ESOS-ENERGY
Energy efficient solutions

Energy Audit and Survey Report

St Peter and St Paul's Church

Boughton under Blean

Version Control

Author	Reviewer	Date	Version
Paul Hamley	Matt Fulford	17th December 2019	1.0

Contents

1. Executive Summary

An energy survey of St Peter and St Paul's Church was undertaken by ESOS Energy Ltd 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 Peter and St Paul's Church is a Grade I listed 13th century Early English style building with aisles and transepts added later followed by a west tower in the 15th century. There is both gas and electricity supplied to the site.

The church has a number of ways in which is 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 is 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 (£)	Simple Payback (years)	Permission needed	CO2 saving (tonnes of CO2e/year)	£/tonne of CO2
Contact suppliers to arrange for the meters to be changed to smart meters	None	None	Nil	N/A	None	N/A	N/A
Switch electricity (and gas) suppliers to ones which provide 100% renewable (or green gas) supplies	None	None	Nil	N/A	None	N/A	N/A
Complete installation of LED lighting	180	£25	£400	16	List A	0.06	£7,233.80
Install an electric heating system	5000	£ 300	£10,000	33	Faculty	0.92	£10,871.93
Fit draught proofing to historic doors	210	£5	£800	160	List B	0.04	£20,708.44

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

Based on current contracted prices of 13.1153p/kWh and 2.192p/kWh for electricity and mains gas respectively. **If all measures were implemented this would save the church up to £300 per year.**

2. Introduction

This report is provided to the PCC of St Peter and St Paul's Church to provide them with 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 Peter and St Paul's Church Boughton under Blean was completed on the 6th November 2019 by Paul Hamley. Paul is an energy auditor with experience of advising churches and small businesses. He is part of the Diocesan Environment Officers Energy Group developing advice for the Church of England and authored the 2018 "Assessing Energy Use in Churches" report for Historic England. He is a CIBSE Associate member and a Chartered Scientist, with experience of the faculty process gained from chairing the building committee of a Grade I listed church.

St Peter and St Paul's Church	606119
Gross Internal Floor Area	330 m^2
Listed Status	Grade I
Typical Congregation Size	50 at 10am, 12 at 8am

The church typically used for 3 hours per week for the following activities

Services	2 hours per week
Meetings and Church Groups	0 hours per week
Community Use	0 hour per week 2 concerts/ year
Occasional Offices	5 weddings/ year 5 funerals / year

The church is used only once a month during winter, and twice a month for the rest of the year, giving an estimated annual use of 150 hours.

Annual footfall is estimated at 2800.

Heating hours: Boiler on 0500-1100 (6 hours) for services.

Services per month J(1), F(1), M(2), A(2), M(n), J(n), J(n), A(n), S(n), O(2), N(2), D(3) =13 annual uses

13 x 6.5h + 8 x 6.5h extra for weddings and funerals = 140h

The church is located about a mile from the village of Boughton and is therefore not normally open to visitors.

3. Energy Procurement Review

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

The current electricity rates are:

Single / Blended Rate	13.1153p/kWh	In line with current market rates
Standing Charge	24.5997p/day	N/A

The current gas rates are:

Single / Blended Rate	2.1920p/kWh	In line with current market rates
Standing Charge	54p/day	N/A

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.

Procuring electricity from Parish Buying is planned to always supply 100% renewable electricity. The scheme currently supplies 20% green gas.

Information about the VAT rate has not been supplied (this will be on every bill).

If the church is being charged 20% VAT and Climate Change Levy, as a charity it should be benefiting from only being charged a 5% VAT rate.

A VAT declaration should be sent to the supplier to adjust this.

4. Energy Usage Details

St Peter and St Paul's Church uses 1,350 kWh/year of electricity, costing in the region of £265per year, and 10,500 kWh/year of gas, costing £425.

This data has been taken from information supplied by the church. St Peter and St Paul's Church has one main electricity meter, and one gas meter serving the site, both of which are located in the kitchen area formed within the north porch, where the boiler is also located.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	E15Z011434	EDMI Atlas Mk7c	2 pulses	Kitchen
Gas – Church	M016 K02627 16 D6			Kitchen

The electricity meters is AMR connected and as such energy profile for the entire energy usage should be possible.

