Energy Efficiency and Net Zero Carbon Advice

St Michael and All Angels, Flax Bourton
Diocese of Bath and Wells

Author	Reviewer	Date of Audit	Version
Marisa Maitland	Matt Fulford	12th June 2024	1.0

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1. Executive Summary

An energy and decarbonisation survey of St Michael and All Angels was undertaken by Inspired Efficiency Ltd. to offer advice to the church on how it can be more energy efficient, provide a sustainable and comfortable environment, and move towards net zero carbon. This is part of the wider environment and parish support programme within the Diocese of Bath and Wells.

St Michael and All Angels is a Grade II* church which dates back to the late mediaeval period. The church underwent a more recent restoration in 1980 when the pews were removed and a new flooring installed. The church is heated by a gas boiler which provides heat to perimeter radiators. There are also infrared heat lamps in the chancel and side chapel. The lighting in the church is a mix of LED, fluorescent and SON lamps. Both gas and single phase electricity are supplied to the site.

The church has a number of ways in which it can be more energy efficient and a clear path towards net zero carbon. 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 diagram below are used as the action plan for the church in implementing these recommendations over the coming years.

Energy and decarbonisation actions	Estimated Annual Energy Saving (kWh)	Estimated Annual Cost Saving (£)	Estimated capital cost (£)	Payback (years)	Permission needed	CO2 saving (tonnes of CO2e/yr)
Contact suppliers to arrange for the meters to be changed to smart meters	Helps monitor use and savings	None	Nil	N/A	None	N/A
Fit timed fused spurs to hot water heaters	162	£47	£99	2.11	List A (None)	0.04
Trace heating for frost protection of water pipes in Tea Room on removal of gas boiler	1,568	£110	£413	3.76	List B	0.28
Insulate exposed pipework and fittings in plantrooms	840	£59	£275	4.67	List A (None)	0.15
Install reflective panels behind radiators	314	£22	£154	7.02	List A (None)	0.06
Draught exclusion to external doors	314	£22	£165	7.52	Consult DAC	0.06
Change existing lighting for low energy lamps/fittings	76	£22	£619	28.08	Consult DAC	0.02
Replace heating system for electrical based heating solution with chandelier infrared heaters	14,645	£798	£28,686	35.97	Consult DAC	2.59

Savings from gas standing charges once church achieves Net Zero and removes gas meter	N/A	Dependant on standing charge	Potential £400 charge for meter removal	N/A	None	Part of above
Create a procurement policy for appliances (and other goods)	Commit to buying only appliances with the new energy efficiency ratings of A, B or C at the lowest when those you currently have reach the end of their useful life. (NB ovens, air conditioners and space or water heaters are still on the older rating scale, so for these, try for A+++.)					

Alternative Options	Estimated Annual Energy Saving (kWh)	Estimated Annual Cost Saving (£)	Estimated capital cost (£)	Payback (years)	Permission needed	CO2 saving (tonnes of CO2e/yr)
Replace heating system for electrical based heating solution with bar infrared heaters	14,831	£851	£7,575	8.90	Consult DAC	2.63

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

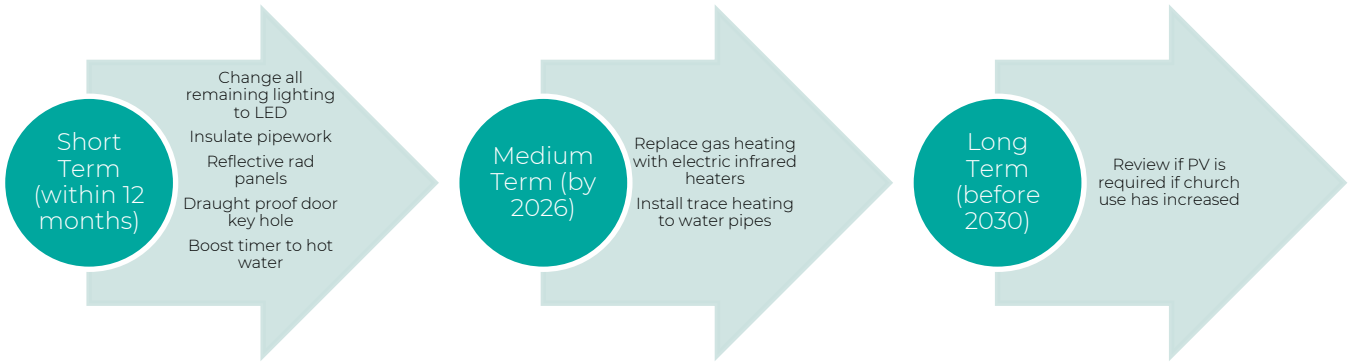
Figures in the table are based on current market prices of 29p/kWh for electricity and 7p/kWh for mains gas respectively. The carbon figures are based on the DEFRA 2023 carbon emission factors of 0.22499 for electricity and 0.18 for gas. Do note that as energy prices vary, payback periods will also vary.

