Energy Audit and Survey Report

St Mary's Church, Thatcham

"There is a plan to reduce global carbon emissions to net zero by 2050. The plan will work. It involves all of us. We need to begin now, in our homes and workplaces and churches"

Revd Dr Stephen Croft, Bishop of Oxford

Version Control

Author	Reviewer	Date	Version
Paul Hamley	Matt Fulford	23rd March 2020	1.0

Contents

1. Executive Summary

An energy survey of St Mary's Church, Thatcham 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 Church, Thatcham is an early mediaeval church with nave built in 1140 and chancel in 1220 with alterations in 1857. The west end was reordered in 1979 to provide meeting rooms with a kitchen and toilets. Electricity and Gas are is 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	To be actioned by who / when?
Purchase temperature datalogger to optimise heating	5% 4,000	£150	£40	<1	none	Warden
Draughtproofing measures	5% 4,000	£150	£50	<1	List A	Warden
Complete LED lighting installation	1,000	£150	-	2	List A	Warden
Replace halogen floodlights with LED	2,000	£300	£1,800	6	List A	PCC

Medium Term: Energy saving recommendation	Estimated Annual Energy Saving (kWh)	Estimated Annual Cost Saving (£)	Estimated capital cost (£)	Simple Payback (years)	Permission needed	To be actioned by who / when?
Insulate ceiling of meeting rooms	10% 3,500	£135	£800	6	List B / Faculty	PCC
Install internal insulation on external walls of meeting rooms	3,500	£135	£1,800	13	Faculty	PCC
Install secondary double glazing to meeting room windows	3,500	£135	£2,000	15	Faculty	PCC
Replace kitchen boiler with Air Source Heat Pump	20,000	/	Approx. £10,000	-	Faculty	PCC

Long Term: Energy saving recommendation	Estimated Annual Energy Saving (kWh)	Estimated Annual Cost Saving (£)	Estimated capital cost (£)	Simple Payback (years)	Permission needed	To be actioned by who / when?
Consider radiant infra-red heating in chapel (dependent on type of use)	5% of church use: 2,000	£77	£2,000	>25	Faculty	PCC
Solar panels – invest in panels elsewhere or a small church system	3,900	£580	£10,500	18	Faculty	PCC

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

Based on the current contracted price of 10.757p/kWh (cheap rate) and 14.87p/kWh (standard rate) for electricity.

If all short and medium term measures were implemented this would save the church around £1,150 in operating costs per year.

2. Introduction

This report is provided to the PCC of St Mary's Church, Thatcham 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, Thatcham, Church Gate, RG19 3PN was completed on the 12th February 2020 by Dr. Paul Hamley, who met with Christopher Watts, Churchwarden.

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 and has been an EcoCongregation assessor.

St Mary's Church, Thatcham	**627434**
Gross Internal Floor Area	525m^2
Listed Status	Grade II*
Typical Congregation Size	95

The church typically used for 28 hours per week for the following activities:

Services	5.5 hours per week
Meetings and Church Groups	18 hours per week
Community Use	10 hours per week
Occasional Offices	20 baptisms

Estimated annual hours of use: 1500 hours

Estimated annual heating hours: 675 hours

Estimated annual footfall: 31,600

3. Energy Procurement Review

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

The current electricity rates are:

Single / Blended Rate	14.780p/kWh	In line with current market rates
Standing Charge	19.854p/day	N/A

The current gas rates are:

Single / Blended Rate	3.870p/kWh	Above current market rates
Standing Charge	Zero p/day	N/A

Both utilities are supplied by Opus Energy.

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 electricity and 20% renewable gas 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 Mary's Church, Thatcham uses around 14,000kWh/year of electricity, costing in the region of £2,300 per year. Gas use is about 78,000kWh, costing £3,200.

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

Utility	Annual use/ kWh	from	to	Cost
Electricity – meter 1	11,319	10/01/19	10/01/20	£1,832.69
Electricity – Meter 2	2,603	01/01/19	01/01/20	£480.02
Gas	77,731	03/12/18	31/12/19	£3,158

4.2 Meter Details

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – meter 1 Supplies Church, floodlights, ringing room	E12Z02881	EDMI Mk7C Atlas	Yes	Vestry
Electricity – meter 2 Supplies west end meeting room and kitchen	E12Z07794	EDMI Mk7c Atlas	Yes	Vestry
Gas	M025 A02854 01 A6	Schlumberger R5	Yes	Vestry

All of the meters are smart meters. Monthly usage data should therefore be available from the suppliers so that the patterns of usage can be reviewed against the times the building is used.

