Energy Efficiency and Zero Carbon Advice

St Matthew's Church, Ealing
PCC of St Matthew's Church

Author	Reviewer	Audit Date	Version
Paul Hamley	Tamsin Hockett	31st October 2022	1.2

Contents

1. Executive Summary

An energy survey of St Matthew's Church, Ealing 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 Matthew's Church, Ealing is a Victorian era church dating from 1884, constructed of brick. It is Grade II listed and described as being "remarkably intact".

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						
Contact suppliers to arrange for the meters to be changed to smart meters	None	None	Nil	N/A	None	N/A
Switch electricity (and gas) suppliers to ones which provide 100% renewable (or green gas) supplies	None	None	Nil	N/A	None	Offset 4.4 tonnes
Insulate pipework in boiler room	5% 5,250	£595	£200	1	None	0.94
Clean and flush central heating system	7% 7,350	£833	£500	1	List A	1.32
Install draught proofing measures	2% 2,100	£238	£200	1	List B	0.37
Install Double glazing in hall	15% 2,700	£306	£7,000 quoted	23	List B	0.48
Complete LED lighting installation in chancel	1,000	£159	£600	4	List B	0.21
MEDIUM TERM						
Install ceiling insulation in hall	10% 1,800	£204	£800	4	List B	0.32
Install under pew heaters for selected pews (and choir stalls)	105,000 gas Use 7,000 electricity	£10,000 At new gas rates	£21,000	2	Faculty	18.9

Install secondary glazing to choir vestry	250	£40	£2,000	50	Faculty	0.05
Install ceiling insulation in vestry	250	£40	£300	7.5	Faculty	0.05
Install Air to Air Heat Pump in choir vestry (for daily nursery use)	2000	£317	£1,800	6	Faculty	0.42
LONG TERM						
Replace hall boiler with air to air heat pumps	18,000 gas Use 4,500 electricity	£1,800	£3,600	2	Faculty	1.72
Install solar photovoltaic panels on hall roof	9,450	£1,900	£13,650	7	Faculty	2.0

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

Based on the current contracted price of 15.878p/kWh (church) for electricity and the tariff applying from March 2023 of 11.33p/kWh for mains gas respectively.

The Hall is currently out of electricity contract and has been supplied at 52p/kWh, with 13.5p/kWh for mains gas (contract from October 2022).

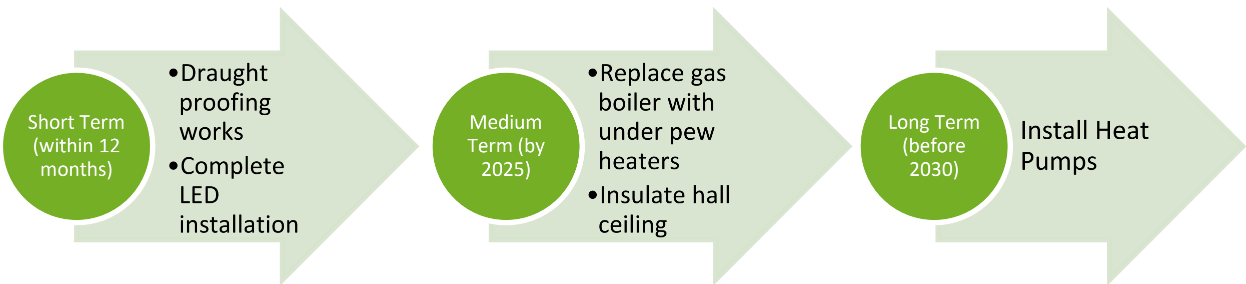
If all measures were implemented this would save the church around £16,000 per year in operating costs against future costs of Around £18,000.

Items highlighted in bold are the most beneficial interventions.

2. The Route to Net Zero Carbon

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

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



3. Introduction

This report is provided to the PCC of St Matthew's Church, Ealing 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 Matthew's Church, Ealing, North Common Road W5 2QA was completed on the 31st October 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 Sarah Spain, Administrator, Lucie Eastwood, Treasurer and Claire Oberman PCC Vice Chair.

