ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Luke's Church
PCC of St Luke's

DIOCESE of WINCHESTER

Author	Reviewer	Date	Version
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Contents

1. Executive Summary

An energy survey of St Luke'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 Luke's Church was built in 1839 and most recently reordered in 2014. The church is brick built of English cross bond construction with a pitched tiled slate roof. The church has flexible seating arrangement internally and is heated by perimeter fan convectors with heat supplied by a single gas fired boiler. 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)
Fit timed fused spurs to hot water heaters	486	£61	£270	4.42	List A (None)	0.12
Install a Solar PV array to roof of building (assumed 100% of energy generated used in building)	8,748	£1,099	£17,266	15.72	Faculty	2.21
Change existing lighting for low energy lamps/fittings	592	£74	£1,217	16.38	Faculty	0.15
Install Draughtproofing to External Doors	1,173	£40	£800	19.78	List B	0.22
Install PIR motion sensors on selected lighting circuits	9	£1	£47	40.15	List B	0.00
Install an Air Source Heat Pump into the building to replace existing heating system	27,370	-£125	£30,000	-240.42	Faculty	4.25

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

Based on current contracted prices of 12.56p/kWh and 3.45p/kWh for electricity and mains gas respectively.

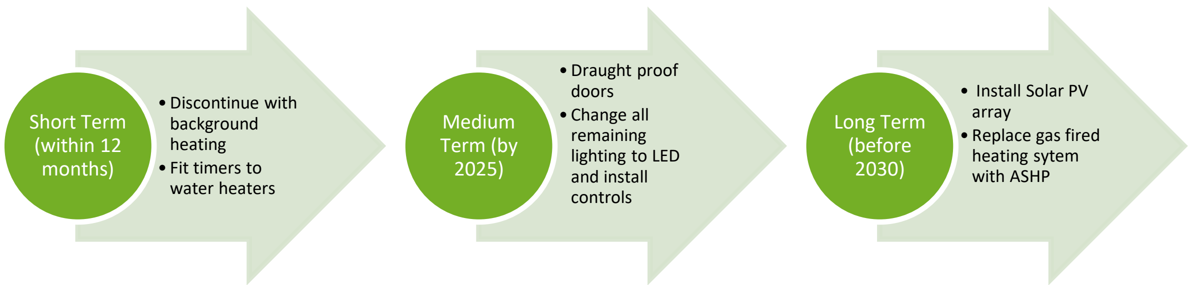
If all measures were implemented this would save the church £1,151 per year and reduce its carbon footprint by 6.95 tonnes (74%).

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 Luke'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 Luke's Church, Church Lane, Sway, SO41 6AB was completed on the 14th June 2021 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 Luke's Church	
Church Code	641277
Gross Internal Floor Area	301 m^2
Listed Status	Unlisted

The church typically used for 7.5 hours per week for the following activities

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	6 hours per week	80
Meetings and Church Groups	1 hours per week	10
Community and ad hoc use	0.5 hours per week	Variable

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

4. Energy Procurement Review

Energy bills for gas and electricity have been supplied by St Luke's Church and have been reviewed against the current market rates for energy.

The current electricity rates are:

Day Rate	14.961 p/kWh	In line with current market rates
Night Rate	12.863 p/kWh	In line with current market rates

The current gas rates are:

Single / Blended Rate	2.976 p/kWh	In line with current market rates

The above review has highlighted that the current rates being paid are in line or below current market levels and the organisation can be confident it is receiving good rates and should continue with their current procurement practices.

A review has also been carried out of the taxation and other levies which are being applied to the bills. These are:

VAT	5%	The correct VAT rate is being applied.
CCL	Not charged	The correct CCL rate is being applied.

The above review confirmed that the correct taxation and levy rates are being charged.

5. Energy Usage Details

St Luke's Church uses 8,510 kWh/year of electricity, costing in the region of £1,069 per year, and 39,101 kWh/year of gas, costing £1,348. The total carbon emissions associated with this energy use are 9.37 CO_2e tonnes/year.

