Energy Audit and Survey Report

Christ Church Clifton

PCC of Christ Church

Version Control

Author	Reviewer	Date	Version
David Legge	Matt Fulford	9th December 2019	1.0

Contents

1. Executive Summary

An energy survey of Christ Church Clifton 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.

Christ Church Clifton was built in 1841 and is a large and active church within the suburb of Clifton, Bristol. The church is used daily with a café on site open weekdays between 9am and 4pm and a preschool in the crypt, used daily during term times. The church is not used on Saturdays and there are 3 services on a Sunday. The church is heated via gas fired boilers to perimeter radiators as well as a gas fired heater which provides warm air via a vent in the chancel. There is both electricity and gas supplied to the site.

The church has a number of ways in which is can be more energy efficient. Our key recommendations have been summarised in the table below and are described in more detail later in this report. It is recommended that this table is used as the action plan for the church in implementing these recommendations over the coming years.

Energy saving recommendation	Estimated Annual Energy Saving (kWh)	Estimated Annual Cost Saving (£)	Estimated capital cost (£)	Simple Payback (years)	Permission needed	CO2 saving (tonnes of CO2e/year)	£/tonne of CO2
Notify energy suppliers of CCL exempt status on electricity bill	None	£635	Nil	Immediate	None	-	-
Contact suppliers to arrange for the meters to be changed to smart meters	None	None	Nil	N/A	None	-	-
Switch electricity (and gas) suppliers to ones which provide 100% renewable (or green gas) supplies	None	N/A	Nil	N/A	None	-	-

Fit timed fused spurs to hot water heaters	7,410	£1,068	£270	0.25	List A	2.28	£118.61
Fit Quattroseal draft proofing to historic doors	6,084	£877	£800	0.91	List B	1.87	£428.01
Fit flow regulators onto existing taps	3,705	£82	£100	1.22	List A	0.68	£146.72
Install SavaWatt devices on fridges and freezers	1,220	£176	£390	2.22	List A	0.37	£1,040.60
Insulate exposed pipework and fittings in plantrooms	17,064	£377	£1,000	2.65	List A	3.14	£318.57
Optimise heating system and strategy	68,254	£1,509	£4,000	2.65	List B / Faculty	12.56	£318.57
Change existing lighting for low energy lamps/fittings	12,885	£1,858	£5,687	3.06	List B / Faculty	3.96	£1,436.65
Install Endotherm advanced heating fluid into heating system(s)	30,422	£673	£2,120	3.15	List A	5.60	£378.81
Install PIR motion sensors on selected lighting circuits	245	£35	£531	15.01	List A / List B	0.08	£7,041.88

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

Based on current contracted prices of 13.57p/kWh and 2.21p/kWh for electricity and mains gas respectively.

If all measures were implemented this would save the church £7,291 per year.

2. Introduction

This report is provided to the PCC of Christ Church Clifton 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 Christ Church Clifton, Clifton Down Rd, Bristol BS8 3BN was completed on the 24th October 2019 by David Legge. David is an experienced energy auditor with over 10 years' experience in sustainability and energy matters in the built environment. David is a fully qualified ESOS lead assessor with CIBSE and a CIBSE Low Carbon Consultant and a fully qualified ISO50001 lead auditor.

Christ Church Clifton	605065
Gross Internal Floor Area	757 m^2
Listed Status	Grade II*
Typical Congregation Size	220

The church typically used for 47.5 hours per week for the following activities

Services	10 hours per week
Meetings and Church Groups	Ad hoc use
Community Use (Café and Preschool)	37.5 hours per week

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

3. Energy Procurement Review

Energy bills for gas and electricity have been supplied by Christ Church Clifton and have been reviewed against the current market rates for energy.

The current electricity rates are:

Day Rate	13.5699 p/kWh	In line with current market rates
Standing Charge	40.8669 p/day	N/A

The current gas rates are:

Single Rate	2.2114p/kWh	In line with current market rates
Daily Charge	£8.97/day	N/A

The above review has highlighted that the current rates being paid are in line current market levels at this site. However, we would recommend that the church obtains a quotation for its gas and electricity supplies from the CofE parish buying scheme, https://www.parishbuying.org.uk/index.php/categories/energy/energy-basket. As this scheme only offers 100% renewable energy sourced electricity 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% gas / 20% electricity	The organization is understood to be a charity and therefore should be benefiting from only be charged a 5% VAT rate. A VAT declaration should be sent to the supplier regarding electricity to adjust this.
CCL	100% charged on electricity contract	As the organisation is being charged the wrong VAT rate, they are also being charged CCL which should not be applied as they are a charitable organisation. Sending the supplier a VAT declaration will remove this charge.