St Matthew's Church, Ealing	CHURCH	HALL
Church Code	623449	
Gross Internal Floor Area	770m^2	80m^2
Volume	8,000m^3	280m^3
Heat requirement	266kW	9kW
Listed Status	Grade II	Unlisted

The church is typically used for 16 hours per week with an extra 20 hours use of the choir vestry by the nursery, and the hall for around 67 hours per week for the following activities:

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	12 hours per week	50 morning 100 afternoon – hired to another congregation
Church Meetings and Groups	4 hours per week	
Community Use	Choir Vestry. 20 hours per week by nursery	

Annual Occupancy Hours: Church 830 Hall 3,500

4. Energy Procurement Review

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

The current electricity rates are:

Meter, Allocation	Rate, p/kWh	Standing Charge
S84R 82613 (centre, red phase) Church	15.878	£21.35/quarter 23.4p/day
K77C 12395 (right, blue phase) Vestries (& organ?)	12.338	£17/quarter 18.63p/day
K77C 01491 (left, yellow phase) Hall	52.34 [Out of contract]	101.46p/day

Supplier SSE, Contract End Date March 2023

The current gas rates are:

Meter, Allocation	Rate, p/kWh	Standing Charge, p/day
Church	Current 4.72 From 6/3/23 11.33	Current Zero From 6/3/23 74
Hall	13.5	25.2

Supplier SSE, Contract End Date March 2023

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

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 Parish Buying scheme, http://www.parishbuying.org.uk/energy-basket.

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

VAT	20% on some electricity bills	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	Climate change levy has been applied to some electricity bills. This is charged when consumption for a particular month exceeds 1,000kWh and a charity declaration has not been received by the supplier	As the organisation is being charged the wrong VAT rate they are also being charged CCL which should not be applied as they are a charitable organisation. Sending the supplier a VAT declaration will remove this charge.

The 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

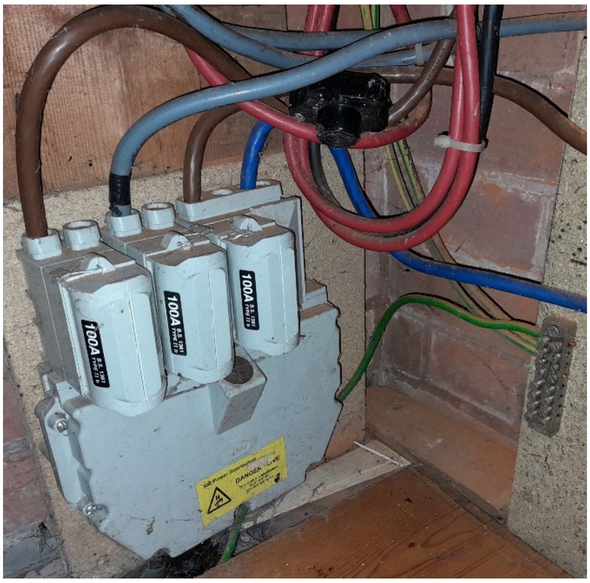
St Matthew's Church, Ealing used 21,160kWh/year of electricity over the year from May 2021 to May 2022, costing £2,876 for the year (sum of church costs) and an overall site annual cost of around £4,000 including the hall.   Consumption was divided between church: 7516kWh, Vestries/organ: 8144kWh, Hall: 5,500kWh.

Gas use for the church was around 105,000kWh for the same period (having been 178,000kWh pre pandemic). costing around £5,200 at the current rate.   Hall use of around 18,000kWh annually cost in the order of £1,000 p.a. at former rates.

