Energy Efficiency and Zero Carbon Advice

St Marks Church
2buy2 Church of England Audits

DIOCESE of WINCHESTER

Author	Reviewer	Date	Version
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Contents

1. Executive Summary

An energy survey of St Marks Church 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. This audit has been provided in conjunction with 2buy2, the Church of England's Parish Buying scheme provider and is subsidised from Total Gas & Power, the Parish Buying schemes principal energy suppliers.

St Marks Church was originally built in 1841 but has been added to in 1932 with an extension to the chancel as well as the addition of the vestries. The church was extended again in 1991 with the addition of the West porch/lobby as well as a DDA WC and flower room and the addition of a gallery. The Grade II listed church is located in a suburban area and is built of Portland ashlar. The roof is pitched and tiled for the most part with exposed timber ceilings internally, with flat roof to the vestries on the North side. The windows are stained glass and leaded within stone surrounds and mullions. The floor is solid and doors to the church are uPVC double glazed as part of the 1991 extension, with some solid timber doors to the vestry. The church makes use of fixed wooden pews to the nave and there are no choir stalls. The gas fired central heating was fully installed in 2020 and distributes to radiators throughout. 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 and the route to net zero carbon are 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)
Install a High Temperature Air-to-Water Source Heat Pump to replace the existing heating system served from the church	9,489	-£105	£61,750	-585.70	Faculty	1.54
Adjust existing timer on external lighting	28	£9	Nil	Immediate	List A (None)	0.01
Consider install Electric Vehicle Charging Points	0	N/A	Nil	Immediate	List B	-
Change existing lighting for low energy lamps/fittings	415	£124	£593	4.76	Consult DAC	0.09
Install Draughtproofing to External Doors	600	£60	£800	13.33	Consult DAC	0.11

Install PIR motion sensors on selected lighting circuits	19	£6	£120	20.66	List B	0.00
Replace windows	3,000	£300	£20,400	68.00	Faculty	0.54
Replace heating system for electrical based heating solution	1,292	-£12	£1,677	-136.51	List B	0.21

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

Based on current market prices of 30p/kWh and 10p/kWh for electricity and mains gas respectively.

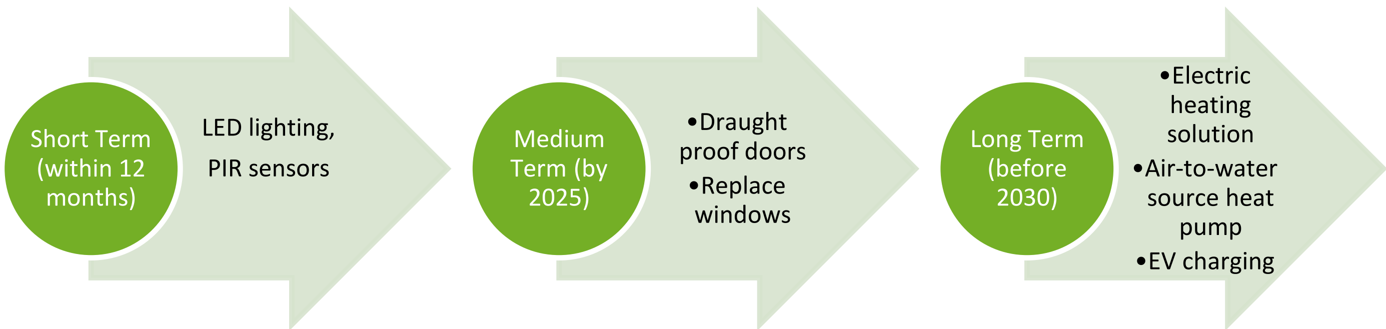
If all measures were implemented this would save the church £381 per year and reduce its carbon footprint by 2.5 tonnes (62%).

2. The Route to Net Zero Carbon

Our government has committed to move towards Net Zero Carbon – the point at which we have reduced emissions as much as we can and then balanced any residual emissions through removal of carbon from the atmosphere. They have done this as part of a worldwide agreement which aims to limit global warming to well under 2 degrees Celsius, with an aim of keeping it below 1.5 degrees Celsius. This will help protect all of us from the impacts of climate change.

In February 2020, the Church of England's General Synod set its own Net Zero Carbon target. The first stage of this target covers energy used by churches, cathedrals, schools, vicarages, other church buildings, as well as emissions caused by reimbursed transport. The target date is 2030.

