Energy Audit and Survey Report

St Barnabas Church, Reading

"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	30th December 2019	1.0

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1. Executive Summary

An energy survey of St Barnabas Church, Reading was undertaken by Inspired Efficiency Ltd on Tuesday 5th November, 2019 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 Barnabas Church, Reading is a modern era church built in 1966 and constructed of brick (laid to Flemish bond, hence with no cavity). 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.

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?
Install under pew heating	50% compared to gas	£1,000	£180 per installed heater 20-30 needed	5-6	Faculty	PCC
Install radiant far infra-red panels in some areas	As above	Inc above	£4000 8 panels	-	Faculty	PCC
Install LED lighting	3,500	£170	750	4.5	List B / Faculty	PCC
Draught proofing of doors	2,000	£70	£20	Less than 1 year	None	Warden

It is not possible to calculate energy savings as annual gas costs have not been provided. Benchmark figures for a church of this size together with cost rates indicate an annual gas cost of around £2000.

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?
Investigate feasibility of adding insulation to foyer area and replacing windows for double glazed units.	Depends on heating solution adopted	-	£8,000	-	Faculty	PCC

The Church should check any faculty requirements with the DAC Secretary at the Diocese before commencing any works. Based on current contracted prices of 13.299p/kWh (weekday), 10.833p/kWh (other times) for electricity and 4.329p/kWh for mains gas.

If all measures were implemented this would save the church in the region of £1,000 per year.

2. Introduction

This report is provided to the PCC of St Barnabas Church, Reading 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 Barnabas Church, Reading, was completed on the 5th November 2019 by 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 who are developing advice for the Church of England and authored the 2018 "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 Barnabas Church, Reading	627455
Gross Internal Floor Area	300 m^2
Listed Status	Unlisted
Typical Congregation Size	20-30

The church typically used for 7 hours per week for the following activities

Services	0800-0900, 2 per month 0930-1030 weekly 1200-1400, use by another congregation 5 use hours/ 12 heating hours
Meetings and Church Groups	2 hours per week
Community Use	Groups normally use the adjacent church hall which was not audited
Occasional offices	rarely

Estimated hours:

Annual hours of use 360h

Annual heating hours (October to May) uncertain due to only receiving data for May-August 2019 and a very large estimated bill for December 2018

3. Energy Procurement Review

Energy bills for gas and electricity have been supplied by St Barnabas Church, Reading and have been reviewed against the current market rates for energy.

The current electricity rates are:

Weekday Rate	13.299p/kWh	Below current market rates.
Other times rate	10.833p/kWh	Below current market rates.
Standing Charge	17.83p/day	N/A

Electricity is obtained from SSE.

The current gas rates are:

Single / Blended Rate	4.329p/kWh	Above current market rates
Standing Charge	27.00p/day	N/A

Gas is obtained from British Gas.

We recommend that the church obtains a quotation for both 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 church was paying 20% VAT on gas during 2018. If this has not been recovered, the PCC should send the supplier a VAT declaration confirming this and check all supplies on other sites, e.g. the church hall.

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

4. Energy Usage Details

4.1 Energy Consumption

St Barnabas Church, Reading uses in the region of 2,300kWh/year of electricity, costing in the region of £360 per year. This has been estimated from one bill covering May 21st to August 21st for which all the entries are estimated.

It is not possible to give an accurate value for gas use. One gas bill covers May 21st to August 21st (2675kWh; 100kW boiler = ~27 hours use) with one reading being an estimate. The second, for December 2018 only is based on two estimated readings which suggest 43,055 kWh use. This would mean the boiler was running for almost 14 hours per day for the whole month, which is unlikely. Benchmark figures indicate an annual consumption of 45,000kWh for a church of this size.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	D00R22162			
Gas – Church	M016 A03058 07 A6			Boiler room