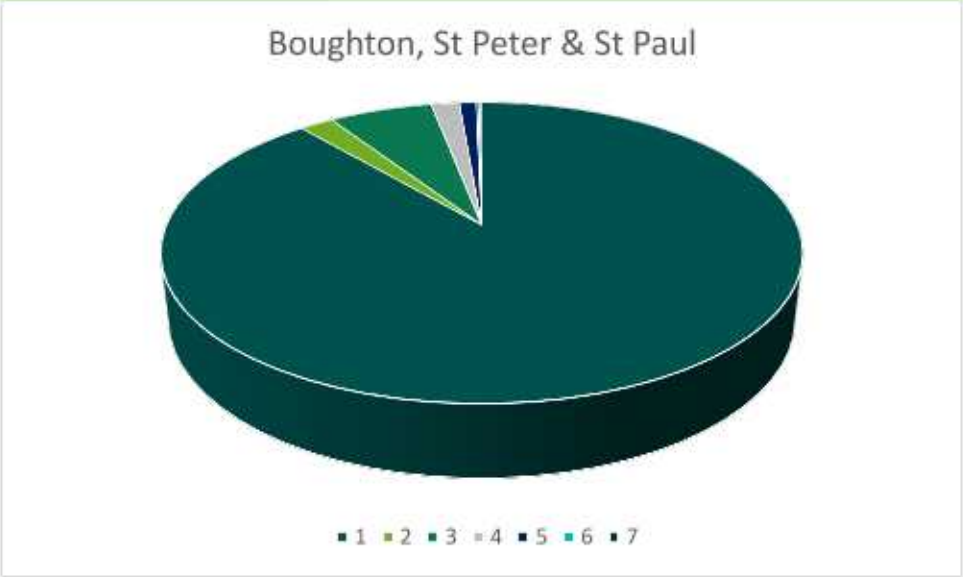
It is recommended that the church consider asking their suppliers to install a smart meter for gas so that the usage can be monitored more closely and the patterns of usage reviewed against the times the building is used.

4.1 Energy Profiling

The main energy use within the church can be summarised as follows:

Service	Description	Power	Annual Use/ kWh	Estimated Proportion of Usage
Lighting	A mixture of halogen and LED bulbs, the latter having been installed gradually.			4.5%
	LED Spotlights 10	250		
	Spotlights 8	800		
	Uplights 2	200		
	Not working 3			
	Unidentified 2	200		
	Kitchen	100		
	Porch	100		
	150 hours use annually, assume lights are on for double service times (for set up and cleaning)		500	
	External floodlight (for path in winter) 10 hours annually	1000W	10	
Heating	Gas, 100kW boiler 140 heating hours, running at 75%	100kW	10,500	92%
Hot Water	Kettle 10 boils of 3 minutes/ week x 40 weeks used	3kW	60	1.1%
	Water heater in south transept kitchen area	3kW	60	
Other Small Power	Organ 0.45hp	335W	20	2.5%
	Vacuum cleaner	1kW	20	
	Fan heater (bell ringing room)	3kW	240	

The annual electricity use of 910kWh suggested by hours of use and electrical items surveyed is half that reported (1336kWh). This may be due to the floodlight being on for much longer than estimated, plus a contribution from the chains of lights connected to the outside weatherproof sockets to light the path from the distant car park for certain events.



Key 1 Gas Heating 2 Electric heating 3 Internal Lighting 4 External lighting

5 Hot water 6 Small power 7 Organ

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[1] for Church energy use, St Peter and St Paul's Church uses only 20% of electricity and 21% of heating energy than would be expected for a church of this size.

	Size (m^2 GIA)	St Peter and St Paul's Church use kWh/m^2	Typical Church use kWh/m^2	Efficient Church Use kWh/m^2	Variance from Typical
St Peter and St Paul's Church (elec)	330	4.05	20	10	20%
St Peter and St Paul's Church (heating fuel)	330	31.7	150	80	21%
TOTAL	330	35.8	170	90	21%

The low values for electricity and heating use derive from the low use hours of the church. The benchmarking figures above are for churches in average use.

[1] CofE Shrinking the Footprint – Energy Audit 2013

5. Energy Saving Recommendations (Electricity)

5.1 Lighting (fittings)

The lighting makes up the majority of the electrical energy load within the building.

A variety of types of lighting are currently fitted of different colour temperatures.

The downlights are a mixture of LED and older bulbs, probably halogen. For the spot lights the Megaman range of LED spot (reflector) lights https://www.megamanuk.com/products/led-lamps/reflector/ provides some very suitable substitutes to the current lamps.