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 Marks Church 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 and seek to improve 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 Marks Church, Hinton Wood Ave, Highcliffe, Christchurch BH23 5AB was completed on the 4th of November 2022 by David Legge. David is an experienced energy auditor with over 10 years' experience in sustainability and energy matters in the built environment. David is a fully qualified ESOS lead assessor with CIBSE and a CIBSE Low Carbon Consultant and a fully qualified ISO50001 lead auditor.

St Marks Church	
Church Code	641209
Gross Internal Floor Area	927 m^2
Listed Status	Grade II

The church typically used for 7 hours per week for the following activities

Type of Use	**Hours Per Week (Typical)**	**Average Number of Attendees**
Services	5 hours per week	
Meetings and Church Groups	2 hours per week	
Community Use	0 hour per week	

There is additional usage over and above these times for festivals, weddings, funerals, and the like.

4. Energy Usage Details

St Marks Church uses 2,500 kWh/year of electricity, costing in the region of £750 per year, and 20,000 kWh/year of gas, costing £2,000. The total carbon emissions associated with this energy use are 4.13 CO_2e tonnes/year.

This data has been taken from the annual energy invoices provided by the suppliers of the site. St Marks Church has one main electricity meter serving the site, serial number E16Z006072. There is one gas meter serving the site.

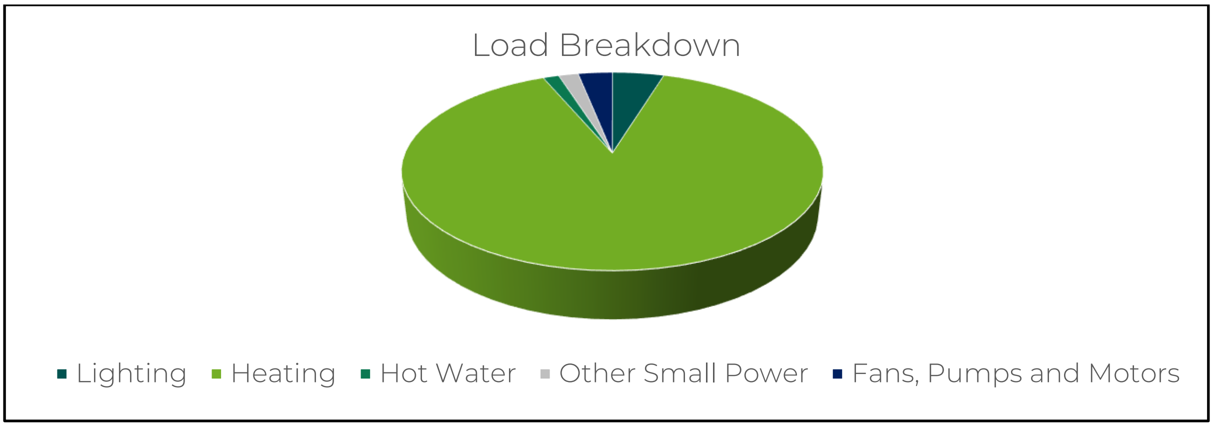
Utility	Meter Serial	Type	Pulsed output	Location
Electricity	E16Z006072	3 phase 100A	Pulse Capable, no AMR connected	Hall Store

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.

4.1 Energy Profiling

The main energy consuming plant can be summarised as follows:

Service	Description	Estimated Proportion of Usage
Lighting	Lighting is predominantly LED but there are 2D bulkheads and some T8 fluorescent tube fittings remain	5%
Heating	Gas fired boiler providing heating to perimeter panel radiators and some radiators under the pews	89%
Hot Water	Electric point of use water heater to WC	1%
Other Small Power	Organ power, projector, and other plug in loads	2%
Fans, Pumps and Motors	Heating pumps	3%



As can been seen from this data, the heating makes up by far the largest proportion of the energy usage on site.

4.2 Energy Benchmarking

In comparison to national benchmarks for church energy use St Marks Church uses 74% less electricity and 51% less heating energy than would be expected for a church of this size.

