Energy Audit and Survey Report

Holy Trinity Church, Walton, Aylesbury

"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	17th March 2020	2.0

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1. Executive Summary

An energy survey of Holy Trinity Church, Walton, Aylesbury 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.

Holy Trinity Church, Walton, Aylesbury is a Victorian church built in 1844, with extensions in 1886, 1895 and in 2010 when a new foyer and café area was constructed. 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?
Adjust Thermostatic Radiator Valves	5% 5,500	£115	Nil	Immediate	None	Building Manager
Complete LED lighting installation	Foyer 1,450	£170	£200 foyer £1,000 nave	Short	List A/B	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?
Install radiant Infra-red heating panels in main church sanctuary	Enhancement of heating	N/A	£3,000	N/A	Faculty	PCC
Install cavity wall insulation in any uninsulated walls e.g. office area	5% 5,500	£115	£3,000	Long	Faculty	PCC
Install Air Source Heat Pumps to replace boiler	C 70,000	See Section 11.4	£40,000	Moderate	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?
Install solar panels plus battery	38,000 large system	Potential of £5,000 with heat pump	£58,000	12	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 13.1327p/kWh and 2.0758p/kWh for electricity and mains gas respectively.

If all measures were implemented this would save the church in the region of £5,000 operating costs per year.

2. Introduction

This report is provided to the PCC of Holy Trinity Church, Walton, Aylesbury 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 Holy Trinity Church, Walton, Aylesbury, Walton Street, HP21 7QX, was completed on the 16th December 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 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.

Holy Trinity Church, Walton, Aylesbury	
Gross Internal Floor Area	650 m^2
Listed Status	Unlisted
Typical Congregation Size	180

The church typically used for 32 hours per week for the following activities

Services	5 hours per week
Meetings and Church Groups	20 hours per week
Community Use	6 hours per week
Occasional Offices 2 Weddings 3 Funerals	1 hour per week

Church annual use = 1,660 hours

The adjacent church hall is also heavily used by several groups.

Heating hours, Church = 567 hours

Estimated footfall (church only) = 23,000 people

3. Energy Procurement Review

Energy bills for gas and electricity have been supplied by Holy Trinity Church, Walton, Aylesbury and have been reviewed against the current market rates for energy.

The current electricity rates are:

Single / Blended Rate	13.1327p/kWh	In line with current market rates
Standing Charge	31.4094p/day	N/A

The current gas rates are:

Single / Blended Rate	2.0758p/kWh	Lower than current market rates
Standing Charge	380p/day	Higher than typically seen.

The above review has highlighted that the current rates being paid are in line or below current market levels and the organisation can be confident it is receiving good rates.

Any change in supplier should be to one offering 100% renewable electricity such as Parish Buying, Bulb, Ecotricity or Good Energy.

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

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 now being charged.

20% VAT was charged before June 2019; the overpayment was credited and the corrected utility bills re-issued.

4. Energy Usage Details

4.1 Annual Consumption

Holy Trinity Church, Walton, Aylesbury uses 14,000 kWh/year of electricity, costing in the region of £2,000 per year, and 110,000kWh/year of gas, costing £5,300.

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	14,086	1/12/18	30/11/19	£1,987.38
Gas	109,879 Calculated use	6/12/18	20/6/19 Scaled up to 12 months	£5,322 Calculated

Utility	Meter Serial
Electricity – Church	K0310415 D6 K014 K60239
Gas – Church	NOT SEEN

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

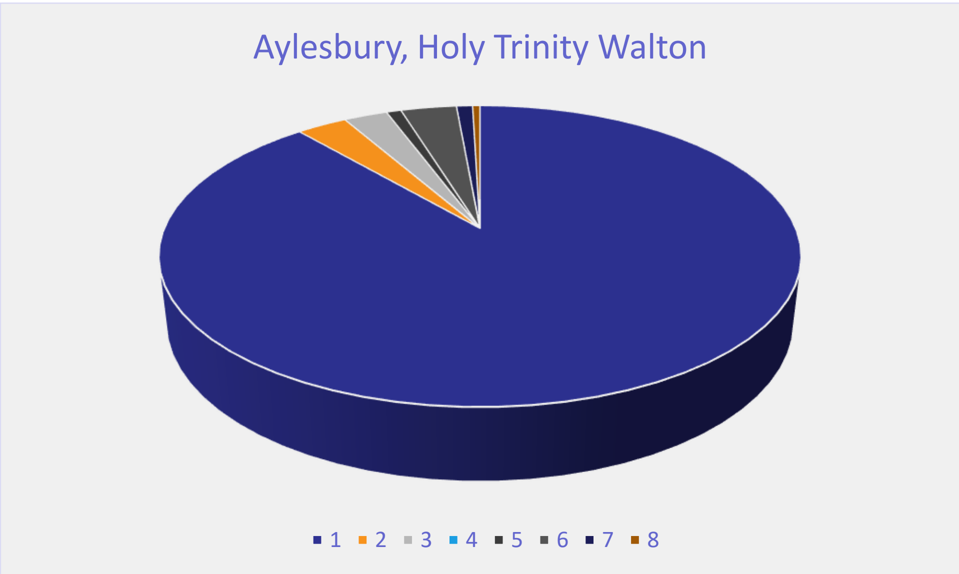
The main energy use within the church can be summarised as follows:

