ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Michael and All Angels, Bedford Park, Chiswick
PCC of St Michael's Church

Author	Reviewer	Date	Version
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Contents

1. Executive Summary

An energy survey of St Michael and All Angels was undertaken by Inspired Efficiency 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 Michael and All Angels is a Victorian Church built of brick in 1880.

There is both gas and electricity supplied to the site.

The church has a number of ways in which it can be 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)
Investigate a group purchasing scheme such as Parish Buying	N/A	5-15% likely	Zero		None	
Install pipe insulation to air/dirt filter piping of hall system	1% 630	20	£20	1	List A	0.1
Install Endotherm heat transfer fluid in both systems	10% 8,500 CH 6,300 H	248CH 205 H	£600	1.5	List A	2.7
Flush and clean both systems	7% 5,950 CH 4,410 H	174 CH 144 H	£800	<2	List A	1.9
Install draught proofing strip to church entry doors.	5% 4,250	124	300	2	List B	0.78
Complete replacement of non LED light bulbs [focus on large spotlights and rectangular floodlights]	Dependent on how many have been changed to date. Estimate 10,000	1,240	£500 (several LED in stock at present)	2.5	None	2.5
Install Magnetic Particle Filter to church heating system	2% 1,700	49	£500	10, but lowers frequency of flushing	List B	0.3
Investigate installation of	All gas 150,000	Save 5,750 Pay 4,527	£50,000	40	Faculty	18.9

Ground Source heat Pump for whole site						
Compare with installation of GSHP for church and ASHP for hall	All gas 150,000	Save 5,750 Pay 5,395	£65,000	Long	Faculty	17.4
Consider installing an Electric Vehicle charging point in the car park.	N/A	N/A	Depends on grant level	N/A		N/A, affects staff CO_2 footprint

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

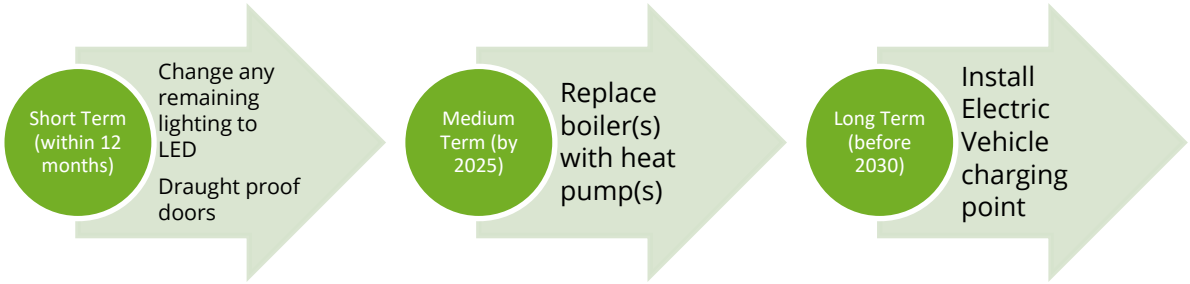
Based on current contracted prices of 12.397p/kWh and 2.923p/kWh for electricity and mains gas respectively.

If all measures were implemented this would save the church around £3,400 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 Michael and All Angels 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 whilst improving 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 Michael and All Angels, Bath Road, London, W4 1TT was completed on the 8th December 2020 by Paul Hamley. Paul is an energy auditor with experience of advising churches and small businesses. He is part of the Diocesan Environment Officers Energy Group developing advice for the Church of England and authored the "Assessing Energy Use in Churches" report for Historic England. He is a CIBSE Associate 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 EcoChurch, a scheme resourcing congregations to become more environmentally conscious.

St Michael and All Angels	
Church Code	623230
Gross Internal Floor Area	Footprint 835m^2 Halls 390m^2 Total all floors 1100m^2
Listed Status	Grade II*

The church typically used for 96 hours per week for the following activities

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	9 hours per week 5.5 on Sundays 4.5 rest of week	 160 130 weekly
Meetings and Church Groups	4 hours per week	
Community Use Schools use of hall	16 hours per week 75 hours (two schools)	780 monthly including above row 50 daily
Occasional offices	2 hours per week average	100

Occupancy hours	5,000
Footfall	35,000

4. Energy Procurement Review

Energy bills for gas and electricity have been supplied by St Michael and All Angels and have been reviewed against the current market rates for energy.