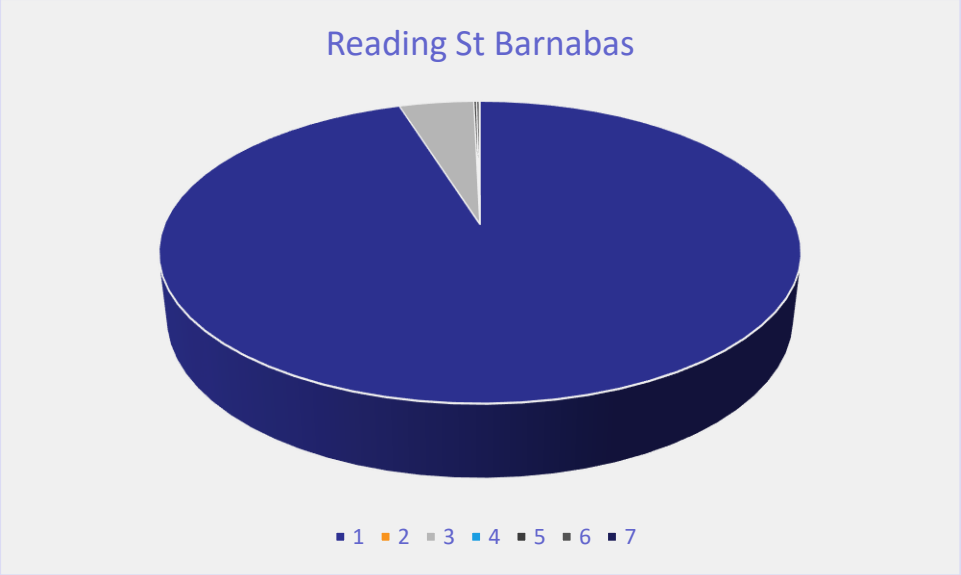
It is recommended that the church consider asking their suppliers to install smart meters so that the usage can be monitored more closely and the patterns of usage reviewed against the times the building is used.

4.2 Energy Profiling

The main energy use within the church can be estimated as follows, the figures in bold being certain:

Service	Description	Power	Annual Use/ kWh	Estimated Proportion of Usage %
Heating (Gas)	Gas boiler, 100kW Usage estimated from benchmark figures using floor area. (450 hours)	**100kW**	45000	95%
Boiler pump	Grundfos	**100W**	45	
Lighting **Nave** **Chancel** **Vestry** **Lobby** **Kitchen** **Toilet**	**8** uplighters (bulbs not viewable) **2** x floodlights **4** overhead fluorescents in diffusers **TOTAL**	 2x500W 8x500W 4x20W 5800W	 2100 Based on bill info	 4.5%
Hot Water	Kettle, 10 x 3 minute boils per week (est 26 hours use p.a.)	**3kW**	78	0.2%
Other Small Power	Sound system (est. 52 hours use)	1kW	52	0.2%
Organ	Organ (est. 52 hours use)	**400W**	20	0.1%
	Sum of electrical use		2295kWh	

Quarterly Electricity Consumption May – August 2019: **571kWh**



KEY 1 Gas Heating 3 Lighting internal (2 and 4 are zero entries)

5 Hot water 6 Small power (sound system) 7 Organ

As can been seen from this data, the heating makes up by far the largest proportion of the energy usage. The lighting load is significant as other items of electrical equipment are of low power and/or used infrequently. This graph does not take into account the recent use of electrical heating (six portable heaters of total load 12.4kW which were not in use during the billing period)

4.3 Energy Benchmarking

In comparison to national benchmarks for Church energy use St Barnabas Church, Reading uses 38% of electricity compared to other churches of this size[1] if the annual consumption follows the same pattern as the summer. This is expected for a church with only around 7 hours of use per week.

