Energy Efficiency and Zero Carbon Advice

St Mary's, Princes Risborough

PCC of St Mary's

Author	Reviewer	Date	Version
Marisa Maitland	Matt Fulford	28th September 2020	1.0

Contents

1. Executive Summary

An energy survey of St Mary's was undertaken by Inspired Efficiency 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.

St Mary's is built on a site where there has been a church from the Saxon times. The church dates back to the 12th Century and has gone through a number of significant changes and alterations during its history. The most recent amendments were made in 2011 when the church interior was renewed. 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 (£)	Payback (years)	Permission needed	CO2 saving (tonnes of CO2e/year)
Contact suppliers to arrange for the meters to be changed to smart meters	None	None	Nil	N/A	None	N/A
Switch electricity (and gas) suppliers to ones which provide 100% renewable supplies (or at least 20% renewable for gas)	None	None	Nil	N/A	None	Offset 5.28 tonnes
Adjust existing timer on external lighting to go off at 10pm.	2,038	£311	£-	0.00	List A (None)	0.52
Install Endotherm advanced heating fluid into heating system	12,929	£306	£560	1.83	List A (None)	2.39

Optimise control system settings and change thermostats to allow for different temperatures to be set for different times of day	19,393	£458	£1,200	2.62	List A (None)	3.58
Insulate exposed pipework and fittings in plantrooms	6,464	£153	£500	3.27	List A (None)	1.19
Add or Replace draught strips to external doors	2,586	£61	£300	4.91	List A (None)	0.48
Change existing lighting for low energy lamps/fittings	10,448	£1,596	£10,034	6.29	Faculty	2.65
Change hot water heating to WC/kitchen to electric point of use	13.575	£321	£3,000	9.35	List A (None)	2.51
Install a Solar PV array to roof of building (assumed 100% of energy generated used in building)	5,719	£873	£10,722	12.28	Faculty	1.45
Install PIR motion sensors on selected lighting circuits	20	£3	£226	74.04	List B	0.01
Install an Air Source Heat Pump into the chapter house building to replace existing heating system	90,502	Would cost £2,867 addition at current prices	£28,000	None (Carbon Saving not cost saving)	Faculty	14.04

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

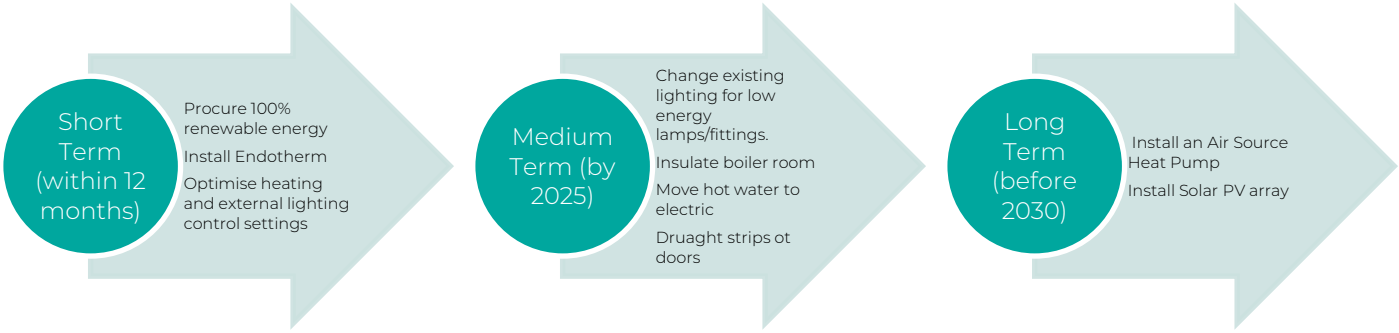
Based on current contracted prices of 15.273p/kWh and 2.364p/kWh for electricity and mains gas respectively.

If all measures were implemented this would save the church £894 per year.

2. The Route to Net Zero Carbon

The Diocese of Oxford's Diocesan Synod has set a target of reaching Net Zero Carbon by 2035, or as soon thereafter as is possible. General Synod, meanwhile, has set a target for the Church of England to reach a limited-scope Net Zero Carbon target by 2030. Our diocese will need to respond to the national target. which, as it is presently framed, means that every church, cathedral, church school and vicarage in the C of E will need to reach net zero - or compensate for residual emissions - within the next ten years..