Service	Description	Power	Annual Use/ kWh	Estimated Proportion of Usage (of gas or elec) %
Gas heating	194kW input Broag Seagold Gas 3A	194kW	110,000	100%
Boiler pump	567 hours estd.	200W	113	0.8%
Lighting **Sanctuary** (800hr) **Foyer** (1200hr) **Meeting Rooms** (500hr)	 8 Pendant lights c 60W 6 CFL c 20W 37 Halogen 12 LED 12 spotlights 6 uplights 5 CFL 1 halogen	 480W 120W 1300W 60W 960W 240W 100W 80W	 384 96 1,560 72 480 120 50 40	23.2%

Office (1600hr)	13 recessed CFLs x 20W	280W	450	
Heating [Electric] Nave	Wall mounted convector heaters (4 x 3kW) Estimated 300 hours use	12	3,650	26.0%
Hot Water	Café, open 15 hours per week. (780 hrs)			15.7%
	Coffee machines	3kW	400	
		2.2kW	300	
	Kettle	3kW	200	
	Water heater	2.1kW	200	
	TOTAL		1,100	
Other Small Power				42.1%
	Fridge (Blizzard)	122W	350	
	Fridge freezer	200W	600	
Kitchen	toasters Breville	2.1kW	150	
	Microwave Samsung	1.6kW	200	
	Microwave	1.15kW	150	
	Cooker 30W	7kW	1,800	
	Dishwasher	6.75kW	900	
Office	6 computers	600W	1,000	
	Printer	200W	200	
Other	Sound system	1kW	260	
	Vacuum cleaner	1.5kW	160	
	Organ	500W	130	

Sum of estimated electrical use: 14,015kWh

Total Annual Electrical Consumption 2019: 14,086kWh



KEY	1 Gas heating	2 Electric heating	3 Lighting	4 Lighting (external)~ zero
	5 Hot water	6 Kitchen	7 Office	8 Other

4.3 Energy Benchmarking

In comparison to national benchmarks[1] for Church energy use Holy Trinity Church, Walton, Aylesbury uses 8% more electricity and 12% more heating energy than would be expected for a church of this size.

This is due to the higher hours of use compared to most churches.

	Size (m^2 GIA)	Holy Trinity Church, Walton, Aylesbury use kWh/m^2	Typical Church use kWh/m^2	Efficient Church Use kWh/m^2	Variance from Typical
Holy Trinity Church, Walton, Aylesbury (elec)	650	21.7	20	10	108%
Holy Trinity Church, Walton, Aylesbury (heating fuel)	650	169	150	80	112%
TOTAL	650	191	170	90	112%

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)

The church is planning to rewire with new lighting and sound system.

5.1 Lighting (fittings)

The lighting offers the opportunity to reduce energy consumption and increase the period between changes of light bulbs by adopting LED lighting where it is not already fitted.

The nave is lit by 8 large pendant 25cm spherical diffusers at around 3.5m height. It was not possible to identify the type of bulbs inside. Lux levels were very poor at 10-30 Lux at 10am on a dull day. A lux level of 50 should be the minimum, with 100 a suitable level for reading. Levels in the aisle area were also poor at 10-50 (the higher values were in places where the light fittings are at a lower level). The aisle is lit by 6 x Compact Fluorescent Lamps, probably of 20W each. The church would benefit from relighting to give Lux levels of 100 or more, using dimmable LED lighting.

The downlights in the foyer, kitchen, community room and toilet areas are GU10 fittings which are a mix of halogen (35 or 50W) and LED (3 to 5W). These number at least 49 lights in this area with around a quarter having been changed to LED.