2. The Route to Net Zero Carbon

The UK 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 carbon by 2030 by undertaking the following steps:


Short Term (within 12 months)
Change all remaining lighting to LED
Insulate pipework
Reflective rad panels
Draught proof door key hole
Boost timer to hot water
Medium Term (by 2026)
Replace gas heating with electric infrared heaters
Install trace heating to water pipes
Long Term (before 2030)
Review if PV is required if church use has increased

3. Introduction

This report is provided to the PCC of St Michael and All Angels to offer advice and guidance as to how the church can be made more energy efficient and work towards net zero carbon. In doing so the church will also become more cost effective to run and potentially have higher 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 St Michael and All Angels, (Main Road, Flax Bourton, Bristol BS48 3PY) was completed on the 12th June 2024 by Marisa Maitland. Marisa is an experienced energy auditor with over 15 years' experience in sustainability and energy matters in the built environment. She is also a CIBSE Low Carbon Energy Assessor.

St Michael and All Angels	
Church Code	601379
Gross Internal Floor Area	181 m^2
Listed Status	Grade II*
Average Congregation Size	20

The church is typically used on average for 2.75 hours per week for the following activities:

Type of Use	Hours Per Week (Typical)
Services	1 hour per week
Meetings and Church Groups	0.5 hours per week
Community Use	1 hour per week
Occasional Services (weddings, funerals, etc averaged out over a year)	0.25 hours per week

4. Energy Usage Details

St Michael and All Angels uses 1,128 kWh/year of electricity per year, which equates to £330 at current market rates, and 15,680 kWh/year of gas, which equates to £1,097 at current market rates.

The total carbon emissions associated with this energy use are 3.1 CO_2e

This data has been taken from the monthly meter readings taken by the chruch.

The energy meters on the site are as detailed below:

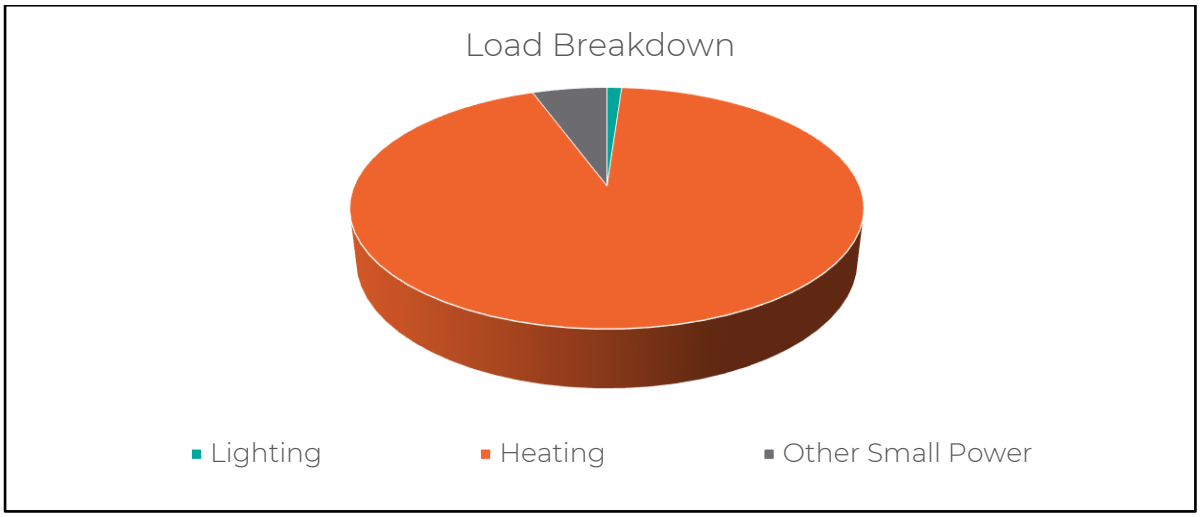
Utility	Meter Serial	Type	Pulsed output	Location
Electricity	E12Z137743	Single phase	Pulse capable	Vestry
Gas	Meter not seen			

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 use within the church can be summarised as follows:

Service	Description	Estimated Proportion of Usage
Lighting	Mix of LED, fluorescent and SON lamps	1%
Heating	Gas boiler to perimeter radiators	93%
Other Small Power	Electric infrared heaters, kitchen, audio/visual equipment	6%



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

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. 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 near future. 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' in the foreseeable future[1].

It is therefore important to review and set out a plan to make heating more efficient and less carbon intensive. One way to achieve this is to consider a transition to electrical heating where this also represents an efficient and comfortable solution for churches. 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 oil and coal-fired power stations.

