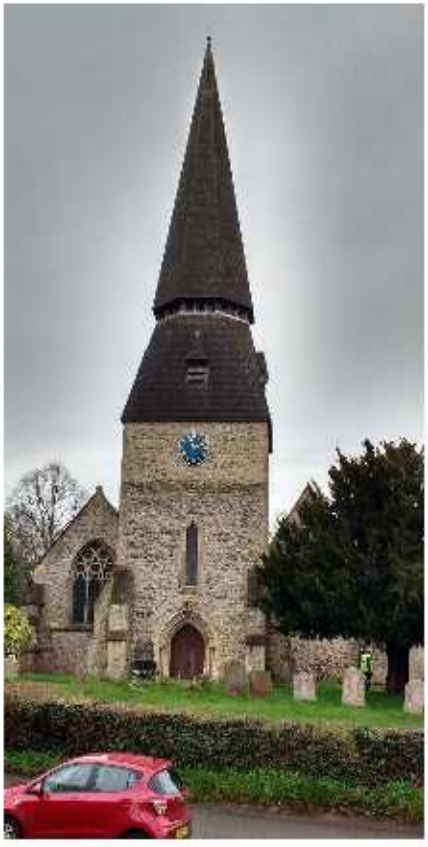
ESOS-ENERGY
Energy efficient solutions

Energy Audit and Survey Report

St Mary the Virgin, Willesborough, Ashford

Ashford Town Parish PCC



Version Control

Author	Reviewer	Date	Version
Paul Hamley	Matt Fulford	27th January 2020	1.0

Contents

1. Executive Summary

An energy survey of St Mary the Virgin, Willesborough, Ashford 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 Mary the Virgin, Willesborough, Ashford is an early mediaeval church built on the site of an earlier Saxon church, a blocked window of which survives. The nave dates from around 1200, chancel from 1320 with a north aisle added during restoration in1868. There are 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.

Short Term: 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
Purchase a temperature datalogger and use to optimise heating system	Potentially 14,000	£314	£50	0.16	None	3.00	£16.65
Fit daylight sensor and timer to control new LED floodlights for tower	None – no floodlights at present	N/A	£300	N/A	None	N/A	N/A
Draught exclusion measures for doors	2,700	£61	£50	0.83	List A	0.58	£86.34
Add Endotherm heating additive to the heating system	7,000	£157	£1,200	7.65	List A	1.50	£799.28
Install SavaWatt devices on to fridges	450	£59	£180	3.08	List A	0.14	£1,302.08

Install solar panels in valleys on north aisle and nave roofs	9,000	1,170	£14,000	12	Faculty	2.76	£5,063.66

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

Based on contracted market prices of 13p/kWh for electricity and 2.2411p/kWh for mains gas respectively.

If all measures were implemented this would save the church around £1,500 operating expenditure per year.

2. Introduction

This report is provided to the PCC of St Mary the Virgin, Willesborough, Ashford 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 Mary the Virgin, Willesborough, Ashford, Sevington Lane, TN24 0YR was completed on the 8th January 2020 by Dr. 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 "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 Mary the Virgin, Willesborough, Ashford	**606223**
Gross Internal Floor Area	460 m^2
Listed Status	Grade II*
Typical Congregation Size	110

The church typically used for 67 hours per week for the following activities

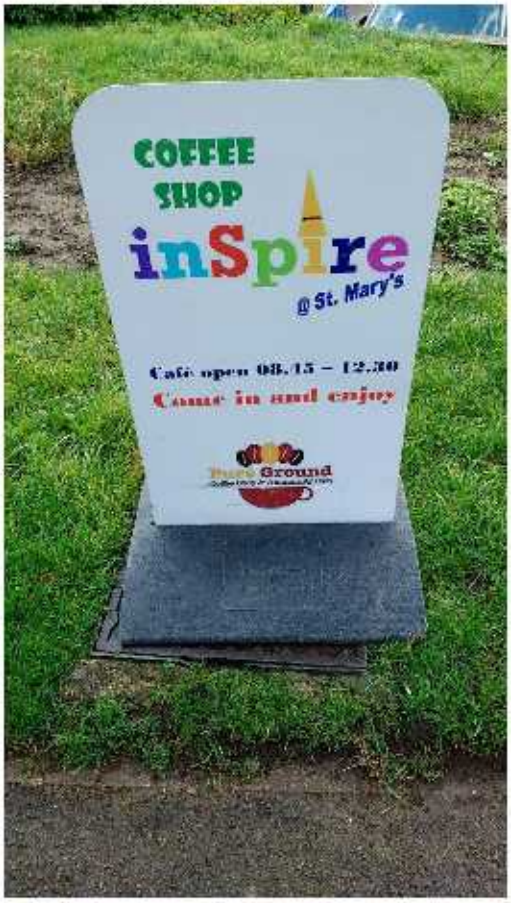
Services	7 hours per week
Meetings and Church Groups	Café, 30 hours per week Messy church, monthly
Community Use	25 hour per week Orchestra, yoga, youth group, brownies, private hire, social events, winter night shelter
Occasional Offices	12 weddings 8 funerals p.a.