The current electricity rates are:

Single / Blended Rate	12.397p/kWh	In line with current market rates
Standing Charge	23.46p/day	N/A
Meter Charges	FIT charge 0.57p/kWh	N/A

The current gas rates are:

Church:

Single / Blended Rate	2.923p/kWh	Above current market rates
Standing Charge	10.91p/day	N/A

Hall:

Single / Blended Rate	3.260p/kWh	Above current market rates
Standing Charge	49.49p/day	N/A

The above review has highlighted that there are opportunities to gain cost savings from improved procurement of the energy supplies at this site, particularly for gas. We would therefore recommend that the church obtains a quotation for its gas and electricity supplies from the Diocese Supported Parish Buying scheme, http://www.parishbuying.org.uk/energy-basket. This scheme only offers 100% renewable energy and therefore it is 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% for electricity 5% for Gas (British Gas, Hall boiler) 20% for Gas (SSE, church boiler)	The organisation is understood to be a charity and therefore should be benefiting from only be charged a 5% VAT rate. A VAT declaration should be sent to the supplier to adjust this.
CCL	Charged along with 20% VAT rate	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 above review has highlighted that VAT and CCL are being charged for one account. The church is a charity and therefore can claim VAT exemption status. As such the PCC of St Michael and All Angels should send the supplier at VAT declaration confirming this and check all supplies on other sites. 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.

5. Energy Usage Details

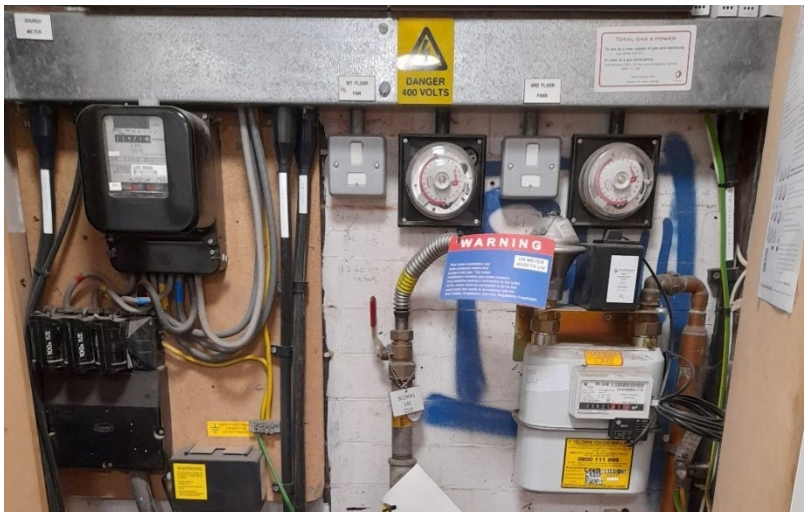
St Michael and All Angels uses 39,000 kWh/year of electricity, costing in the region of £6,900 per year, and 150,000 kWh/year of gas, [Church 85,000kWh, Hall 65,000kWh] costing around £5,800.

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

St Michael and All Angels has one main electricity meter. There are two gas meters serving the church and hall.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	L20C00436	3 phase 100A	No	Meter Cupboard inside Office external door
Gas – Church	M016 K01392 16 D6	BK-G10M	Yes	As above
Gas - Hall	G4 K0008584 13 01	BK-G4M	Yes	As above

It is recommended that the church consider asking their supplier to install a smart meter for electricity so that the usage can be monitored more closely, and the patterns of usage reviewed against the times the building is used.



Three phases of power are provided.