	Size (m^2 GIA)	St Barnabas Church, Reading use kWh/m^2	Typical Church use kWh/m^2	Efficient Church Use kWh/m^2	Variance from Typical
St Barnabas Church, Reading (elec)	300	7.6 ?	20	10	38%
St Barnabas Church, Reading (heating fuel)	300	?	150	80	%
TOTAL	300	?	170	90	%

There is not currently any 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

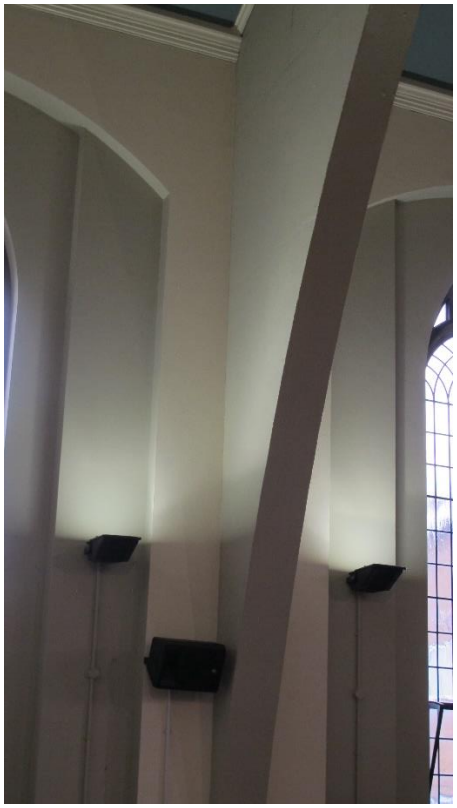
The lighting makes up a significant component of the electrical energy load within the building.

Although it was not possible to identify the main lighting, as the uplighters were concealed by the luminaires; the electrical consumption and the combination of church use profile and small number of other electrical items present indicate lighting to be the main use of electricity.

During the audit, Lux levels were measured during an overcast day with all lighting on, values measured at head level in the pews were very good at between 385 and 400.

It is recommended that all lights are replaced by LEDs; LED bulbs have a much longer life and hence reduce the need to replace the lamps in the ceiling as often as with CFL or halogen bulbs.

It is not possible to give an estimate of cost for a church relighting project as much of the expense is often with control systems, re-cabling and access, rather than the bulbs and fittings themselves. However, for a simple replacement of 10 halogen bulbs of 500W; LED floodlights and compatible luminaires are available at around £100 each.



6. Energy Saving Recommendation (Heating)

6.1 Heating System and Strategy

The church has been using a gas boiler to directly heat the church using conventional radiators.

This system failed in autumn 2019 and during the time of the audit the church was being heated by six temporary portable electric heaters (12.4kW in total).

An email sent to the PCC in November indicated that rather than replacing the boiler, under pew heating would be the most suitable option for a church with a low use pattern, as it enables the church to be rapidly heated with the heat close to the occupants.

In addition, radiant far infra-red panels could be installed on some of the walls.

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

Sections 6.2 to 6.6 describe optimisation of the central heating system.

Section 7 describes alternative heating systems.

6.2 Controls

The boiler timings for Sundays can be optimised with experimentation and record keeping.

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.

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/

6.3 Thermostatic Radiator Valves (TRVs)

Radiators in the church (as above) did not appear to have TRVs fitted.

It is recommended that TRVs are installed on all radiators and users advised as to the best way to operate these once they have been installed. TRV's can be supplied and installed by any good heating engineer.

6.4 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. The boiler did not appear to be fitted with a magnetic particle filter. This apparatus catches any rust or metal particles and prevents them being deposited on the boiler heat exchanger. One should be installed if it is planned to continue using the water heating system long term. Corrosion inhibitor should be added to the system when your boilers are serviced annually.