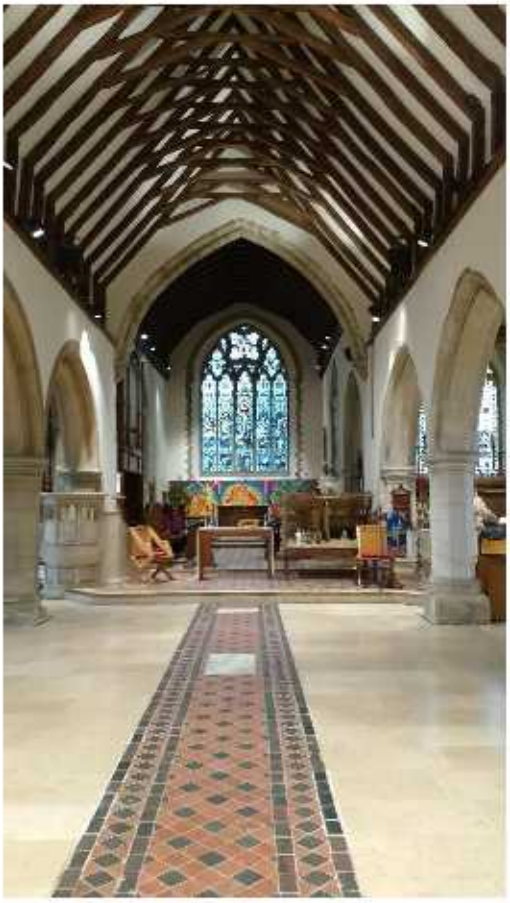
Church annual use = 3500 hours

Heating hours: = 5000 hours.

Estimated footfall (church only) = 30,000 people

The church is heavily used, with a café open every morning and several groups and community events hosted during the evenings and at weekends. Underfloor heating was fitted in 2014 which is currently run constantly during the heating season.





3. Energy Procurement Review

Energy bills for gas and electricity have been supplied by St Mary the Virgin, Willesborough, Ashford and have been reviewed against the current market rates for energy.

The current electricity rates are:

Meter D0261252	13.1148p/kWh	In line with current market rates
Standing Charge	21.5260p/day	N/A
Meter D0261253	12.9645p/kWh	In line with current market rates
Standing Charge	21.9760p/day	N/A
Meter D0261254	13.1148p/kWh	In line with current market rates
Standing Charge	21.5260p/day	N/A

The current gas rates are:

Single / Blended Rate	2.2411p/kWh	Below current market rates
Standing Charge	355p/day	N/A
Availability Charge	p/kVA	N/A
Meter Charges	p/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.

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.

4. Energy Usage Details

4.1 Annual Consumption

St Mary the Virgin, Willesborough, Ashford uses over 24,000 kWh/year of electricity, costing in the region of £3,550 per year, and 140,000kWh/year of gas, costing £4,600.

This data has been taken from the annual energy invoices provided by the suppliers of the site.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity Church Three phases supplied	D0261252 D0261253 D0261254	Type 5196A Single phase watt hour	Yes	Blower Cupboard, outside office
Gas – Church	E016 K04145 15 D6	BK-G10E	Yes	Gas meter box in churchyard next to road

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

4.2 Energy Profiling

The main energy use within the church can be estimated as follows using a combination of known figures and reasonable assumptions of hours of use based on discussions:

Service	Description	Power	Annual Use/ kWh	Estimated Proportion of Usage %
Gas heating	Mikofill Ethos boiler, maximum 130kW Underfloor heating system runs constantly October – April, est. 5000 hours	28 average	**139,580**	85%
Boiler pump	5000 hours	200W	**1,000**	0.6%
Lighting	All LED lighting in church			
Nave	23 fittings			
Chancel	12 fittings			
Aisles	13 + 19 fittings			
	TOTAL 67 est 15W	1005W		
Office		100W		
Cafe	8 recessed	400W		
Kitchen	3 recessed	150W		
	2 fluorescent T8, 4' length	120W		
Toilets	2 recessed	20W		
Tower	2 fluorescent T8, Osram L59WC	118W	**6,600**	4%
Heating [Electric]	Choir Stalls – Under Pew heaters 14 x BN Thermic 300W each	4.2kW	**420**	
Office	Portable electric heater, occasional use	2kW	**150**	0.3%
Hot Water	Zip Varipoint 11, 10 litre heater in kitchen.	2.2kW	**2,746**	
	Assumed on when café open, 24h per week		**300**	1.9%
	Three other water heaters (vestry, toilets), assumed rarely used.			
Other Small Power	Sound system, est use 6 hours/week	1.5kW	**470**	
	Projector, est use 2 hours/week	1.5kW	**150**	
Church	Vacuum cleaner, est use 1 hours/week	2kW	**100**	

Office	Computer estimates for daily use Photocopier	100kW 500W	**132** **33**	0.5%
Kitchen	Lincat Coffee Machine Iberital IB7 Coffee Machine Fridge/freezer Dishwasher Washrite (5 x per day) Toaster (30 mins/day) Sandwich maker x2 (30 mins/day) Microwave (30 mins/day) Warming Cabinet Commercial oven, 6 ring hob (30 mins/day) Extractor fan Till	3kW 2.85kW 300W 4.5kW 1kW 2 x 1kW 1kW 1kW 1.5kW 3kW 100W 50W	**2800** **2650** **2500** **2340** **156** **156** **156** **624** **132** **468** **31** **15**	7.3%
Organ	Organ	1kW	100	0.06%

Estimates sum to 24,229kWh

Total Annual Consumption 2019: 24,238kWh

4.3 Energy Benchmarking

In comparison to national benchmarks for Church energy use St Mary the Virgin, Willesborough, Ashford uses more electricity heating energy than would be expected for a church of this size[1].

This is due to the high hours of use rather than any inefficiencies.

	Size (m^2 GIA)	St Mary the Virgin, Willesborough, Ashford use kWh/m^2	Typical Church use kWh/m^2	Efficient Church Use kWh/m^2	Variance from Typical
St Mary the Virgin, Willesborough, Ashford (electricity)	460	52.7	20	10	263%
St Mary the Virgin, Willesborough, Ashford (heating fuel)	460	303	150	80	202%
TOTAL	460	356	170	90	209%

There is currently no benchmark data which takes hours of use and footfall into account.

