ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Mary's Church, Redbourn
PCC of St Mary's Church

Author	Reviewer	Audit Date	Version
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1. Executive Summary

An energy survey of St Mary's Church, Redbourn 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's Church, Redbourn is a Grade I listed church dating from around 1100 with 14th and 15th century additions. The adjoining unlisted hall ["Transept Hall"] is to the north. [Historic England reference 1295584]. 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						
Manage control of hall heating system	20% 15,000	£864	Zero	Immediate	None	2.70
Install a remote controller for hall heating system	Included in above	Included in above	£200	1	List B	Included above
Porch Inner Door replacement	2% 1,500	£86	Unknown	Unknown	Faculty	0.27
Install Roof insulation in hall	10% 7.500	£432	£1.900	5	Faculty	1.38
MEDIUM TERM						
Install solar photovoltaic panels on south aisle roof	Up to 10,830	Up to £1,672	£14,400	11	Faculty	Up to 2.74
Replace hall boiler with Ground Source heat pump	75,000 gas	Equal	£30,000	Not recovered	Faculty	6,58
Replace Church boiler with heat pump	75,000 gas	£1,900	£21,600	11	Faculty	9.84
OR						
Install under pew heaters	75,000 gas	Equal or greater costs	£16,100	Not recovered	Faculty	1.97

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

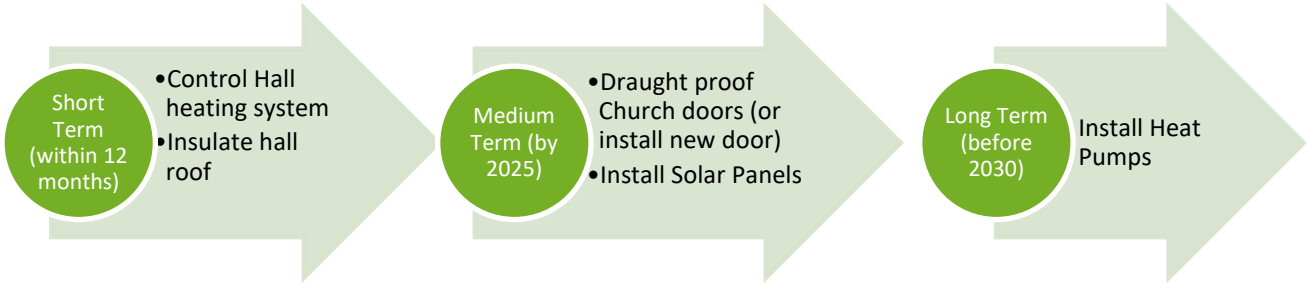
Based on current contracted prices of 15.44p/kWh and 4.643p/kWh for electricity and mains gas respectively.

If all measures were implemented this would save the church around £5,000 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's Church, Redbourn 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's Church, Redbourn, Hemel Hempstead Road, AL3 7SA was completed on the 17th 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 Paul Vernon, Church Warden.

St Mary's Church, Redbourn	CHURCH	HALL
Church Code	632250	
Gross Internal Floor Area	335m^2	210m^2
Volume	2380m^3	755m^3
Heat requirement	78kW	17kW
Listed Status	Grade I	Unlisted

The church is typically used for 14 hours per week and the hall for 16 hours per week for the following activities:

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	5 hours per week	180
Community Use	16 hours per week	Daily use by various groups School visits and 6 annual concerts
Occasional Offices	8 weddings 50 funerals 30 baptisms	100 100 50

Annual Occupancy Hours: Church 750 Hall 850

Estimated Footfall: 12,800

4. Energy Procurement Review

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

The current electricity rates are:

Single / Blended Rate	15.44p/kWh	Below current market rates
Standing Charge	27.35p/day	N/A

The current gas rates are:

Single / Blended Rate	4.643p/kWh	Below current market rates
Standing Charge	Zero	N/A

The above review has highlighted that 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. 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 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.