This data has been taken from a detailed summary of consumption, tracked from 2019, provided by the treasurer.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity - Church	S84R 82613 (centre, red phase)	Dial Meter	No	Corner of "S" aisle Central meter
Electricity – Vicar's Vestry (possibly choir vestry and organ also)	K77C 12395 (right, blue phase)	Dial Meter	No	Right meter
Electricity - Hall	K77C 01491 (left, yellow phase)	Dial Meter	No	Left meter
Gas – Church	M016 K06024 14 D6	Elster Bk-G10M metric	Yes	Entrance porch cupboard

Note that the phase colour designations displayed on the meters do not correspond to the wiring colours.



It is recommended that the church consider asking their suppliers to install smart meters so that the usage can be monitored more closely, and the patterns of usage reviewed against the times the building is used. At this time the church may wish to consider asking for one three phase meter to be installed rather than three single phase meters as this will reduce the standing charges and make procurement of the electricity contracts simpler.

5.2 Energy Profiling

The main energy consuming plant can be summarised as follows:

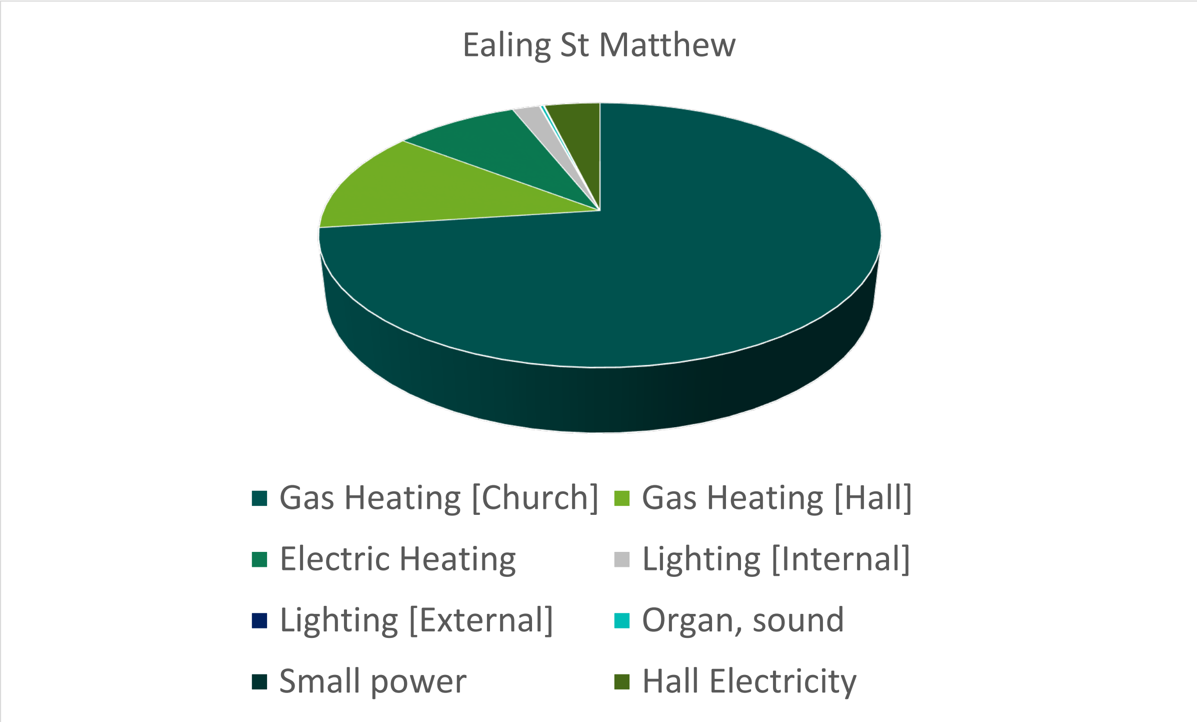
	Equipment	Power kW	Annual Consumption kWh	Portion
Heating [Gas]	CHURCH Songiorgio Regency SLP3/4 sectional boiler 112kW input, 92kW output (82%) [c, 1000 operating hours] HALL Not observed	 112 25?	105,000 18,000 TOTAL 123,000	%
Heating [Electric]	Boiler circulation pump Nave, radiant overhead quartz heaters, 18 elements. Possibly 8 hours operation per winter Sunday Chancel, 3 elements Choir vestry, 3 elements + wall mounted electric radiator Daily Morning nursery use	0.3 27 4.5 4.5 3	300 7500 1000 2000 1500 TOTAL 12,300	0%
Lighting [Internal]	CHURCH 830 hours use Mostly converted to LED, not dimmed 96 pillar mounted x 6W Chancel 15 mercury arc floodlights 4 LED floodlights 3 halogen R7s floodlights Chapel 24 chandelier mounted Choir vestry 6 LED chandelier, 10 LED spots Vicar's vestry and corridor 2 fluorescent F58W, 2 CFL 18W	 576W 1500W 200W 750W 144W 100W 150W	 500 1200 170 620 80 100 30 TOTAL 2,700	%
Lighting [External]	6 Bulkhead security lights	250W	100	0%
Sound, Music	Sound system Organ	0.2 1	100 200	%
Small Power	Vacuum cleaner	1.5	100	%
Hall Heating and Lighting			5,500	%