[1] CofE Shrinking the Footprint – Energy Audit 2013

5. Energy Saving Recommendations (Electricity)

5.1 Lighting (fittings)

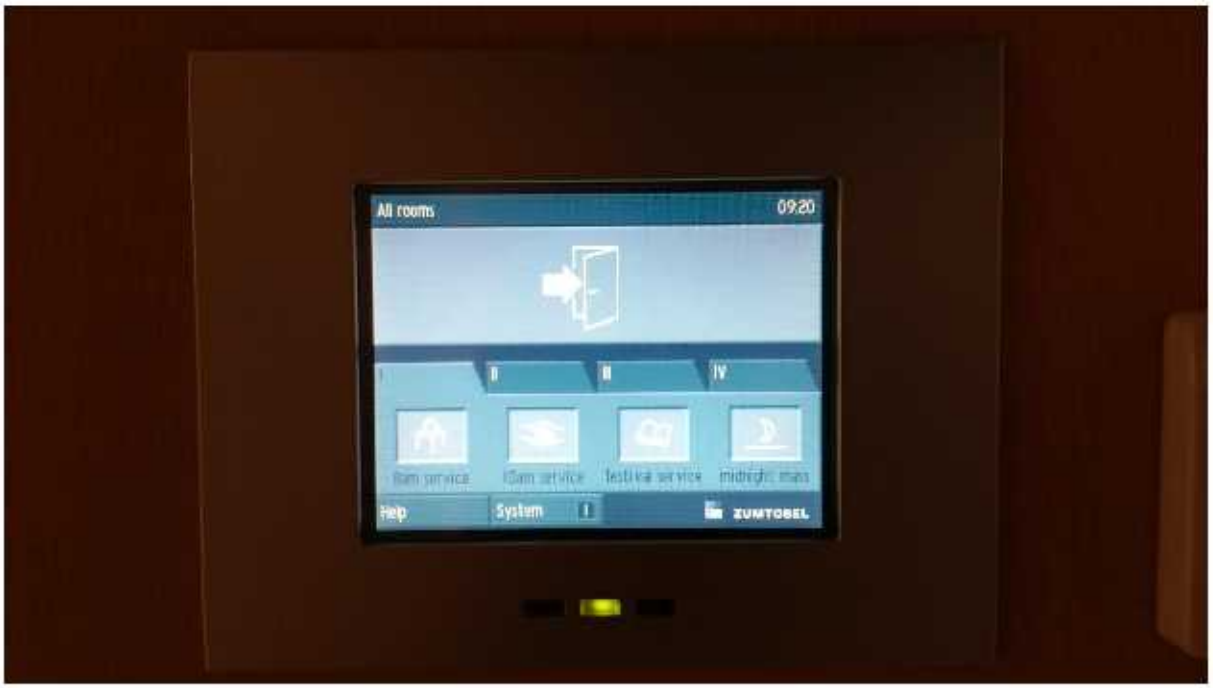
The lighting in the church itself is LED, installed in 2015 for a cost of approximately £50k.

Lux values were recorded with all lighting on, as 100-340 in the north aisle, 200-400 in the nave, 100-300 in the chancel, 50-150 in the café at the rear of the nave and 570 in the kitchen. These are good values, recorded on a dull morning when the south chapel was in use for a midweek service.

It is recommended to check that replacement recessed lighting bulbs are LED. These lights are probably GU10 fittings.

5.2 Lighting Controls

Control is by a very flexible Zumtobel touch screen system with 16 settings, which is described as being easy to use.



It is recommended that the existing lighting presence detectors are added to areas such as toilets and store cupboards

Depending on the type of light fitting installed it is normally recommended that areas such as store rooms and cleaners' cupboards switch off after just 1 minute and WCs after 5 minutes. Generally lighting levels should be around 300lux but it is highly dependent on the use of the space.

5.3 Lighting (control for external lights)

When LED floodlights are installed for the tower as planned, they should be controlled by a method such as a light monitor set to switch on after dusk and a timer to switch off at around 11pm.

Sangamo (http://sangamo.co.uk/) make a wide range of commonly used timeclocks which any qualified electrician can install which includes this range:

https://www.sangamo.co.uk/collections/astro-suntracker

5.4 Refrigeration controls

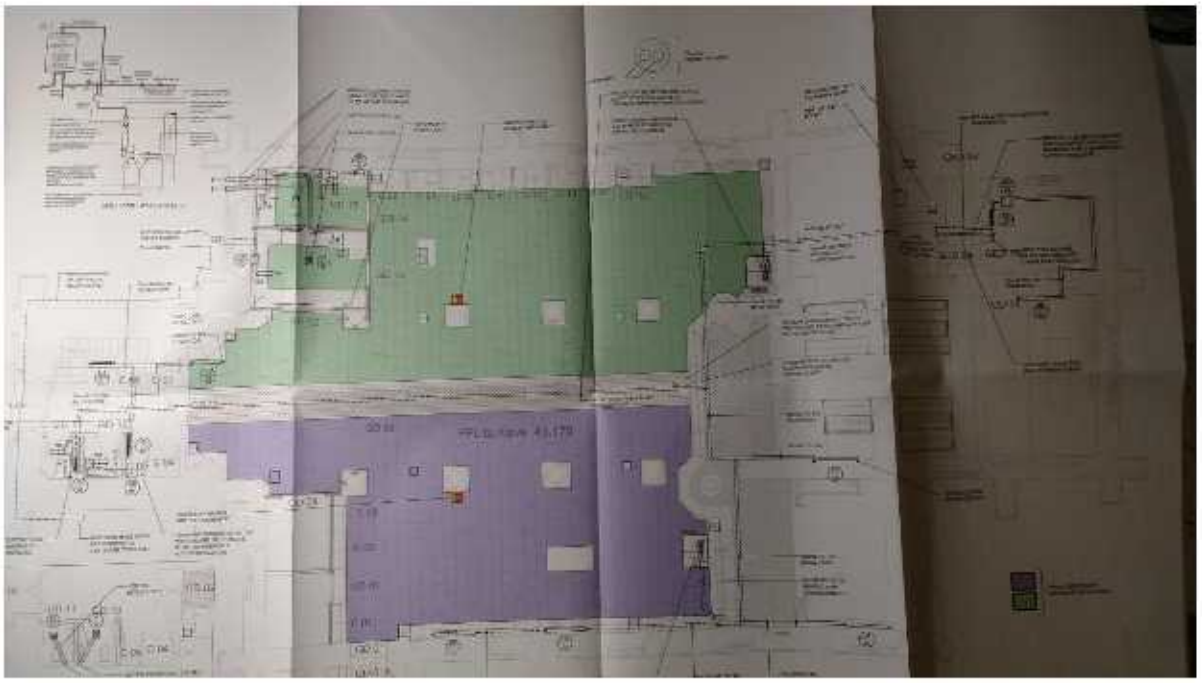
To reduce the electrical consumption of these appliances it is recommended that they are all fitted with a SavaWatt unit. These units work by automatically detecting the load of the compressor and turning down the power when it is not in full load. This reduces the energy consumption of the refrigeration unit by around 18% while maintaining the cooling of the appliance. It does this by reducing the voltage delivered to the unit when it is idling but allowing the full energy to the unit when it is required.