It is recommended that all of the non LED bulbs are changed for LED, which will produce an immediate drop in consumption – in the foyer and meeting rooms this can be done by the church as they are at easily accessible heights.

If all the lights were changed the total capital cost (purchase cost only) would be around £150 for 37 further GU10 LEDs. The annual cost saving would be £170 (based on 1000 hours use) resulting in a payback of less than 1 year. These lights could be self-installed.

In this case the £150 grant available through this process could be very usefully employed to fund the purchase of replacement LED lamps which the church installs themselves.

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.

For the nave lighting, a lighting contractor should be consulted *IF* it is required to dim the lights, as a type of LED bulb which is compatible with the existing dimming controls is required. If dimming is not required, 8 new LED bulbs at around 3.5m height can probably be self installed.

Alternatively, supply and installation can be carried out by any reputable electrical contractor and a free survey and quotation can be obtained from Batchelor Electrical, contact Stuart Patience on 01202 266212; 07793 256684; stuart@batchelor-electrical.co.uk.

5.2 Lighting (control for internal lights)

There are several lights which currently remain on all the time in areas such as corridors, toilet areas, staircases and the like. Some of these areas are only used occasionally and for a short amount of time and as such, the lights do 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 considered 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). Depending on the type of light fitting installed it is normally recommended that areas such as storerooms and cleaners' cupboards switch off after just 1 minute, corridors and stair lobbies after 2 minutes and WCs after 5 minutes. Generally lighting levels should be around 100 lux in corridors but it is highly dependent on the use of the space.

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.

It is recommended that light switches such as those pictured below are labelled for clarity (e.g. with a labelling machine), with any complex arrangements of lights having a colour coded plan.

5.3 Refrigeration controls

Install SavaWatt energy saving devices on fridges and freezers

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

A 100W fridge will run for about 8 hours per day, using about 300kWh annually.

To reduce the electrical consumption of these appliances it is recommended that they are all fitted with a SavaWatt unit. These units work by automatically detecting the load of the compressor and turning down the power when it is not in full load. This reduces the energy consumption of the refrigeration unit by around 18% while maintaining the cooling of the appliance. It does this by reducing the voltage delivered to the unit when it is idling but allowing the full energy to the unit when it is required.

Supply and installation and further details can be undertaken by SavaWatt directly http://savawatt.com/. The installation does not cause any significant disruption to operations and can be undertaken during normal operating times.

6. Energy Saving Recommendation (Heating)

6.1 Heating System and Strategy

The building is currently divided into two systems, with a boiler heating the offices, meeting rooms, foyer and café areas.

The church currently uses four* wall mounted electric fan assisted convector heaters to heat the church itself of around 240m^2. They are mounted at high level, ~ 4m up on the walls. There are no central heating radiators in the sanctuary. Gas fired central heating supplies the offices, meeting rooms and the 2010 built front foyer and café area which has underfloor heating; a greater area of around 420m^2. The office area of the first floor is heated 5 days per week from 0830-1330 (1300 heating hours annually).

The current boiler was installed in 1983. The church is considering replacing this with three domestic sized boilers to allow for zoning.

If the gas boiler is repaired or replaced, then long term, the boiler(s) will need to be made hydrogen ready. Hydrogen is due to be added to the gas grid over the next five year period (a pilot project is underway). 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.

The different potential zones will be considered in the remainder of Section 6; Section 7 refers to optimisation and maintenance of the existing system, Section 8 considers alternative heating methods.

** It was not possible to obtain access to the chancel as a school group were rehearsing their nativity play, so the heating in this area has not been thoroughly investigated.*