Sum of estimated electricity consumption (does not include the hall which is separately metered): 15,500kWh

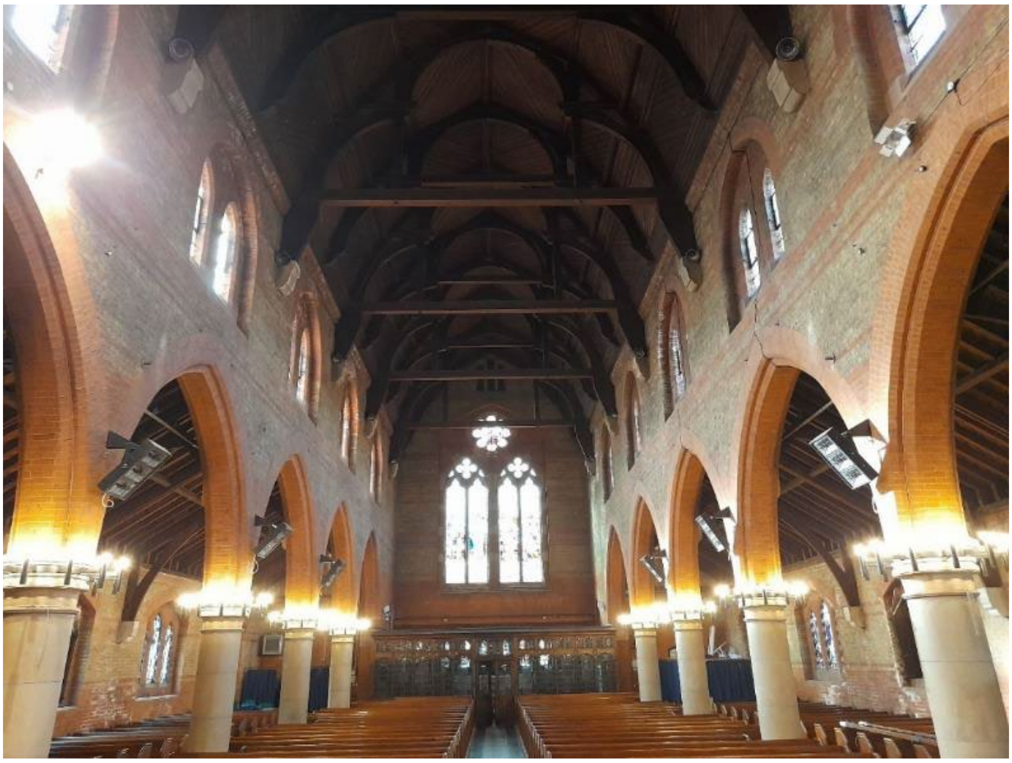
Annual church electricity consumption (sum of two meters), 2021-22: 15,660kWh

Annual site electricity consumption including hall), 2021-22: estimated at 21,000kWh

Since which meter feeds exactly which area in the chancel / chapel / vestries / organ area is not clear, the consumption data is combined.