The above review has highlighted that VAT and CCL are being charged when the organisation is understood to be a charity and have VAT exemption status. As such the PCC of Christ Church Clifton should send the supplier at VAT declaration confirming this and check all supplies on other sites.

4. Energy Usage Details

Christ Church Clifton uses 74,939 kWh/year of electricity, costing in the region of £10,804 per year, and 304,221 kWh/year of gas, costing £6,728.

This data has been taken from the annual energy invoices provided by the suppliers of the site (see Appendix 2). Christ Church Clifton has one main electricity meter, serial number E15UP05640. There is one gas meter serving the site, serial number M040K0091310D6.

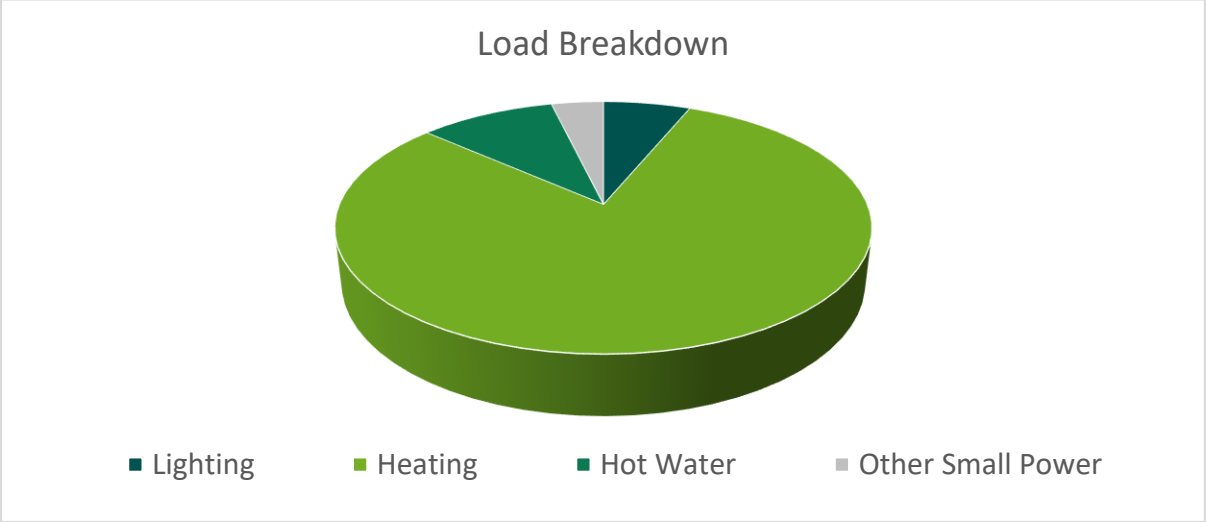
Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	E15UP05640	3 phase 100A	Yes, Full AMR connectivity	Cupboard in Narthex
Gas – Church	M040K00913 10 D6	BKG 25 / MDK40	Capable but no pulse block	Preschool cupboard

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.

4.1 Energy Profiling

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

Service	Description	Estimated Proportion of Usage
Lighting	Church lighting is predominantly SON floodlights. Ancillary areas and the crypt has a mixture of very inefficient T12 and T8 fluorescent tubes through to LED lighting.	6%
Heating	Heating is provided by gas fired boilers to perimeter radiators in all areas. There is an additional direct gas fired heater providing hot air to the chancel.	80%
Hot Water	Provided by electric point of use water heaters and water boilers as well as a large hot water cylinder with an electric immersion heater.	10%
Other Small Power	Sound system, CCTV, alarm systems, café appliances, small plug loads and the like.	4%



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

4.2 Energy Benchmarking

In comparison to national benchmarks[1] for Church energy use, Christ Church Clifton uses 395% more electricity and 168% more heating energy than would be expected for a church of this size. As the site has a café running daily all day and a preschool in the crypt during term time (39 weeks per year), then the consumption would be expected to be higher than in most churches. However, the gas heating running in the crypt continuously will be exacerbating the high gas consumption and the inefficient SON lighting in the church will be adding significantly to the electrical consumption.