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

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

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

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 Mary's Church, Redbourn uses 6,200 kWh/year of electricity (2021 figures), costing in the region of £964per year, and 149,689 kWh/year of gas (2021), costing £8,644.

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	E15Z 010940	EDMI Atlas Mk7c	Yes	Porch electrical cupboard
Gas – Church	E016 K02348 20 D6	Honeywell Bk-G10E	Yes	Tower, cupboard in NW corner

All the meters 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:

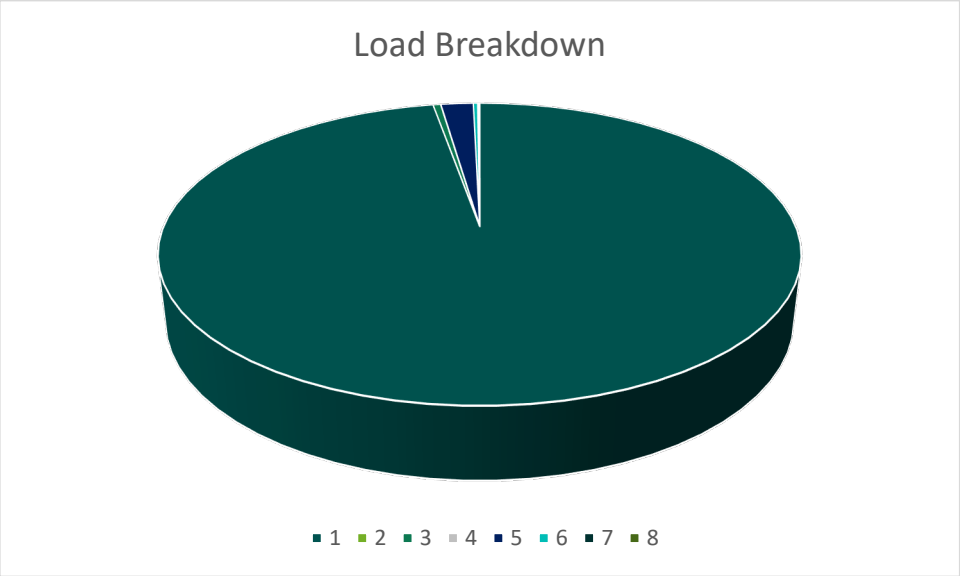
Hall items are italicised

	Equipment	Power kW	Annual Consumption kWh	Portion
Heating [Gas]	CHURCH Ideal Concord CXA Sectional Cast Iron boiler HALL Worcester Greenstar 30CDi boiler	48 30	75,000 75,000	 96.0%
Heating [Electric]	Nil			0%
Lighting [Internal]	CHURCH 750 hours use 36 LED spotlights HALL 850 hours use *30 LEDs x 7W* *3 x fluorescent T8 x F58W*	 360W *400W*	 300 *400* TOTAL 700	 0.45%
Lighting [External]	8 Floodlights, SON 250W (rarely used)	2	0	0%
Hot Water	Fixed water heater, Vestry (1 hour per week, normally off) Fixed water heater, Ariston, under kitfchen sink(4 uses/ week, normally on c 100W heat loss) *Kettle* *2 Coffee machines, regular use* *Urn* *Dishwasher, weekly use*	*3* *3* *3* *6* *2* *3*	200 *1000* *300* *900* *200* *400* *TOTAL 3,000*	 1.9%
Kitchen	*Microwave* *Fridge (on constantly)*	*1* *0.1*	*100* *300* *TOTAL 400*	 0.26%
Sound, Music	Sound system Organ	0.2 0.5	30 70	 0.06%
Small Power	Vacuum cleaner	1.5	100	0.06%

Sum of estimates: 4,400kWh

Annual site electricity consumption, 2020: 6,200kWh

The difference arises from the consumption data being from 2021 before completion of LED lighting in the church.



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

5 Hot water *6 Kitchen* *7 Sound, music* *8 Small power*

As can been seen from this data, the heating makes up by far the largest proportion of the energy usage on site. The other significant load is hot water.