	Size (m^2 GIA)	Annual Energy Usage (kWh)	Actual kWh/m^2	Benchmark kWh/m^2	Variance from Benchmark
St Marks Church (elec)	389	2,000	5.15	20.00	-74%
St Marks Church (gas)	389	20,000	51.47	105.00	-51%
TOTAL	389	22,000	56.61	125.00	-55%

5. Efficient / Low Carbon Heating Strategy

The energy used for heating a church typically makes up around 80% to 90% of the overall energy consumption. Putting in place a heating strategy that is energy efficient and low carbon is, therefore, of the highest priority

The Church of England is in the process of reviewing its heating guidelines. The process has already established some principles for heating that can help churches as they seek an acceptable combination of comfort, conservation, affordability, and environmental care. The principles can be found at https://www.churchofengland.org/sites/default/files/2020-04/CBC%20Heating%20guidance%20principles%20FINAL%20issued.pdf

As the principles make clear, every church's strategy will be unique to it, informed by many factors, including the nature of its usage, the system it's starting from, the conservation needs of the building, and the resources available. The strategies in this audit are designed specifically for your church.

Our recommendations on heating generally fall within three major areas. Firstly, for all churches we make recommendations that will help to reduce energy wastage and, as a starting point, to optimise the system that you already have

Secondly, we recommend options for many churches that focus on heating people rather than the full volume of the church. Some of the changes that can help with this will be 'soft' changes – others will relate to the heating system itself.

Finally, we make recommendations about moving away from fossil fuels. Moves away from fossil fuels are key to cutting emissions. For most churches, this will involve moving from gas, oil or LPG to electricity. Electricity currently creates carbon emissions around the same level as mains gas, but the carbon emissions associated with it are reducing rapidly as the UK builds more renewable energy and decommissions its remaining oil and coal fired power stations. Mains gas does have some potential to reduce its carbon content through the use of biogas and hydrogen, but these are less developed solutions and will be unable to deliver 'zero carbon mains gas'. Some local areas may also be considering the option of district heating networks.

While moving away from fossil fuels may not always be possible, as the principles state, "churches should be expected to have at least carefully considered the option of moving away from fossil-fuel based heating (gas and oil boilers) towards electric-based heating." And if such options are not viable now, the churches "can try to be ready for a future retro-fit when technology and the grid has progressed."

The church is currently heated by a gas fired boiler which was installed in 2020 and appears to have a further 18-20 years serviceable life before requiring replacement with any of the options described within this report. The boilers provide heating to panel radiators around the perimeter of the church as well as a select number of under pew areas. In addition, there is exposed pipework which contributes to the heating of the church.

The church makes use of fixed wooden pews in the main, with some flexible seating to the lobby/narthex area.

The church is used twice per week for services, on Sunday and Wednesday and the typical congregation size is 70. The church is also used for choir practice on Thursday evenings.

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

Decarbonisation Heating Solution	Viable
High Temperature Air to Water Source Heat Pump	Yes – preferred solution due to new heating pipework and heat emitters
Air to Air Source Heat Pump	Yes – would require new heat emitters so not recommended at present
Water Source Heat Pump	No – no water source locally
Ground Source Heat Pump	No – significant archaeology
Under Pew Electric Heating Panels	Yes – but not preferred solution due to new heating system installation
Electric Panel Heaters (to provide supplemental heating only)	Yes – to vestry areas for closer control
Over Door Air Heater (to provide a supplemental warm welcome at the door only)	No – already installed
Overhead Infra-Red Heaters	No – visual intrusion to the church would do harm, least preferred heating source due to comfort
Heated Chair Cushions	No – other solutions preferred

The recommendation is therefore that the church consider a high temperature air to water source heat pump when the current system reaches the end of its serviceable life in around 2040 as described below.

5.1 High Temperature Air to Water Source Heat Pumps

Air-to-Water Source Heat Pumps (AWSHPs) work by having an external unit which sucks air in and extracts the heat from it. It concentrates this heat and puts it directly into water that can then flow through the heating system. They work most efficiently when trying to produce water temperatures in the heating system between 40°C and 50°C. They tend to warm up slowly and steadily and are therefore well suited to situations where the heating is required for long periods of the day, and with heating systems that have a low temperature requirement such as underfloor heating systems.