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 electric heating in the church.



6. Efficient / Low Carbon Heating Strategy

6.1 Reducing Environmental Impact

The energy used for heating a church typically makes up around 80% to 90% of the overall energy consumption. Heating also often uses gas or oil as its primary fuel, these are fossil fuels with high carbon emissions and little opportunity to decarbonise in the future. Electricity currently has carbon emissions of around the same level as mains gas but the carbon emissions associated with electricity are reducing rapidly as the UK builds more renewable energy and decommissions its remaining coal fired power stations. Mains gas does have some potential to reduce its carbon content through the use of bio gas and hydrogen but these are less developed solutions and will be unable to deliver 'zero carbon mains gas'.

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.

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 should develop a boiler replacement plan, by obtaining detailed quotations for the options presented in this report. Where electric heating can be obtained at similar or lower operating cost, this is recommended.

6.2 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	8,000	0.033	266
Choir vestry	775	0.0022	17
Hall	775	0.0020	15.5

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

Area	kWh	Boiler power kW	Annual use hours
Church	105,000	112	940
Hall	18,000	Averaging 15	1,200 (40 hours/ week x 30 weeks

7. Improve the Existing Heating System

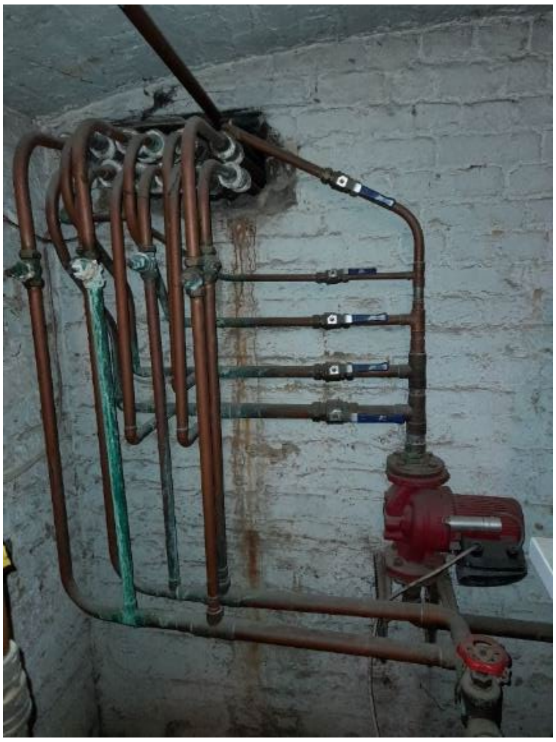
In the years before the replacement of the existing heating system it is recommended that measures are taken to improve the efficiency of the existing heating system, this should include:

7.1 Insulation of Pipework and Fittings

Insulate exposed pipework and fittings around boilers and tanks

The pipework within the boiler room is not insulated. These exposed areas of pipework contribute significantly to wasted heat loss from the system.

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



7.2 Clean the Existing Heating System

Magnetic sludge circulates within heating systems and prevents the proper and efficient operation of the system by reducing the ability of the boiler to heat up the water and reducing the output of the radiators. It is similar to how scale build up can adversely affect kettles and showers.

It is strongly recommended that the heating system is cleaned to remove this sludge from the system, this is done by using a chemical clean and/or power flush procedure where cleaning chemicals are put into the system which is then turned on and run through a filter consisting of high power magnetics to remove the sludge.

The cleaning of a heating system can be carried out by any competent heating engineer and typically increases the efficiency of a system by between 10 to 15%. This can dramatically improve comfort for the congregation.

8. Future Heating Options

8.1 Options Overview – Building use pattern and seating.

The church is currently seated using a large number of pews in the nave and aisles.   The listing entry for the church describes it as "intact"; thus it is less likely that permission would be given for pew removal.

The current provision of central heating consists of pipes mounted in trenches (with no radiators) and overhead radiant heaters.