5.3 Energy Benchmarking

In comparison to national benchmarks for church energy use St Mary's Church, Redbourn uses 40% less electricity and 86% more heating energy than is average for a church of this size.

It is possible that the hours of operation of the hall heating may be contributing to this, as well as a church boiler of low efficiency.

	Size (m^2 GIA)	Annual Energy Usage (kWh)	Actual kWh/m^2	Benchmark kWh/m^2	Variance from Benchmark
St Mary's Church, Redbourn (elec)	545	6,200	11.3	19	-40%
St Mary's Church, Redbourn (gas)	545	150,000	275	148	+86%
TOTAL	545	156,200	287	167	+71%

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

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.

The church is currently seated by pews in the nave; the aisles are seated with removable chairs.

The roof is too high, with closely spaced beams for installation of radiant infra red panels, plus the proximity of the organ to hight temperature panels rules out this option.

Chandelier mounted visible radiant quartz heaters (which are usually, when installed in churches, suspended from arch centres) would only align with a small number of pews here. It is not normally considered aesthetically suitable to suspend them from high nave roofs. There is always the issue of hot spots.

The unlisted hall roof offers a location for solar panels but installation may not be permissible.

6.1 Options Overview

The church is currently seated using pews in the nave and approximately 20 moveable chairs in each of the aisles. If pews are retained, fitting under pew convector heaters is one option.

The low hours of use of the church itself of around 14 hours per week is too low for technical success of an Air Source Heat Pump supplying radiators, and too low to justify capital costs of a Ground Source Heat Pump. If pews are removed, an Air to Air Heat Pump (requiring fan heaters to replace some of the existing radiators) is suggested.

The church boiler is an Ideal Concord CXA, which has a maximum efficiency of only 80% (48kW input, 40kW output).

The hall has higher hours of use (16) which are on the low side for an ASHP. GSHP installations offer higher efficiency and the land at the east of the site may offer a suitable area for this technology – it should be assessed as the potential replacement for the hall boiler when this needs replacement. The boiler, a Worcester Greenstar 30CDi of 30kW is relatively recent and should offer an efficiency of around 92%.

6.2 Fuel Supply

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.

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 Manage Hall Heating System

The hall boiler was found to be running and the radiators hot on a day when the external temperature was 21°C. Boiler control timings call for heat from 0900-1230 and 1300-1630; 210kWh which produces 38.6kg of CO_2.

It is recommended that installation of a Remote control operating system such as Hive or Nest would allow the heating to be switched on and off without attending the building, which would save transport energy and facilitate hall bookings at short notice.

The Honeywell controller is relatively easy to programme, but does not offer remote operation.

8. Future Heating Options

It is recommended that plans are developed for replacement of the boilers by the end of the decade.

8.1 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

Poorly insulated	0.033kW/m^3
Well insulated	0.0022kW/m^3
Insulated to 2010 regulations	0.0013kW/m^3

Area	Volume m^3	Insulation Factor kW/m^3	Heat Required kW
Church	2380	0.0033	78

Hall No roof insulation, double glazed	775	0.0022	17
Hall, with added roof insulation [10% improvement]	775	0.0020	15.5

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 750 hours and the hall 850, with boiler powers of 48kW and 30kW respectively. Assuming that the heating season is 30 weeks, adding two concerts, 4 weddings and 30 funerals gives 66 heating episodes. At ten hours each for preheating, this is 31,680kWh.

Daily hall heating for seven hours over 30 weeks sums to 44,100kWh. This sum is only half of the annual bill total which suggests further investigation is necessary to determine why use is high (December to February).

For the calculations below, a 50/50 split between church and hall heating consumption has been used.

Area	Estimated split kWh	Boiler power kW	Annual use hours
Church	75,000	48	1562
Hall	75,000	30	2500

8.2 Heat Pump Overview

Heat Pumps are a low carbon method of creating heat.

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.