However, a high temperature AWSHP essentially provides a two-stage approach where the first stage raises the water temperature to between 40°C and 50°C as detailed above and the second stage applies the same process to raise this again to a flow temperature of between 70°C and 80°C, which is the same flow temperature as the gas boiler system will be designed to provide. High temperature AWSHPs will provide around 2.5-2.8 units of heat for every 1 unit of electricity used in the heat pump; they therefore have a Coefficient of Performance (CoP) of 2.5 to 2.8.

The Centre for Sustainable Energy model[1] 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/m³
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 m³	Insulation Factor kW/m³	Heat Required (Space heating) kW
Church	2,875	0.028	80

Therefore, a heat pump of 80 kW would be required.

AWSHPs 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.

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

Examples of external units for ASHP comprising of three smaller 3kW units and two larger 10kW units.

A case study of a church which has installed this solution is available at Heat pumps and fabric improvements make a rural church warm and well used: St Anne in Ings | The Church of England

5.2 Install Electric Panel Heaters

It is recommended that the PCC consider installing electrical panel heaters in the areas specified on the table below on a time delay switch and remove the existing radiators.

Area	Type/ Size	Length (mm)	Watts	Area Heated	Number (or m) Required
Vestry	Electric Far IR Wall Panel 900W	1200	900	13-22 m2	1
Choir vestry	Electric Far IR Wall Panel 900W	1200	900	13-22 m2	2

Suitable electric panel heaters would be far infrared panels such as https://www.warm4less.com/product/63/1200-watt-platinum-white- . These can be purchased widely and fitted by any competent electrician. It is recommended that they are fitted with a time delay switch such as https://www.danlers.co.uk/time-lag-switches/77-products/time-lag-switches/multi-selectable-time-lag-switch/159-tlsw-ms so they cannot be left on accidently after use.

These heaters have a strong radiative effect (where heat is reflected to people from the surface) as well as a light convective effect (where air is warmed and moves around to heat the general space). For this reason, these heaters tend to provide a relatively instant sense of heat and comfort within the space and only need to be on for short periods of time. This reduces the amount of preheating required before each use of the building and can make electric heating cost competitive with gas. It also means that the building can rapidly and economically be brought into used for short or unplanned meetings if needed.

6. Energy Saving Recommendations

In addition to having a revise heating strategy there are also a number of other measures that can be taken to reduce the amount of energy used within the church.

6.1 New LED Lighting

The lighting makes up a relatively small overall energy proportion of the electricity used within the church. There are some areas of the building which have had efficient LED lights installed but there still remains a large number of inefficient fluorescent fittings within areas such as the vestry.

It is recommended that the fittings scheduled in Appendix 1 are all changed for LED. There are a vast number of specifications of LED lights on the market, but it is recommended that any LED light should come with branded chips and drivers and offer a 5 year warranty. An example of such a range of fittings is available from http://www.qvisled.com/

If all the lights were changed on a simple "like for like" the total capital cost (supplied and fitted) would be £120. The annual cost saving would be £600 resulting in a payback of around 5 years. This estimate includes for the supply of the lights, the labour to install them and the access required. It does not include for any upgrade to the wiring or a new lighting design both of which the church may wish to consider. Guidance on lighting, produced by Historic England for churches, can be found at https://historicengland.org.uk/advice/caring-for-heritage/places-of-worship/making-changes-to-your-place-of-worship/advice-by-topic/lighting/

6.2 Lighting Controls (Internal)

There are several lights which currently remain on all the time in areas such as the vestry, stairway and corridor. Some of these areas are only used occasionally and for a short amount of time so that, in actuality, the light does not need to remain on constantly. There are also spaces which benefit from a good amount of natural daylight coming in through the windows, such that artificial lighting is not required for much use during the year.

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 considered 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.

6.3 External Lighting Controls

The external flood lights are currently on for longer than needed. For efficient operation and to reduce light pollution and nuisance to neighbours it is generally recommended that external lighting is turned off between 10pm and 6am, unless required for specific purposes.

It is therefore recommended that the existing timer is adjusted to switch on at 7pm and turned off at 11pm. Therefore, they will only be on between dawn and dusk. A dawn to dusk timeclock with a time and day capacity is recommended over those that only have time of day capacity.

Sangamo (http://sangamo.co.uk/) make a wide range of commonly used timeclocks which any qualified electrician can install.

6.4 Draught Proof External Doors

There are a number of external doors in the church, particularly the vestry door. The historic timber doors do not close tightly against the stone surround and hence a large amount of cold air is coming into the church around the side and base of these doors.