This church has a clear route to become net zero by 2035 by undertaking the following steps:



3. Introduction

This report is provided to the PCC of St Mary's to give them advice and guidance as to how the church can be improved to be more energy efficient. In doing so the church will also become more cost effective to run and seek to improve the levels of comfort. Where future church development and reordering plans are known, the recommendations in this report have been aligned with them.

An energy survey of the St Mary's, Church Lane, Princes Risborough, HP27 9AW was completed on the 16th September 2020 by Matt Fulford. Matt is a highly experienced energy auditor with over 15 years' experience in sustainability and energy matters in the built environment. He is a chartered surveyor with RICS and a CIBSE Low Carbon Energy Assessor. He is a Member of the DAC in the Diocese of Gloucester and advises hundreds of churches on energy matters.

St Mary's	
Church Code	627620
Gross Internal Floor Area	486 m^2
Listed Status	Grade II*

The church typically used for 12.5 hours per week for the following activities

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Sunday Services	6 hours per week	173
Midweek Services	1.5 hour per week	18
Visitors and other groups	3 hours per week	138
Other	2 hour per week	

There is additional usage over and above these times for festivals, weddings, funerals and the like.

4. Energy Procurement Review

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

The current electricity rates are:

Day Rate	15.27p/kWh	In line with current market rates
Night Rate	9.82p/kWh	In line with current market rates

The current gas rates are:

Single / Blended Rate	2.364p/kWh	In line with current market rates
Standing Charge	278.0p/day	N/A

The electricity is supplied by SSE and the gas from Total and does not appear to be purchased on a renewable tariff .

Going onto a renewable tariff is an important part of the process of taking churches towards net zero. The church is therefore encouraged to consider the Parish Buying Scheme, which uses the power of group purchasing to offer economies of scale in the procurement of energy. Its 'Green Energy Basket' tariff delivers 100% renewable electricity and 20% green gas. We would recommend that the church obtain a quotation for its gas and electricity supplies from the scheme: http://www.parishbuying.org.uk/energy-basket. Alternatively, Bulb, Ecotricity and Good Energy are suppliers which offer 100% renewable electricity.

A review has also been carried out of the taxation and other levies which are being applied to the bills. These are:

VAT	5%	The correct VAT rate is being applied
CCL	Not charged	The correct CCL rate is being applied.

The above review confirmed that the correct taxation and levy rates are being charged.

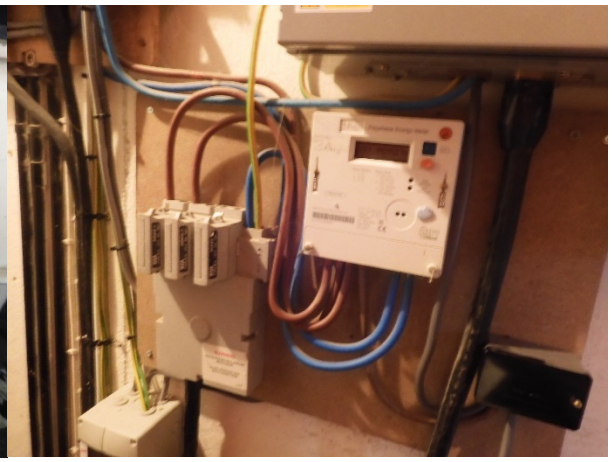
5. Energy Usage Details

St Mary's uses 20,868 kWh/year of electricity, costing in the region of £3,187 per year, and 129,288 kWh/year of gas, costing £3,056.

This data has been taken from the annual energy invoices provided by the suppliers of the site. St Mary's has one main electricity meter, serial number Z07E006908. There is one gas meter serving the site, serial number M016A0646114A6.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	Z07E006908	3 rate, 3 phase 100A	Full AMR Connected	Rear of organ
Gas – Church	M016A0646114A6	MDA16	Full AMR Connected	Churchyard