The church is currently heated by a gas fired boiler which was installed in 2009 and appears to have a further 5 years serviceable life before requiring replacement. The boilers provide heating to cast iron column radiators around the perimeter of the church. In the chancel and new room there are electric infrared heaters.

The church makes use of fully flexible seating in the nave and side aisle.

The church is used once every other week on a Sunday for service and the typical congregation size is 20. The heating is set to come on several hours earlier in the winter to ensure the church is warm for this service.

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

Decarbonisation Heating Solution	Viable	Notes
Air-to-Water Source Heat Pump	No	Unsuited to current heating pipework and heat emitters
Air-to-Air Source Heat Pump	No	Does not suit use of building
Water Source Heat Pump	No	No water source locally

[1] https://www.churchofengland.org/resources/churchcare/advice-and-guidance-church-buildings/hydrogen-and-hydrotreated-vegetable-oils

Ground Source Heat Pump	No	Significant archaeology
Under Pew Electric Heating Panels	No	No fixed pews
Electric Panel Heaters (to provide supplemental heating only)	No	Not required
Over Door Air Heater (to provide a supplemental warm welcome at the door only)	No	Architecture around door would not permit unit to be fixed
Overhead Infra-Red Heaters	Yes	Either Halo units or far infrared units
Heated Chair Cushions	No	Other solutions preferred

The recommendation is therefore that the church consider replacing the aging gas boiler with an infrared heating solution. This can either be using chandelier type unit, or wall mounted unit.

Further details about these recommendations are given below.

5.1 Overhead Infrared Heaters

In areas where there are no fixed pews on to which heaters could be fitted, an option for heating the people, rather than all the air in the space, is to use overhead infrared heaters. These come in a variety of forms from the traditional models that emit a visible red-light glow, to ceramic units and the more modern 'black heat' units which emit no visible light. In most cases the distance from the heater to the people being heated needs to be no more than around 2.5 to 3m, although this varies slightly between heater types (therefore a mounting height of between 3m to 4m is typical). Units mounted outside of their heating range are likely to give poor performance.

This form of heating provides heat from above and can leave lower limbs and feet feeling cold; therefore, some people find this form of heating less comfortable, especially for longer periods of time. Comfort perceptions tend to improve in spaces where people are standing and more able to move around but reduce in areas where they are sitting in a fixed position for more than around 15 minutes. Some of these units can also have extremely high surface temperatures, and care should be taken not to mount them directly next to historic timbers or fabric that may be impacted by high heat levels.

A new style of chandelier heater has recently come onto the market that addresses some of the previous concerns over this type of heating and is much more visually acceptable within a heritage church setting. See Radiant Heating Trial, St Matthew's, Bristol | The Church of England. These units are more expensive than

In this church it is recommended that an overhead radiant heater in a chandelier format could provide a useful heating solution to the nave area, and then overhead infrared bar heaters. Also included is an option for all overhead infrared bar heaters as a lower cost option.

6. Energy Saving Recommendations

In addition to revising the heating strategy, the parish can also undertake other measures to reduce the amount of energy used within the church.

6.1 New LED Lighting

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

It is recommended that the fittings scheduled in Appendix 1 are all changed for LED fittings. There are numerous specifications of LED light fittings on the market, but it is recommended that any purchased should come with branded chips and drivers and offer a 5-year warranty. An example of such a range of fittings is available through Parish Buying.

If all the light fittings were changed on a simple 'like-for-like' basis the total capital cost (supplied and fitted) would be £466. The annual cost saving would be £21. This estimate includes the supply of the lights, the labour to install them and the access required. It does not include 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 fittings in the porch and vestry 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 church's internal team, very cost effectively and, unlike a change of fittings, would be a List A item, so no permissions would be required.

6.2 Insulation of Pipework and Fittings

The pipework within the boiler room does not have any of its straight lengths insulated. These exposed areas of pipework contribute significantly to heat loss from the system and make the boiler room unnecessarily warm. The exposed hot surfaces also represent a health and safety risk of burns for those working in the area.

It is recommended that these areas of exposed pipework and fittings are insulated. These wrap around the various elements but can be removed and then replaced for any servicing activities. If however the gas boiler is going to be replaced imminently then this may not be relevant.

6.3 Reflective Radiator Panels

The church is heated by radiators served from the boiler. These radiators are located on the external, uninsulated walls and have no reflective or insulated surfaces directly behind them at present. They therefore lose much of their heat into the masonry of the wall behind the radiator rather than giving it out 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. 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. The more rigid panel types tend to be easier to install than the rolls of flexible material.

