ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Michael the Archangel, Winterbourne
PCC of St Michael

Author	Reviewer	Date	Version
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Contents

1. Executive Summary

An energy survey of St Michael the Archangel 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 Michael the Archangel is a Grade I listed church which dates back to 1170. The church is of stone construction with an unusual South tower. The church is currently heated from an oil boiler to radiators located around the church. There is only hot water provided to the vestry from an electric point of use hot water heater. The lighting in the church is a mix of some LED, along with fluorescent, halogen and PAR38 lamps. There is only 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)
Change existing lighting for low energy lamps/fittings	1,299	£221	£1,653	7.47	List B / Faculty	0.33
Install PIR motion sensors on selected lighting circuits	1	£0	£12	68.42	List B	0.00
Replace heating system for electrical based heating solution	14,852	£186	£13,143	70.58	List B	2.38
Refurbish window ironmongery / draught seals	1,007	£60	£200	3.31	List A (None)	0.27
Install Draughtproofing to External Doors	604	£36	£1,600	44.14	List B	0.16

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

Based on current market prices of 17p/kWh and 6p/kWh for electricity and mains gas respectively.

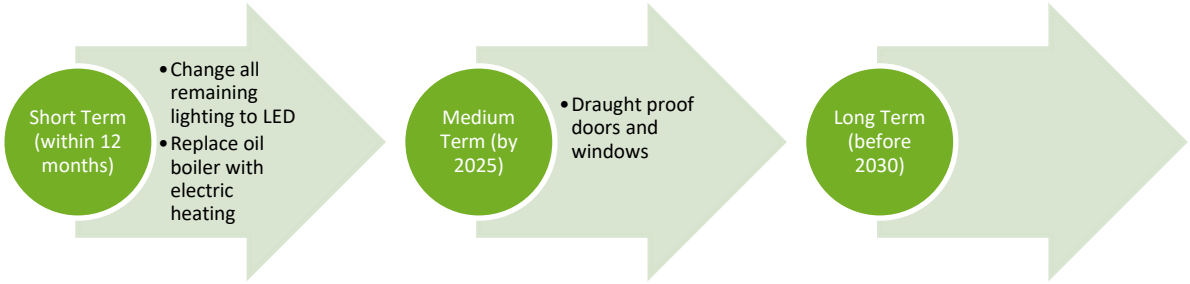
If all measures were implemented this would save the church £234 per year and reduce its carbon footprint by 3.1 tonnes (76%).

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 Michael the Archangel 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 Michael the Archangel, Church Lane, Winterbourne, BS36 1SE was completed on the 8th July 2022 by Marisa Maitland. Marisa is an experienced energy auditor with over 12 years' experience in sustainability and energy matters in the built environment and a CIBSE Low Carbon Energy Assessor

St Michael the Archangel	
Church Code	605098
Gross Internal Floor Area	451 m^2
Listed Status	Grade I

The church typically used for 6 hours per week for the following activities

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	5 hours per week	
Occasional Use	1 hours per week	

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

4. Energy Usage Details

St Michael the Archangel uses 3,198 kWh/year of electricity, costing in the region of £550 per year, and 20,140 kWh/year of oil, costing £1,200. The total carbon emissions associated with this energy use are 6.2 CO_2e tonnes/year.

This data has been taken from the annual energy invoices provided by the suppliers of the site. St Michael the Archangel has one main electricity meter, serial number D08D20325.

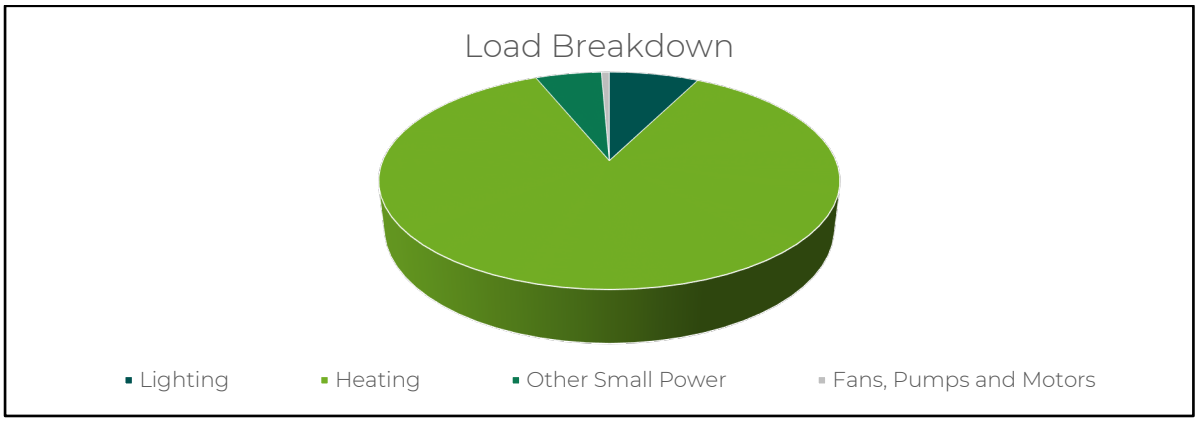
Utility	Meter Serial	Type	Pulsed output	Location
Electricity	D08D20325	1 phase 100A	No, but capable	Electric cupboard at rear of church

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	Mix of LED, along with fluorescent, halogen and PAR38 lamps	7%
Heating	Oil boiler to column radiators	86%
Other Small Power	Tea and coffee making facilities, hot water to the vestry	6%
Fans, pumps and motors	Pumps and motors associated with the heating system	1%



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 Michael the Archangel uses 65% less electricity and 70% 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 Michael the Archangel (elec)	451	3,198	7.09	20.00	-65%
St Michael the Archangel (gas)	451	20,140	44.66	150.00	-70%
TOTAL	451	23,338	51.75	170.00	-70%

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 bio gas 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."