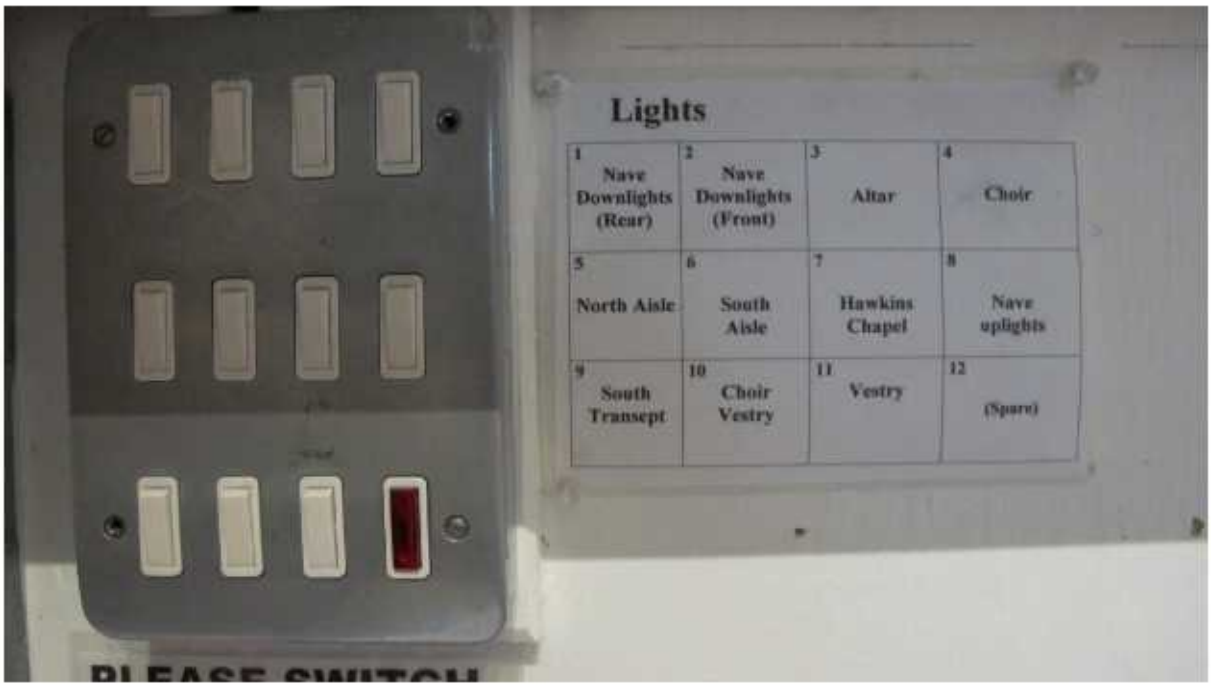
These fittings are widely available on the market and it is suggested that the complete fitting (including the luminaire, not just the lamp, in order to ensure compatibility) is replaced. Any new LED fitting would have a much longer life and hence reduce the need to replace the lamps in the ceiling as often:15 to 20 years is the likely lifetime.

It is recommended that all of the fittings, scheduled in Appendix 1, are changed for LED.

If all the lights were changed the total capital cost (supplied and fitted) would be £225 for bulbs alone; with luminaires (holders) and fitting this is likely to be £1000. An estimated 1200W can be reduced on full changeover to LED saving 180kWh. The annual cost saving would be £23 resulting in a payback of around 10 -15 years, but as LED bulb lifetimes are 15-20 years, then approximately 3 sets of access charges for replacement will be avoided.

5.2 Lighting (control for internal lights)

Lights are controlled from a single location with a clear plan highlighting switch function.



6. Energy Saving Recommendation (Heating)

6.1 Heating System and Strategy

The church currently uses gas central heating to heat the church. This is reported to work well and provides adequate thermal comfort into the church. However, the boiler is five years old and has suffered a recent failure. Consideration should be given to an alternative system of relatively low installation cost which is compatible with an infrequently used building.

Given the churches usage profile we would suggest that a revised heating strategy for the church would provide a much more efficient use of energy and a more comfortable church.

To avoid having to heat up the entire church building for services with a small congregation it is recommended that the PCC consider installing electrical heating. For an infrequently used church, either under pew heaters, overhead radiant heaters or radiant infrared panels mounted on walls or under the ceiling can be used.

These three options could be installed individually, or in some combination. The use pattern of the church, layout, number and location of pews and heritage considerations all impact the best option.

6.2 Reduce / Discontinue Background Heating

As with most medieval churches, this church would have survived most of its life 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. If necessary, organs can be fitted 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)

6.3 Boiler Optimisation

The boiler is turned on at 0500 before services. The timing should be revised so that it turns off 45 minutes before the service ends. Sufficient heat will be present in the water to allow radiators to emit heat for some time. This advice is based on experiments conducted at many churches in the Diocese of Lichfield.

6.4 Space Temperature Set Point

The thermostat, positioned high on the wall in the north porch, was set to 20°C. It is questionable whether the temperature reaches this level.