6.2 Potential Heating Zones

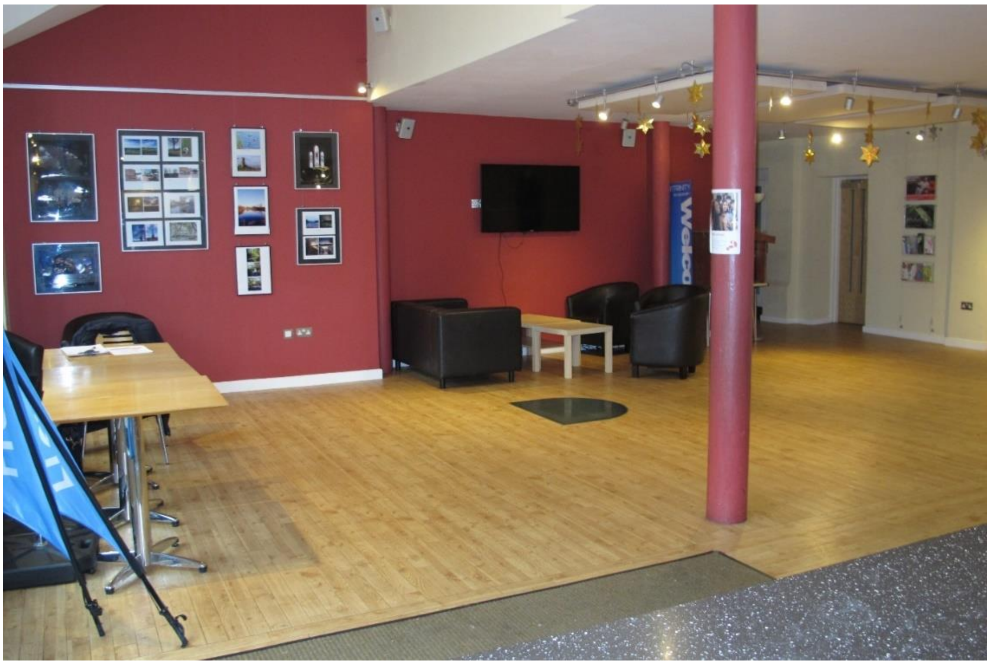
Sanctuary - Approximately 240m^2

The church itself is heated by fan assisted electric convector radiators. A full analysis was not possible as the church was in use by a primary school.

Electric heat means this part of the building can be heated by 100% renewable energy if the church signs up to such a tariff. On average, grid electricity currently emits more CO_2 than gas, it's footprint is rapidly falling as further wind generation capacity is added, replacing coal. The comparison of non-renewable "brown" tariffs is 0.25kg CO_2 per kWh for electricity and 0.18kg CO2 per kWh for gas.

Replacement of some of the convector heaters by far infra-red radiant heating panels located in positions where they will be directly heating the congregation would address the problem of heat rising to the ceiling and consequent long heat up times. This could involve ceiling mounted and perhaps wall mounted panels, which offer rapid heating. Heating which is better directed at the congregation would be expected to cut operating costs, provided that radiant panels are located in the optimum positions and their use monitored.

Welcome – Foyer and Café area. Approximately 125m^2.



This area benefits from underfloor heating, which works best when delivering low grade heat over long periods. It is in regular use; the café 5 mornings per week, plus some evening use. This should be one heating zone and could be supplied ideally by an Air Source Heat Pump. Potential locations for heat pumps are at the rear of the building, and in the valley of the adjacent centre roof, where there is an existing walkway (i.e. not too far from the foyer area). An ASHP providing low grade heat on a semi constant basis will be operating efficiently and is likely to consume 1/3 of the electricity (in kWh) as required by gas heating. The most efficient timing of heat pump operation would be the time of day when the air temperature is warmest. Operating costs will be more, given the low gas tariff at present; so the technology should be considered along with installing solar panels; feasible on an unlisted church. See Section 11.3 for potential installation locations.

Office - Approximately 75m^2 (rear office) + 45m^2 (mid area).

The office is in regular use, 5 days per week. This zone, as above could either be supplied by a heat pump. The meeting room next to the office includes one desk. The radiator here was found to be extremely hot, at 84^{o}C, which is a dangerous level next to office workplace seating.

It is recommended that the temperature is reduced using the thermostatic valve.

First floor rear areas, situated under the office area. Recommended to be kept at a background temperature during the winter using any existing radiators with thermostatic radiator valves turned down. This could be connected to the office zone above.

Meeting Room Approximately $65m^2$.

It is recommended that far infrared radiant panels are installed to give rapid heating at short notice.

7. Optimisation of the Current Heating System

7.1 Boiler Timing Optimisation

The boiler timings are reported to be ON 08:30, OFF 13:30.

Radiator systems with hot water remain hot for several hours after the boiler is switched off – experiments in the Diocese of Lichfield at over 50 churches have established that hot water radiator heating can be optimised by being switched off 45 minutes before the end of the service. As you have people present until 13:00 you could experiment with turning it off at 12:00.

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/

7.2 Space Temperature Set Point

It is unclear whether normal Sunday operation raises the temperature above 18ºC at pew level – you may find that if the temperature is measured at the ceiling it is above 20ºC.

To assist in optimising and understanding the temperatures in the church, a datalogger such as an Easylog USB, Haxo-8 or Mindsets mini temperature datalogger could be purchased.

