ESOS-ENERGY
Energy efficient solutions

Energy Audit and Survey Report

St Martin's, Northumberland Avenue, Maidstone

PCC of St Martin's Church

Version Control

Author	Reviewer	Date	Version
Paul Hamley	Matt Fulford	10th February 2020	1.0

Contents

1. Executive Summary

An energy survey of St Martin's, Northumberland Avenue, Maidstone 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 Martin's, Northumberland Avenue, Maidstone is a brick built church dating from the 1960s, the concrete vaulting giving a "whalebone" effect to the space. 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
Switch electricity (and gas) suppliers to ones which provide 100% renewable (or green gas) supplies	Nil	5-15% savings likely	Nil	immediate	None	N/A	N/A
Kitchen: draughtproofing measures to windows	350	£53	£20	0.38	None	0.11	£186.01
Draughtproofing measures to doors	2,500	£90	£400	4.43	List A	0.46	£869.75
Purchase a temperature datalogger for heating optimisation	3,700	£134	£50	0.37	None	0.68	£73.46
Install Cavity Wall Insulation	6,000	£217	£2,000	9.22	List B	1.10	£1,811.99

Install Roof Insulation	7,000	£253	£3,000	11.86	List B	1.29	£2,329.70
Install solar photovoltaic panels on south facing roof with battery	21,000	£2,841	£28,800	11	Faculty	6.45	£4,464.29
Kitchen: double glazed windows or internal secondary glazing	700	106	£1,500	14.10	Faculty	0.22	£6,975.45
Kitchen: ceiling insulation / new insulated roof	700	106	£3,000	28.20	Faculty	0.22	£13,950.89

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

Based on contracted market prices of 15.1990p/kWh (day), 10.1880p/kWh (night), 13.529p/kWh (average) for electricity and 3.614p/kWh for mains gas.

If all measures were implemented this would save the church around £3,000 operating expenditure per year.

Operating costs of electric heating are equivalent to those of gas, since less preheating is required.

2. Introduction

This report is provided to the PCC of St Martin's, Northumberland Avenue, Maidstone 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 Martin's, Northumberland Avenue, Maidstone, was completed on the 20th 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 Martin's, Northumberland Avenue, Maidstone	**606335**
Gross Internal Floor Area	500 m^2
Listed Status	Unlisted
Typical Congregation Size	60

The church typically used for 18 hours per week for the following activities

Services	4 hours per week
Meetings and Church Groups	3 hours per week
Community Use	11 hours per week

There is additional usage over and above these times for occasional offices.

Church annual use = 930 hours

Heating hours = 720 hours.

Estimated footfall = 10,800 people

3. Energy Procurement Review

Energy bills been supplied by St Martin's, Northumberland Avenue, Maidstone and have been reviewed against the current market rates for energy.

The current electricity rates are:

Day Rate	15.1990p/kWh	Above current market rates
Night Rate	10.1880p/kWh	In line with current market rates
Standing Charge	59p/day	N/A

The current gas rates are:

Single / Blended Rate	3.614p/kWh	Above current market rates
Standing Charge	10.95p/day	N/A

The above review has highlighted that there are opportunities to gain cost savings from improved procurement of the energy supplies at this site. We would therefore recommend that the church obtains a quotation for its gas and electricity supplies from the Diocese Supported parish buying scheme, http://www.parishbuying.org.uk/energy-basket. This scheme only offers 100% renewable energy sourced energy and therefore it is an important part of the process of making churches more sustainable.

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

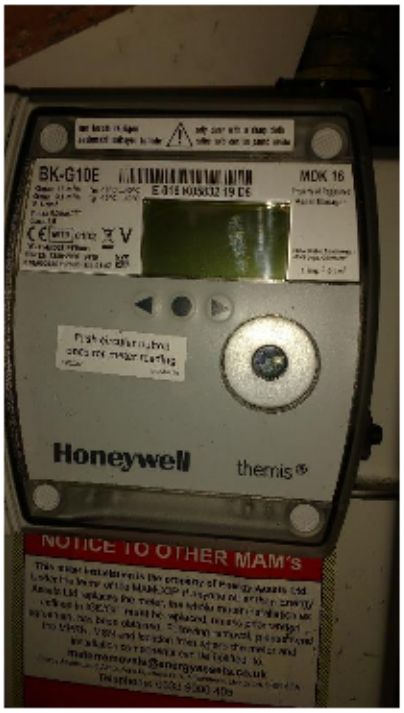
4.1 Annual Consumption

St Martin's, Northumberland Avenue, Maidstone uses 7,200kWh/year of electricity, costing in the region of £1,200 per year, and 75,000kWh/year of gas, costing around £3,000.