4.3 Energy Benchmarking

In comparison to national benchmarks for Church energy use St Mary's Church, Thatcham uses 33% more electricity for lighting, etc and an average amount of heating energy compared to average figures for churches of this size. The extra electricity is likely to be repeated to use of the kitchen and meeting room area at the west end of the church.

	Size (m^2 GIA)	St Mary's Church, Thatcham use kWh/m^2	Typical Church use kWh/m^2	Efficient Church Use kWh/m^2	Variance from Typical
St Mary's Church, Thatcham - electricity	525	26.5	20	10	133%
St Mary's Church, Thatcham - heating fuel	525	148	150	80	99%
TOTAL	525	41.5	170	90	24%

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)

Reordering in 2006 involved fitting of tungsten halogen floodlights and uplights. All downlights (approximately 40) have been changed to LED bulbs.

It is recommended that all halogen lamps are changed to LED.

5.2 Lighting (external floodlights)

Six halogen floodlights are currently fitted. These should be changed for lower powered LED versions such as illustrated below, Brackenheath 150W or similar IP65 rated (waterproof) models.

For efficient operation and to reduce light pollution and nuisance to neighbours it is generally recommended that external lighting is turned off no later than 11pm unless required for specific purposes.

6. Energy Saving Recommendation (Heating)

6.1 Heating System and Strategy

The church is divided into two zones with independent heating. The body of the church is heated by a 115kW Remeha Quinta boiler. The main church is further divided into zones, but these are considered to be ineffective as separate zones due to air circulation. There is a mixture of fan assisted radiators, vertically oriented radiators attached to square cross section pillars, and skirting level radiators along the base of the north aisle outer wall. The latter are below external ground level and suspected of pulling in moisture through this wall.

The four zones are: Three supplied by the church boiler; Main Church (thermostat set to 17°C), Chapel (separate thermostat), Conservation heating circuit (never used). The kitchen boiler supplies hot water and heats the kitchen, main meeting room and room above the kitchen.

Timers are set by the warden on a weekly basis. There is an override button allowing for 30 minutes of heating which can be operated when access to the controls (in a locked room) is not possible. Thermostatic radiator valves are fitted but are of limited use in an undivided space.

The heating system is shut down in May, and kept off as long as possible. October to April gives a heating season of around 30 weeks. Normally, one hour of preheating is used.

If the gas boilers are replaced, then long term, they 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.

6.2 Boiler Timing Optimisation

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

6.3 Boiler Maintenance; Clean / Flush Existing Heating System

To ensure longevity, the system should be periodically flushed and cleaned to remove any scale and corrosion. The church should have a record of when this was done last.

It is strongly recommended that the heating system is cleaned to remove sludge from the system, this is done by using a chemical clean and/or power flush procedure where cleaning chemicals are put into the system which is then turn on and run through a filter consisting of high power magnetics to remove the sludge.

The cleaning of a heating system can be carried out by any competent heating engineer and typically increases the efficiency of a system by between 10 to 15%. This can dramatically improve comfort for the occupants.

6.4 Magnetic Particle Filter

Neither boiler is fitted with a magnetic particle filter such as illustrated here. This apparatus catches any rust or metal particles and prevents them being deposited on the boiler heat exchanger. One should be installed if it is planned to continue using the water heating systems long term. Corrosion inhibitor should be added to the system when your boilers are serviced annually.

6.5 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 is 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.

6.6 Insulation of Pipework and Fittings

As both boilers are entirely within the church structure, further insulation is not necessary.

The church boiler is effectively heating the vestry / office.