	Size (m^2 GIA)	Christ Church Clifton use kWh/m^2	Typical Church use kWh/m^2	Efficient Church Use kWh/m^2	Variance from Typical
Christ Church Clifton (elec)	757	98.99	20	10	395%
Christ Church Clifton (heating fuel)	757	401.88	150	80	168%
TOTAL	757	500.87	170	90	195%

[1] CofE Shrinking the Footprint – Energy

5. Energy Saving Recommendations (Electricity)

5.1 Lighting (fittings)

The lighting makes up a relatively large overall energy load within the building, and most areas are lit by inefficient fittings. The main lighting in the nave are inefficient SON floodlight fittings which provide a fairly undesirable orange colour temperature, coupled with CFL lamps in chandelier fittings. The church may wish to consider using the opportunity to improve the lighting and consider a track lighting solution, fixed to the wall plate, which would provide greater flexibility and ability to create lighting effects. Track fittings such as https://www.sylvania-lighting.com/product/en-GB/products/2059568/ are regularly used to light churches such as this.

The crypt, which houses the preschool and ancillary areas uses inefficient T8 and T12 fluorescent tube fittings throughout. LED replacements for these fittings are widely available on the market and it is suggested that the complete fitting (not just the lamp) is replaced. Any new LED fitting would have a much longer life and hence reduce the need to replace the lamps in the ceiling.

The chancel uses a range of halogen spotlights, typically R50 and R63 lamps to highlight the altar. For the spot lights the Megaman range of LED spot (reflector) lights https://www.megamanuk.com/products/led-lamps/reflector/ provides some very suitable substitutes to the current lamps.

It is recommended that all of the fittings, scheduled in Appendix 1, are changed for LED. (Note that these costs are based on a like for like replacement and do not include for any improvements in the lighting scheme other than energy saving)

If all the lights were changed the total capital cost (supplied and fitted) would be £5,687. The annual cost saving would be £1,858 resulting in a payback of around 3.1 years. Many of the lights could be self-installed and therefore cost much less than the supply and fit cost above.

5.2 Lighting (control for internal lights)

Several of the lighting circuits within the building already have motion / daylight sensors installed on them. However, it was noted during the audit that these sensors are not currently set up to work to their full potential.

It is recommended that the existing lighting sensors installed within the building are reviewed and optimised so that the time lag before they turn off the lights, and the light level at which they allow the artificial light to be turned on is adjusted so that it is suitable for the space. Depending on the type of light fitting installed it is normally recommended that areas such as

storerooms and cupboards switch off after just 1 minute, narthex, corridors and stair lobbies after 2 minutes and kitchenettes and WCs after 5 minutes. Generally lighting levels should be around 300lux but it is highly dependent on the use of the space.

5.3 Refrigeration Controls

Across the site there are various domestic refrigeration units such as fridges within the café, preschool and basement catering kitchen for storage of milk and food. These units 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.

The supply and installation of these units and further details can only 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.

5.4 Timeclocks to Hot Water Heaters

There are a number of electric point of use water heaters in the café and WCs to provide hot water for hand washing as well as a large hot water calorifier in the catering kitchen. This only needs to heat the water to the required temperature when the building is in occupation but at the moment these heaters are directly wired in without any form of time control and therefore maintain their set temperature 24/7.

It is recommended that each of the heaters is fitted with a 24 hour/7-day timeclock to replace the fused spur switch. An example of such a unit would be a TimeGuard FST77. It should be set up with times to match the times that the building is occupied, and this will prevent the standing losses from the unit wasting energy during periods when the building is not occupied.

Such units can be purchased at any electrical wholesaler and fitted by your existing electrician or any NICEIC registered electrical contractor.