Supply and installation and further details can be undertaken by SavaWatt directly http://savawatt.com/. The installation does not cause any significant disruption to operations and can be undertaken during normal operating times.

6. Energy Saving Recommendation (Heating)

6.1 Heating System and Strategy

The church currently uses a gas fired boiler to heat the church via an underfloor heating system under the nave with ten radiators (1 cast iron, 5 pressed steel, 4 small). This is reported to work well and provides adequate thermal comfort into the church. There are two zones covering the north and south sides of the floor.

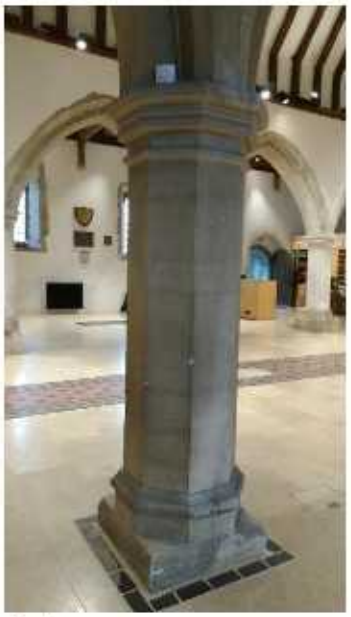


Given that the system is successful and not overly wasteful of energy we would recommend that this system is continued with and consideration is given to the following improvements:

6.2 Boiler future supply

Over the next decade, the boiler will need to be made hydrogen ready. Hydrogen is due to be added to the gas grid over the next five year period. If plans to decarbonise the gas grid are implemented; the hydrogen mix will eventually exceed 20% and a hydrogen compatible boiler (and piping) will be required. The transition will be overseen by the regulatory bodies in a similar way to that between town gas and north sea gas.

6.3 Radiator Optimisation



Purchasing of a temperature datalogger will allow the church to optimise settings of the radiators. This would require someone with a computer to plug in the device and download the readings.

A suitable model retailing for around £40 is
https://www.lascarelectronics.com/easylog-data-logger-el-usb-1/

6.4 Boiler Temperature Setting

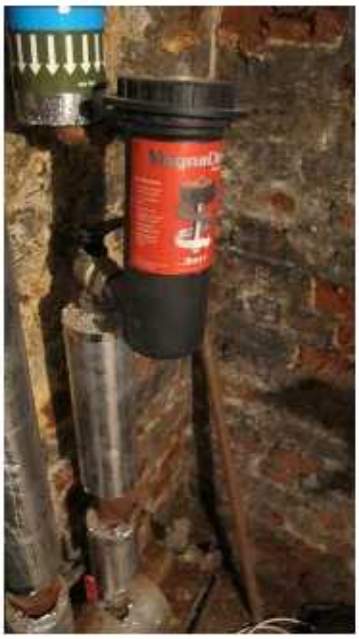
An initial setting of 55°C for the flow temperature was found to be inadequate to heat the church.