7. Re-Ordering and Alternative Heating Systems

7.1 Re Ordering Proposals – Rear Meeting Room Area

The church plans to refurbish the 1979 converted west bay area comprising of a large meeting room, kitchen with small meeting room above. It is intended to:

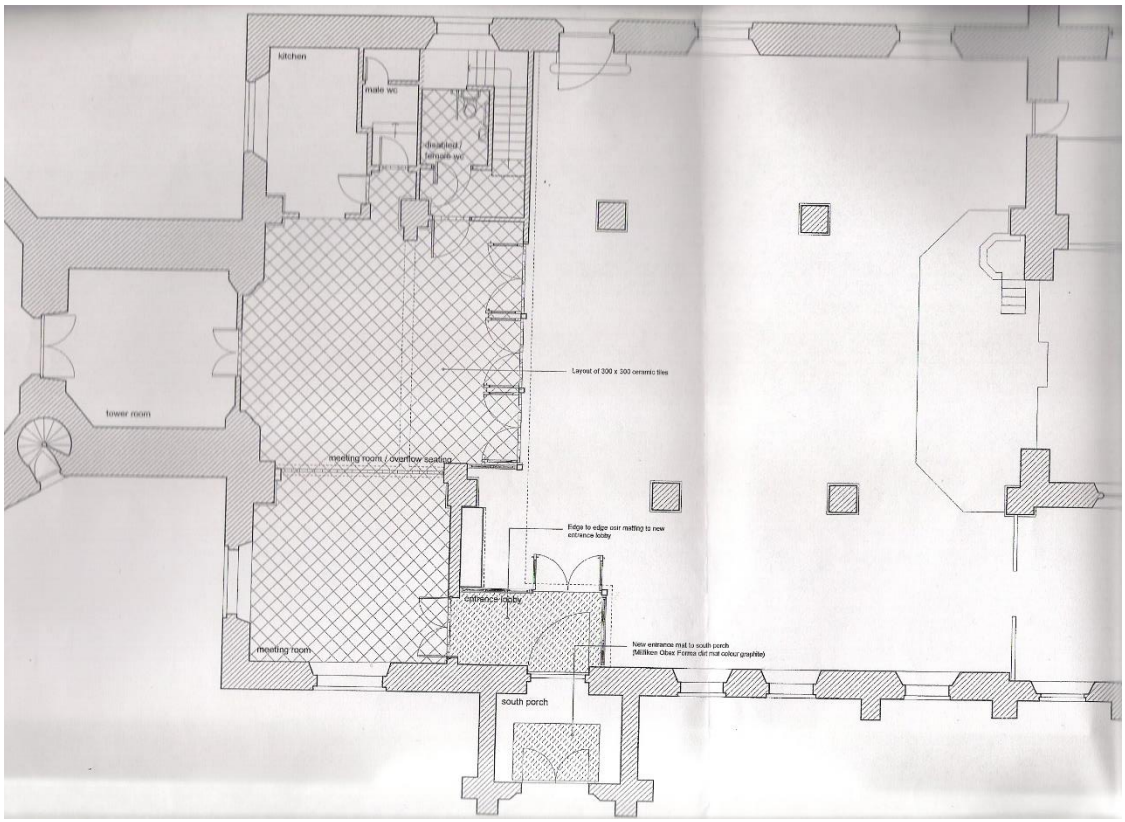
- upgrade the kitchen so it can be used for cooking
- install secondary double glazing
- replace the suspended ceiling with a properly insulated ceiling
- replace fluorescent lighting with LED lighting
- add sound reducing panels on internal walls

These alterations will reduce the heat loss of this area of the building, perhaps by 10% or more.

It is recommended that works to eliminate draughts be included, and the feasibility of installing internal wall insulation to the area be considered, which would further reduce heating requirements.

The room is currently used each weekday evening for three hours and for a toddler group on Wednesdays, giving a total weekday use of around 18 hours plus Sunday use. This can be envisaged to increase if the kitchen is brought into greater use.

Reduced heating requirements and a regular pattern of use are compatible with installing a heat pump to replace the boiler.



Plan showing 1979 meeting room area (hatched) at west end of nave.

7.2 Air Source Heat Pump Overview

Replacement of the kitchen gas boiler supplying the rear area with a heat pump is an option to reduce the carbon footprint of the church, as it is due to be replaced.

Operating costs will depend on the efficiency of the system; making the space as energy efficient as possible will raise capital costs but decrease long term operating costs.

Total annual gas use ~ 78,000kWh, £3,200 annual cost.