This data has been taken from the annual energy invoices provided by the suppliers of the site. St Luke's Church has one main electricity meter, serial number P99C78873. There is one gas meter serving the site.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	P99C78873	3 phase 100A	Yes but not fully AMR connected	Vestry cupboard

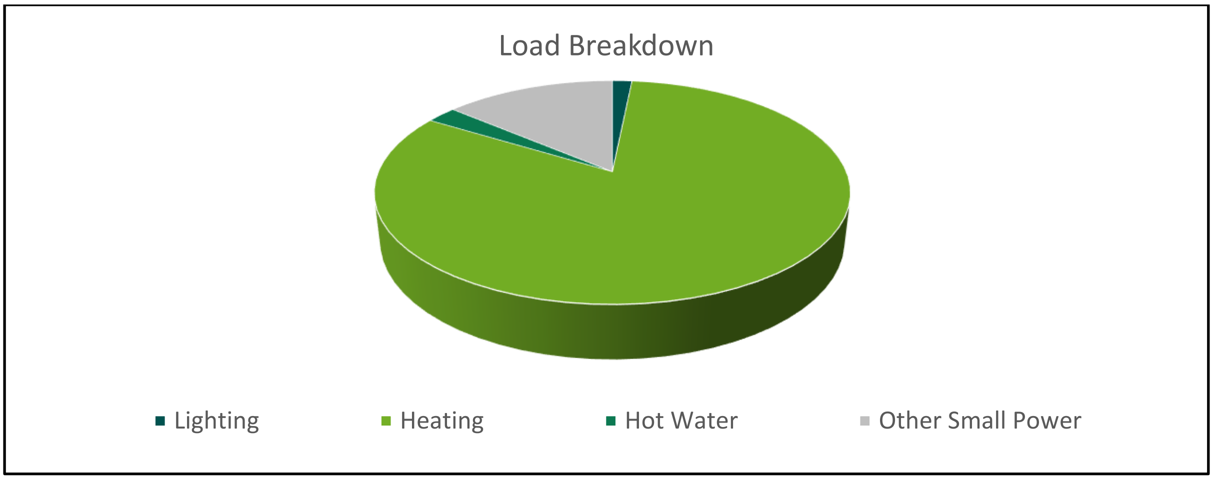
It is recommended that the church consider asking their suppliers to install smart meters so that the usage can be monitored more closely, and the patterns of usage reviewed against the times the building is used.

5.1 Energy Profiling

The main energy consuming plant can be summarised as follows:

Service	Description	Estimated Proportion of Usage
Lighting (fixed)	A mix of halogen and metal halide spot lights, 2D fluorescent fittings and move to LED lighting	2%
Heating	MHG 75kW gas fired condensing boiler providing heat to perimeter fan convector heaters throughout.	82%
Hot Water	2no. Ariston electric point of use water heaters	2%
Other Small Power	Stage and temporary lighting, AV equipment, sound system, organ and other plug in loads	14%

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



5.2 Energy Benchmarking

In comparison to national benchmarks for church energy use St Luke's Church uses 41% more electricity and 13% 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 Luke's Church (elec)	301	8,510	28.27	20.00	41%
St Luke's Church (gas)	301	39,101	129.90	150.00	-13%
TOTAL	301	47,611	158.18	170.00	-7%

6. Efficient / Low Carbon Heating Strategy

The energy used for heating a church typically makes up around 80% to 90% of the overall energy consumption. 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 pews were removed in 2014 to create a more flexible space and as such the central 'aisle' of the nave becomes inherently more difficult to heat with no structure to site any heating emitters. The gas boiler and fan convectors were also installed in 2014 and have another 10 years plus until they reach the end of their serviceable life. There is also an overdoor heater on the main entrance and a well sealed draught lobby.

It is recommended that once the gas boilers have reached the end of their life (c. 2034), that an air source heat pump solution is considered (discussed in further detail in section 8. This could be combined with a solar PV array and battery storage. It may also be possible at this stage to create a separate zone in the chancel for smaller services and choir practice so as to reduce the need to run the whole heating system for reduced requirements.

6.1 Discontinue with Background Heating Strategy

Most traditional churches were constructed without any form of heating. The modern additional of heating is not needed to preserve the fabric but only to provide thermal comfort to occupants. The previous trend of 'conservation heating' for fabric issues is now largely considered to be unnecessary and is being avoided by the likes of National Trust and English Heritage. The only times when background heating may be required is if there are historic wall paintings or to for the preservation of large artefacts such as tapestries. The organ (and other sensitive areas such as historic papers stored in the vestry) may require some local background heating specific to that area. In general, sensitive paper records should be removed for storage in the county archive and organs can be installed with a local background tube heater such as https://www.dimplex.co.uk/product/ecot-4ft-tubular-heater-thermostat within the organ casing in order to provide the heat where it is required. The fabric is often subject to the greatest damage by humidity (which is naturally higher when the air is warmer as warmer air has greater capacity for holding more moisture), as a result of large temperature swings (from central heating systems turning on and off) and from the excessive drying out/baking of timbers where high temperature heating units have been fixed to them (such as overhead heaters fixed to timber wall plates)

Providing constant background heating to the church building as a whole is excessive and wasteful of energy. At the very least we would recommend that this background level ideally avoided all together.