7.3 Thermostatic Radiator Valves (TRVs)

TRV’s should be installed where not fitted on the existing radiators in the office, meeting room and corridor areas to allow the users of the room to have some element of control over the temperature in the room and prevent over-heating which often leads to situations where the heating is on and the windows are open. It also allows un-used spaces to have the heating in them turned down.

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.

Use of TRVs will allow the temperature to be balanced across the building.

7.4 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.

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.

7.5 Magnetic Particle Filter

The boiler is reported not 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 systems long term. Corrosion Inhibitor should be added to the system when your boilers are serviced annually.

7.6 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.

7.7 Insulation of Pipework and Fittings

The pipework insulation should be supplemented with further insulation to cover any uninsulated valve bodies. It is recommended that exposed fittings are insulated with bespoke made flexible insulation jackets. These wrap around the various elements but can be removed and then replaced for any servicing activities

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

8. Alternative Heating Systems

A church with low hours of use per week will always fall back to "base" temperature between heating events (it may take around 24 hours for the temperature to fall). A system which can heat rapidly, without sending most of the heat to the ceiling first, and in addition can be configured to heat small areas independently for small services or midweek meetings will be more efficient than one which seeks to heat up the whole volume.

8.1 Use of Electric Radiant Panels for Heating Specific Areas only

Spaces of this area (240m^2) would normally be heated by a 50-80kW boiler providing space heating from cold; with electric heating less power is normally suitable as the focus is on heating the people, not the ceiling. Under pew heating systems would deliver 15-30kW. The four convector heaters noted probably deliver 12kW (are there further heaters in the chancel and south aisle?).

Replacement of the convector heaters located 4m up on the walls with far infra-red radiant panel heaters would deliver heat to the congregation more rapidly. A further location would be under the aisle ceiling. The low height area under the mezzanine floor may offer a location for further (low temperature) panels, attached to vertical surfaces.

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 cannot be left on accidently after use.

The nave roof is too high for radiant panels to be effective unless they are very high powered

8.2 Overdoor Air Heaters

In order to achieve the sense of a ‘warm welcome’ into the church an over door air heater could be provided. This would complement radiant heaters and provide warmth to the rear of the church at a lower level than the existing convector heaters do. Such an over door unit should be sized to cover the whole width of the door and it is suggested the BN Thermic 860 model would be quite suitable. This has a 6kW output.

9. Energy Saving Measures (Building Fabric)

9.1 Roof Insulation

Fit 270mm of insulation into suitable areas

Where there are areas of ceiling which can be insulated above, this should be actioned. It would be particularly effective in areas with regular use such as the office area, below centre and right. It is expected that the foyer and café area at the front of the building is constructed to modern standards of insulation. Where there is a loft, 270mm of insulation is recommended.

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

9.2 Wall Insulation

The Church reports that sprayed insulation has been added to the church (sanctuary). The brickwork of the rear office area, above, is laid to stretcher bond, indicating a cavity, but no evidence of cavity wall insulation having been added (from the outside – small holes with brown plugs inserted) can be seen on the above façade. This is recommended for a regularly used portion of the building.

9.3 Draught Proofing to Doors

External doors should be kept well maintained and draught free – draughts will blow 24/7 and this can have a significant cooling and financial effect, perhaps 5% or greater. The foyer doors are fitted with draught strips. In the case of non-listed buildings, "E" or "P" cross section rubber draught excluders may be sufficient, depending on the size of the gaps.

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 include 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.

9.4 Closed Door Policy

The main entry doors in the should be quickly closed behind the congregation during cold or windy weather by your friendly welcome team!

9.5 Windows

If there are draughts caused by any windows not shutting correctly, a temporary solution is to use plasticine to fill gaps. This is often a problem with hopper windows.

Any windows in areas which are regularly heated (i.e. in the office) would benefit from double glazing where this is not already installed.

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	Yes - church and hall
Battery Storage	Yes
Wind	No – no suitable land away from buildings
Micro-Hydro	No – no water course
Solar Thermal	No – insufficient hot water need
Ground Source Heat Pump	No – no accessible ground
Air Source Heat Pump	Yes
Biomass	No – not enough heating load as well as air quality issues

10.1 Overview

The church is not listed and has a large roof area which is suitable for solar panels. In addition, the adjacent church hall has an equivalent area.