5.1 Energy Profiling

The main energy consuming plant can be summarised as follows:

Service	Description	Power kW	Annual use kWh	Estimated Proportion of Usage
Heating - Church	3 x Keston C55 boilers	165 max	84,500	47.6%
Heating - Hall	Vaillant Eco Tec	37 approx.	63,000	35.4%
Heating - Electric	Boiler circulation pumps (3) Sacristry stairs, wall mounted heater. Hall ground floor curtain heaters (2). Morning warm up for school room as required.	0.6 2 6	2000 200 300	1.4%
Hot Water	Immersion heater tank in hall boiler room. Thought to be on constantly when used in the summer (4 months), it will use energy to compensate for heat loss with no water use 2 urns Coffee machine Kettles Dishwasher	3 max Average 1 3 3 2 5	2900 300 600 100 500	2.5%

Lighting	Church 60 chandelier mounted LED 16 floodlights 50 spotlights (various) Hall (upper) Includes 10 theatre spotlights Halls (lower), high school use Mostly F58W fluorescent Office, Vestry, Sacristry, Kitchens, Toilets		5000 5000 5000 3000	10.1%
Other Small Power	Office Photocopier Desktop printer Computer Kitchen 4 fridge/ freezers Extraction fan Warming Cabinet Microwave Toaster Ventilation Duct fan Organ PA Equipment Vacuum cleaning	 0.5 0.3 0.1 0.15 each 0.2 1 1.8 2 0.315 1 1 2	 200 50 250 1750 30 100 200 400 500 + 520 1000 240	2.9%

Total estimated electricity use: 30,000kWh

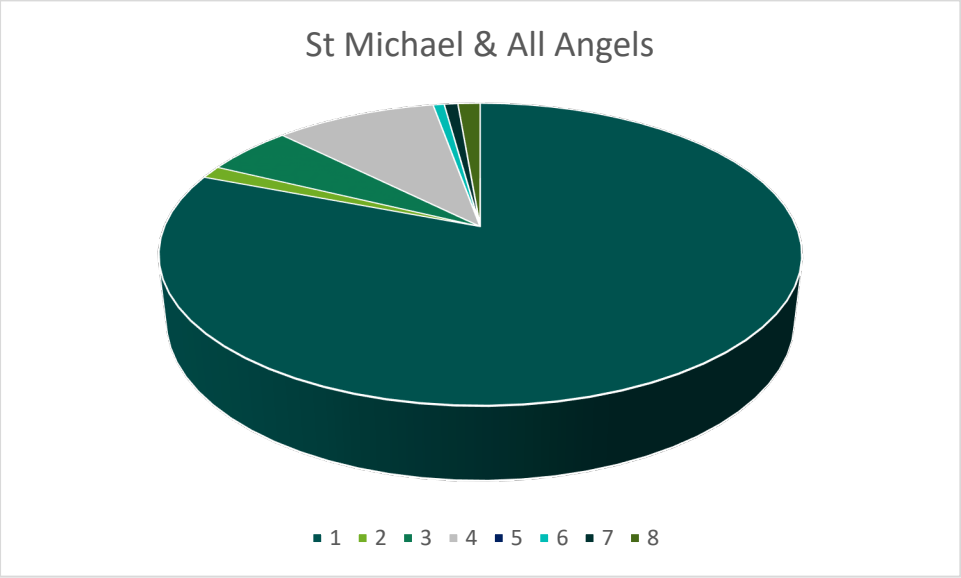
Annual Electricity use August 2019 – July 2020: 38,268kWh

The shortfall may be due some of these possibilities:

- more lighting being used when the church is open during the week than observed (when 5 chandeliers were lit)
- greater use of halls in the evenings than calculated
- toilet and kitchen lighting being left on during the day
- high hot water use (e.g. for hand washing by pupils) in summer.

Gas figures for the church refer to 31/10/19 until 31/7/20; the majority of the heating season occurred before lockdown, so these figures are considered valid.

Gas figures for the Church hall refer to 14/8/19 until 31/7/20 and is considered valid as above.



KEY 1 Gas Heating 2 Electric Heating 3 Hot water 4 Lighting 5 External lighting 6 Small power 7 Organ, PA equipment 8 Kitchen

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

5.2 Energy Benchmarking

In comparison to national benchmarks[1] for church energy use St Michael and All Angels uses 31% more electricity and 13% less heating energy than would be expected for a church of this size. The extra electricity is largely due to lighting the hall rooms for daily school use.

	Size (m^2 GIA)	Annual Energy Usage (kWh)	Actual kWh/m^2	Benchmark kWh/m^2	Variance from Benchmark
St Michael and All Angels (elec)	1100 including hall	39,000	35.5	27	131%
St Michael and All Angels (gas)	1100	150,000	136.3	156	87%
TOTAL	1100	189,000	171.8	183	94%

1 Church of England Shrinking the Footprint Energy Audit Report, 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 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 it remain 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 critical to review and set out a plan to make more efficient and less carbon intensive and one way to achieve this is to consider a transition to electrical heating where this provides an efficient and comfortable solution.

