ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Helen's, Tarpoley

PCC of St Helen's

Author	Reviewer	Date	Version
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1. Executive Summary

An energy survey of St Helen's 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 Helen's dates back to the 15th Century and had major additions and alterations in the 19th Century. The church is heated by gas fired boilers to column radiators, fan convector heaters and trench heating. The lighting is predominantly LED with a few fluorescent tubes remaining. 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)
Adjust existing timer on external lighting	178	£24	Nil	Immediate	List A (None)	0.05
Discontinue background heating	13,566	£444	Nil	Immediate	£-	2.50
Insulate exposed pipework and fittings in plantrooms	4,522	£148	£300	2.03	List A (None)	0.83
Install reflective panels behind radiators	1,809	£59	£200	3.38	List B	0.33
Change existing lighting for low energy lamps/fittings	1,589	£217	£1,125	5.17	Faculty	0.40
Add or Replace draught strips to external doors	2,713	£89	£1,250	14.07	List B	0.50
Replace heating system for electrical based heating solution	66,064	-£374	£73,471	n/a	Faculty	10.52

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

Based on current contracted prices of 17.64p/kWh and 3.27p/kWh for electricity and mains gas respectively.

If all measures were implemented this would reduce its carbon footprint by 15.14 tonnes (84%) and would save £608 per year. The change to electric heating provides the most substantial impact on carbon reduction but is currently estimated to cost more to heat the church.

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 Helen's 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 Helen's, High Street, Tarporley, Cheshire CW6 0AG was completed on the 24th March 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 Helen's	
Church Code	609103
Gross Internal Floor Area	564m^2
Listed Status	Grade II*

The church typically used for 6.5 hours per week for the following activities

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	4 hours per week	92
Meetings and Church Groups	2 hours per week	6
Occasional services	0.5 hour 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 Helen's and have been reviewed against the current market rates for energy.

The current electricity rates are:

Single / Blended Rate	13.682p/kWh	Below current market rates

The current gas rates are:

Single / Blended Rate	3.11p/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 Helen's uses 5,266 kWh/year of electricity, costing in the region of £929 per year, and 90,437 kWh/year of gas, costing £2,960. The total carbon emissions associated with this energy use are 18.02 CO_2e tonnes/year.

This data has been taken from the annual energy invoices provided by the suppliers of the site. St Helen's has three electricity meters, serial numbers L310J07002, L310J07003 and L310J07004. There is one gas meter serving the site, serial number M025AA00877 10D6.

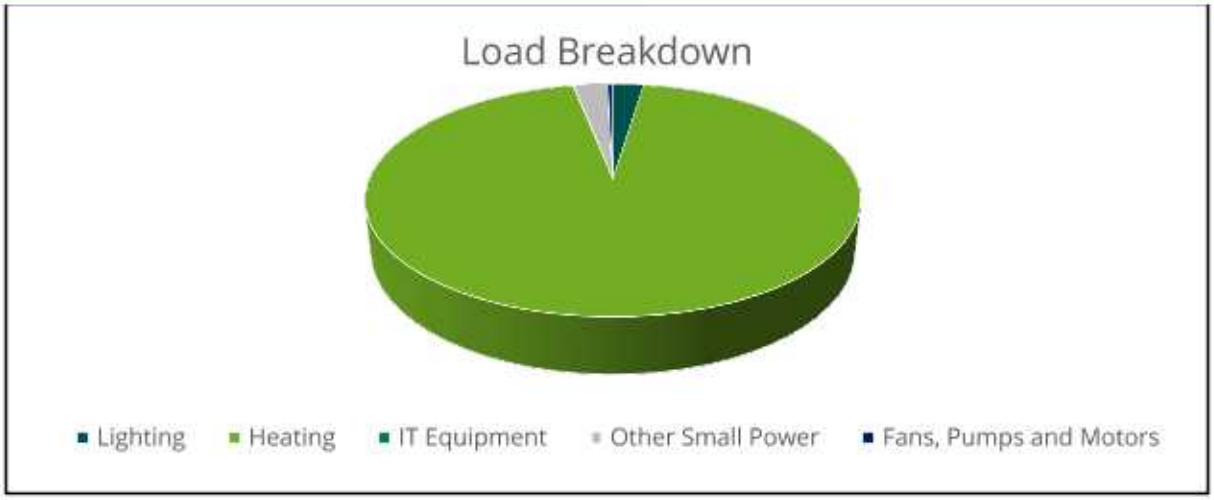
Utility	Meter Serial	Type	Pulsed output	Location
Electricity	L310J07002	Landis and Gyr	Pulse Capable, not AMR connected	Cupboard near organ
	L310J07003	Landis and Gyr		
	L310J07004	Landis and Gyr		
Gas	M025AA00877 10D6	Itron MDA25	Pulse Capable, no pulse block or AMR connected	External meter cupboard

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	Almost exclusively LED lighting throughout, with a number of fluorescent tubes remaining	2.4%
Heating	Provided by 2no. Ideal gas fired boilers providing heat to perimeter radiators, fan convectors and to trench heating via grilles	94.5%
IT Equipment	Office equipment	0.1%
Other Small Power	Organ, sound system, electric heaters, printer, and other plug in loads	2.6%
Fans, Pumps and Motors	Heating pump	0.4%



As can been seen from this data, the heating makes up by far the largest proportion of the energy usage on site due to the extensive background heating and the installation of LED lighting.