6. Energy Saving Recommendation (Heating)

6.1 Heating System and Strategy

A high level review of the heating system and its associated settings highlighted a number of areas that can be optimised to both reduce energy consumption and improve comfort. With regards to the controls for example:

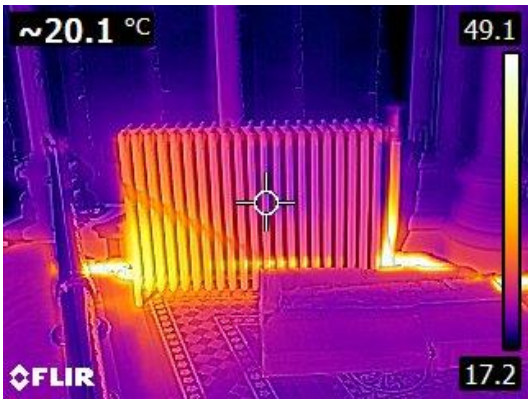
- There is no current time control for the crypt/preschool heating boiler; it is reported that this boiler remains on 24/7 at present.
- The church heating time schedules should more closely match occupied hours; for example, this heating system runs from 0630 – 2000 on a Sunday and 0630 – 2130 on a Monday, but this is not in line with reported occupancy.
- The hot air heater in the chancel runs for 2.5 hours per day regardless of occupancy.

With regard to the crypt heating system running continuously, 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. Sensitive areas 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 and other areas 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 or discreetly 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)

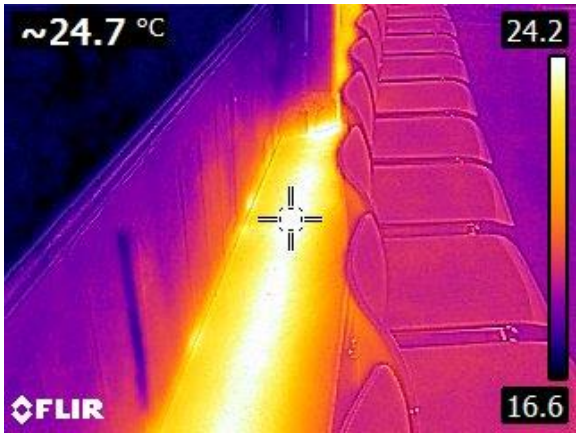
Providing constant background heating to the crypt as a whole is excessive and wasteful of energy. At the very least we would recommend that this background level is reduced to a maximum of 12°C and ideally avoided all together. This may require the introduction of a thermostat that can provide two levels of heating.

Within the main body of the church, there is a café which is open from 9am until 4pm Monday to Friday. To avoid having to heat up the entire church building for the café which is exclusively housed within the North aisle, it is recommended that the PCC consider installing either a zone valve to the existing gas fired central heating system or introducing electrical panel heaters in this area on a time delay switch and utilise the existing radiators for church services only.

There is a room thermostat controlling the hot air gas heater in the chancel, however there is no room thermostat for the main perimeter radiators, which are driven only by the timeclock and flow temperature from the boiler. It is strongly recommended that a combined thermostat and timeclock is installed within the church, with internet enabled controllers, such as a Hive, Nest or tado controller, offering good flexibility in terms of maintaining or removing a continuous heat as well as programming whilst off-site.



It was noted during the survey that there was a lot of air within the heating systems. It is recommended to bleed all radiators of air in the first instance and ensure there is adequate pressure in the boiler following/during this exercise. Frequent checks should be made by bleeding the radiators of air and if a frequent problem persists, leak sealant should be added as a first port of call https://fernox.com/product/leak-sealer-f4-500ml/. If this is unsuccessful, a qualified heating engineer should be consulted but care should be taken if air pressure testing is suggested due to the age of the pipework.



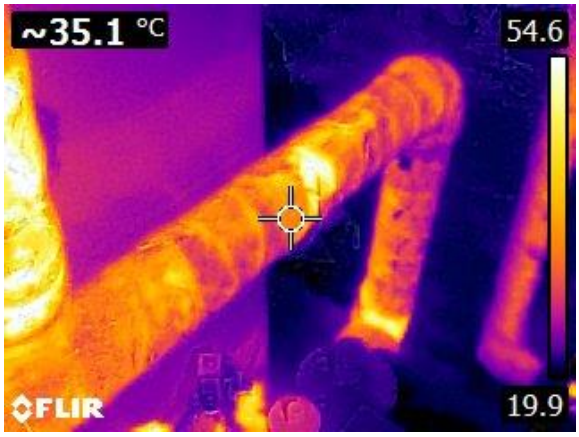
Within the church, the pipework has been housed within wooden boxing which will reduce the ability to convect heat into the space where it is required. It is suggested that the boxing is considered to be removed to allow greater heat distribution into the main body of the church as the pipework is essentially acting as a radiator.