Currently, it is set at 75°C.

There may be an opportunity to reduce this at the end of the annual heating season if temperatures within the church are monitored, and the thermostat located on a pillar could also be optimised.

6.5 Magnetic Particle Filter

The boiler did not appear to be fitted with a magnetic particle filter. This apparatus catches any rust or metal particles and prevents them being deposited on the boiler heat exchanger. They should be installed if it is planned to continue using the water heating systems long term. Corrosion inhibitor should also be checked and topped up as part of the annual service.



6.6 Endotherm Advanced Heating Fluid

In order to improve the efficiency of the heating system further it is recommended that an advanced heating fluid (http://www.endotherm.co.uk/) is added to the heating system.

This fluid in in addition to, and complements any existing inhibitors in the heating system and is added in a similar way. The fluid works to improve the ability of the boiler to transfer heat into the heating system and for the radiators and other heating elements to give out their heat into the rooms. It does this by reducing the surface tension of the water and increasing its capacity to transfer and hold heat. Case studies have demonstrated that the addition of this fluid into heating systems reduces heating energy consumptions by over 10% as well as helping the building heat up quicker.

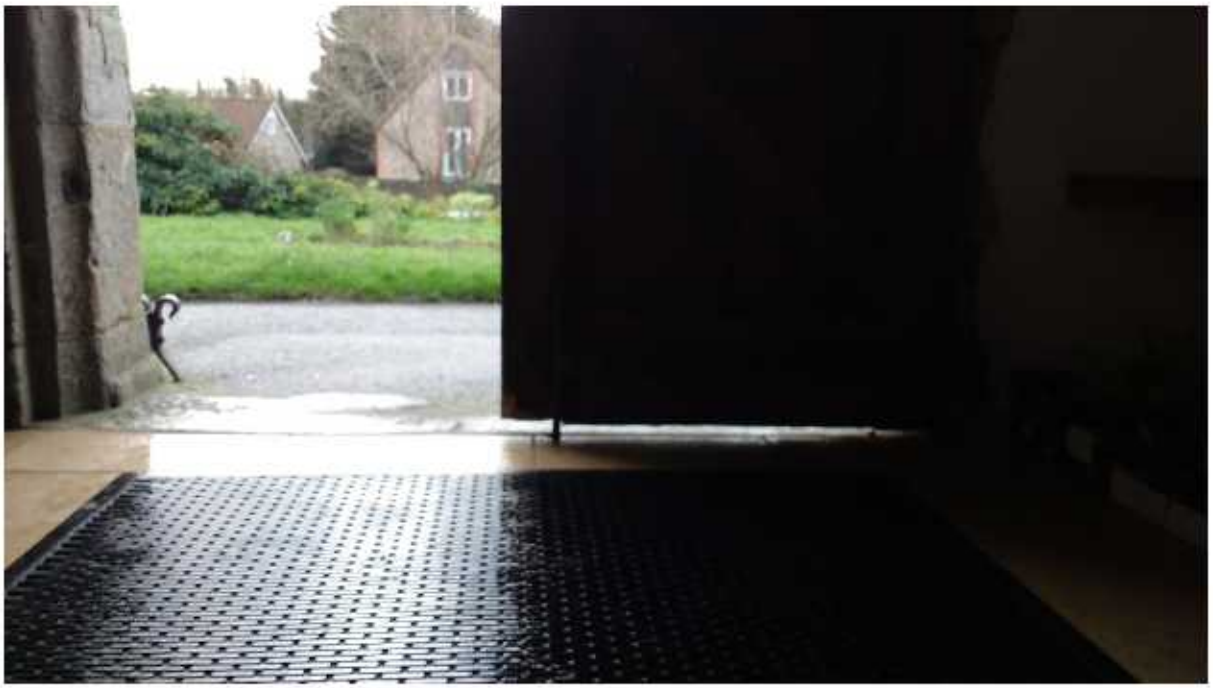
Endotherm can be self-installed.