6.4 Timers on Fuse Spurs to Water Heaters

There is an electric point-of-use water heaters in the boiler room to provide hot water for hand washing in the tea point and WC. This only needs to heat the water to the required temperature when the building is in occupation but at the moment this heater is directly wired in without any form of time control and is manually controlled. If the heater is accidentally left on this will result in the water in the heater being kept hot 24/7 until this is noticed.

It is recommended that the heater is fitted with a boost timer to replace the fused spur switch. These come in a variety of time period, from 15 minute to 4 hours, however it is probably more suitable for the church to have a timer that allows for 30mins, 1 hr, 2 hr and 4hr on periods. This will then turn off at the end of the boost period and will prevent the standing losses from the unit wasting energy during periods when the building is not occupied.

An example of such a unit is below:

https://www.tlc-direct.co.uk/Products/SMTGBT4N.html?source=adwords&ad_position=&ad_id=&placement=&kw=&network=x&matchtype=&ad_type=pla&product_id=SMTGBT4N&product_partition_id=&campaign=shopping_accessories&version=finalurl_v3&gad_source=1&gclid=CjwKCAjw-O6zBhASEiwAOHeGxR8LNWHclq-tinxHkWUNME60SQ_U78rfcPxQdopx7aqJWGYWXwDNlhoCD-IQAvD_BwE

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

6.5 Draught Proof External Doors

There are a number of external doors in the church. The historic timber doors appear to close tightly against the stone surround however this could be improved by other 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.

Such measures should be considered carefully around bat conservation needs to ensure that any access points bats use are not disturbed. Check your draught excluding plans with the Bat Conservation Trust's free helpline: 0345 1300 228 www.bats.org.uk

6.6 Trace heating for water pipes

With the potential removal of a gas heating system, there can be concern about water pipes in the WC area freezing in winter time and bursting. A solution to this, is with the installation of trace heating, also known as electric heat tracing.

This is a system that is used to maintain or raise the temperature of pipes and vessels using heat tracing cables. A special heating cable is wrapped or run along the length of the pipe or vessel. When electrical current passes through the heating cable, it generates heat due to the cable's electrical resistance which can then keep the water in the pipes from freezing. The system is often controlled by a thermostat or controller to maintain the desired temperature.

The cost is dependent on the length of pipework required to be heated, the cost provided is based on a 21m length of trace heating.

This can be self installed by someone competent in DIY or can be professionally installed.

7. Photo Voltaic Electricity Generation Potential

The potential for the generation of renewable energy on site has been reviewed and the viability noted.

Renewable Energy Type	Viable
Solar Photo Voltaic (PV)	Potentially possible on the roof of the tower, however the church has very low use.
Battery Storage	Limited weekly use, so not required

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 a small array could be installed on the roof of the tower, however as the church use is very limited we recommend that a good clear focus on reducing the energy demand of the building should continue with a targeted approach on reducing the heating energy.

As per the interest expressed in PV panels at the audit, it is estimated that approximately 6m^2 could be installed on the roof of the tower, which would cost in the region of ~£2,000-£4,000. This would generate around 665kWh per year, which is 60% of the current electrical use.

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/

The Church of England's webinars on getting to net zero programme includes a series of webinar recordings on environmental fundraising: https://www.churchofengland.org/about/environment-and-climate-change/webinars-getting-net-zero-carbon

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 includes the installation of under pew heaters to pews which are made in or after 1850 and are not of historic interest.

All other works, including the like for like replacement of gas and oil boilers 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. This includes items such as solar PV installations.

10. Other Observations

10.1 Bats in Churches

The Bat Conservation Trust has a project with the Church Buildings Council Natural England, the Church of England, Historic England and the Churches Conservation Trust to address bat issues: *www.churchofengland.org/resources/churchcare/advice-and-guidance-church-buildings/bats-churches*

Appendix 1 – Schedule of Lighting to be Replaced or Upgraded

Room/Location	Number of Fittings	Recommended Upgrade	Annual Saving (£)	Total Cost (£)	Payback
Boiler room	1	LED GLS	£2	£12	7.67
Tea point	1	LED GLS	£1	£12	13.90
WC	1	LED GLS	£1	£12	13.90
New room	2	50W LED Flood	£3	£240	92.75
Altar	2	PAR38 LED	£10	£34	3.31
Porch light	1	LED GLS	£3	£12	4.74
Inside porch light	1	50W LED Flood	£1	£120	92.75
Bell tower	1	R63 LED	£1	£22	16.78
Bell tower	1	LED GLS	£1	£12	13.90

Note: the costs in the table above are for the supply and installation of the number of light fittings in that space. They do not include wider project costs such as management, access equipment and the like which is included in the costs in the main table of this report.

1 The Coaches, Fields Road, Chedworth, GL54 4NQ

01285 721134

07971 787363

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