ESOS-ENERGY
Energy efficient solutions

Energy Audit and Survey Report

St Mary's Church, Kennington, Ashford

Ashford Town Parish PCC

Version Control

Author	Reviewer	Date	Version
Paul Hamley	Matt Fulford	6th February 2020	1.0

Contents

1. Executive Summary

An energy survey of St Mary's Church, Kennington, 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's Church, Kennington, Ashford is a Grade II listed mediaeval church, built from c.1100 with the chancel extended in 1270, much dates from the 15th century. It has a crown post roof with tie beans and an intact ceiling. A small array of solar photovoltaic panels are fitted to the chancel roof. Electricity only supplied to the site, heating is by oil.

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
Stop background heating	16,000	£688	Nil	Immediate	None	4.29	-
Install electric fan heating curtain above porch doorway (instead of background heating)	Nil	Nil	£1,000	N/A	Faculty	Nil	N/A
Draughtproofing measures	800	£104	£25	0.24	List A	0.25	£101.73
Install Under Pew Heating	40,000kWh Oil replaced by 4,500kWh electric Included in above	£1,143 Included in above	£8,320	12.53	Faculty	9.35	£1,531.55
Install radiant infrared panel heaters in chapel and other areas as necessary			£6,000				
Install further solar panels On hall roof	5,000	£650	£10,000	15.39	Faculty	1.54	£6,510.42

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

Based on contracted prices of 12.9917p/kWh for electricity and 4.3p/kWh for oil.

If all measures were implemented this would save the church £2,200 operating expenditure per year.

2. Introduction

This report is provided to the PCC of St Mary's Church, Kennington, 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's Church, Kennington, Ashford, Church Road, TN23 9DQ 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's Church, Kennington, Ashford	606212
Gross Internal Floor Area	312 m^2
Listed Status	Grade II
Typical Congregation Size	60

The church typically used for 6 hours per week for the following activities

Services	4.5 hours per week
Meetings and Church Groups	0 hours per week Easter course
Community Use	0 hour per week

Church annual use = 416 hours

The adjacent hall is used by several groups.

Heating hours: Church = 270 hours at 18°C, portion of 5000 hours to maintain 12°C

Estimated footfall (church only) = 5,600 people

3. Energy Procurement Review

Energy bills for oil and electricity have been supplied by St Mary's Church, Kennington, Ashford and have been reviewed against the current market rates for energy.

The current electricity rates are:

Single / Blended Rate	12.9917p/kWh	At lower end of current market rates
Standing Charge	21.3804p/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 its current electricity 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's Church, Kennington, Ashford uses 5,200 kWh/year of electricity, costing in the region of £790 per year, and 3750 litres (40,200kWh)/year of oil, costing £1,700.

It was unclear whether the electric meter located in the church vestry supplied the hall as well (none was located in the hall despite a search). No data was supplied to show the amount of solar power generated. The solar array appears to be of about 18m^2 size, so could potentially generate 2,700kWh annually.

Utility	Annual use/ kWh	from	to	Cost
Electricity	5,211	1/9/18	31/8/18	£785.98
Oil - Church	40,210 (3751 litres)	22/1/19	15/10/19	£1,727.65
Gas – hall	12,493	31/8/18	31/8/19	£502.70

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	E15UP12451	EDMI Atlas Mk7c	Yes	Vestry
Gas - Hall	04596 11501			

The electricity meter is AMR connected and as such obtaining an energy profile for the annual energy usage should be possible.

4.2 Energy Profiling

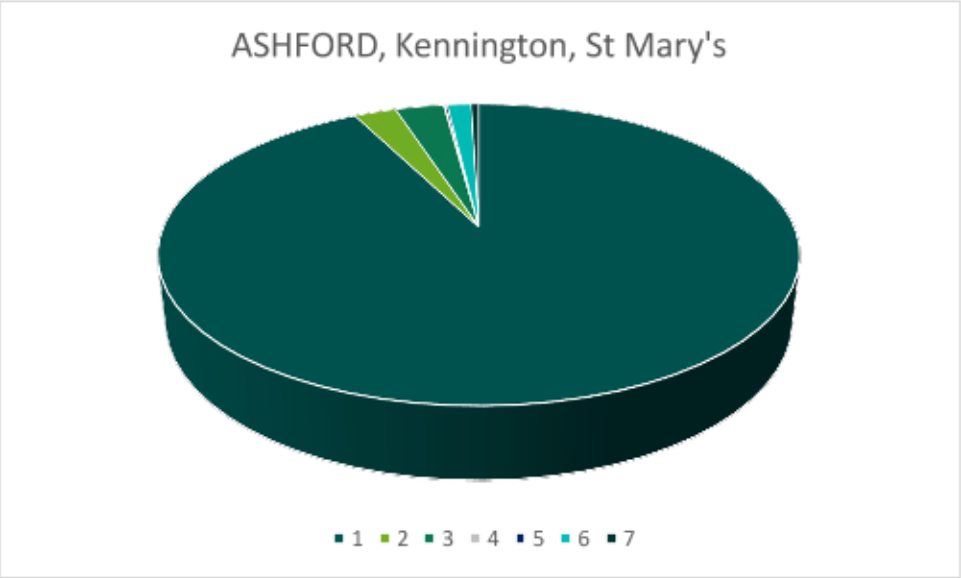
The main energy use within the church can be estimated as follows:

Service	Description	Power	Annual Use/ kWh	Estimated Proportion of Usage %
Oil heating	Grant Vortex Utility boiler	70kW	40210	88.6%
Boiler pump	Grundfos, maximum 140W (5000 hours)	140W	500	1.1%
Lighting				
Nave	16 LED arrays estimated 50W each	800W		
	8 spotlights	640W		
Chancel	10 LED arrays estimated 50W each	500W		
	8 spotlights	640W		
Chapel	16 LED arrays estimated 50W each	800W		
	8 spotlights	640W		2.9%
	TOTAL			
		4020W	1270	
	Operated by motion sensor			
Path Lights		400W	30	
Heating [Electric]	Fan assisted radiator – fan	80W	400	
	Radiant bar heater next to organ	1kW	100max	
Vestry	Portable heater - Glen	2kW	100	1.30%
Hot Water	Kettle, 7 boils/week = 18 hours p.a.	3kW	54	
	Kitchen water heater	3kW	10	0.1%
Other Small Power	Sound system annual use estimate 260h	1kW	260	
	Projector	1kW	260	
Kitchen	TV Screens, flat, x 4	200W	52	
		2kW	52	
	Vacuum cleaner 30 minutes/week			1.4%
Organ	Organ	1kW	200	0.4%

Above total 3,288kWh

Total Annual Consumption 2019: 5,211kWh.

It is uncertain if this is only the church or if it includes the adjacent hall. In addition, the solar power generated is unknown and not included in the amount of grid electricity consumed annually.



KEY 1 Oil Heating 2 Electric heating including pumps 3 Lighting internal

4 Lighting external 5 Hot water 6 Small power 7 Organ

4.3 Energy Benchmarking

In comparison to national benchmarks for Church energy use St Mary's Church, Kennington, Ashford uses 83% electricity and 86% heating energy than would be expected for a church of this size.

This is largely due to the low hours of use.

	Size (m^2 GIA)	St Mary's Church, Kennington, Ashford use kWh/m^2	Typical Church use kWh/m^2	Efficient Church Use kWh/m^2	Variance from Typical
St Mary's Church, Kennington, Ashford (elec)	312	16.7	20	10	83%
St Mary's Church, Kennington, Ashford (heating oil)	312	128.8	150	80	86%
TOTAL	312	145.6	170	90	86%

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

5. Energy Saving Recommendations (Electricity)

5.1 Lighting (fittings)

The lighting makes up a relatively small overall energy load within the building approximately one fifth of the electricity use. The lighting is believed to be a mixture of LED and Compact Fluorescent Lamps [CFL].

5.2 Lighting (control for internal lights)

The church has small south facing windows, so relies on good lighting.

The existing lighting control panel is well labelled, but extra instructions should be laminated regarding the use of the slider (dimmer) switches, whose operation was unclear during the audit.

5.3 Refrigeration controls (Hall Kitchen)

Install SavaWatt energy saving devices on fridges and freezers

Fridges run 24/7 and contribute to the baseload electrical consumption of the building.

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 oil fired central heating to heat the church.

Background heating is used to maintain the temperature at 12°C during the week when the church is closed, apart from a Wednesday morning meeting.

Heating on Sundays begins two hours before the 08:00 service at 06:00. The 10:00 service finishes by 11:30, but the heating is thought to be running until 12:00.

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.

The remainder of Section 6 focusses on maintenance and optimisation of the present system; alternative options are considered in Section 7.

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. 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 and 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 at a level of 12°C is excessive and wasteful of energy in churches which are used only on Sundays and one mid-week service. At the very least we would recommend that this background level is reduced to a maximum of 8°C and ideally avoided all together. If there is a problem with the boiler taking a very long time to heat the church from cold, this may indicate it, and /or the rest of the heating system is inefficient. Studies in Lichfield diocese show that it is normal for churches to require 8-12 hours to heat from 10 degrees.

