ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St John the Evangelist
PCC of St John's, Workington

Author	Reviewer	Date	Version
Matt Fulford		4th August 2021	1.0

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1. Executive Summary

A remote energy survey (via video call) of St John the Evangelist 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 John the Evangelist was built in 1823 to commemorate the battle of Waterloo. It is built of local sandstone and bears some resemblance to Inigo Jones' St. Paul's Church in Covent Garden, London. The church is used predominantly for Sunday and mid-week worship and there is a well-used hall space to the rear of the church. 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)
Purchase 100% renewable electricity	-	-	-	-	-	Offset 1.72 tonnes
Replace heating system for electrical based heating solution to the church	24,013	-£676	£27,280	N/A	Faculty	3.71
Fit 270mm of insulation into the roof space (mainly for hall)	9,874	£215	£5,100	23.74	List B / Faculty	1.82
Replace windows to hall	14,811	£322	£10,200	31.66	Faculty	2.73
Install a Hybrid Air Source Heat Pump into the hall to replace existing heating system	55,952	£96	£23,440	245.18	Faculty	9.65

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

Based on current contracted prices of 13.54p/kWh and 2.18p/kWh for electricity and mains gas respectively.

If all measures were implemented this would reduce the churches carbon footprint by 17.91 tonnes (90%).

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 John the Evangelist 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 John the Evangelist, Washington Street, Workington, Cumbria, CA14 3AX was completed via video call on 22nd June 2021 by Matt Fulford. Matt is a highly experienced energy auditor with over 15 years' experience in sustainability and energy matters in the built environment. He is a chartered surveyor with RICS and a CIBSE Low Carbon Energy Assessor. He is a Member of the DAC in the Diocese of Gloucester and advises hundreds of churches on energy matters.

St John the Evangelist	
Church Code	607368
Gross Internal Floor Area	852 m^2
Listed Status	Grade II*

The church and hall are typically used for 26 hours per week for the following activities

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services (Wednesday AM and two Sunday morning)	6 hours per week	40+ average Sunday congregation
Community Use of hall	20 hours per week	

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 John the Evangelist and have been reviewed against the current market rates for energy.

The current electricity rates are:

Day Rate	14.8p/kWh	In line with current market rates
Night Rate	12.8p/kWh	In line with current market rates

The current gas rates are:

Single / Blended Rate	2.1p/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. We would recommend that future procurement of energy supplies (especially electricity) use 100% renewable energy suppliers from the Diocese Supported parish buying scheme, http://www.parishbuying.org.uk/energy-basket.

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	1not 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 John the Evangelist uses 6,784 kWh/year of electricity, costing in the region of £918 per year, and 98,7380 kWh/year of gas,, costing £2,150. The total carbon emissions associated with this energy use are 19.94 CO_2e tonnes/year.

This data has been taken from the annual energy invoices provided by the suppliers of the site. St John the Evangelist has two main electricity meters, serial numbers E10BG01249 and E10BG01248. There is one gas meter serving the site, serial number E025K0158815D6.

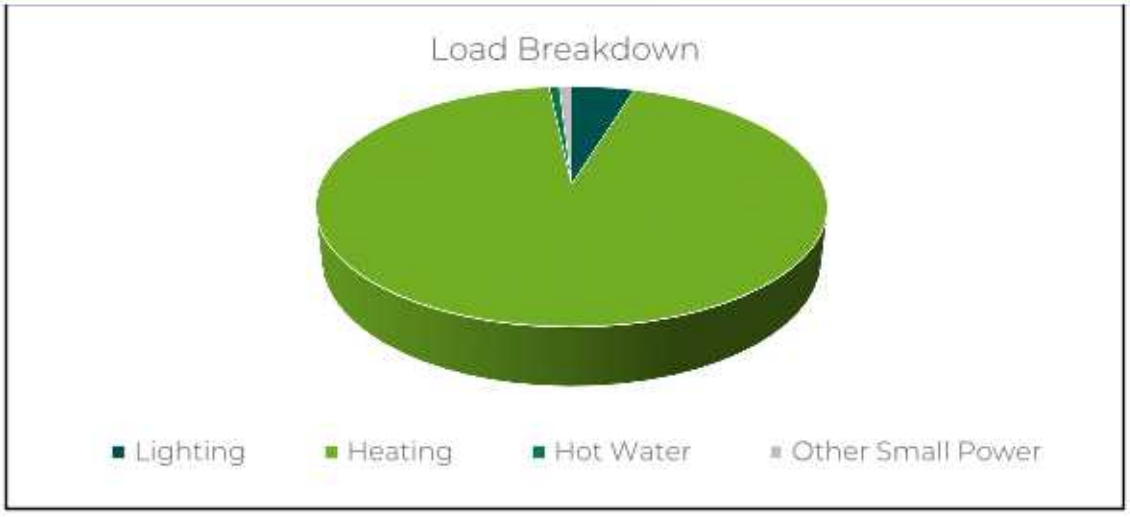
Utility	Meter Serial	Type	Pulsed output
Electricity – Church	E10BG01249	3 phase 100A	Yes
Electricity – Hall	E10BG01248	3 phase 100A	Yes
Gas	E025K0158815D6	Elster BK-G16E	Yes

All the meters are AMR connected and as such energy profile for the entire energy usage should be possible. Half hour meter data has not been provided for the purpose of this report but should be obtained 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	Reports to be energy efficient lighting throughout	4.7%
Heating	Gas fired heating to column radiators from end of life efficient gas boilers	93.6%
Hot Water	Reported to be from electric point of use water heaters	0.8%
Other Small Power	Sound systems, cleaning and kitchen appliances and the like.	0.9%



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 John the Evangelist uses 60% less electricity and 23% less heating energy than would be expected for a church of this size. This reflects the more limited usage of the church space but the differential between the gas and electricity usage suggests that the gas usage has significant scope for reduction.