Ground Source Heat Pumps [GSHP] deliver more heat per kW of electricity consumed than for Air Source. (This is measured by the Coefficient of Performance, or COP. 4 is a reliable assumption).

They require either a sufficient area of land to lay subsurface pipes or a borehole. It may be possible to utilise the adjacent land to the east of the church for subsurface pipes as it does not appear to have been used for burials.

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. Both church and hall have low weekly hours of use, so this could lead to a situation where the pump is unable to run its defrost cycle.

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 small available area of the south aisle roof means that the majority of electricity will still be required from the grid.

8.3 Replace Hall Boiler with a Heat Pump

If the heating power is the same as the current boiler, a 30kW output Ground Source Heat Pump operating at CoP 3.5 requires 8.5kW of electricity.

With the total number of heating hours for each section of the building uncertain, a comparison per hour will be used:

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 4.643p/kWh = 139.3p/hour

GSHP costs 8.5kW x 15.44p/kWh = 131.2p/hour

The heat model, estimating a steady state heat loss rate of 17kW means that if the building is in regular use and thus heated for a greater proportion of the time, a smaller capacity unit is required. This would cut capital and operating costs, but would create a system which took longer to heat from cold.

There is a large area of land to the E and SE of the site which does not appear to have burials and therefore could be investigated for suitability for ground source heat pump use.

8.4 Replace Church Boiler with a Heat Pump

The current boiler specifications are 48kW gas input giving 40kW output, 83% efficiency when new. Comparative costs for heat pumps involve specifying an equal heat output of 40kW. This will result in a similar heating rate from cold IF the system is used to provide specific heating episodes. The heat calculation model predicts a larger requirement of 78kW – it is likely that the current boiler is underspecified and that larger plant would be required.

Air to Air pumps have their own internal fan units which could be installed in place of some of the radiators. This gives the advantage of more rapid heating times with warm air being blown directly at floor level, rather than convecting up to the ceiling from the radiators to begin with.

Costs below are calculated as follows:

Gas boiler operating costs 48kW gas input x 4.643p/kWh = 222.8p/hour

GSHP operating costs [CoP 3.5] 11.4kW x 15.44p/kWh = 176p/hour

Location	Item	Power input kW	CoP	Power Output kW	Capital cost £	Annual hours	Operating cost Pence Per hour	Annual Cost £
Church	Gas boiler	48	0.83	40	/	1,562	223	4,322
Hall	Gas boiler	30	0.93	28	/	2,500	223	4,322
Hall	GSHP	11.4	3.5	30	30,000	2,500	176	4,400
Hall	ASHP	16	2.5	30	12,000	2,500	247	6,175
Church	AASHP	10	4	48	21,600	1,562	154	2,405
Church	Under pew electric	29.9	1	29.9	16,100	1,562	461	7,200 *

- Under pew costs assume same operating hours. More preheating use would increase, but less use for small congregations and early and late in the heating season would reduce.

8.5 Install Electric Under Pew Heaters

If the pews are retained, fitting under pew convector heaters allows targeted heating. Heat is delivered exactly where required, for a small congregation only a suitable number of pews need to be fitted, or where numbers vary, just those required can be used. For particularly cold periods, the heaters can all be turned on in advance and used to preheat the building.

There are 23 pews, most of which could accommodate two 90cm heaters under the seats.

46 x 650W = 29.9Kw heating capacity x 15.44p/kWh = 461p/hour.

46 x £350 installed cost = £16,100

Although the heating capacity is less, all of the heat is being delivered where required.

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.

Cable runs to the pew heaters could run under the wooden pew platforms. 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.

8.6 Upgrade to 3 Phase Electricity Supply

For under pew heating, the requirement of about 30kW is greater than the maximum a single phase of power can provide (23kW).

To be able to have sufficient electrical power to supply enough energy into an electrical heating system the church will need to increase the electrical supply it current has coming in from the existing single phase 100A supply to a 3 phase 100A supply.

The upgrade to the supply has to be carried out by the District Network Operator in the areas.