Church; 115kW boiler. ¾ of area, ~ 8 hours per week. Estimated 55%, 42550kWh, £1,760

Rooms; 40kW(?) boiler, ¼ of area, ~ 20 hours per week. Estimated 45%, 35450kWh, £1,440

Air Source Heat Pumps will deliver the same amount of heat energy, by using between one quarter and a half of that amount of electricity. How efficient they are is described by the Coefficient of Performance (COP); COP = Heat energy delivered/Electrical energy consumed. For an ASHP they are most efficient when the air temperature is warmer. An ideal scenario would be for an ASHP to operate during the afternoon when the air temperature is warmest, to preheat the area for the evening.

COP	Electricity requirement to deliver 35,450kWh of heat	Annual electricity cost
2	17,725	£2,620
2.5	14,180	£2,100
3	11,817	£1,746
3.5	10,128	£1,497

ASHPs work most efficiently when the air temperature is warmest, so a system can be envisaged with an ASHP operating during the afternoon and early evening to preheat the area for the evening's use.

An air conditioning unit has recently been installed on the tower roof to cool the unventilated ringing room [The church has a peal of ten bells and regularly hosts ringing competitions].

This location may offer potential for siting an ASHP.

Useful advice on heat pump efficiency (in a domestic context – the meeting room area is of similar size).

https://www.thegreenage.co.uk/coefficient-of-performance-seasonal-performance-factor/

https://www.which.co.uk/reviews/ground-and-air-source-heat-pumps/article/air-source-heat-pumps-explained

https://www.greenmatch.co.uk/heat-pump/air-to-water-heat-pump

7.3 Body of Church

The church is fitted with movable pews. The south aisle is seated with chairs.

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.

The church currently has a gas fired central heating radiator system. This has a reasonably large boiler (115kW) and is reported to require only one hour of preheating, which is much less than required elsewhere. Having large vertical radiators attached to pillars next to the seating areas means that the congregation will benefit from both radiant and convective heating immediately adjacent to them.

Air Source Heat Pump. This is not recommended or economically viable for an occasionally heated church. A heat pump would have to work very hard, and uneconomically, to heat a church from cold once per week. The alternative of regular or constant heating would be more expensive than the current gas heating system given the poor thermal performance of the building.

Ground Source Heat Pump. These systems give a better Coefficient of Performance than ASHPs, but again are suited to regularly used buildings. Churchyards usually preclude installation of pipework arrays; the alternative is an expensive borehole.

Under Pew Heating. This is not possible with removable pews and chairs.

Under Floor Heating. The church averages around 8 hours of use per week with most use on Sundays. Under floor systems are very expensive to install and take a long time to warm up and begin to deliver low grade heat – the floor temperature should be not more than 25°C, so constant heating over a wide floor area is required to provide adequate heat to the building. Churches with underfloor heating usually have significant community use throughout the week; for instance, hosting a daily café, or a community arts venue.

It is recommended that the church plan to replace its existing gas boiler with a hydrogen compatible boiler when this technology becomes available. For the present, it should seek to procure a gas tariff offering a percentage of renewable gas, such as from parish Buying, Bulb, Good Energy of Ecotricity. It can also offset its gas use by using a scheme such as Climate Stewards.

7.4 Radiant Heating for Specific Areas

Radiant electric panels – far infra-red radiant panels for localised heating are possible in place of the existing vertical water radiators, and in other locations. Electric heating for churches is often viable despite the 3 to 4x cost of electricity per kWh compared to gas, because it removes the need for very long (8-12 hours) preheating which some churches require. St Mary's, Thatcham reports just one hour preheating requirement; thus, there would be little to be gained.

The south aisle chapel, which is separated from the body of the church by a screen and a glazed archway, offers the potential for a space which could be rapidly heated for small midweek meetings.

Currently it is heated by (fan assisted?) central heating radiators, so requires a long period to warm although it is independent of the body of the church. This area may have potential for radiant electric heating, should the use of the space justify it and there be a suitable location for the panels.

Behind the seating is poor, and immediately above the seating would require low temperature (42oC "hospital" panels). The other option is ceiling mounted panels.

A radiator can be glimpsed to the right of the right door post.

Far Infra-red radiant panels could also be used as “top up” heating for the coldest periods, “end of season” heating with the main heating turned off, and an “extra comfort” area for the elderly.

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.

8. Energy Saving Measures (Building Fabric)

8.1 Wall Insulation

As part of the re-ordering of the 1979 refurbished area incorporating the bay at the west end of the nave, it is suggested that internal wall insulation be considered. The area does not present a “traditional” appearance at present due to the type of doors and screen fitted to separate it from the nave, and the installation of a lowered false ceiling (planned to be replaced with a new one, properly insulated.