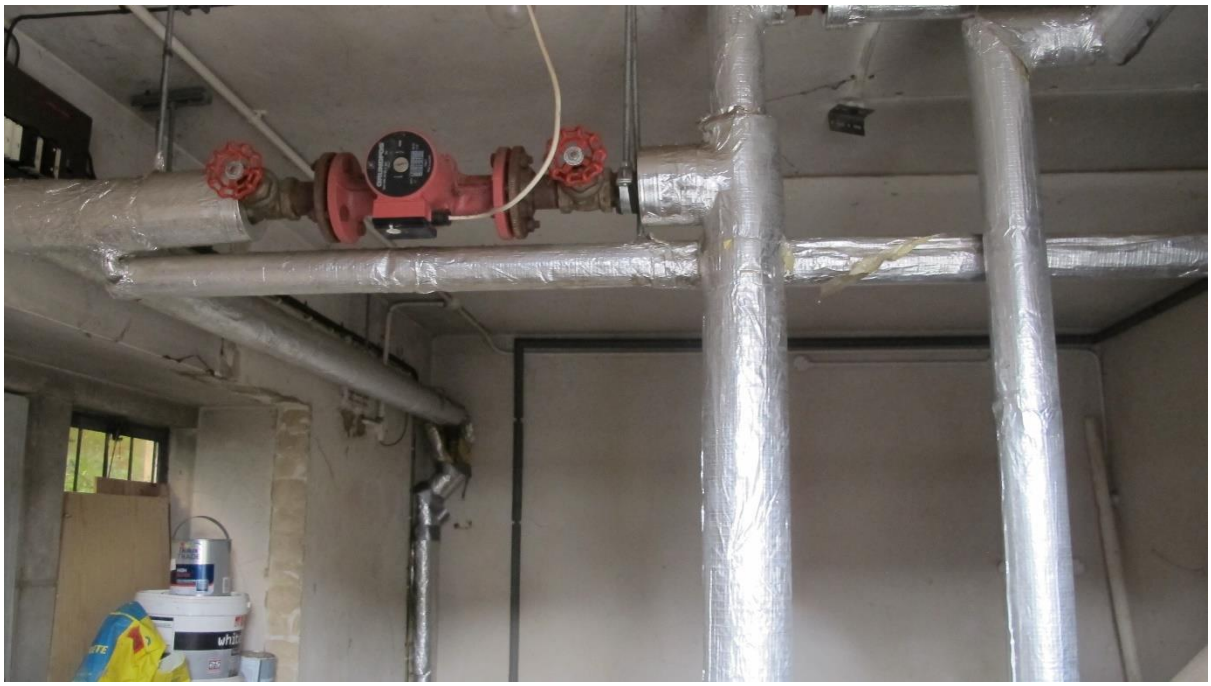
6.5 Endotherm Advanced Heating Fluid

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 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.

6.6 Insulation of Pipework and Fittings

The pipework insulation is mostly adequate. A small section to the rear of the photograph requires re-attachment. This should be supplemented with further insulation which ideally should cover the valve bodies seen below.



7. Alternative Heating Strategies

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 building volume.

There are several different configurations of electric heating which can be installed individually or together.

Under pew heating can be installed under all the pews, or just a selected area to begin with. Radiant panel heaters can be used with or without pews; it is suggested to be installed at the side areas.

Underfloor heating is only viable when a building (or room) is used regularly throughout the week as it takes a long time to heat up, so is unsuited to the use pattern of St Barnabas.

Churches in the diocese fitted with electric heating include St Catherine’s, Towersey, St Mary’s Chalgrove, St Giles, Standlake.

7.1 Under Pew Heating

An alternative (to the present gas heating system) which is compatible with a church with a "Mostly Sunday" use profile is to install under pew heating. An advantage of this system is that small areas could be equipped at a time. The cabling could be led from the pews to the corners of the walls (of the store area and toilet area) to avoid disturbing much of the parquet floor.

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 should be in armoured cable or FP200 Gold when above ground.

Heaters of around 300-400W seem to be the most suitable.

7.2 Use of Electric Radiant Panels for Heating Specific Areas only

To avoid having to heat up the entire church building for any smaller mid-week meetings it is recommended that the PCC consider installing electrical panel heaters in any spaces which are needed for small midweek or evening meetings such as the north side seating area(where there are no pews).

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.