This data has been taken from the annual energy invoices.

Utility	Annual use/ kWh	from	to	Cost
Electricity	7,260 (calculated from cost and rates)	1/1/19	31/12/19	£1,260
Gas	74,570 (calculated from cost and rates)	1/1/19	21/12/19	£3,063

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	D0342035	AMPY 5192A	Yes	Store room next to north west door
Gas – Church	E016 K05832 19 D6	Bk-G10E	Yes	Cabinet next to west wall



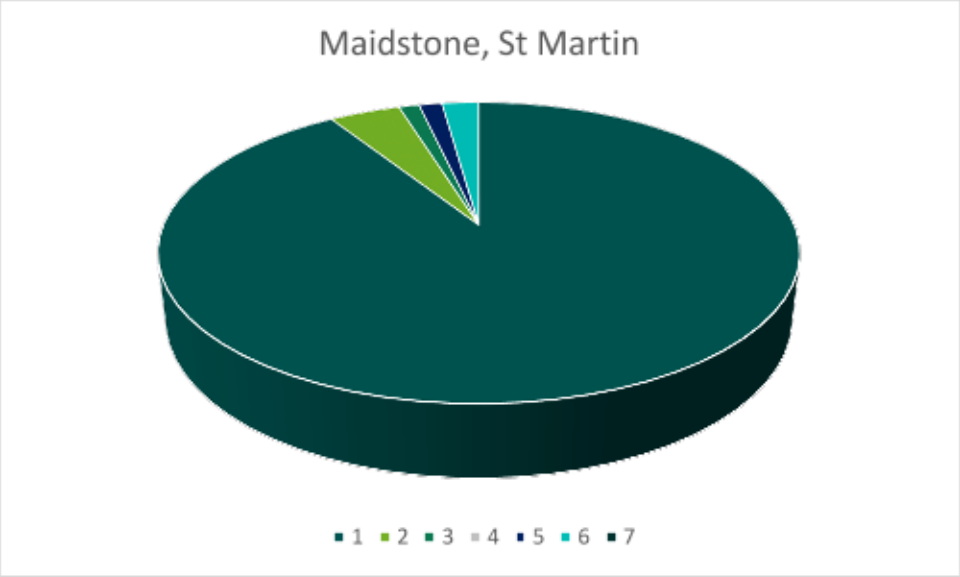
All the meters are AMR connected and obtaining an energy profile for the annual energy usage should be possible.

4.2 Energy Profiling

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

Service	Description	Power	Annual Use/ kWh	Estimated Proportion of Usage %
Gas heating	7 ducted gas heaters, 10.5kW each	73.5kW	74570	91.1%
Lighting **Nave** **Office** **Kitchen** 	LED spotlights (10 nave sides, 4 rear, 6 chancel) 20 x 15W 12 x Fluorescent T8, 4' length 2 X Fluorescent T12, 3' length 3 x Fluorescent T12, 4' length Toilet, corridor	 TOTAL 1kW	 1000	 1.2%
Heating [Electric] Kitchen	Wall mounted convector heater in constant use, possibly 5000 hours Vestry – portable, rarely used **TOTAL**	2kW	[10000 if max] 3500	 4.3%
Hot Water	Kettles ~25 boils/week = 1.25 hours Water heater, wall mounted 4 h/week Coffee machine ~ 6 hours per week	3kW 1.5kW 2kW	200 312 624	 1.4%
Other Small Power **Kitchen**	Sound system Vacuum cleaner Cooker Extraction fan Microwave, Panasonic Toaster Food warmer Fridge Dishwasher, Hotpoint (6 hours per week)	1kW 1.5kW 3kW 200W 800W 1kW 1kW 75W 1.9kW	220 100 150 10 10 12 52 650 600	 2.2%
Organ	Organ (rarely used)	1kW	10	-

Total Annual Consumption 2019: 7,260kWh



KEY 1 Gas heating 2 Electric Heating 3 Lighting 4 External lighting (zero)

5 Hot water 6 Small power including kitchen 7 Organ

4.3 Energy Benchmarking

In comparison to national benchmarks[1] for Church energy use St Martin's, Northumberland Avenue, Maidstone uses 72% electricity and an average amount of heating energy for a church of this size.