Space heating by convection via these pipes will be slow: firstly due to the collection of warm air under the roof, which cools, with the level of warm air gradually falling towards the seated area and secondly due to the poor airflow under the pipes.

Future replacement of the boiler with more efficient condensing boilers (increasing efficiency from 82% to 93-95%) would not overcome these drawbacks.

Replacement of radiant overhead heaters with under pew heaters would, for the same use of electricity, deliver heat directly to (under) the congregation and not require the long preheating times of a space heating system (as well as deliver aesthetic benefits). However, if all the pews were equipped, this would be an expensive solution, both for capital and operating costs.

If the congregation remains relatively small, it is recommended that a selected number of pews only are fitted with under pew heaters. This gives the lowest capital and operational expenditures.

If it is considered that the congregation will grow, or there will be several concerts held in winter, and the church using the building on Sunday afternoons uses the majority of the seating, then

(i) heating serving the whole area rather than a selected portion is required.
(ii) this leads to higher operating costs

Both (i) and (ii) can be addressed by using a Heat Pump system, delivering around 4kW of heat for every 1kW of electricity used.

With no radiator network, an Air to Air Heat Pump system is recommended.

The chapel could continue to be heated by overhead radiant heaters (which are suited to short meetings, and give instant heat).

The Choir Vestry is used by the nursery during mornings. This is currently heated by one radiant overhead heater and an electric convector heater, made very inefficient by enclosure within a wooden cabinet (necessary to meet surface temperature regulations for young children).

If an AASHP system was installed, this regularly heated room should also be equipped, but as a separate zone with the heating operating independently. This would require around one quarter of the electricity to operate.

Above, triple quartz radiant heating unit.

Below, boxed in electric heater in choir vestry.

The roof is too high (peak 15.7m) for the installation of radiant infra-red panels, plus the diagonal planking is a feature of the listing designation.

8.2 Install Electric Under Pew Heaters

Electric under pew heaters provide a high level of thermal comfort to people sat in the pews. They are not installed to try and heat the entire air volume of the church, instead thermal comfort is achieved through a flow of warm air rising past the person in the pew. This means that the heaters should be installed under the entire length of all the pews that are likely to be used.

These heaters warm up almost instantly and a flow of warm air over the pew area is created within around 15 minutes of their being turned on. This significantly reduces the amount of preheating required before each use of the building and can make electric heating cost competitive with gas. It is important that this reduced 'on time' is properly reflected in any comparisons with other types of heating.

We would therefore suggest that the following works could be considered:

Install under pew heaters suspended from brackets from the underside of the pew seats as follows:

North nave, 10 rows with three 650W heaters in each row between uprights

South nave, 10 rows with three 650W heaters in each row between uprights

This would provide heated seating for 100. It is possible to alternate heated and unheated rows of pews to give a more widely distributed system.

The main pews in the nave are mostly 4.0m long between ends with two supports under , thus accommodating three of the longer type of heaters.

Capital cost: 60 x £350 (2019 installed price) = £21,000

Present Operating cost: 30 Sundays x 6 hours x 60 x 0.65kW x 15.878p/kWh = £1,115

7020kWh. [Assumes all heaters on for the full period of use]

Cable runs to the pew heaters should run along the along the existing routes (all cabling should be in armoured cable or FP200 Gold when above ground) to both rows of pews. Each pew heater to be switched with a neon indicated fused spur located underneath the pew seat.

A master controller should be fitted with a timer.

The eight high level radiant heaters within the nave should be removed completed with all associated cabling back to the distribution boards.

A similar installation could be fitted to the choir stalls, if so desired.

A case study of a church which has adopted this solution is available at https://www.churchofengland.org/about/environment-and-climate-change/st-andrews-chedworth-electric-heating

Photos of installations are shown below.

Brown BN Thermic 650W under pew heaters fixed to underside of pew seats for pews which have no solid backs.

Black 650W Norel under pew heaters fitted to solid pew backs.