There are locations where Air Source Heat Pumps can be fitted – these deliver medium temperature water to radiator systems, suitable for a building with significant hours of use including the office area in daily use. Heat pumps will deliver around 3 times the amount of heat for the electricity they consume. In the case of Holy Trinity which has an extremely cheap gas tariff, 6.3 times less per kWh than electricity, a change from gas boiler to electric heat pump would involve an approximate doubling of cost. However, with free on site electricity generation the economics improve, as does the carbon footprint.

Therefore, the church is recommended to thoroughly investigate a heat pump & solar panel installation.

10.2 Solar PV potential

The south east facing roofs of both church and adjacent hall offer good sites for solar photovoltaic panels. The church roof is approximately 23m long with 5.2m of nave roof at approximately 55 degrees inclination and 3m of aisle roof at 30 degrees and is oriented approximately south east. With these angles and orientation, generation is 90% of the theoretical maximum. This could support 160m^2 of panels. The hall roof is of similar size. This could generate 0.15kWpeak/m^2 giving a 24kWpeak system for each roof. A 1kWpeak system can generate 800kWh annually, giving 19,200kWh for one roof, and 38,400kWh for both.

Without installation of heat pumps, a one roof system would be recommended (with no Feed in Tariff there is no advantage in generating more than is consumed). It could supply both church and hall.

Using average 2018 installation costs for large systems (£1,200 per kWpeak); a 24kWpeak system would cost £28,800 and both roofs £57,600. This does not include cost of any battery.

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). This appears to have a maximum payment rate of 5.5p/kWh, around a third of what is paid for grid electricity, but is dependent on individual contracts with energy companies so could be much lower.

One of the issues for churches is that most lighting use is at periods when the electricity is not being generated, so battery storage is becoming increasingly viable in place of purchasing grid electricity for solar systems. 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 batteries may be worth delaying at this stage, but is recommended. (This should not delay investment into PV panels, but a non-battery system should be designed and wired to be battery ready).

10.3 Heat Pumps

Heat Pumps consume electricity, but deliver between 2.5 and 4 times the amount of heat in kWh that they consume (the Coefficient of Performance, COP). They are most efficient delivering low grade heat – water at 40-50°C at a constant / semi constant basis, so may require larger (or more) radiators in some rooms. An efficient system requires a well-insulated building. They are compatible with a regularly used building (such at Holy Trinity’s offices plus meeting rooms plus foyer and café), but not with heating a church once a week from cold.

Ground source systems are more efficient (since the average ground temperature is higher than the average air temperature). A borehole would be required in the limited space available at the rear of the church and this may be possible through radial drilling techniques.

Air source systems are cheaper to install. They units look like air conditioning modules and must be installed in well ventilated places. Several smaller units would probably be required. Potential locations include in the space between the church and hall, behind the curved boundary wall at the rear of the church, or on the walkway in the valley of the roof of the church hall.


CHURCH OFFICE

10.4 Economic Estimate

Costs for Office, meeting rooms and foyer heating.

		Operating cost at current rates	Capital cost 2018 rates	Payback
Current Gas Use	110,000kWh			
Efficiency (max)	78%			
Current heat Supply (offices, meeting rooms, foyer)	85,800kWh			
Annual gas cost (calculated from data provided; £2,872 for 197 days)		£5,300		
Heat Pump (Ground Source) delivers 85,800kWh heat at COP of 3 requires	28,600kWh electricity	£3,756	£80,000	
Heat Pump (Air Source) delivers 85,800kWh heat at COP of 2.5 requires	34,320kWh electricity	£4,507	£40,000	
Annual generation, 160m^2 SPV system	19,200kWh		£28,800	
Grid electricity requirement (at COP 2.5)	15,120kWh	£1,985 **Saving £2,522**		11.4 years
Annual generation, 320m^2 SPV system	38,400kWh		£57,600	
Grid electricity requirement (at COP 2.5)	zero	Zero **Saving £4,507 Heat pump + £536 other electric use**		11.4 years

The payback period is based on the lower Heat Pump efficiency (COP) of 2.5. In the case of the double roof scenario, there is an excess of 4080kWh generated over estimated heat pump needs, this is 29% of current annual electricity use which would save a further £536 annually.

These calculations are estimates and will need to be backed up by full costings.

11. 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.

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.

13. 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 colleagues, the Cathedral and Church Buildings team centrally who lead on the environment, who want 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	Recommended Upgrade	Annual Saving (£)	Total Cost (£)	Payback
NAVE	8 pendants	Discuss with DAC / lighting contractor – LED bulbs to give at least 100Lux			
AISLES	6 (+?) CFL	LED		120	
FOYER AREAS	37 approx	GU10 LED	170	150-200	<2 years