It is not in heavy use, most events taking place on Saturdays to Mondays.

	Size (m^2 GIA)	St Martin's, Northumberland Avenue, Maidstone use kWh/m^2	Typical Church use kWh/m^2	Efficient Church Use kWh/m^2	Variance from Typical
St Martin's, Northumberland Avenue, Maidstone (elec)	500	14.5	20	10	72.6%
St Martin's, Northumberland Avenue, Maidstone (heating fuel)	500	149	150	80	99.4%
TOTAL	500	164	170	90	96.3%

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 makes up a relatively small overall energy load within the building, as the majority of the lighting is LED or fluorescent. When any lighting is changed, it should be replaced with LED.

5.2 Lighting (control for internal lights)

The church is well lit in daylight, with relatively large south facing windows, therefore the number of lights used to light the church during summer could be reduced with some experimentation.

The light switches are located in the store room next to the west door which did not appear to be the most convenient location.

6. Energy Saving Recommendations (Kitchen)

The kitchen is a single storey extension on the south side of the church with a flat roof.

It has single glazed windows. It is used regularly on Monday evenings to cook a meal for 30-40 people, but perhaps sporadically at other times, just for preparing hot drinks.

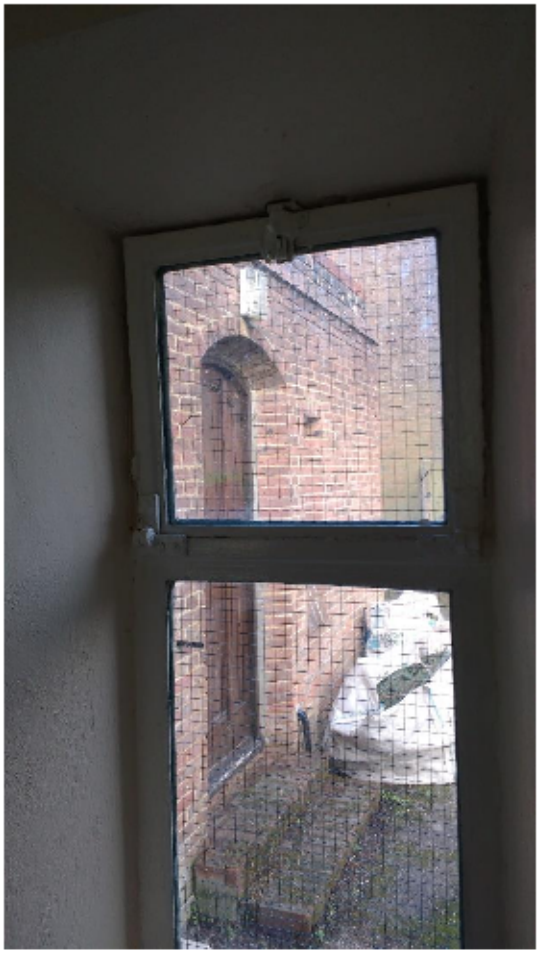
It was noted that the 2kW convector heater on the south (outer) wall was left running. If it is indeed left on at full power constantly during the heating season as suggested by the notice, it will consume around 10,000kWh, Given the church's actual energy bill, 3,500kWh is more likely. This is still a considerable use at a cost of around £475.

Recommendations:

The PCC should consider the use pattern of the kitchen and if it can be heated suitably for the periods when it is occupied more efficiently, given that the heater is fitted with a timer.

