24 Degree AR111 track mounted super spots
18	Bays 7 - 8	West End	9	75W 12V 24 Degree AR111 track mounted super spots



Some LED units have been installed but there are issues with the load and the control system.

The lights are dimmed to turn off, but do not appear to have a dimmed setting whilst in use. Any LED bulbs used with a dimmer controller must be compatible, otherwise the controller lifetime will be significantly shortened.

It is recommended that the church seeks advice to install an appropriate control system allowing lamps giving the lowest lighting load to be installed.

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 Lych Gate Lighting

If a new light to illuminate the path from the lych gate to the church after dark is installed; this could be a solar charged (LED) unit, equipped with two presence detectors, one pointing in each direction.

9.3 Water Heating – Instantaneous Heater

A Heatrae Sadia 25 litre water heater is located under the kitchen worktop. This appears to be turned off all the time (the switch is to the left).

Note that 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.

The church wishes to replace this unit. An instantaneous heater is recommended (with no tank). An example is the “Zip” heater. These devices can be leased as well as purchased.

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 close tightly against the stone surround and hence a large amount of cold air is coming in to the church around the side and base of these doors.

It is recommended that the draughtproofing around doors are 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 can be added, installed 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

There are several windows which have opening panels. Where these are not regularly opened, black Plasticene can be used to fill gaps where there are draughts. Any rust should be treated – rust occupies a larger volume than the parent metal, leading to distortion of frames, damage to leading and glass and further leaks.

11. Photo Voltaic Electricity Generation 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 – small system
Battery Storage	Future potential

Now that the Feed in Tariff scheme has come to an end the installation of solar PV panels in situations where there is not almost full usage of the electricity generated on site is not really viable.

The lighting could be run from solar panels, which could be sized appropriately for an all (or mostly) LED system. The electric heating installed is most likely to be run after dark (e.g. for

Monday evening Bible Class) and will have relatively low hours of use, so it is not worth installing a large Solar PV system to power this – it would generate much more than could be consumed in summer. It is suggested that an annual generation of 4,000kWh is suitable.

The only suitable section of roof is that over the south aisle which has a low parapet, and which offers a maximum area of 50m^2.

This could generate 0.15kWpeak/m^2 giving a 7.5kWpeak system. A 1kWpeak system can generate up to 1000kWh annually, giving a total annual generation of around 7,500kWh.

The angle of the aisle roof is approximately 10^o. 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
Aisle	29	4.3	0.92	1	4,000

The ability of the roof structures to support the extra loads should be discussed with the church's inspecting architect.

A 4kW peak system installed on a relatively easy access roof at 2019 prices of £1,300/kW peak would cost around £5,200.

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.

12. Funding Sources

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

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

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

13. Faculty Requirements

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

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

Under the new faculty rules;

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

List B is for works which can be undertaken without a faculty but must be consulted on with permission sought from the Archdeacon through the DAC. This includes works of adaptation (but not substantial addition or replacement) of heating and electrical systems and also the replacement of existing boilers so long at the same pipe work, fuel source and flues are used. It can also be used to replace heating controls.

All other works will be subject to a full faculty.

Works which affect the external appearance of the church will also require planning permission (but not listed building consent) from the local authority and this will be required for items such as PV installations.