5.2 Energy Benchmarking

In comparison to national benchmarks for church energy use St Helen's uses 53% less electricity, most likely due to the prevalence of LED lighting and 7% more heating energy, due to the set times of the heating, 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 Helen's (elec)	564	5,266	9.34	20.00	-53%
St Helen's (gas)	564	90,437	160.35	150.00	7%
TOTAL	564	95,703	169.69	170.00	0%

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 current boilers were installed around 2007 and therefore should have a serviceable life of 20-25 years, reaching end of life between 2027 and 2032. Therefore, the boilers can be seen as fit for purpose and the succession plan for the replacement with electric heating should begin now.

As the church is infrequently used, the first recommendation is to fix the timing of the heating to only switch on for occupied periods (detailed below). Whilst on site, it was found that there was air in the radiators and therefore it is recommended that the radiators are bled frequently and if there is a continual issue that your regular heating engineer provide advice on whether adding

leak sealant to the heating system would solve the issue or whether the problem is more complex.

Where there are smaller events services, such as midweek services and choir practice, electric under pew heating should be installed to the choir stalls and lady chapel which would only then heat a small area of the church but deliver heat to where it is required and remove the need to heat the entire church with the gas heating system.

Once the boilers have reached the end of their life, then under pew electric heating (as detailed below) should be introduced for the remaining pews and individual pews switched to allow closer control over the heating distribution within the church.

6.1 Discontinue with Background Heating Strategy

The church's current heating pattern is as in the below table. The temperature set point for each period is 18^0C.

Day	Period 1	Period 2	Period 3	Hours of heating per day
Monday	0600-1230	1430-1630	2200-2330	10
Tuesday	0630-1300	1400-2200	2300-2359	15.5
Wednesday	0600 - 1030	1230-1930	2300-2330	12
Thursday	0730-1230	1930-0010		10
Friday	0630-1100	1530-2030	2300-2330	10
Saturday	0630-1130	1400-2230	2300-2330	14
Sunday	0500-1030	1530-1900	1930-2330	13
TOTAL				**84.5 hrs**

Given the church is only **used** for **6 hours a week**, the current setting of heating the church for an average of **12 hours a day** is a very inefficient use of resources and finances.

Most traditional churches were constructed without any form of heating. The modern addition 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. 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 is reduced to a maximum of 12°C and ideally avoided all together.

6.2 Install Electric Under Pew Heaters

The gas boilers will need to be replaced in around ten years' time and the most suitable low carbon option for this church, based on its current use, is to move to electric heating, with a mix of pew heating as detailed here, and infra-red heating as detailed in section 6.3. Choir stall heaters could be introduced now to only heat this space for choir practice and avoid the use of the gas heating system for this type of meeting.

For replacement, two most popular under pew heaters within churches are BN Thermic PH65 heaters (http://www.bnthermic.co.uk/products/convection-heaters/ph/) or similar from http://www.electricheatingsolutions.co.uk/Content/PewHeating.

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

Area	Type/ Size	Length (mm)	Watts	Number Required
Choir stalls	Electric Under Pew 300W	525	300	18
Choir stalls	Electric Under Pew 650W	948	650	8
Main church	Electric Under Pew 450W	702	450	100 (to cover most Sunday services)
Main church	Electric Under Pew 450W	702	450	75 (for remaining pews)

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 the both 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.

6.3 Install Electric Panel Heaters

In addition to the pew heaters, there are also some areas of the church, such as the Lady Chapel, Chanel/alter and vestry that are unable to be heated this way. In these areas it is recommended that the PCC consider installing electrical panel heaters in on a time delay switch and remove the existing radiators. As noted earlier, installing panels to the Lady Chapel now would allow midweek and smaller services to use local electric heating without the need for the gas heating system to be used at all. Along with amending the time schedule for the gas heating system, this should lead to significant savings.

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.

Area	Type/ Size	Length (mm)	Watts	Number Required
Chancel/altar	Electric Far IR Wall Panel 1200W	1200	1200	3
Choir vestry	Pulsar 2400W	-	1800	2
Lady chapel	Electric Far IR Wall Panel 1200W	1200	1200	3

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. Most areas of the building which have had efficient LED lights installed but there still remains a few inefficient fluorescent fittings within the vestry and ringing chamber.

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 £1,125. The annual cost saving would be £217 resulting in a payback of around 5 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/

7.2 External Lighting Controls

The external flood lights are currently on from 6pm until 11pm. For efficient operation and to reduce light pollution and nuisance to neighbours it is generally recommended that external lighting is turned on at 7pm and then off between 11pm and 6am unless required for specific purposes.

It is therefore recommended that the existing timer is adjusted to switch on the lights on at 7pm, instead of 6pm.

7.3 Insulation of Pipework and Fittings

The pipework within the boiler room has the majority of its straight lengths insulated, but the more complex shaped pipework fittings, such as valves, have been left uninsulated. These exposed areas of pipework contribute significantly to heat loss from the system and make the plant 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 with bespoke flexible insulation jackets. These wrap around the various elements but can be removed and then replaced for any servicing activities.

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

7.4 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.

7.5 Draught Proof External Doors

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

Alternatively, 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.

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	No – visible roof on listed building, insufficient demand
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 use of the building
Ground Source Heat Pump	No – archaeology in ground and radiator system

There are no renewable technologies that are currently suitable for this church based on its current usage. If, in the future, electric heating is installed and the church was being used a greater amount then this could be reviewed alongside battery storage (which is currently costly but it is expected that prices will reduce in the next 10 years as the technology develops).

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
Choir vestry	2	5ft Single LED	£7	£176	26.58
Pulpit spot	2	AR111 LED	£9	£85	9.90
Bell ringing chamber	2	5ft Single LED	£16	£176	11.26
External	3	LED GLS	£25	£36	1.44
External	1	100W LED Flood	£225	£200	0.89