- Understand when the kitchen needs to be heated
- Experiment with using the heater timer to preheat in advance of uses, but not running constantly
- Draughtproofing of single glazed windows (maintenance so that they close, block gaps using plasticine which can easily allow them to be opened in the summer)
-
- Replace windows with double glazed units
- Investigate the potential of ceiling insulation (is there a void? Will the flat roof require renewal – if so raise it and install adequate insulation)
- Install a radiant heating panel on the ceiling for rapid heating


Please don't touch the heater settings or switch it off.
Thanks
Joyce



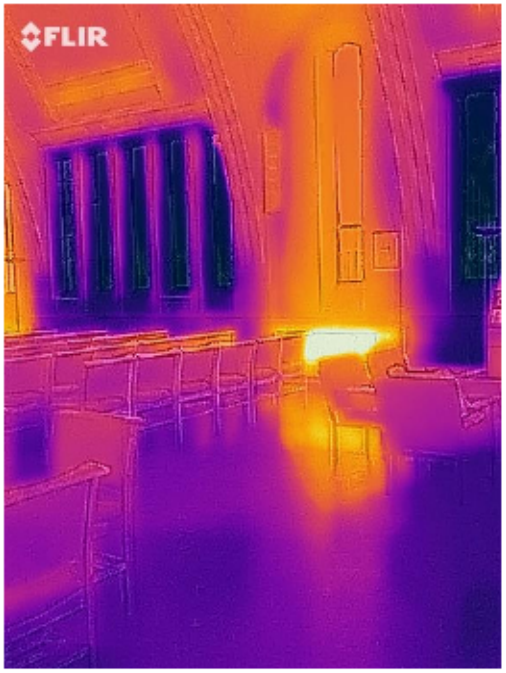
7. Energy Saving Recommendation (Heating)

7.1 Heating System and Strategy

The church currently uses seven direct gas convector radiators venting via flues through the walls to heat the church, with a total output of 73.5kW.

This is reported to work reasonably well and provides adequate thermal comfort into the church, although much heat goes directly upwards to the ceiling as can be seen in the thermal images below.

Actual temperatures, measured using an infrared thermometer were: Tiled floor 16.2, Carpet 17.7, South wall 17.3, West wall (away from heaters) 15.0, font 16.2 (a good indicator of the temperature of a church and how much the building is used due to its large thermal mass), ceiling 20.1 (three degrees warmer), heater case 66, element inside 200.