St Michael the Archangel is currently heated from an oil boiler to column radiators situated around the church, with some additional glowing infrared heaters provided to the choir stalls in the chancel. The church was reported as not being a warm space even when the heating has been running. Given the age of the boiler, which is at the end of its life, a new heating system is required in the church. Based on the use of the church and the number in the congregation, the most suitable option is to replace the oil-fired system with a heating system that heats the people and not the space.

For this church the most suitable heating system will be to make use of the pews, which are not planned to be removed, and install electric pew heaters. The costing is to provide heaters to the pew in the centre of the nave only, which is the front seven on the left and right hand sides. Based on the congregation size it was thought no more would be required. The proposal also includes cost to place pew heaters in the choir stalls and remove the glowing infrared heaters that are currently used if this was an option the church wished to consider.

There are also areas within the church which do not have any pews however heating there might be seen as a benefit, such as at the rear of the church for coffee after the service. A provision in the costs for a number of Far Infrared Panels is included. The church can then discuss and decide on the best location for such a space.

Full details on the electric heaters is detailed below.

5.1 Install Electric Under Pew Heaters

As indicated above, the oil boiler currently providing the heating into the church requires replacing. For replacement, two most popular under pew heaters within churches are BN Thermic PH65 heaters (http://www.bnthermic.co.uk/products/convection-heaters/ph/) or similar from http://www.electricheatingsolutions.co.uk/Content/PewHeating.

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

Area	Type/ Size	Length (mm)	Watts	Number (or m) Required	Notes
Nave	Electric Under Pew 650W	948	650	28	Central nave pews only, 7 on each side.
Choir stalls	Electric Under Pew 650W	948	650	4	Choir stall heaters and remove glowing infrared heaters
Altar	Electric Under Pew 650W	948	650	1	Pew heater behind alter, as no room for an infrared heater

In the nave, due to the central support under each pew, 2 pew heaters will be required.

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.

The high level glowing infrared heaters within the chancel should be removed completed with all associated cabling back to the distribution boards.

The under pew (see photo below) and panel heaters have been recently installed at St Andrews Church, Chedworth, Gloucestershire, GL54 4AJ. The church is open in daylight hours so can be viewed at any time.

5.2 Install Electric Panel Heaters

For the areas of the church that might require heating for more informal periods within the church in areas that do not have pew, then it is recommended that the PCC consider installing electrical panel heaters on a time delay switches.

Area	Type/ Size	Length (mm)	Watts	Number (or m) Required	Notes
Vestry	Electric Far IR Wall Panel 350W	600	350	1	Provide heating into the vestry
Rear circulation space	Electric Far IR Wall Panel 580W	1000	580	3	To provide heating to space at the rear of the church for coffee etc

Suitable electric panel heaters would be far infrared panels such as https://www.warm4less.com/product/infrared-heaters/wall-panels/350-watt-eco-with-in-built-controller/ and https://www.warm4less.com/product/infrared-heaters/wall-panels/580-watt-eco-with-in-built-controller/

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.

5.3 Upgrade to 3 Phase Electricity Supply

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

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

The DNO in your area is thought to be Western Power Distribution - www.westernpower.co.uk; 0800 0963080 (East Midlands, West Midlands, South Wales & South West England)

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

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 large 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 and halogen fittings within the church.

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 £1,086. The annual cost saving would be £255 resulting in a payback of around 4.8 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/

There are some fittings such as the circle pendant fittings in the nave where the existing fitting can be made more efficient by simply changing the bulb/lamp within the existing fitting to a new LED bulb/lamp. This could be carried out by competent members of the churches internal team, very cost effectively and would be a List A item so no permissions would be required.

6.2 Draught Proof External Doors and Windows

There are a number of external doors in the church. 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. The vestry door and manor room external doors were noted for particularly being draughty and daylight clearly seen around the door.

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.

It was also reported that there can be a perceptible down draught from the windows. This could just be caused by the circulatory effect caused by the convection heating pattern of the current radiator system which will create the feeling of a draught, however it is worth checking all the windows for cracks and gaps. For a low cost solution these can be filled in using black plasticine, or of a colour to match to reduce any occurrence of draughts into the church.

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, Grade I church and South tower shading the 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	No – insufficient electricity supply
Ground Source Heat Pump	No – archaeology in ground and radiator system

Having reviewed the site it is not considered that there is good viability for any 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. It has recently been extended to cover the installation of under pew electric heating.

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.

Appendix 1 – Schedule of Lighting to be Replaced or Upgraded

Room/Location	Number of Fittings	Recommended Upgrade	Annual Saving (£)	Total Cost (£)	Payback
Nave	20	LED GLS	£22	£238	10.85
Tower room	1	50W LED Flood	£7	£120	18.21
Kitchen	2	PLL LED	£8	£140	17.94
Alter	2	GU10 LED	£27	£626	23.09
Alter window	2	R63 LED	£3	£43	13.09
Alter carving	2	LED Tubular Strip	£14	£14	0.98
Store area	1	PAR38 LED	£7	£17	2.59
Vestry	1	2D LED 11W	£2	£59	24.58
Nave	3	PAR38 LED	£20	£51	2.59
External	1	50W LED Flood	£112	£120	1.08