The DNO in your area is UK Power Networks - www.ukpowernetworks.co.uk; 0800 029 4282 (London, South East and Eastern England)

The cost of bringing in a new 3 phase supply can range from £300 to £30,000 but the DNO will provide a quotation for free so it is well worth obtain a quotation in the short term so that decisions can be made on a well informed basis.

8.7 Replace the Existing Boiler for a High Efficiency Condensing Boiler

If, on receiving detailed quotations from suppliers, a heat pump is not possible and pews are to be removed, installation of a high efficiency condensing boiler is the remaining option.

This will increase efficiency from 83% 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), this will lead to gas use and operating cost increases.

9. Energy Saving Recommendations

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 Fixed Water Heater: Timer Control

An Ariston 15 litre water heater is located under the kitchen sink. This appears to be turned on all the time. Whilst the tank itself is well insulated, the copper pipework 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. It is recommended that, if used regularly, it is fitted with a 24 hour/7 day timeclock to replace the fused spur switch. An example of such a unit would be a TimeGuard FST77. They should be set up with times to match the times that the building is occupied This will prevent the standing losses from the unit wasting energy during periods when the building is not occupied.

Note that a 15 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 hall 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 kitchen 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.

A second unit is located in the vestry, believed to be normally turned off. Provided that it is only on when required and it is remembered to turn it off after each use, further action is not required.

9.2 Draught Proof External Doors

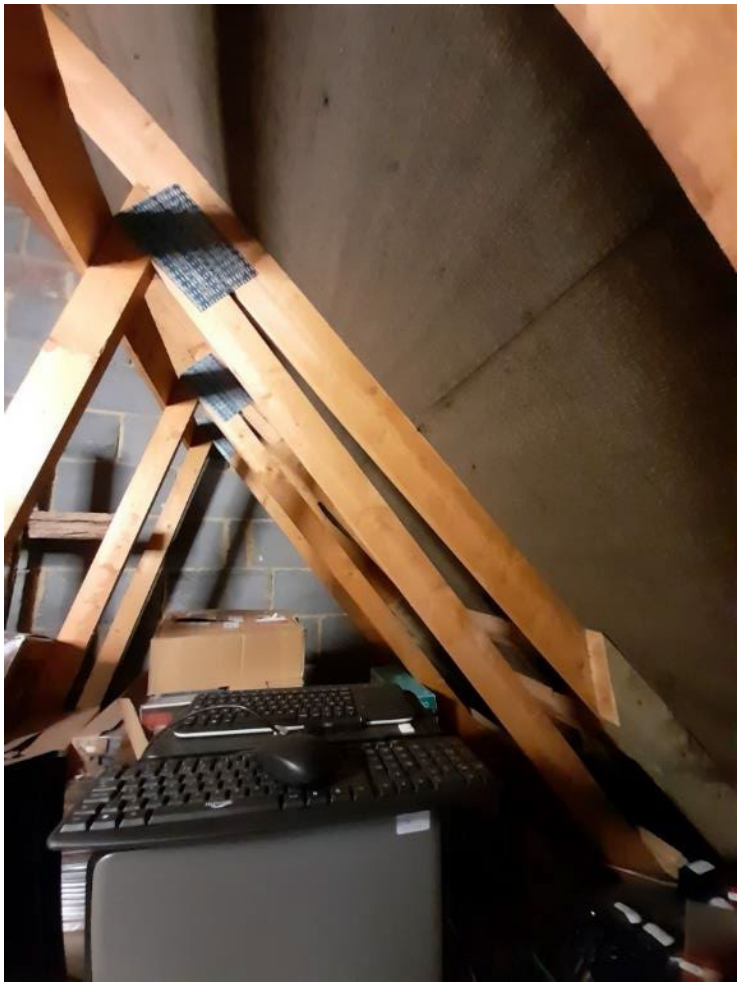
The church is planning to replace the current internal wooden door, which is believed to have been installed in 1930 (coming from another site) with a glass door (or pair of doors). It is recommended that these be installed in such a way as to stop draughts when they are closed.