6.5 Clean / Flush Existing Heating System

This should form part of the annual service. Ideally, a magnetic particle filter should be fitted to the circuit just before the boiler, to protect it against sludge and rust. The level of corrosion inhibitor should be checked and topped up or replaced following cleaning of the system

6.6 Use of Electric Heating

St Catherine's, Faversham (left) has five heating chandeliers in the nave and two in the chancel, consisting of six radiant heaters mounted on chandeliers hung from arch centres. These were installed during 2018 at St Catherine's, Faversham and are now the only source of heating.

St Peter & St Paul's has three chandeliers for lighting (right). There are four arches under which heating chandeliers could be hung; larger diameter ones could reach much of the seating, although the north aisle pews next to the wall would be far. Advantages are potentially heating the congregation with four chandeliers (24 or 32 elements) for an installed cost of around £500 per element (based on Faversham's costs), £12 k or £16k, although extra heating for other areas may well be required in addition.

Under pew heating, if applied to all pews at once may be more cost effective. If the nave pews require two heaters each, 2 x 16 + 8 = 40 heaters. At an installed cost of £200 per heater, this is £8k. Advantages are easier cable routing than for chandeliers, the ability to do the work in stages to reduce the initial cost. Under pew heaters could be fitted in all pews, or just a selection. They should be wired so that blocks can be switched individually (or each could have its own independent switch). All Saints, Hollingbourne is heated entirely by under pew heaters. St Cosmus & St Damian, Blean have a mix of under pew and wall mounted heating.

For replacement, two most popular under pew heaters within churches are BN Thermic PH30 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 could run along the North and South walls (all cabling should be in armoured cable or FP200 Gold when above ground) to the both rows of pews quite easily.

Far infra-red panel heaters do not emit any visible radiation; they appear as flat rectangular panels, normally finished in white (although they can be supplied in other colours and with artwork such as by the Surya company). There are three classes, low surface temperature (42C for hospitals, 55C for schools; which can be installed at floor level), normal and high temperature (150C) industrial, originally designed to be installed under warehouse ceilings.

Radiant panel heaters are often difficult to integrate in a church; one option is to install them under the ceiling between rafters if there is sufficient distance. Being higher up they are likely to consume more power for the same heating effect compared to chandelier mounted heaters. Wall (or ceiling) mounted panels may be required in addition to under pew heaters in the music area next to the organ and perhaps in the chancel – if it is used.

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 can not be left on accidently after use.

7. Energy Saving Measures (Building Fabric)

7.1 Draught Proofing to Doors

There are a number of external doorways in the building. These have the original historic timber doors on them. The west tower door has large gaps between the wood and the uneven stonework, hence a large amount of cold air is coming into the church around the side and base of these doors. The internal draught lobby doors should be kept well maintained to ensure that they close properly.

Where a timber door closes against a timber frame it is recommended that draught proofing is fitted. 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

Note this cannot be used where the timber door closes directly against a stone surround which is the case for the tower door.

Other simple measures such as using a small fridge magnet painted black over the large keyhole or the use of 'sausage dog' type draught excluders at the base of little used doors can prove to be very effective. Doors should be reviewed in daylight and gaps where the light shines through sealed or filled in whatever the most appropriate way is for the specific door.

The north porch door appears adequately sealed. The internal doorway and draught lobby should be kept adequately sealed.

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

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-Nov-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.

Appendix 1 – Schedule of Lighting to be Replaced or Upgraded

Room/Location	Number of Fittings	Recommended Upgrade	Annual Saving (£)	Total Cost (£)	Payback
Nave Lux 150-180, 50 where lights failed	8 down (2 LED? 450W 2 up 150W	LED bulbs in appropriate luminaires where not already fitted.			
North Aisle Lux 280 under working light, 40 under failed light	4 down 280W				
South Aisle	4 down? 280W				
Tower Lux 80 at centre	2 down LED 20W				
North Porch					
North Transept Lux 280	2 down, LED? 20W				
South Transept	2 down? 150W				
Chancel Lux 90-160	6 down (2 LED?) 300W				
TOTAL LOAD estimate	1650W				

Lux levels were measured during strong daylight, which contributed, giving high light levels on the south side. On the north side, dull areas were apparent beneath failed bulbs.

The kitchen areas in the north porch and south transept need to be equipped with lighting to deliver good levels of illumination for food preparation; 200-300 Lux.

It is suggested that the existing LED bulbs and holders are recycled and transferred to one area with the nave and aisles refitted with new LED equipment.

Around 15 new LED bulbs seem to be needed, bulbs alone at £15 each will cost £225, plus installation costs, although new luminaries (holders) may be required.