6.1 Future Heating Strategy

The church is currently heated by three 55kW gas boilers dating from 2003, which together have the capacity to heat the building rapidly from cold – necessary if a building is used only weekly. Many churches of this size (730m^2) have boilers of smaller capacity (80-100kW). One boiler should normally be sufficient to maintain heat once warmed for a building in semi continuous use. As the church is open every day for prayer, and is heated for services (held daily), a heat pump would offer a more efficient way to heat the building whilst helping to decarbonise it.

It is noted that there is a safety issue resulting from the boiler flues being installed horizontally such that the condensate cannot drain back – addressing this for either existing or new gas boilers will be expensive and adds further weight in favour of a heat pump.

The church is heated by the Victorian underfloor ducted pipe system, plus some cast iron radiators such as the example below in the chapel.

The hall is fitted with a Viessmann Eco Tec boiler of unknown output (probably a 37kW model) which heats the two storey building. The upper floor is fitted with underfloor heating plus a radiator, whilst the lower floor rooms, heated by radiators are rented for school use during the week. It also hosts events during evenings and weekends. Thus the building is in high use and is also compatible with a heat pump. The lower hall entrance has two electric curtain heaters installed.

There are several options:

- Install one heat pump system serving both church and hall
- Install separate systems for each, both ground source
- Install an air source heat pump for the halls and ground source for the church.

It was noted that there is ducting and a fan installed in the hall boiler room. A Ground Source Heat Pump system could be configured to offer cooling as well as heating; which might be useful for the summer term. Separate systems allow for phased installation and expenditure.

Ground Source systems are more expensive to install but offer lower operating costs.

7. Improvements to the Existing Heating System

As the existing heating system of radiators and underfloor heating circuit should be retained, it is recommended that measures are taken to improve the efficiency of the existing heating system, this should include:

7.1 Improve Heating Control Settings

The church's heating is controlled by a controller located in a cupboard below the sacristy.

The controller is temperature compensated and calculates the time at which the heating must be activated based on external temperature when a "start" time is pre-programmed.

- Measurements at over 50 churches in the Diocese of Lichfield have shown that heating should be turned off 45 minutes before the end of a service where water radiators are used, as they keep emitting heat for a considerable period.
- Frost settings should be reduced to 2℃ as it is needed to prevent freezing pipes only.

The adjustment of the heating system should be above to be carried out by any member of the church that is competent in using the controls.

The hall heating is controlled by a timer located in the corner of the office. This is in a difficult position for it to be used and should be moved to a more convenient location.

There are two important principles in setting efficient heating settings to support a comfortable church. The first is that most historic buildings survive very well without being heated and that in a number of cases the later addition of heating has actually caused fabric issues (such as the drying out of timbers, drawing damp through walls into a warmer and drier environment or causing issues beneath metal roof covings where warmer moist air becomes trapped). In most cases the fabric of a historic building would prefer not to be heated and the constant 'yo-yo' up and down of the heating is the most damaging. The second principle is that to provide comfort

to occupants one either needs to provide an immediate injection of heat close to where the congregation are heaters (i.e. under pew heaters or radiant heaters) that warm the air around the people but makes no attempt to heat the entire air volume of the church or has a long slow building up of heat within the church building. Having the heating switch on for an hour or two once or twice a day in the mis-conceived idea that it will 'take the cold off the building' is the most damaging heating strategy for the fabric and does very little to provide comfort as the heat is lost before the next heating session. It is better to leave the building unheated when it is not occupied and then have a longer period of heating before the time when there are services or the like.

If a heat pump is installed, this will allow for relatively constant heating of the church with extra heat provided on Sundays.

7.2 Clean the Existing Heating System

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

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

7.3 Install a Magnetic Particle Filter

There was no evidence of a particle filter fitted to the church system. It is recommended that one is installed.

The hall system has a filter fitted, below.

The instructions should be protected by a document wallet.

7.4 Endotherm Advanced Heating Fluid

In order to improve the efficiency of the heating system further it is recommended that an advanced heating fluid (http://www.endotherm.co.uk/) is added to the heating system.

