ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St. James's Church
PCC of St James's

CARLISLE DIOCESE

Author	Reviewer	Date	Version
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1. Executive Summary

An energy survey of St. James's 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. James's Church is a Grade II listed church located in a suburban area in Denton Holme, Carlisle. The church was built in 1867 of red sandstone and has slate roofs and single glazed leaded and stained glass windows. Internally, the seating is fixed pews throughout and there is a balcony to the West end. Heating is provided by gas fired boilers to perimeter radiators and exposed pipework in aisles. 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)
Change existing lighting for low energy lamps/fittings	1,137	£341	£2,650	7.77	Faculty	0.29
Install PIR motion sensors on selected lighting circuits	6	£2	£48	27.53	List B	0.00
Replace heating system for electrical based heating solution	59,734	£2,510	£57,969	23.10	Faculty	9.25
Install Draughtproofing to External Doors	2,568	£308	£1,600	5.19	List B	0.47
Install local electric point of use hot water heaters near to taps to decarbonise hot water heating	927	£115	£1,400	12.17	Faculty	0.17

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 12p/kWh for electricity and mains gas respectively.

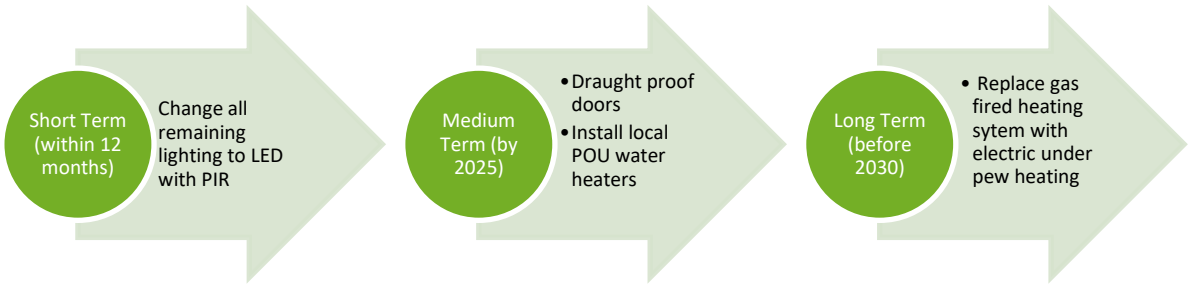
If all measures were implemented this would save the church £3,276 per year and reduce its carbon footprint by 10.18 tonnes (56%).

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. James's 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. James's Church, St James Road, Denton Holme, Carlisle, CA2 5PD was completed on the 21st July 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. James's Church	
Church Code	607092
Gross Internal Floor Area	544 m^2
Listed Status	Grade II

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	4 hours per week	100
Meetings and Church Groups	2 hours per week	Varies
Community Use	Ad hoc use only	Varies

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

4. Energy Usage Details

St. James's Church uses 2,220 kWh/year of electricity, costing in the region of £666 per year, and 95,127 kWh/year of gas, costing £11,415. The total carbon emissions associated with this energy use are 18.12 CO_2e tonnes/year.

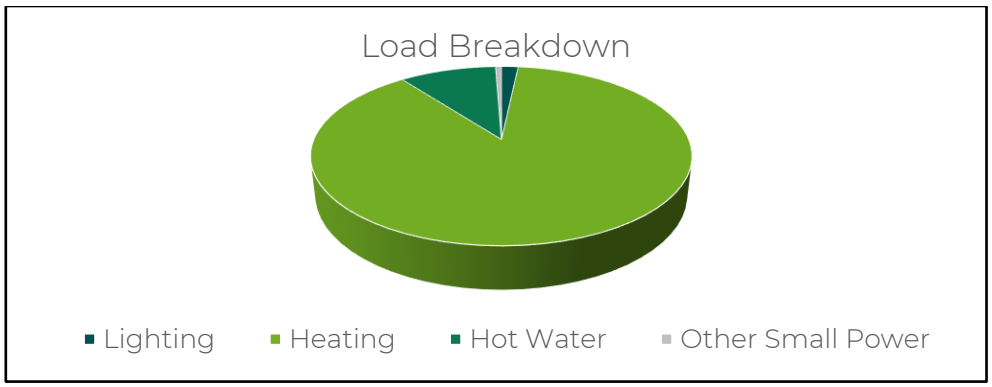
This data has been taken from the annual energy invoices provided by the suppliers of the site. St. James's Church has one main electricity meter, serial number E09BG04150. There is one gas meter serving the site, serial number M025K00828 13D6.

All the meters are AMR connected and as such energy profile for the entire energy usage should be possible. Half hour meter data has been provided for the purpose of this report and this has been used to verify the data.

4.1 Energy Profiling

The main energy consuming plant can be summarised as follows:

Service	Description	Estimated Proportion of Usage
Lighting	A variety of lighting including LED and SON floodlights as well as CFL lamps and GU10 downlights	2%
Heating	Gas fired boilers providing heating to perimeter radiators and exposed oversized pipework	88%
Hot Water	Combination boiler providing hot water to kitchenette sink and WC	10%
Other Small Power	Organ power, sound and alarm systems and other plug in loads	<1%



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.