7. Energy Saving Measures (Building Fabric)

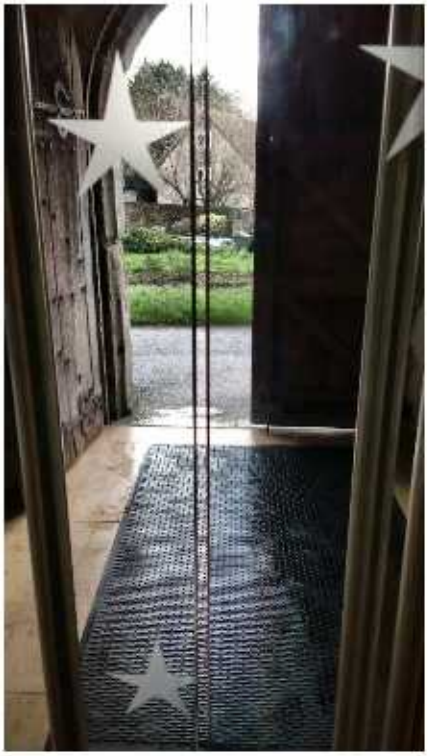
7.1 Draught Proofing to Doors

There are a number of external doors in the building. 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.

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 can not be used where the timber door closes directly against a stone surround.



Other simple measures such as using a small fridge magnet painted black over the large key hole 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.



7.2 Closed Door Policy

The glass doors in the south porch should be kept closed in cold or windy weather and quickly closed behind the congregation by your friendly welcome team!

8. Saving Recommendations (Water)

8.1 Tap Flow Regulators

If there is public access to the toilets in the Attwood Rooms ground floor, consideration should be given to fitting tap flow regulators.

The flow rate of the taps can be easily regulated by fitting flow regulators within the taps. It is recommended that flow regulators such as those manufactured by neoperl (http://www.neoperl.net/en/) are fitted into all the viable hand wash basin taps to save on both water and heating of the hot water.

These regulators can be self-installed or by any good facilities staff.

9. 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 – future option
Battery Storage	Yes – future option
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 electricity supply
Biomass	No – not enough heating load as well as air quality issues

9.1 Solar PV potential

The church has previously considered installing solar panels.

The government replaced the Feed in Tariff (which paid for electricity generated, plus half deemed exported to the grid) with the "Smart Export Guarantee" which pays for measured amount of electricity exported to the grid. Any excess generated can be sold. One of the issues for churches is that most lighting use is at periods when the electricity is not being generated, so unless a battery is also installed, electricity will be required from the grid when it is dark.

The south facing north aisle and nave roof valleys offer a site, although it will be partially shaded by roofs and the tower. Partial shade allows 70-80% of electricity generation.

The two sections of roof together offer an area of around 80m^2 [22 x 2 + 18 x 2m]. This could generate 0.15kWpeak/m^2 giving a 12kWpeak system. A 1kWpeak system can generate 1000kWh annually in Kent, although due to the overshading this is reduced factor should be applied to give 800kWh per kW peak and a total annual generation of 9600kWh. This is much less than the annual energy use of 24,000kWh, so (i) most of it is likely to be used and (ii) there will be little income from the grid as a result.

Using recent larger installation costs (£1,200 per kWpeak compared to £1,667 per kWpeak for domestic installations in 2018); a 12kWpeak system would cost £14,400. This does not include cost of any battery.

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 therefore investment into this may be worth delaying at this stage.

9.2 Heat Pumps to supply the underfloor heating system

The large size of the church indicates that any heat pump system would also have to be large.

Sometimes, adding onsite generated electricity will make heat pumps more viable. Here, the annual generation from SPV is much less than the existing annual use, so it would not offset the extra requirement for electricity from a heat pump.

ASHPs consume electricity, but deliver between 2.5 and 4 times the amount of heat in kWh that they consume. Assuming an average Coefficient of Performance (COP) of 3, replacing 139,850kWh of gas heat input would require around 47,000kWh of electricity to drive the heat pump, costing around £6,000 at current rates.

Air source heat pumps require externally mounted units of similar appearance to air conditioning units, so would have to be located within the boiler compound.

Therefore, retention of an efficient gas boiler, to be made hydrogen ready, with a group buying tariff offering at least 20% of renewable gas is the most cost effective and low carbon solution at present.

10. 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

11. 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.

12. Report Circulation

In addition to the PCC, this report is also sent to:

1. Your DAC secretary and your DEO, because
    - They maybe be able to offer you help and support with implementing your audit
    - They want to look across all the audits in your diocese to learn what the most common recommendations are.
2. Catherine Ross, the officer in the Cathedral and Church Buildings team centrally who leads on the environment, who wants to learn from all the audits across the country. She will be identifying cost-effective actions churches like yours might be able to make.