This fluid in in addition to, and complements any existing inhibitors in the heating system and is added in a similar way. The fluid works to improve the ability of the boiler to transfer heat into the heating system and for the radiators and other heating elements to give out their heat into the rooms. It does this by reducing the surface tension of the water and increasing its capacity to transfer and hold heat. Case studies have demonstrated that the addition of this fluid into heating systems reduces heating energy consumptions by over 10% as well as helping the building heat up quicker.

Endotherm can be self-installed by someone competent to repressurise the system.

7.5 Pipework Insulation

The pipework leading to the air and dirt separator is uninsulated and against an outside wall.

As the system is used throughout the week; this will be constantly losing heat.

The insulation would benefit from minor repair in places, including the corners on the right.

8. 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.

8.1 New LED Lighting

The lighting makes up a relatively large overall energy proportion of the electricity used within the church. Although there are many LED light bulbs in the store cupboard, it is unclear how many of the spotlights in the church and upper hall have been changed to LED. The high annual electricity use suggests that many bulbs are not low energy (unless they have been changed recently).

In addition there are several rectangular floodlights, which take 250 or 500W elements (there will be considerable savings when using 20 to 50W LED replacements).

High level lighting will require changing by a contractor – the lifetime of LED equipment is much longer than for incandescent or halogen bulbs, so this should be an infrequent activity.

Chandelier lighting appears to use LED bulbs.

8.2 Lighting Controls (Internal)

There are several lights which could remain on all the time in areas such as the toilet and kitchen areas. Some of these areas are only used occasionally and for a short amount of time and as such, the lights do not need to remain on constantly. With daily weekday school use at present, these lights could easily remain on for the whole day.

The church is open for prayer daily, but is not occupied constantly. Selected lights could be controlled by a motion sensor (perhaps only lighting up the portion of the church which you wish to be visited).

It is recommended that a motion sensor is installed on these specific lighting circuits so that the lights come on only when movement is detected in the space and turn off approximately two to five minutes after the last movement has been detected (note that the duration of the time lag after which the light goes off needs to be consider alongside the type of light that is fitted. LED lights are much more suited to being switched off after only a short duration than some fluorescent lights). These movement sensors (commonly called PIRs) also have light sensors integrated into them so they can be used to make sure that the light does not come on if there is already sufficient daylight in the space.

Your existing electrician or any NICEIC registered electrical contractor can install PIR sensors onto existing lighting circuits. This can be carried out without significant disruption to the use of the space.

8.3 Reflective Radiator Panels

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

In order to improve the insulation directly behind the radiators a reflective panel can be installed, this helps to make sure more of the heat from the radiator goes into the space and requires less overall heating from the boiler to achieve the set point. There are a wide variety of reflective panels for installing behind radiators on the market such as www.heatkeeper.co.uk. It is recommended that these panels are installed behind all radiators within the building

The installation of radiator panels can be carried out by anybody competent in basic DIY and does not require the radiators to be removed, and can be achieved for a small outlay.

Where heating pipes are located in trenches in the body of the church, an insulating / heat reflective layer should be positioned below them.

8.4 Immersion Water Heater: Timer for Summer Use

Hot water for the halls is provided by a Heatrae Sadia CL145 water heater located in the boiler room in the loft. Of 145 litre capacity, it can deliver up to 50 litres of hot water (after which the incoming cold water means that the rest of the tankfull will become progressively cooler.

This unit supplies two sets of toilets and kitchens on the first and ground floors. It is unclear how much use is made of it; should school use (regular hand washing) mean that large volumes of water are used regularly. It is assumed that this unit is heated entirely by the boiler during the heating season. In the summer, when it is heated electrically, it should be operated from a timer and not left on constantly.

It is recommended that the heater 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. It should be set up with times to match the times that the building is occupied and this will prevent the standing losses from the unit wasting energy during periods when the building is not occupied.

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

Apart from school use, sporadic use of hot water in kitchens and toilets mean that it is wasteful to maintain 145 litres of water, kept at 90°C. Also, it can only supply around 70 litres of hot water in one go, then requiring to reheat the tank contents.

Note that there are detergents suitable for cold water hand washing; time and thoroughness of the washing procedure are more important than water temperature.