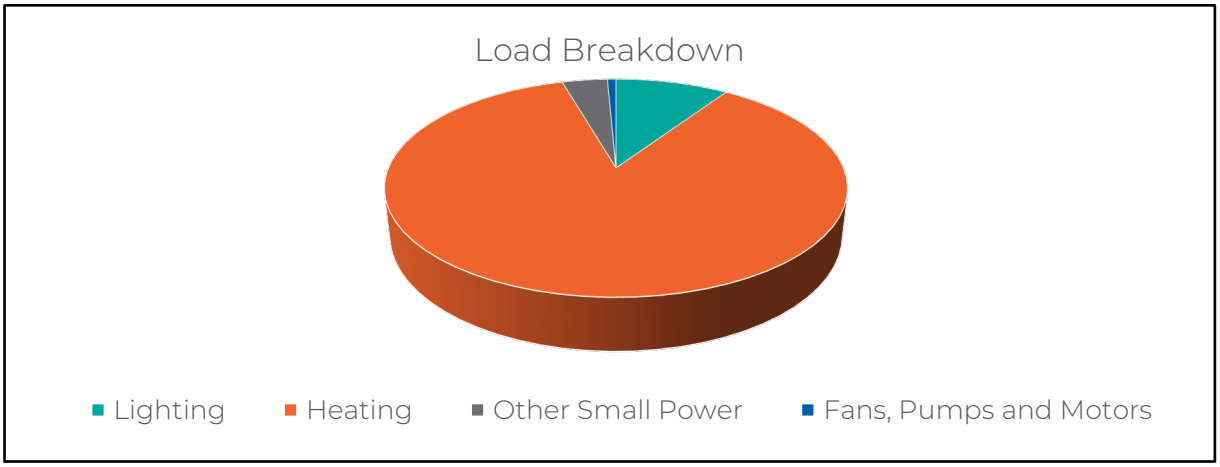
All the meters are AMR connected and as such energy profile for the entire energy usage should be possible. However, no half hour meter data has been provided for the purpose of this report.



5.1 Energy Profiling

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

Service	Description	Estimated Proportion of Usage
Lighting	A mix of reflector spots, halogen downlights, some LED and fluorescent lights, SON floods externally	9%
Heating	Gas fired underfloor heating to church and chapter house with radiator circuit to chancel	86%
Other Small Power	Office and kitchen appliances, organ and sound equipment.	3.8%
Fans, Pumps and Motors	Heating distribution pumps	0.7%



As can been seen from this data, the heating makes up by far the largest proportion of the energy usage on site.

5.2 Energy Benchmarking

In comparison to national benchmarks for church energy use St Mary's uses 115% more electricity and 77% more heating energy than would be expected for a church of this size.

	Size (m^2 GIA)	St Mary's use kWh	St Mary's use kWh/m2	Efficient Church Use kWh/m^2	Variance from Typical
St Mary's (elec)	486	20,868	42.95	20.00	115%
St Mary's (heating fuel)	486	129,288	266.08	150.00	77%
TOTAL	486	150,156	309.03	170.00	82%

6. Efficient / Low Carbon Heating Strategy

The energy used for heating a church typically makes up around 80% to 90% of the overall energy consumption. Heating also often uses gas or oil as its primary fuel, these are fossil fuels with high carbon emissions and little opportunity to decarbonise in the future. Electricity currently has carbon emissions around the same level as mains gas but the carbon emissions associated with electricity are reducing rapidly as the UK builds more renewable energy and decommissions it remaining oil and coal fired power stations. Mains gas does have some potential to reduce its carbon content through the use of biogas and hydrogen but these are less developed solutions and will be unable to deliver 'zero carbon mains gas'. It is therefore a critical element to review and set out a plan to make more efficient and less carbon intensive and one way to achieve this is to consider a transition to electrical heating where this also represents a more efficient and comfortable solution for churches..

The existing heating is relatively modern (11 years old) and comprises of predominantly underfloor heating to the church and the chapter house with some radiators within the chancel. It is served from an efficient gas condensing boiler. There is no pressing need for change to the boiler; however, plans and consideration should be made as to what direction to consider when the boiler reaches the end of its life in 10 or so years time. In the meantime, improvement on efficiencies should be made with improved control and other measures recommended in this report.

Being on underfloor heating and having a good thermally insulated fabric, the chapter house is ideal for converting to an air source heat pump and being the area of the building which is in most frequent use, this approach would generate good carbon savings. This change could be made within the next 10 years and the boiler retained to heat the church only. This could extend the life of the boiler and also protect against the risk of failure of the boiler making the whole building unusable.

The heating for the church, being both underfloor and radiators as well as the building fabric being poorly insulated, does not neatly suit the current air source heat pump technology. This technology is constantly developing as is the use of ground source with alternative drilling techniques which are less disruptive. At this point in time it is difficult to make a firm recommendation for the church to convert to a heat pump but this could well change in the future. Therefore, continuing with the current situation of using an efficient gas boiler, trying to extend its life by taking the chapter house off this system and improving the controls further and then reviewing the possibility of heat pumps again in 10 years would seem the most prudent approach.