6.2 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 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 supplied and self-installed.

6.3 Insulation of Pipework and Fittings



The pipework within the plant room has the majority of its straight lengths insulated but this is now old and the insulation is quite poor allowing heat to escape. In addition, 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.

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

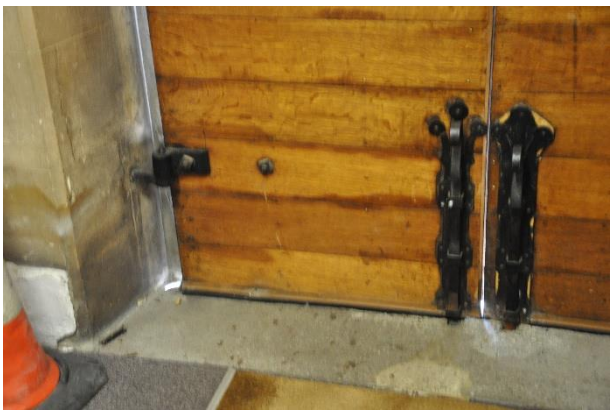
7. Energy Saving Measures (Building Fabric)

7.1 Draught Proofing to Doors

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

Where a timber door closes against a timber frame it is recommended that draught proofing is fitted. A product called QuattroSeal (see link below) is often used in heritage environments to provide appropriate draught proofing. http://www.theenergysavers.co.uk/application/files/1714/7197/4194/National_Trust_Case_Study.pdf. Note this cannot be used where the timber door closes directly against a stone surround.

Other simple measures such as using a small fridge magnet painted black over the large keyhole or the use of 'sausage dog' type draught excluders at the base of little used doors can prove to be very effective. Doors should be reviewed in daylight and gaps where the light shines through sealed or filled in whatever the most appropriate way is for the specific door.



8. Saving Recommendations (Water)

8.1 Tap Flow Regulators

The taps to the wash hand basins within the building have been checked as part of the audit and the average flow rate within these has been measured to be 9l/min. The recommended flow rate for hand washing is 4.8l/min and therefore the taps are providing around double the amount of water that is necessary.

The over provision of water for hand washing is not only a source of excessive water use, but in the case of hot water, it is also a source of wasted energy in the heating that has to go into providing the hot water.

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.

9. Renewable Energy Potential

The potential for the generation of renewable energy on site has been reviewed and the viability noted.