Thus, it is recommended that the church consults with its architect and considers installation of internal insulation in order to make this space much more energy efficient.

This will enhance the effectiveness of the proposed internal double glazing of this area.

8.2 Draught Proofing to Doors

The external doors in the building should be kept well maintained and draught proofing measures applied when necessary. 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 a large keyhole or the use of 'sausage dog' type draught excluders at the base of little used doors, which can prove to be very effective. Doors should be reviewed in daylight and gaps where the light shines through sealed or filled in whatever the most appropriate way is for the specific door.

The inner doors offer the best scope for draughtproofing measures.

The north aisle door is assumed to be normally shut. There are places where daylight could be seen (including the keyhole!) which offer opportunities to stop draughts – which will be constant when the wind is blowing.

8.3 Closed Door Policy

The three stages of entry doors in the porch and inner lobby should be managed in cold or windy weather to ensure that all three sets of doors are not simultaneously open. This will need some coordination by your friendly welcome team!

8.4 Windows

The church is planning to install secondary double glazing inside the windows of the meeting area (four windows).

Any gaps or cracks in window glass or frames should be temporarily addressed. Any damaged windows should be repaired before further deterioration occurs. If there are draughts caused by hopper windows or hinged sections not shutting correctly, a temporary solution is to use black plasticine to fill gaps.

9. Saving Recommendations (Water)

9.1 Tap Flow Regulators

Where there is public access to toilets, 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. Regulators can be self-installed or by any good facilities staff.

9.2 Reduce Toilet Flushing Volume

This can be achieved either by installing a duo flush cistern, or (cheaply) by reducing the flushing volume using a toilet hippo, or alternatively placing some suitably sized glass jars full of water (with lids) in the cistern.

10. 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	**Possible small system**
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	Difficult – archaeology in ground
Air Source Heat Pump	**Consider for refurbishment of meeting rooms**
Biomass	No – not enough heating load as well as air quality issues

10.1 Solar PV potential

St Mary's church is a listed building with a visible nave roof. The north aisle roof creates a valley, although the south facing portion of the aisle roof will often be shaded by the higher nave roof.

This section would offer a maximum area of 20m x 2.5m.

An area of 40m^2 would generate 0.15kWpeak/m^2 giving a 6kWpeak system. A 1kWpeak system can generate 800kWh annually, applying an over shading factor gives 650kWh per kW peak and a total annual generation of 3,900kWh. This is much less than the church's current annual electricity use (13,900kWh). It would offer a useful reduction in electricity operating costs, but not be able to supply much of the extra electricity required by a heat pump.

Using average 2015-18 domestic installation costs for smaller systems (£1,750 per kWpeak); a 6kWpeak system would cost £10,500. This does not include cost of any battery.

It would have to be confirmed with your architect as to suitability for extra weight and wind loading on the roof structure.

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 government has advertised a "Smart Export Guarantee" to begin in 2020 which would pay for electricity generated and exported to the grid (the Feed in Tariff having ended). However, it appears that rates will be no more that 5.5p/kWh and have to be negotiated with the utility company. It does not offer a financial incentive towards installation of SPV panels.

11. Other Recommendations

11.1 Climate Stewards

Climate Stewards offer carbon offsetting which should be used to offset emissions once all energy reduction interventions have been applied. www.climatestewards.org

11.2 EcoChurch

EcoChurch is a very useful scheme offering a structure and resources for the church to engage with to improve its environmental performance and engagement in several areas including buildings, liturgy, children's work, creation care, lifestyle.

11.3 Investment

It is recommended that rather than investing £10k towards solar PV panels on the roof, money should be spent on maximising the energy efficiency of the meeting room / kitchen area.

It may be possible to invest in a solar farm (on glebe land?) in the future, rather than on site generation.

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

Trust for Oxfordshire's Environment (TOE) does have some funds available (over and above the small implementation grants of £150 available through this scheme) to support energy efficiency improvements in community facilities. If your church is used by the wider community, visit www.trustforoxfordshire.org.uk or contact admin@trustforoxfordshire.org.uk to find out if your project is eligible for a grant of up to about £5,000.

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 and team, 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.