The hot water to the two main WC's/kitchen areas within the chapter house are currently served from the main gas boiler. In order to make the generation of the small amounts of hot water that is required more efficient, and to facilitate the easy transition to a heat pump, it is strongly recommended that the provision of hot water is moved to electric point of use units.

7. Improve the Existing Heating System

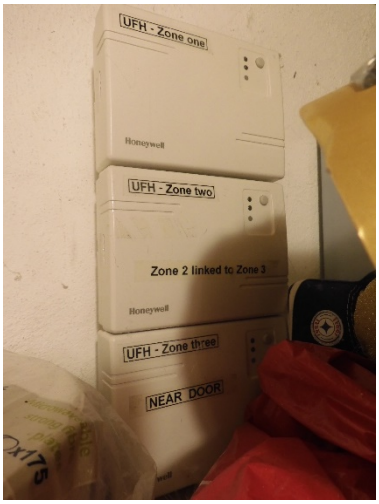
In the years before the replacement of the existing heating system it is recommended that measures are taken to improve the efficiency of the existing heating system, this should include:

7.1 Improve Heating Control Settings

The churches heating is controlled by a Chanel Plus H47XL controller located boiler room. Within the church there are three underfloor zones controlled by a Honeywell Wireless Thermostat system.

The timings and settings on this were reviewed as part of the audit and there are opportunities to adjust these controls to provide more efficient energy usage of the building and to provide a more comfortable environment for the congregation.

The principle would be to have different temperature set points at different times within the church to reflect its usage. To enable this the three wall mounted thermostats within the church would need to be changed for ones which would allow for different time and temperature settings. Honeywell do make such units such as https://heatingcontrols.honeywellhome.com/products/Programmable-Thermostats/Wireless-Digital/T4R-7-Day-Wireless-Programmable-Thermostat/ and these should be reviewed to see if they will link to the existing zone control units.



7.2 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.

7.3 Convert Hot Water to Electric Point of Use Units

The building is currently provided with hot water from a large hot water tank located in the boiler room. This is heated from the gas boiler within the boiler room. As such the hot water is being heated by the gas boilers for long period during the week when there is little demand for hot water which is limited to handwashing, the kitchenette sink and some of the cleaning.

A far more efficient method of generating hot water would be to remove the centralised large hot water storage tank and to have small, local electric point of use hot water heaters installed within both of the WC and kitchen areas. Units such as this heat the hot water only when the tap is turned on and does not have any stored hot water element. As such it is very energy efficient and it only ever heats the hot water that is required. It has additional advantages that it is 'always on' so does not require to have timings reset for ad hoc uses and as it does not have any stored water element it represents the lowest possible legionella risk profile. Installing electric hot water units will remove the need for the gas boiler and associated pumps to have to operate outside of the heating season and will assist in the transition to net zero carbon as the hot water is no longer served by burning of fossil fuels on site.

The installation of electric point of use hot water units and the removal of the gas hot water system can be undertaken by any competent mechanical engineer.

8. Energy Saving Recommendations

In addition to having a revise heating strategy there are also a number of other measures that can be taken to reduce the amount of energy used within the church.

8.1 New LED Lighting

The lighting makes up a relatively small overall energy proportion of the electricity used within the church, and large areas are lit by relatively inefficient fluorescent and halogen fittings.

There are some areas of the building which have had efficient LED lights installed but there still remains a large number of inefficient lamps within the church.

It is recommended that the fittings scheduled in Appendix 1 are all changed for LED. The square 'flood' type fittings within the nave would need to be changed for new LED flood type fittings which are widely available on the market. Care should be taken over their appearance the output and colour of light which is likely to be best specified at between 3000K and 4000K.

Many of the main spotlights appear to be AR111 12V lamps. A number of churches have successfully managed to change the lamps/bulbs in these to LED and retain the existing fitting. The new lamp does need to be very carefully specified and this can involve using a more specialist lamp.

If all the lights were changed on a simple "like for like" the total capital cost (supplied and fitted) would be £10,034. The annual cost saving would be £1,596 resulting in a payback of around 6.3 years. This estimate includes for the supply of the lights, the labour to install them and the access required. It does not include for any upgrade to the wiring or a new lighting design both of which the church may wish to consider.