8.3 Air to Air Source Heat Pumps

Air-to-Air Source Heat Pumps (AASHP) work by having an external unit which sucks air in and extracts the heat from it. The pumps concentrate this heat and put 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; they therefore have a Coefficient of Performance (CoP) of 4.5.

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.

AASHPs 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, which condenses and sometimes freezes 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 (10kW output each) and two larger 10kW units (37.5kW output each). Together they supply a building of 660m².

Internal units come in a variety of styles. The most appropriate internal units for most churches are floor mounted units which look very similar to a fan convector heater.

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

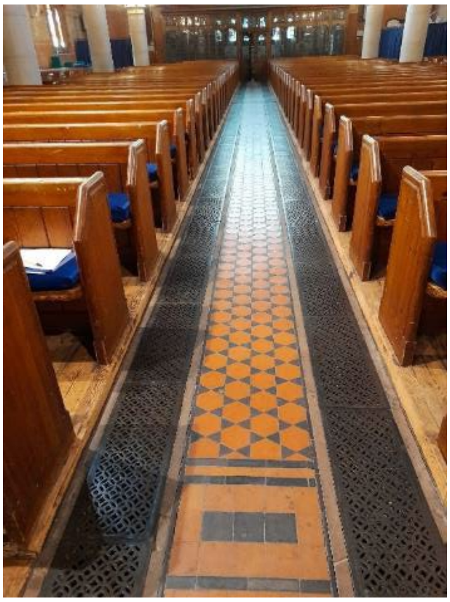
Designed to fit rooms of any size and shape, it blends well with the interior due to the new design which incorporates more flowing lines and softer edges. These units are ideal when it is not possible to fit a high level wall mount unit for aesthetic or practical reasons.

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 and similar to the noise from a fridge or freezer. Air conditioning units are commonplace in hotel rooms, indicating that the noise is low enough even 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

The church has a network of underfloor heating ducts where the current 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 to accommodate the fan units).   Other internal fan units could be installed at floor level,



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. The rear of the church behind the choir vestry, apse and chancel offers a location for the equipment. Hedge planting has been used to hide oil tanks at some churches; there may be locations within the existing planted area.

The shed (with blue door), which has structural problems, could be de-roofed and provide a location.

8.4 Air to Air Source Heat Pumps Costs

The heat load model indicates a 266kW requirement. The boiler output is 92kW and the radiant heaters add a further 40kW (approximately).

Pumps to supply 266kW of heat (with capital cost estimated at £450 per kW output: £119,700) would deliver the same amount of heat annually, 105,000kWh, as the current system – over about 400 hours.

The current space heating system is run for an estimated 1000 hours. Installing a similar powered heat pump system, (less power output than above but run for longer) would have a lower capital cost.

Pumps to supply 100kW of heat (with capital cost estimated at £450 per kW output: £45,000) would deliver the same amount of heat annually, 105,000kWh, as the current system – over about 400 hours.

Delivery of 105,000kWh of heat at CoP 4 requires 26,250kWh electricity, costing £4,168.

9. Energy Saving Recommendations

9.1 Lighting

Most of the lighting is LED (as above), but the chancel is lighted by some high level mercury arc lamps and at lower level, there are three halogen lamps (above, right) containing 250W 118mm R7S bulbs.

There is a further LED replacement of similar size. It is recommended that the halogen lamps are replaced by LED units [R7S linear slim LED halogen replacement 118mm].

(many LED units are too large in diameter to fit in the housing)

10. Energy Saving Recommendations – Building Fabric

10.1 Draught Proof External Doors

There are a number of external doors in the church. The original historic timber doors do not close tightly against the frame or floor and consequently a large amount of cold air is coming in to the church around the 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, could be used. 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.

The choir vestry door keyhole could be addressed using a small cover affixed by blu tack.

10.2 Windows

Where there are opening panels such as sliding sections or hinged hopper windows and there are draughts, gaps can be filled with black plasticene. Often, windows do not shut because of a build up of paint, or corrosion which causes frame distortion and further water ingress. Where this has occurred they should be repaired.