9.3 Insulation to Hall Roof

The loft void next to the first floor room of the hall was inspected as part of this audit and found to have little or no insulation present, only roofing felt could be seen. In all cases where there is 100mm or less of insulation within accessible roof spaces it is recommended that insulation be added to prevent heat loss and create a more comfortable environment for the occupants of the building.

The ceiling/roof of a building is the largest contributing area to heat loss from a building, as heat rises. The insulation of such spaces can therefore have a dramatic impact on both the efficiency of the heating system and the temperature of the space below.

Ceiling insulation for an area of 200m^2 would cost approximately £1,900.



10. Saving Recommendations (Water)

10.1 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/

11. Other Recommendations

11.1 Electric Vehicle Charging Points

The church has a small car park on the south side of the site which serves the church and also the frequently used church hall. In order to make a visible statement on the churches mission of stewardship and to facilitate more sustainable transport choices by those both visiting the church and using the hall, the church may wish to consider installing an electric vehicle charging point, probably on the side of the church hall to allow visitors to charge their electric car.

Installing a unit such as a Rolec Securi-Charge http://www.rolecserv.com/ev-charging/news/view/Robust-EV-Charging-With-Rolecs-SecuriCharge-EV-Wall-Unit-Coin-Token-PAYG would allow the organisation control over who is allowed to use the unit with a key operated system. Or given the type of use of the building and control over the usage of the car park as a whole a simple 32 amp type 2 wall pod type charger may be most suitable and these are widely available through many suppliers such as http://www.rolecserv.com/ev-charging/product/EV-Charging-Points-For-The-Home.

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	Possible
Ground Source Heat Pump	Yes for hall
Air to Air Source Heat Pump	Yes

12.1 Solar Photovoltaic Panels

Most of the roof is visible from the ground apart from the south aisle which has a low parapet.

The north side of the hall roof may offer a further site, however this also is shaded by trees.

The aisle roof, together with the tower offer areas of around 50m^2 and 20m^2. This could generate 0.15kWpeak/m^2 giving a 10.5kWpeak system. A 1kWpeak system can generate up to 1000kWh annually, giving a total annual generation of around 10,500kWh.

The angle of the church roof is approximately 10^o and the tower roof will be considered as flat.

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	60	9	170 degrees / 10^0 0.92	1	8,280
Tower	20	3	170 degrees / 0^o 0.85	1	2,550
Total	80	12			10,830

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 (6,200kWh in 2019). 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, if heat pumps achieved an average of CoP 3 this would require 50,000kWh of electricity, so there would still be reliance on grid electricity (which should be sourced from a 100% renewable supplier).

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 12 kWpeak system would cost £17,400.

12.2 Biomass Boiler

The client is interested in this technology.

For biomass to be viable, the system needs to be regularly used. There needs to be a plant room of considerable size to house the boiler, the feed hopper and mechanism and to store suitable quantities of bagged fuel for about 6 months. A long term supply contract is desirable, ideally sourcing local biomass and not relying on imported material.
There should be no local air quality issues (this rules out urban deployments. The proximity of the church to the M1 may be an issue with high background particulate levels already).
Biomass systems have high maintenance requirements; there need to be a couple of people available to regularly reload the pellet hopper and clean out the dust - it is labour intensive and there seems to be much more work to do than simply setting a boiler timer. [It has worked well at a church next to a school who share the boiler where the caretaker manages it].
For these reasons it is not recommended for St Mary's where there is no suitable location for the plant room.

13. Other Items

The downpipes empty onto stone gulley's around the base of the walls leading to drains. There were places which were noted to have a lot of growth which could lead to clogging – this was reported as having been picked up by a Quinquennial Inspection and needed to be addressed.

Drainage (or lack of) can have an effect on energy use if water is retained within the building fabric; evaporation causes cooling, and heat provided will be absorbed by any excess water present.

14. 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 .

15. 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.