Annual oil use is 3750 litres giving 40,200kWh of heat. The church records a higher energy use in kWh per m^2 than other oil heated churches, 128.8kWh/m^2 compared to 86.8 kWh/m2, 91.8 kWh/m2, 91.9 kWh/m2 for three churches which range from smaller to larger. St Mary's Kennington is in the middle of the group in terms of size, occupancy hours and footfall, but is using 40% more heating energy. This is due to use of background heating to prevent the temperature falling below 12°C.

Most radiators noted in the church were located in the chancel (two), south chapel (three) with one fan assisted radiator at the rear of the church. This would suggest that warm up times from cold will be very long as most heat is being delivered to the end of the church furthest from where the congregation sit. This, taken together with oil heating (giving the worst carbon footprint of heating methods), a church only used on Sundays and old radiators provides a strong argument for installing an electric heating method.

6.3 Boiler Timing Optimisation

The boiler timings for Sundays are reported to be ON 06:00, OFF 12:00. It is understood that the church service at 10:00 finishes by 11:30, so there is scope for reducing the operating hours. Radiator systems with hot water remain hot for several hours after the boiler is switched off – experiments in the Diocese of Lichfield at over 50 churches have established that hot water radiator heating can be optimised by being switched off 45 minutes before the end of the service. As you have people present until 11:30 you could experiment with turning it off at 10:45, 75minutes earlier than at present. During the coldest part of the year the heating could be timed to start earlier.

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/

6.4 Space Temperature Set Point

The set temperature of 18°C is appropriate for service, although the temperature at the thermostat near the organ may not be the same as the temperature in the pews.

To assist in optimising and understanding the temperatures in the church, a datalogger such as an Easylog USB or Mindsets mini temperature datalogger could be purchased.

6.5 Insulation of Pipework and Fittings

Insulate exposed pipework and fittings around boilers and tanks

The pipework insulation is inadequate and incomplete. This should be supplemented with further insulation which ideally should cover the valve bodies. The pipework within the plant 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 wasted heat loss from the system.

It is recommended that these areas of exposed pipework and fittings are insulated with bespoke made 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. 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.

7.1 Under Pew heating

A future option is to install under pew electric heating. This form of heating requires little preheating time and delivers heat directly to the congregation. There are sixteen pews on the north side of the nave and ten on the south side.

Heaters with an output of 400W seem to be more suitable than 500W models according to reports from different churches. 26 pews with a total of 52 heaters delivering about 21kW of heat, plus a 3kW overdoor curtain heater and 6kW of radiant panels in the chapel /south aisle area give 30kW; if used for 5 hours per Sunday over 30 weeks this gives 4,500kWh or about 11% of the current heat consumption. This would cost £584 at current rates compared to £1,727 for oil.

Capital cost would be in the region of 52 x £160 + £1000 + 12 x £500 = £15,320

Most churches with this form of under pew heating report warm up periods required between 30mins and 1 hours, even if addition warm up periods were preferred there is significant margin for cost saving. Also, only the pews needed for seating could be heated – although some top up electric convection or radiant panel heat may be required.

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.

The under pew (see photo below) together with radiant 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.

Another option is to sue fabric covered Cooltouch heaters as below, which appear to be available in longer lengths so only 26 would be required.

https://www.cooltouchheaters.co.uk/

7.2 Use of Electric Radiant Panels for Heating Specific Areas only

Where there are areas without pews such as in the south chapel area which has chairs as illustrated in Section 6.2, installation of radiant panels would allow the area to be heated independently.

Far infrared panels come in three types, low surface temperature designed for ground level installation and safe for schools (55°C) and hospitals (42°C), medium temperature, and high temperature at 150°C designed for installation under high ceilings. In churches they have been successfully installed under ceilings, often in aisles between the beams. Normally available in white, they can be sourced in other colours including marching to stonework or brickwork, or decorated with printed patterns or pictures, e.g.: https://www.suryaheating.co.uk/custom-image-heating-panels.html

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.

Costs are £350-500 wall mounted and £500-700 ceiling mounted.

Another option would be to use radiant (glowing) heating elements – these normally look unsightly when hung from ceilings or attached to walls, but have been successfully deployed in churches mounted on chandeliers hung from arch centres. They can be combined with lighting if desired.

The image below is from St Catherine's, Faversham, which is heated solely by chandelier mounted radiant heaters. Costs are approximately £500 per 1kW element.

7.3 Overdoor Air Heaters

In order to achieve the sense of a 'warm welcome' into the church an over door air heater could be provided. This would also help to provide warmth to the rear of the church and help to heat the church if background heating is abandoned. Such an over door unit should be sized to cover the whole width of the door and it is suggested the BN Thermic 860 model would be quite suitable. This has a 6kW output.