These could be installed on the walls at each side of the church, especially next to the north side seating area. Another location is along the bottom of the wall at the west end of the church, i.e. above the foyer opening – this would radiate heat to all pews from behind. Radiant heaters need to be installed high enough up that they are not blocked by furniture (so should not directly replace the existing radiators at floor level).

7.3 Use of Overhead Radiant Panels for Heating the Whole Church

Some churches such as St Mary's, Chalgrove have installed overhead radiant panels (often they are installed between rafters); these are often used together with under pew heaters. St Catherine's, Towersey has a mix of radiant bar heaters and low temperature under pew heaters (fabric covered); whilst St Catherine's, Faversham is heated entirely by overhead radiant bars suspended from chandeliers hung from the centre points of the nave arches. This approach with each area switched independently can provide rapid heat, with 30 minutes or less preheating being normal. Installed costs of radiant overhead heating for a church of this size would be expected to be in the region of £30,000.

The glowing bar type radiant heaters above are clearly visible (the chandelier mounted ones can be interspersed with lighting), whereas the far infrared rectangular panels do not emit any visible radiation and can be coloured to blend in. If St Barnabas plans to retain pews, these types of heaters will be less effective than under pew heaters.

7.4 Under Floor Heating

Under floor heating is only viable in a church which is regularly used, i.e. has a usage pattern covering much of the time throughout the week. This is because of the long heat up time.

Also, installation is expensive and disruptive, and only possible in churches without archaeology under the floor, and where the floor itself can be lifted and lowered (or raised). St Barnabas does not have a use pattern which can justify this heating method.

8. Energy Saving Measures (Building Fabric)

8.1 Insulation

The low roofed entrance area which comprises the entrance lobby, kitchen and toilet on the left and store room on the right is a single glazed structure which could benefit from insulation.

8.2 Draught Proofing to Doors

Two sets of external doors create a draught lobby. The church welcomers should ensure that in cold or windy weather the doors are quickly closed to prevent cold air entering.

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.

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 Windows

Double glazing should be installed in the toilets, kitchen and lobby areas.

9. Other Recommendations

9.1 Electric Vehicle Charging Points

The church has a frequently used church hall nearby with parking behind the church for around 15 cars. 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 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. 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	No – insufficient demand, visible roof
Battery Storage	No – no viable PV
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 - incompatible with heating system
Air Source Heat Pump	No – incompatible with heating system
Biomass	No – not enough heating load as well as air quality issues

If the church were in more regular use, either form of heat pump could be used to replace the boiler.

Air source pumps could be accommodated within the existing boiler room (with door and side window louvered to provide sufficient airflow. A ground source pump could use coils positioned under the current car parking area. However, both systems are designed to provide low grade continuous / semi continuous heat. With a church used only around 7 hours per week, it would not be economic to run the system for many hours, and either system would struggle to raise the temperature quickly from cold on Sundays.

11. 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 .

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.

12. 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
Body of church	8 uplighters Replace 500W ? bulbs	LED Floodlights	From 4000W to 1200W: 360 hours use Est. £135	£600	4.5 years
Chancel	2 uplighters Replace 500W ? bulbs	LED Floodlights	From 1000W to 300W: 360 hours use Est. £33	£150	4,5 years
Vestry, Kitchen, Toilet		Replace any non low energy bulbs By LEDs			

There are a variety of LED floodlights on the market ranging from those around 10-25W retailing at £25 to powerful 12000 Lumen lamps (150W replacing 1200W non LED) at around £75, such as the V-Tac Slimline LED Floodlight 150w Daylight. There is no need to purchase outdoor IP65 rated moisture resistant models. The calculations above are based on these 150W lamps.

Note that LED lamps also offer savings from 3-4 times longer lifetimes in addition to lower operating costs.

You will need to source the appropriate luminaires (holders) for the uplighters (unless you are lucky enough to be able to find lamps which fit in the current holders). As there are so many different items on the market, it is suggested that you contact your inspecting architect for advice on the appropriate lamp / lumen value / colour temperature and luminaire.