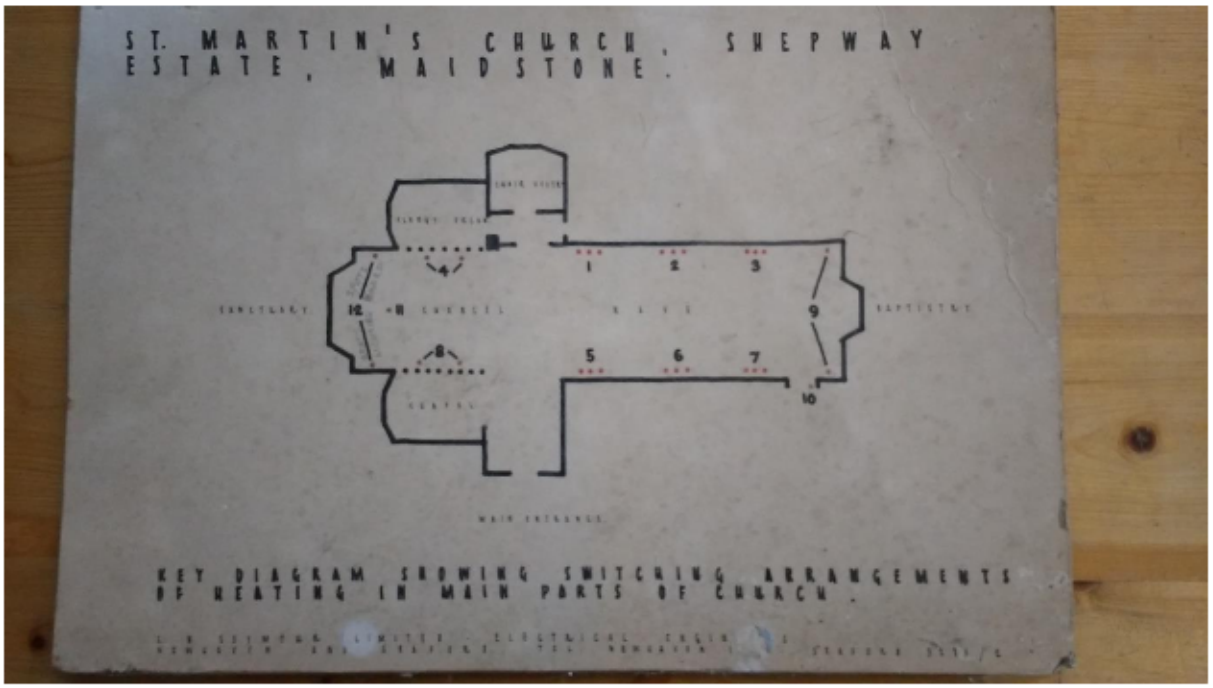


The low level at which the heaters are fitted means that much of the heat radiating from them is blocked by the nearby seating, as can be seen by the yellow area on the floor in the gap between the chairs in the image above.

If this method of heating is to be continued, then the gas heaters will have to be upgraded to be hydrogen compatible. Hydrogen is planned to be added to the natural gas supply within the next decade. The transition will be overseen by the regulatory bodies in a similar way to that between town gas and North Sea gas.

There are also 20 unused radiant heaters along the nave at 3 metre height. It is unclear whether these are in working order. These are grouped in threes along the nave as shown below:

The numbers on the diagram below refer to the radiant heaters, eighteen in the nave and 28 in total.



The slots above the windows and below the fluorescent lighting which accommodate the radiant heaters can clearly be seen.

7.2 Avoid Background Heating

As the church has both convection heaters and radiant heaters; it can in theory be heated relatively quickly.

Providing constant background heating to a church building is excessive and wasteful of energy and should be avoided.

7.3 Heater Timing Optimisation

The heater timings for Sundays can be optimised by the heating being turned off before everyone has left – how early will depend on how quickly the building cools.

Purchasing of a temperature datalogger will allow the time for the church to heat (in different weather conditions) to be understood, as well as the time to switch off to be optimised. 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/

8. Alternative Heating Systems

A church with low hours of use per week will always fall back to "base" temperature between heating events (it may take around 24 hours for the temperature to fall). A system which can heat rapidly, without sending most of the heat to the ceiling first, and in addition can be configured to heat small areas independently for small services or midweek meetings will be more efficient than one which seeks to heat up the whole volume.

8.1 Use of Electric Radiant Panels for Heating Specific Areas only

Repairing or refitting the high level radiant heaters would mean that sections of the church could be specifically heated at short notice for occasional meetings, avoiding having to heat up the entire church building.

The image below shows one fluorescent tube lighting a recess, below which is a second fluorescent tube, unlit behind a diffuser. Below this is a bank of three 1kW(?) radiant heaters.

These are of the incandescent bar type which emit a visible glow.

It is not known why the church ceased to use these heaters. As an alternative, which does not emit any visible radiation and also could increase the power available, due to a greater area, would be to install rectangular far infra-red (non-glowing) heaters on the vertical section of wall below the radiant heater slots, or each side of the lights into the rectangular recessed panel of the ceiling.

There are a large variety of products; suitable far infrared panels include https://www.warm4less.com/p/3200-watts-alpha-bar-heater/ . 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.

Using the infrared heaters completely instead of gas would move the church off gas but the additional use of electricity would not currently provide any cost or carbon benefit. At this stage the overhead units should only be used as an alternative to heating small discrete areas of the church for say a meeting, rather than for the entire building. This should be review in future as the cost and carbon dynamics of gas and electricity change.

9. Energy Saving Measures (Building Fabric)

9.1 Roof Insulation

Fit 270mm of insulation into the loft

There is a void between the ceiling of curved profile and the roof. This was not inspected as part of the audit. 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.

The ceiling/roof of a building is the largest contributing area to heat loss from a building as heat rises. 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. Insulation measures such as this

also need to be combined with control measures such as TRV's or room sensors to ensure that the space does not overheat because of the additional insulation.

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).