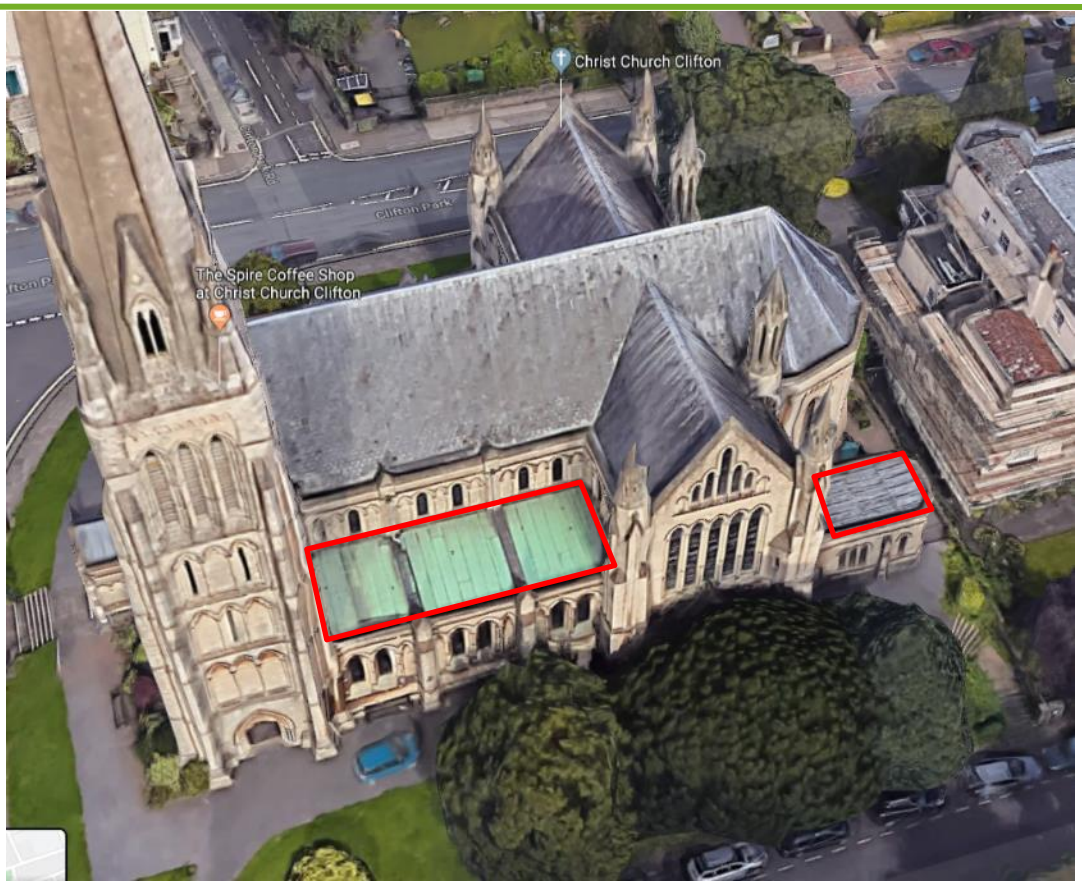
Renewable Energy Type	Viable
Solar PV	Yes, some roofs are not visible on listed building
Battery Storage	Yes, if required following feasibility study
Wind	No – no suitable land away from buildings
Micro-Hydro	No – no water course
Solar Thermal	No – insufficient hot water need
Ground Source Heat Pump	No – archaeology in ground and radiator system
Air Source Heat Pump	No – insufficient electricity supply
Biomass	No – not enough heating load as well as air quality issues

Prior to the consideration of any renewable energy technologies, a good clear focus on reducing the energy demand of the building should be prioritised, with a targeted approach on reducing both the electrical and heating energy.

Now that the Feed in Tariff scheme has come to an end the installation of solar PV panels neds to be carefully considered and balanced against the electrical load requirements for the site.

There is potential for a small PV array on the roof of the south aisle and on the flat roof of the vestry (as shown on the photo overleaf). 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 churches energy consumption is reasonable due to the café and preschool, but careful consideration should be made to the number of panels required or if any battery storage should be considered.

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. This is a new but fast-growing technology with prices expected to fall substantial over the next 2 to 3 years.


Christ Church Clifton
The Spire Coffee Shop
at Christ Church Clifton

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.

Appendix 1 – Schedule of Lighting to be Replaced or Upgraded

Room/Location	Number of Fittings	Direct Replacement Upgrade	Annual Saving (£)	Total Cost (£)	Payback
Church	24	50W LED Flood (track lighting to be considered)	£1,059.75	£2,191.20	2.07
Narthex	1	5ft Single LED	£57.69	£93.70	1.62
Church	4	R63 LED	£44.01	£85.96	1.95
Church	4	R50 LED	£61.11	£47.56	0.78
Jacobs Well Room	5	LED GLS	£36.75	£52.50	1.43
Organ	2	5ft Single LED	£22.79	£187.40	8.22
Narthex	3	5ft Single LED	£59.18	£281.10	4.75
Crypt	2	5ft Single LED	£50.57	£187.40	3.71
WC	3	2D LED 11W	£22.35	£163.65	7.32
Kitchen	4	5ft Single Vapour LED	£76.06	£323.56	4.25
Dry Store	1	5ft Single Vapour LED	£24.57	£80.89	3.29
Crypt wall washers	8	5ft Single LED	£202.26	£749.60	3.71
WC	6	Virgo 15W (190mm dia)	£94.61	£277.86	2.94
Pre-School	2	5ft Single LED	£45.94	£187.40	4.08