Install a BN Thermic 860 Overdoor Fan heater above the main entrance door wired in with a BN Thermic CS-7 control switch. The unit requires single phase power. All new cabling to be run in FP200 Gold.

8. Energy Saving Measures (Building Fabric)

8.1 Roof Insulation

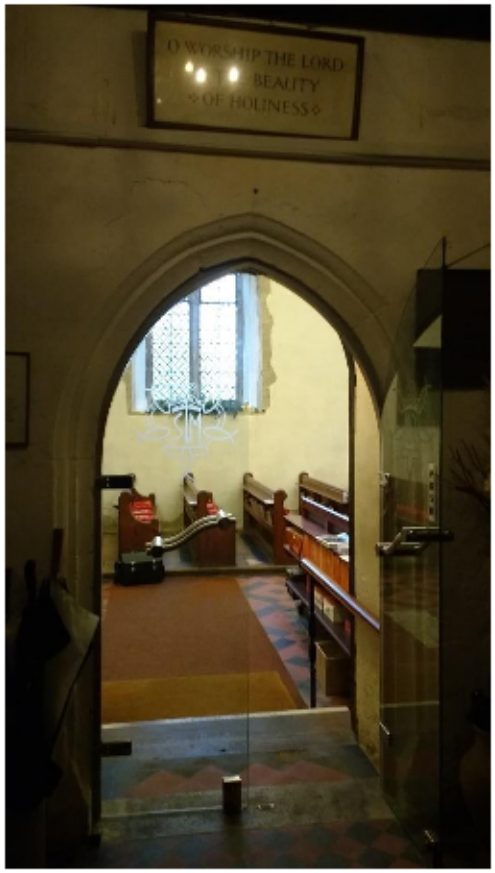
Fit 270mm of insulation into the loft

There appears to be a void between the nave ceiling and the roof. It was not investigated during the audit. For a rarely heated church, installing insulation would not be cost effective. If it were proposed to use the building more intensively in the future, the possibility of adding insulation should be discussed with your church architect.

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

8.2 Draught Proofing to Doors

The external timber doors should be kept well maintained to ensure that they close in an airtight manner, to prevent large amounts 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 cannot be used where the timber door closes directly against a stone surround.

Where there are large gaps between wood and stone, one option would be to use a soft leather strip, rolled into a loop with elastic stuffing inside the loop (probably foam) which is then tacked to the door edge using brass or copper nails. The example below is from St Michael & All Angels, Kingsnorth, Ashford.

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.

8.3 Closed Door Policy

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

8.4 Windows

The windows are noted to be protected by plastic (probably polycarbonate) sheeting on the outside. This is not airtight, but measurements at other churches have shown that it does prevent heat loss with the glass no longer being the coldest surface. The PCC should note that polycarbonate panels will not last forever, they tend to yellow with age and become brittle. The "bulletproof" quality only applies when new as they suffer from degradation under UV light.

If there are draughts caused by cracked windows leading to gaps at the edges against the stonework, or where hopper windows do not shut correctly, a temporary solution is to use black plasticine to fill gaps.

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	13 currently installed on chancel roof Potential to add double this amount on church hall roof (and some on nave)
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 – archaeology in ground and radiator system
Air Source Heat Pump	No – radiator system inefficient
Biomass	No – not enough heating load as well as air quality issues

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9.1 Solar PV potential

No information was provided regarding the annual generation of solar electricity from the array of 13 panels installed in the chancel roof. The inverter is located in the vestry next to the lighting controls and electricity meter. A small extension of the system onto the nave roof may be possible.

The south facing church hall roof also offers a site, although there is some shading by trees.

The roof of approximately 15m x 3m offers a useable area of around 40m^2. This could generate 0.15kWpeak/m^2 giving a 6kWpeak system. A 1kWpeak system can generate 1000kWh annually in Kent, although due to the proximity of the trees an over shading factor should be applied to give a total annual generation of 5,000kWh. This is in the same region as the church's annual electricity use (5,211kWh).

Using average 2015-18 domestic installation costs (£1,667 per kWpeak); a 6kWpeak system would cost £10,000, plus extra for access at height and cabling. 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.

The Smart Export Guarantee pays for the measured amount of electricity exported to the grid – but the rate is dependent on the purchaser. It appears the maximum rates are about 5.5p/kWh, so it is not worth investing money in a system which is larger than the needs. Installation of electric heating would make a solar power-battery system more attractive.

9.2 Heat Pumps

Heat pumps are not recommended for St Mary's Kennington because of the occasional, twice weekly use pattern of the building. Such systems work efficiently delivering low grade heat constantly, or for much of the week. Also, with a poor distribution of radiators concentrated at one end of the church, replacing the boiler with a heat pump is unlikely to work.

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.