10.3 Secondary Glazing

The windows of the building are singled glazed with metal frames. It is not possible or desirable to change the window(s) as the building carries listed status. Most of the building is not used frequently enough to justify secondary glazing. The choir vestry is both used daily by the nursery and described as cold. It is fitted with steel grilles outside the windows; it is suggested that external secondary glazing be fitted between the grilles and the current glazing. This would not be noticeable from either side.

The introduction of secondary glazing would considerably reduce the heat loss through the existing windows and improve both thermal comfort and noise levels 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 Ceiling Insulation

The Choir vestry would benefit from installation of ceiling insulation, if permissible. This is envisaged as using panel materials installed under the ceiling.

11. 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	For Hall
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	Church - No, lack of radiator network Hall – Yes if radiators compatible
Ground Source Heat Pump	No - no radiator network
Air to Air Source Heat Pump	Yes

11.1 Solar Photovoltaic Panels

The roof is oriented north – south and offers a location on the east facing side which is virtually invisible from the road (above). However, apart from low (energy) use of the choir vestry, the rest of the building is in low use apart from Sundays so the costs of a solar PV system will outweigh the benefits.

For the hall, which is in daily use, installing solar panels on the flat roof would be justified.

The hall roof offers an area of around 70m². This could generate 0.15kWpeak/m² giving a 10.5kWpeak system. A 1kWpeak system can generate up to 1000kWh annually, giving a total annual generation of around 10,500kWh. There is some shading from adjacent buildings and trees.

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/m² x 1000kWh/kWp x Orientation Factor x Overshading Factor.

Roof Section	Useable area / m²	System Size / kW peak	Orientation factor	Shading factor	Annual Generation, kWh
Hall	70	10.5	180 degrees / 35^0 1.00	0.9	9,450

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.

It is double the current consumption of the hall, approximately 5,000kWh. If a heat pump is installed in the hall a solar PV system of this size would be justified. Otherwise, a 6kWpeak system generating what can be consumed is recommended. Most of the hall consumption will occur in daylight hours.

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 for simple systems (£1,300 per kWpeak); a 10.5 kWpeak system would cost £13,650.

12. Hall

12.1 Hall Double Glazing

A quotation has been received by the church for replacement of the hall windows for £7,000.

The building has an internal area of approximately 80m^2, an estimated heat loss of 8kW (it has solid walls, Flemish bond) with an annual heating cost around £2k.

It was not possible to enter the building as it was in use by a nursery but external dimensions were taken.

Installing double glazing will save around 15% of heating costs, which is justified for a heavily used building, approximately 67 hours weekly. Savings of around £300 annually (at current rates) gives a payback period of 23 years. [This will reduce if gas costs rise faster than general inflation]. Investing this amount into a heat pump would result in greater decarbonisation and cost reduction, although double glazing would still be beneficial.

12.2 Insulation to Roof

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 80m^2 would cost approximately £760.

[Cost estimate £9.50/m^2]

12.3 Replace Hall Boiler with a Heat Pump

When the boiler requires replacement; an Air to Air heat pump system is recommended. Capital costs are similar to air to water units, but they provide 4 to 5 kWh of heat per 1 kW of electricity input as opposed to 2.5 and are therefore much cheaper to run. Also there are no issues of corrosion associated with retaining an existing radiator network, and the fan heaters warm the building more rapidly. Small external units linked to one or two internal units each are suggested.

An 8kW output unit would have a capital cost around £3,600.

13. Other Observations

13.1 Health and Safety concerns noted on site

The boiler room steps are covered by a hinged lid. This is very heavy and could not be opened during the visit, rendering access awkward. Options for improving access to the boiler room could include:

- Maintenance and installation of a counterweight to assist opening (probably the most difficult option).
- Raising the whole unit to give more clearance (then no need to hinge open).
- Removing the end panel to give more clearance and adding a door (thus preventing items being thrown down the steps).

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.