There are some fittings such as spot downlights in the Chapter House where the existing fitting can be made more efficient by simply changing the bulb/lamp within the existing fitting to a new LED bulb/lamp. This could be carried out by competent members of the church's internal team, very cost effectively and would be a List A item so no permissions would be required. This would be good area to consider using the £150 implementation grant for.

8.2 Lighting Controls (Internal)

There are several lights which could easily remain on all the time in areas such as toilet areas, storerooms, stairs and the like. Some of these areas are only used occasionally and for a short amount of time and as such, the light does not need to remain on constantly. There are also spaces which benefit from a good amount of natural daylight coming in through the windows where artificial lighting is not required for much of the year during the day.

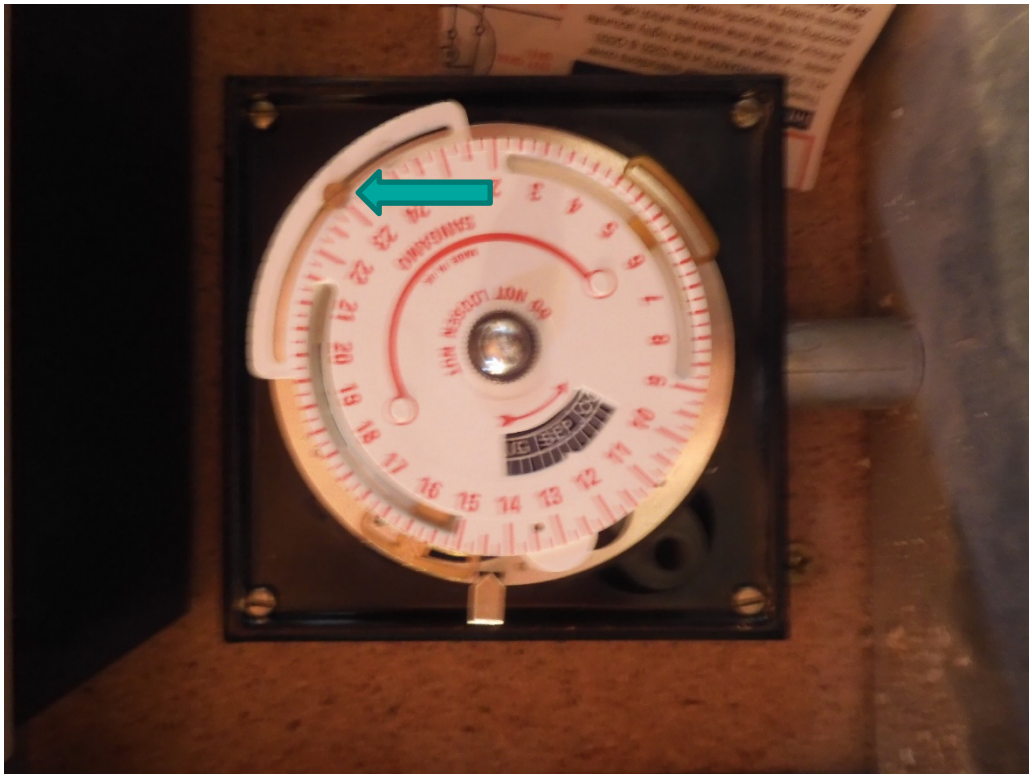
It is recommended that a motion sensor is installed on these specific lighting circuits so that the lights come on only when movement is detected in the space and turn off approximately two to five minutes after the last movement has been detected (note that the duration of the time lag after which the light goes off needs to be consider alongside the type of light that is fitted. LED lights are much more suited to being switched off after only a short duration than some fluorescent lights). These movement sensors (commonly called PIRs) also have light sensors integrated into them so they can be used to make sure that the light does not come on if there is already sufficient daylight in the space.

Your existing electrician or any NICEIC registered electrical contractor can install PIR sensors onto existing lighting circuits. This can be carried out without significant disruption to the use of the space.

8.3 External Lighting Controls

The external flood lights are currently on until 11pm. For efficient operation and to reduce light pollution and nuisance to neighbours it is generally recommended that external lighting is turned off at 10pm unless required for specific purposes.

This adjustment can be relatively simply achieved by carefully relocating the off screw lug on the current timer from 23:00 to 22:00. A little care is required to ensure that this is correctly positioned when tightened as the lug behind the dial has a split half which needs to be orientated correctly to trigger the off lever. This can be easily checked by twisting the dial and ensuring that the lug fully connects and switches the lights off.