9.2 Wall Insulation

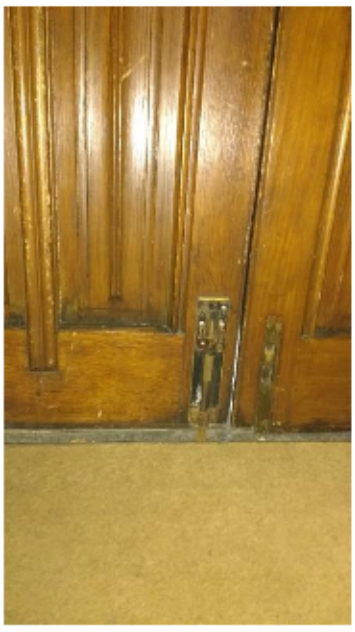
Inject cavity wall insulation into walls

The building is constructed of brick laid to stretcher bond which indicates a cavity, and inspection of the wall showed no signs that insulation has been added. Prior to the early 1990's cavity walls did not require to be insulated and therefore it is likely that there is no insulation present but it could be added through injecting it into the cavity walls.

It is recommended that cavity wall insulation is considered and added to the walls where appropriate. A survey to check the width of the cavity, exposure of the wall and condition of the cavity should be carried out by a CIGA approved installer who will then be able to provide you with a quotation to undertake the works. Installing cavity wall insulation will help to reduce heat loss and improve the comfort of the space.

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).

9.3 Draught Proofing to Doors



The western pair of doors has a gap between the two doors when they close which is big enough to admit a large amount of air when it is windy. This will be a constant source of heat loss throughout the heating season, in fact at all times when the external temperature is colder than the internal temperature in the church.

Daylight can be seen between the two door leaves.

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.

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.

9.4 Closed Door Policy

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

10. Other Recommendations

10.1 Electric Vehicle Charging Points

The church has a car park to front of it which serves the church and also the frequently used church hall. In order to make a visible statement on the churches mission of stewardship and to facilitate more sustainable transport choices by those both visiting the church and using the hall, the church may wish to consider installing an electric vehicle charging point, probably on the side of the church hall to allow visitors to charge their electric car.

Installing a unit such as a Rolec Securi-Charge http://www.rolecserv.com/ev-charging/news/view/Robust-EV-Charging-With-Rolecs-SecuriCharge-EV-Wall-Unit-Coin-Token-PAYG would allow the church to be able to sell tokens or have a coin operated device that would at least cover the costs of the electricity use and could make a small income. As the hall is a place of work for the pre-school users it may be able to benefit from a grant to part cover the installation costs of a charger from https://www.gov.uk/government/publications/workplace-charging-scheme-guidance-for-applicants-installers-and-manufacturers.

10.2 Security of Gas Meter

It was noted that the gas meter cover was not attached to the ground and could be easily removed, allowing anyone access to the meter and main supply valve. It is recommended that the cover be securely fastened to the ground as a priority.

11. 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
Battery Storage	Yes
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 radiator system
Air Source Heat Pump	No radiator system
Biomass	No radiator system

11.1 Solar PV potential

The south facing roof offers a large site, relatively unshaded (there are two trees on the church boundary). The ridge is approximately 35m long with a maximum area in the region of 160m^2. At maximum capacity this would generate at 0.15kWpeak/m^2 giving a 24kWpeak system. A 1kWpeak system can generate 1000kWh annually in Kent. The roof is oriented approximately 20 degrees east of south and taken together with an overshading factor this gives a total annual generation of 21.000kWh.

This is much larger than the church's current annual electricity use (7,260kWh) – although much of that use will be during the evening and night. If the original radiant electric heating were to be used; 28 elements of nominally 1kW each run for 700 hours annually gives around 20,000kWh. This suggests that the church should develop a plan for the reintroduction of radiant electric heating, powered by solar electricity generated on site with battery storage.

It is assumed that solar panels would have to be laid directly onto the roof surface. The advice of the inspecting architect should be sought to ensure that the roof structure can support the extra weight and wind loading forces.

Using average 2018 costs for larger systems of £1,200 per kWpeak, a 24kWpeak system would cost £28,800. 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.

The government has proposed a new "Smart Export Guarantee" to replace the Feed in Tariff. The payments are dependent on the particular buyer of the power, and are unlikely to exceed 5.5p/kWhour. Hence the system should be sized such that most or all generation is consumed on site, so a battery is a good investment.

12. 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

13. 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.

14. 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.