7. 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.

7.1 New LED Lighting

The lighting makes up a relatively small overall energy proportion of the electricity used within the church, and large areas are lit by relatively inefficient halogen fittings.

There are some areas of the building which have had efficient LED lights installed but there still remains a large number of inefficient R50, AR11 and PAR38 within the chancel, nave and gallery

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 £1,217. The annual cost saving would be £74 resulting in a payback of around 16 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.

Many of the fittings 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.

7.2 Lighting Controls (Internal)

The lights in the vestry currently remain for longer than necessary due to the nature of the space. This areas is only used occasionally and for a short amount of time and as such, 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 where artificial lighting is not required for much of the year during the day.

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

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

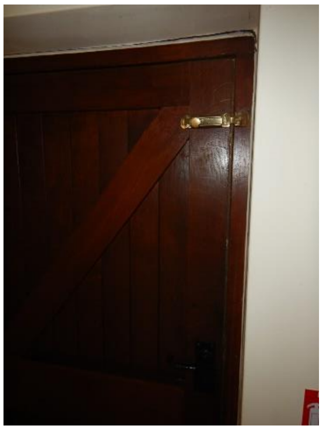
7.3 Timers on Fuse Spurs to Water Heaters

There are a number of electric point of use water heaters in the church to provide hot water for hand washing. 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 therefore maintains it set temperature 24/7.

It is recommended that the heaters are fitted with a 24 hour/7 day timeclock to replace the fused spur switch. An example of such a unit would be a TimeGuard FST77. They should be set up with times to match the times that the building is occupied and this will prevent the standing losses from the unit wasting energy during periods when the building is not occupied.

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

7.4 Draught Proof External Doors



There are a number of external doors in the church. These have the original historic timber doors on them, but these 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 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 and keeping the door maintained in a good condition is important.

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

8. 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	Yes – when electric heating is installed
Wind	No – no suitable land away from buildings
Battery Storage	Yes in line with PV installation at later date
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 – after current gas boilers have reached end of life

Ground Source Heat Pump	No – archaeology in ground and radiator system

8.1 Solar Photovoltaics

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.

There is potential for a small PV array on the main South East roof of the church. The current arrangements around solar panels mean that to be financially viable the building on which they are mounted needs to consume the vast majority of the energy that they produce. The church's energy consumption is already very small and the consumption during the daytime when the sun is shining is likely to be very low indeed, therefore while technically viable only a very small number of panels (maximum of around 4) would be worth considering if at all. However, when an ASHP is introduced, the sizing of a solar array with associated battery storage should be considered to maximise the amount of on site generation to contribute to the heating requirements.

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 five years.

8.2 Air Source Heat Pump

The building is currently heated from a gas boiler which provides hot water into the heating system. The use of fossil fuels for heating means that it will not be possible for the building to become zero carbon without changing the heating system. A boiler also has heat and other efficiency losses within it, which means that the efficiency of a boiler in converting the gas into the heat is typically around 80 to 95% (depending on the age and type of boiler). Air source heat pumps use electricity to power the heat pump which takes heat from the air and puts this into water which can then go into the heating system. A heat pump can create around 3 units of heat for every one unit of electricity.

The existing boiler is not yet approaching the end of its serviceable life and it is therefore recommended that the replacement of the existing boiler for an air source heat pump is considered at the end of the current boiler lifetime (c.2034).

A new air source heat pump is likely to need a heating capacity of around 75kW (c. 25kW input) and could be located to the North of the church and the existing boiler room may be suitable. As heat pumps operate on a low temperature basis some of the radiators and other heat emitters around the site may require upgrading. The existing 3 phase electrical power will be required to power the units.

Good local renewable companies can be contacted for further detailed assessment of heat pumps and quotes or contact www.yourfutureenergy.co.uk

There are currently government incentives available for installing air to water heat pumps, but these are subject to future change and adaption so should be reviewed at the time of implementation.

9. Funding Sources

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

10. 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.

11. 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
Lobby	2	2D LED 11W	£2	£118	57.39
Chancel	3	PAR38 LED	£18	£51	2.81
Nave	6	R50 LED	£13	£71	5.66
Gallery	6	R50 LED	£13	£71	5.66
Nave	4	AR111 LED	£14	£170	12.05
Vestry	4	5ft Single LED	£9	£466	51.53
WC	1	2D LED 11W	£1	£59	57.39