4.2 Energy Benchmarking

In comparison to national benchmarks for church energy use St. James's Church uses 80% less electricity and 17% more 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. James's Church (elec)	544	2,220	4.08	20.00	-80%
St. James's Church (gas)	544	95,127	174.87	150.00	17%
TOTAL	544	97,347	178.95	170.00	5%

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."

The current heating arrangement is gas fired boilers distributing heat via perimeter column radiators and oversized exposed pipework throughout. The current heating boiler was installed in 2018 and therefore has a further 15 years' serviceable life remaining. There is a second smaller boiler installed in around 2002 which serves the gallery and provides hot water to the kitchenette and WCs. The gallery boiler has reached the end of its serviceable life and the hot water should now be generated by localised electric point of use water heaters.

The approach to the heating system could be undertaken in two phases. The first phase could involve the installation of under pew heaters to provide heating for the smaller Sunday services and choir practice to reduce gas consumption over the next 15 years. Once the gas boiler has reached the end of its serviceable life, the remaining pews should have under pew heaters installed as well as electric panel heaters to ancillary spaces to provide heating to all areas as detailed below.

5.1 Install Electric Under Pew Heaters

To install under pew heaters, 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
Central aisle	Electric Under Pew 450W	702	450	102
Side aisles	Electric Under Pew 650W	948	650	54

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 all rows of pews. Each pew heater to be switched with a neon indicated fused spur located underneath the pew seat.

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

It is recommended that the PCC consider installing electrical panel heaters in the gallery, narthex, WC and chancel on a time delay switch and remove the existing radiators.

Area	Type/ Size	Length (mm)	Watts	Number (or m) Required
Gallery	Electric Far IR Wall Panel 900W	1200	900	2
Narthex	Electric Far IR Wall Panel 1200W	1200	1200	2
Narthex	Overdoor air heater 9kW	1620	9000	1
Vestry	Near IR Overhead Heater 1.5kW	480	1500	1
Chancel	Electric Far IR Wall Panel 900W	1200	900	3
WC	Electric Far IR Wall Panel 350W	600	350	1

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/ or 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/products/switches/time-lag-switches/interior-time-lag-switches/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 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 SON fittings within the nave.

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 £2,650. The annual cost saving would be £341 resulting in a payback of around 7.8 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 GU10 downlights in the Narthex where the existing fitting can be made more efficient by simply changing the bulb/lamp within the existing fitting to w 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 Lighting Controls (Internal)

There are several lights which currently remain on all the time in areas such as vestry, toilet areas and the like. 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 Electric Point of Use Water Heaters

The existing 2002 gas fired combination boiler is currently providing hot water to the kitchenette and WC. A more efficient and decarbonised method of generating hot water would be to have small, local electric point of use hot water heaters installed within each WC and kitchen area. Units such as https://www.zipwater.co.uk/shop/hot-water/zip-inline-instantaneous-hot-water-heater-6kw-es6 heat the hot water only when the tap is turned on and does not have any stored hot water element. As such it is very energy efficient and it only ever heats the hot water that is required. It has additional advantages that it is 'always on' so does not require to have timings reset for ad hoc uses and as it does not have any stored water element it represents the lowest possible legionella risk profile. Installing electric hot water units will remove the need for the gas boiler and associated pumps to have to operate outside of the heating season and will assist in the transition to net zero carbon as the hot water is no longer served by burning of fossil fuels on site.

The installation of electric point of use hot water units and the removal of the gas hot water system can be undertaken by any competent mechanical engineer.

6.4 Draught proofing

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.

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

For timber doors that close onto a timber frame a product called QuattroSeal (see link below) is often used in heritage environments to provide appropriate draught proofing. http://www.theenergysavers.co.uk/application/files/1714/7197/4194/National_Trust_Case_Study.pdf

For timber doors that close onto a stone surround more traditional solutions such as brush draught strips rebated into the edge of the door by a skilled joiner. Other traditional methods such as using hessian or felt pads tacked to the door could be used. Keeping the door maintained in a good condition is also important.

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.

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	No – insufficient electricity supply, better heating alternatives available
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 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.

Battery Storage is not strictly a renewable energy solution, but battery storage does however provide a means of storing energy generated from solar PV on site to be able to be used at peak times or later into the day when the PV is no longer generating. It therefore extends the usefulness of the existing PV system particularly in this sort of church. This is a new but fast-growing technology with prices expected to fall substantial over the next 2 to 3 years.

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.

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	£8	£88	11.32
Nave	8	600 x 600 HO 40W Panel	£218	£675	3.09
WC	3	2D LED 11W	£8	£176	21.20
Wall washers	8	LED GLS	£18	£95	5.28
Narthex	12	GU10 LED	£67	£751	11.24
Narthex	1	LED GLS	£2	£12	5.28
Gallery	6	LED GLS	£14	£71	5.28
External	1	50W LED Flood	£6	£120	19.74