	Size (m^2 GIA)	Annual Energy Usage (kWh)	Actual kWh/m^2	Benchmark kWh/m^2	Variance from Benchmark
St John the Evangelist (elec)	852	6,784	7.96	20.00	-60%
St John the Evangelist (gas)	852	98,738	115.89	150.00	-23%
TOTAL	852	105,522	123.85	170.00	-27%

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 biogas and hydrogen but these are less developed solutions and will be unable to deliver 'zero carbon mains gas'. Some local areas may also be considering the option of district heating networks.

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

Then hall space is used far more frequently than the church space and therefore should be the focus of future works to reduce the energy and carbon emissions of the building. Given its more regular use insulation within the hall space becomes more relevant and therefore adding insulation into the roof void and also considering replacement of the halls west end windows (which have far less visual importance than the main church windows) should be considered. A decarbonised heating solution for the hall would then be to install a hybrid heat pump which would use an air source heat pump to provide the majority of the heating requirement with a small gas boiler able to provide a boast during peak demand / cold weather. Such a system would then be capable of producing a high enough flow temperature (which would not otherwise be able to be produced from a 100% heat pump solution) and therefore connect onto

the existing radiators without modification. The existing boiler it at the end of its serviceable life and there is a dedicated 3 phase 100A electricity supply to the hall which will have sufficient capacity to power a heat pump.

For the church, while it is understood that some areas of pews may be considered for removal the intention is that many of the pews will be retained. The most efficient way of providing good levels of thermal comfort into a church with pews that is only used for a few services a week is to provide electric under pew heaters (as described below). Additional electric wall panels can be added to areas where there are no pews (around the font or behind the altar and the like) and/or where pews are removed. There is therefore some sense in considering pew removal to areas which are close to walls on which wall heaters can be located and retain pews in location far away from walls where it is much harder to find a location to place a device that will give out heat. If pew removal is being considered, from a heat perspective, removing pews in the side aisle areas and retaining a core block of pews in the central nave would be preferable and this would also retain pews to form an aisle which is often seen as the preferred layout for congregations. The costs in this report are for pew heaters under all the existing pews on the ground floor but this could be substituted for a mix of pew and panel heaters for similar costs if some of the pews were removed to the side aisles.

6.1 Install Electric Under Pew Heaters

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.

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). 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.

6.2 Install Electric Panel Heaters

It is recommended that the PCC consider installing electrical panel heaters to areas with no pews on a time delay switch.

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

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

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 Replace windows to hall

The windows to the west end of the hall are relative plain metal casements set into a stone mullion with single glazing which are not on a primary elevation. These metal casements can be replaced for new metal units with double glazing in a manner which retains a similar appearance and is likely to be acceptable to the planning and DAC requirements. Suppliers such as Direct to Stone Windows Installation by Heritage Window Company (theheritagewindowcompany.co.uk) have experience in this type of installation and many other local suppliers are likely to be available.

7.2 Insulation to Roof

The loft void above the ceiling has been viewed audit and found to have little or no insulation present. In all cases where there is 100mm or less of insulation within accessible roof spaces it is recommended that insulation be added to prevent heat loss and create a more comfortable environment for the occupants of the building.

Because heat rises, the ceiling/roof of a building is the largest contributing area to heat loss from a building. The insulation of such spaces can therefore have a dramatic impact on both the efficiency of the heating system and the temperature of the space below.

A free survey and quotation for the supply and installation of insulation to the loft spaces can be arranged through ESOS Energy Ltd (contact Adrian Newton 0117 9309689, adrian@esos-energy.com).

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

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

There is potential for a small PV array on the south roof of the nave which is reported to have limited visibility but is still visible and may not be found to be acceptable on this heritage building. 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 small and the consumption during the daytime when the sun is shining is likely to be very low indeed although the hall will have some

use, therefore while technically viable only a very small number of panels (maximum of around 12) would be worth considering if at all and this is likely to be best wired into the hall electricity supply with an element of battery storage.

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.

The view on the acceptability of solar panels on visible roofs is changing and therefore open early discussions with planners and the DAC would be a recommended starting point.

As indicated in the heating strategy above, given the more regular usage of the hall a heating solution using a hybrid heat pump is recommended. 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. Having a hybrid system would mean having a small gas boiler which is able to run alongside the heat pump and boast the temperature of the system at times of peak demand.

The existing boiler is 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.

A new air source heat pump is likely to need a heating capacity of around 20kW and could be located on the external west elevation at ground level. 3 phase electrical power will be required to power the units and this is available from the existing hall supply. The use of a hybrid system will allow higher flow temperatures to be achieved that will allow the existing radiators and pipework to be retained and utilised.

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.