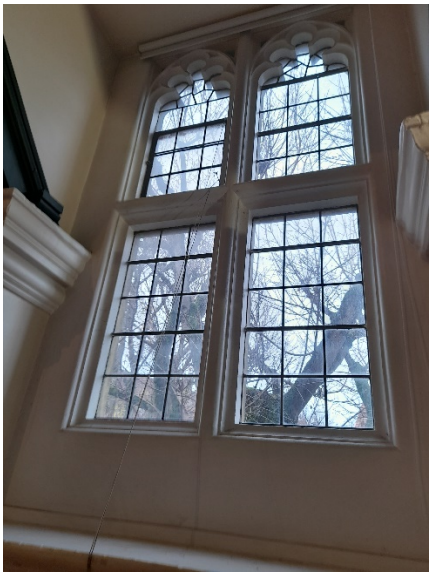
8.5 Draught Proof External Doors

The south west porch is the public entrance to the church. This is fitted with an inner pair of doors, (green) which are not close fitting to the floor and thus allow a constant cold draught to enter the building. The outer pair of doors (white) do not normally appear to be closed.

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

8.6 Hoper Window Draughtproofing



Hopper windows are fitted in the upper hall, and to four of the six church clerestory windows. These should be kept well maintained so that they can be shut without draughts occurring. Where such windows are kept closed for the winter and are draughty, a temporary solution is to use black plasticine to fill gaps.

9. Saving Recommendations (Water)

9.1 Tap Flow Regulators

The over provision of water for hand washing is not only a source of excessive water use, but in the case of hot water, it is also a source of wasted energy in the heating that has to go into providing the hot water. This is likely to occur when children are regularly present.

The flow rate of the taps can be easily regulated by fitting flow regulators within the taps. It is recommended that flow regulators such as those manufactured by neoperl (http://www.neoperl.net/en/) are fitted into all the viable hand wash basin taps to save on both water and heating of the hot water.

These regulators can be self-installed or by any good facilities staff.

10. Other Recommendations

10.1 Electric Vehicle Charging Points

The church has a car park located to the east of the vestry, used by staff.

In order to make a visible statement on the churches mission of stewardship and to facilitate more sustainable transport choices by those visiting the church, the church may wish to consider installing an electric vehicle charging point, probably at the east side of the vestry 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.

Because of the parish office within the building the church is considered as a place of work, and as such installation grants are available through the work place charging scheme

https://www.gov.uk/government/publications/workplace-charging-scheme-guidance-for-applicants-installers-and-manufacturers which will fund 75% of the installation cost up to £500.

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	No – visible roof
Battery Storage	No – no viable PV
Wind	No – no suitable land away from buildings
Micro-Hydro	No – no water course
Solar Thermal	No – insufficient hot water need
Biomass	No – air quality issues
Air Source Heat Pump	Yes for hall, hidden in roof valley
Ground Source Heat Pump	Yes for church (and hall) with borehole system

Heat Pumps are a low carbon method of creating heat, there use and suitability for this church have been review in the section earlier on in this report; Section 6.1 Efficient / Low Carbon Heating Strategy.

11.1 Heat Pump options

Heat Pumps use electricity to move heat from a low grade reservoir source (the air, soil or water) and "upgrade" it to provide (usually) water in the range 40-70°C, or sometimes warm air.
A large amount of reservoir air or water is cooled by a degree or two, extracting a large amount of heat. The pump uses refrigeration fluid to capture this heat by evaporation in a heat exchanger, causing cooling of the reservoir air or water. When the fluid is compressed again it heats, transferring the heat across a second heat exchanger into the water (or air) which is then circulated around the building. The Coefficient of Performance is the ratio of how much useful heat is obtained compared to the energy expended by the pump to "lift" the heat from the external reservoir.
For ASHPs, this is usually in the range 2-3, for GSHPs 3-4. This means an efficiency of up to 400% with a COP of 4; you receive 4 times more heat energy in kWh than you pay for in electricity. However, no laws of physics have been broken: the "missing" heat has come from the reservoir (air, ground or water); these sources provide free heat, ultimately from the sun.

Air Source Heat Pump [ASHP] for Hall

Equipment could be installed to the south of the hall roof where satellite imagery appears to show a hidden valley. This would enable an easy connection to the existing pipework in the boiler room.