It is recommended that the draughtproofing around the door is improved and draught strips are added. This could be achieved in a number of ways:

For timber doors that close onto a timber frame a product called QuattroSeal (see link below) is often used in heritage environments to provide appropriate draught proofing.

http://www.theenergysavers.co.uk/application/files/1714/7197/4194/National_Trust_Case_Study.pdf

Simple measures such as having a 'sausage dog' style draught excluder laid along the base of a door (it needs to be sufficiently heavy to stay in place), using plasticine of the right colour to fill gaps where daylight can be seen, and putting painted fridge magnets over large keyholes can all be simple DIY measures which are effective.

6.5 Replace Windows

The windows in the church are mostly stained glass in stone surrounds. However, there are some crittall windows in the 1960s extensions to the north aisle (vestry and choir vestry) which are very poor in terms of thermal quality. In addition, many of the openings do not close well against the frames and excessive cold air is being let into the space.

The introduction of new double glazed units would considerably reduce the heat loss from the building and improve thermal comfort. This measure would be costly and disruptive to install but could be considered as part of a refurbishment programme. The use of high quality windows will also reduce external noise transfer and provide added security. To enhance heat ingress in particularly cold areas, double glazing with low emissivity

(Low-E) glass could be selected as this allows more solar gain than standard double glazing.

It is therefore recommended to replace these windows with new double glazed windows with aluminium casements set into the existing surrounds. It is suggested that any window installation is undertaken by a FENSA Approved Installer www.fensa.org.uk

7. 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 – not sufficient demand, visible roof
Wind	No – no suitable land away from buildings
Battery Storage	No – no viable PV
Micro-Hydro	No – no water course
Solar Thermal	No – insufficient hot water need
Biomass	No – not enough heating load as well as air quality issues
Air Source Heat Pump	Yes
Ground Source Heat Pump	No – archaeology in ground and radiator system

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

Having reviewed the site it is not considered that there is good viability for most renewables and instead a good clear focus on reducing the energy demand of the building should continue with a targeted approach on reducing the heating energy.

8. Funding Sources

There are a variety of charitable grants for churches undertaking works and a comprehensive list of available grants is available on this Parish Resources page: https://www.parishresources.org.uk/resources-for-treasurers/funding/

9. 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.

10. Offsetting

As you take action to reduce your emissions, you may also wish to offset those that you cannot yet reduce. If you would like to engage in offsetting, it is important to use a reputable scheme. The Church of England recommends Climate Stewards, which has a simple calculator that can help you to work out how much you would need to offset. https://www.climatestewards.org/

Climate Stewards encourages people to 'reduce what you can and offset the rest' as part of your journey to Net Zero carbon emissions. They provide training and resources to help you understand climate change and its impacts, and to calculate the carbon footprint from your activities including travel, energy, expenditure, and food. Their online carbon calculators for individuals and smaller organisations are free to use, and they provide bespoke carbon footprint audits for larger organisations.

Having reduced as much of your organisation's carbon footprint as you can, there will always be unavoidable emissions from your work and travel. Carbon offsetting allows you to compensate for the negative impact of your carbon emissions by funding projects which take an equivalent amount of CO_2 out of the atmosphere. These either involve locking up ('sequestrating') CO_2 as trees grow or reducing emissions by using low-carbon technology such as fuel-efficient cookstoves or water filters.

Climate Stewards has a close relationship with all their project partners in Ghana, Uganda, Kenya, Tanzania, Nepal, and Peru. They work closely with them to design, develop, implement, and monitor projects which will not only mitigate carbon, but also bring tangible benefits to the local community - including improved health, savings in time and money previously spent on buying or collecting fuel, and improvements in local biodiversity. Each project is assessed using their Seal of Approval protocol which enables us to assess and monitor carbon mitigation and ensure robust, sustainable, and transparent partnerships.

11. Appendix 1 – Schedule of Lighting to be Replaced or Upgraded

Room/Location	Number of fittings	Recommended Upgrade	Annual Saving (£)	Total Cost (£)	Payback
Vestry	1	5ft Single LED	£18	£88	4.96
Stairs and corridor	6	2D LED 11W	£17	£353	21.20
External	6	LED GLS	£90	£71	0.79