8.4 Insulation of Pipework and Fittings

The pipework within the boiler room has the majority of its straight lengths insulated but the more complex shaped pipework fittings, such as valves, have been left uninsulated. These exposed areas of pipework contribute significantly to wasted heat loss from the system and make the plant room unnecessarily warm. The exposed hot surfaces also represent a health and safety risk of burns for those working in the area.

It is recommended that these areas of expose 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.

8.5 Draught Proof External Doors

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

It is recommend that the draughtproofing around the door is improved and draught strips are added. This could be achieved in a number of ways.

For timber doors that close onto a stone surround such as this, traditional solutions such brush draught strips rebated into the edge of the door by a skilled joiner. Other traditional methods such as using hessian or felt pads tacked to the door could be used and keeping the door maintained in a good condition is important.

Simple measures such as having a 'sausage dog' style draught excluder laid along the base of a door, using plasticine of the right colour to fill gaps where daylight can be seen and putting painted fridge magnetic over large keyholes can all be simple DIY measures which are effective.

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 - On south side aisle roof, very discrete visibility of portion of roof considered acceptable
Wind	No – no suitable land away from buildings
Battery Storage	Yes – with the PV
Micro-Hydro	No – no water course
Solar Thermal	No – insufficient hot water need
Biomass	No – issues with boiler size, location, fuel store and deliveries
Air Source Heat Pump	Yes - Could locate on roof between chapter house and north aisle or ground
Ground Source Heat Pump	No – Ancient site with significant archaeology

Now that the Feed in Tariff scheme has come to an end the installation of solar PV panels in situations where there is not almost full usage of the electricity generated on site is not really viable.

There may be some potential for a small PV array on lead roof of the South Aisle. This does have some discrete visibility form limited areas in the church yard but as this is not impacting on the main view of the church this could be considered to be acceptable. The current arrangements around solar panels mean that to be financially viable the building on which they are mounted needs to consume the vast majority of the energy that they produce. The church's energy consumption ha got some regular use during the day from the Chapter House and the running of heating pumps and the like. Therefore, while technically viable only a small number of panels (maximum of around 20) would be worth considering.

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.

Heat Pumps are a low carbon method of creating heat, there use and suitability for this church have been review in the section earlier on in this report on Efficient and Low Carbon Heating Strategies. The installation of an air source heat pump to provide heating to the underfloor system in the Chapter House is recommended over the next 10 years. There are external units required for the air source heat pump that look similar to the external air conditioning units seen on many office buildings. These could be discretely located on the roof linking the chapter house and the church which not only provides a discrete location but is also relatively close to the existing boiler room allowing for easier integration.

10. Funding Sources

This audit programme offers each participating church the chance to apply for a grant of up to £150 towards implementing some of the audit's recommendations. An application form is included with this report.

There are a variety of charitable grants for churches undertaking works and a comprehensive list of available grants is available at https://www.parishresources.org.uk/wp-content/uploads/Charitable-Grants-for-Churches-Jan-2019.pdf .

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.

Appendix 1 – Schedule of Lighting to be Replaced or Upgraded

Room/Location	Number of Fittings	Recommended Upgrade	Annual Saving (£)	Total Cost (£)	Payback
Chapter House Store	1	2D LED 11W	£2	£59	28.31
Ground	1	2D LED 11W	£2	£59	28.31
WC	3	GU10 LED	£15	£188	12.36
Disabled	3	GU10 LED	£15	£188	12.36
1st floor	14	GU10 LED	£71	£876	12.36
WC	2	GU10 LED	£10	£125	12.36
Kitchen	4	GU10 LED	£20	£250	12.36
Nave uplighters	10	50W LED Flood	£31	£1,200	38.74
Nave downlights	5	50W LED Flood	£54	£600	11.03
Nave spots	4	AR111 LED	£29	£170	5.95
Side aisle downlights	10	50W LED Flood	£75	£1,200	16.03
Side aisle spots	7	AR111 LED	£50	£298	5.95
Chancel	2	100W LED Flood	£38	£400	10.60
Chancel spots	6	AR111 LED	£43	£255	5.95
External	14	100W LED Flood	£1,133	£2,800	2.47

1 The Coaches, Fields Road, Chedworth, GL54 4NQ

01285 721134

07971 787363

INSPIRED EFFICIENCY

ENERGY • CARBON ; SUSTAINABILITY