The size of the church and the lack of constant use suggests that an ASHP system would be unsuitable *for the church*.

The valley between the church and hall provides a potential site for an Air Source Heat Pump, located outside the existing hall boiler room.

Ground Source Heat Pump [GSHP] for Church (and Hall).

The existing boiler room could be utilised if the floor was lowered. This could involve removing the existing steps and excavate the stairwell to east to provide a greater drop before reaching the concrete beam which currently gives a headroom of only around 4' high.

This energy audit is unable to state whether the church has enough land around its perimeter for the installation of ground loops. It is understood that there are no burials, but some ashes are interred. A borehole system with directional drilling (similar to the system installed at St Mary the Virgin, central Ashford) may be more suitable for the site.

A system for the Hall could provide cooling as well as heating. This would be useful for the school and provide a long term community asset. There may be local grants which the church could access in addition to donations.

A heating and cooling system would also enable heat to be returned to the ground, thus improving winter performance.

The church is surrounded by a small amount of land which could make a Ground Source Heat Pump system feasible.

11.2 Cost Comparison

Technology	Use Pattern	Annual Hours	Installed Power kW	kWh	Operating Cost
Gas Central Heating (current)	18°C for services, thirty minutes daily, plus Sundays	2900 church 3500 hall	165 (maximum) Average power 28kW if 3,000 hours 37 (maximum) Average power 18kW if 3,500 hours	gas used 85,000 Church 63,000 Hall	Including VAT £3,400 £2,350
Gas Central Heating, System cleaned, heat transfer fluid installed	As above		17% saving	70,550 church 52,300 hall	
Gas Central Heating as above,			5% saving	67,000 church	

Draughtproofing measures, reflective sheet behind radiators					
			TOTAL with efficiency savings	119,300	
				CURRENT COSTS	£5,750
			Calculations below assume that efficiency savings above have been made		
GSHP, Single system for church plus hall 50kW heat supply. COP = 3.5 14.5kW electricity requirement Church and hall supplied alternately		4000 (overlap of church and hall heating times)	4000 hours at 50kW output = 200,000kWh requiring 14.5kW electricity. Less will be required	119,300 Heat 34,100 electricity	£4,225 £4,527 including standing charge plus VAT
GSHP, church only COP 3.5 Similar sized system required		2,900	50	67,000 heat output 19,150 electric input	£2,373 £2,582 including standing charge plus VAT
ASHP, hall only COP 2.5		3500	37 (same due to constant use and existing underfloor heating)	52,300 heat 20,920 electric input	£2,593 £2,813 including standing charge plus VAT
				Total cost present gas	£5,750
				Estimated electric cost for Heat Pump system(s)	£4,527 single GSHP system £5,395 two systems

COP = Coefficient of Performance (how many kW of heat are produced for each kW of electricity used to run the heat pump). These numbers are reasonable estimates.

Detailed calculation and design by a supplier are needed to produce accurate figures. This energy audit does not provide detailed heat loss calculations necessary to accurately size the equipment, or specific costs of installation. Cost estimates are based on industry averages.

Savings of around £1,200 per year appear feasible with a single GSHP system costing £4,527 to run replacing £5,750 total gas costs. The standing charge for electricity will be payable anyway. This gives a payback period of around 40 years. However, there is a long term expected increase in gas prices (partly as North Sea gas runs out, replaced by imports, partly a gradual rise planned to encourage transition to electric heating), so the actual payback period is likely to be shorter

Electricity costs have the potential for a 20% reduction with a cheaper tariff, also reducing the payback period. **All the electric heating options can be zero carbon with a fully renewable tariff.**

11.3 Capital Costs

A 50kW GSHP system supplying both church and hall alternately (e.g. heating the hall for much of the day, switching to the church in the evenings and at weekends particularly Sundays) would cost in the region of £50,000.

An 37kW ASHP system for the hall is likely to cost in the region of £15,000, plus a GSHP system for the church, which would likely need to be 40-50kW, at £40-50,000.

12. Funding Sources

There are a variety of charitable grants for churches undertaking works and a comprehensive list of available grants is available at https://www.parishresources.org.uk/wp-content/uploads/Charitable-Grants-for-Churches-Jan-2019.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.