ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Saviour's Church, Guildford
PCC of St Saviour's Church

Author	Reviewer	Audit Date	Version
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Contents

1. Executive Summary

An energy survey of St Saviour's Church, Guildford was undertaken by ESOS Energy 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 Saviour's Church, Guildford is a Grade II listed church built in 1896. [Historic England reference 1377906]. The adjoining late 20th century unlisted hall is to the north. Both gas and electricity are supplied to the site.

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

Energy saving recommendation	Estimated Annual Energy Saving (kWh)	Estimated Annual Cost Saving (£)	Estimated capital cost (£)	Payback (years)	Permission needed	CO2 saving (tonnes of CO2e/year)
SHORT TERM						
Add timer controls to Air Handling Units to align operation with building use hours	30,000	£4,000	£1,000	<1	None	7.6
Install Carbon dioxide monitor in staff office, link to ventilation rate	Unknown		£200		None	
Use night flushing for hall cooling in summer	Potentially 5,000	£670	None	Immediate	None	1.2
Formulate heating policy and train selected staff in operating system controls	N/A	N/A	None	N/A	None	0
Replace 250 litre hot water tank with electric shower unit.	800	£96	£500	5	None	0.2
Refurbish church entrance doors	5% church heat 2,850	55	£500	<10	None	0.5
Draughtproofing door and windows in or near prayer chapel	2% 1,100	22	£50	2	List B	0.2
MEDIUM TERM						
Install infra red heating panel in prayer chapel	No change	N/A	£	N/A	Faculty	0
Install LED lighting in church building	8,500	£1,150	£5,000 contractor	5	List B	1.5
Install solar photovoltaic panels on south facing roof	26,000	£3,500	£50,000	14	Faculty	6.6
LONG TERM						

Install Heat Pumps, separate zones for church and hall	227,000gas saved 60,000 electricity required	£3,555 greater cost at current rates	£185,000 at current costs		Faculty	26

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

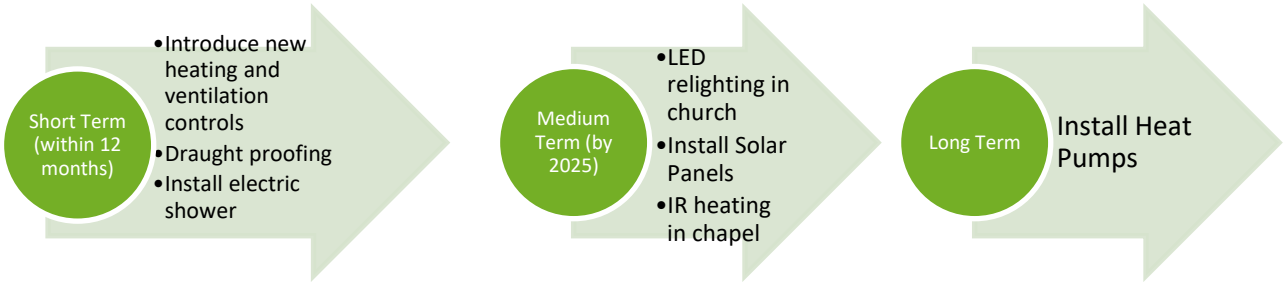
Based on current contracted prices of 13.4811p/kWh (day), 10.4843p/kWh (night) and 1.9530p/kWh for electricity and mains gas respectively.

If all measures were implemented this would save the church around £6,000 per year in operating costs.

2. The Route to Net Zero Carbon

The General Synod of the Church of England has indicated that the Church of England should be Net Zero Carbon by 2030. Every church, cathedral, church school and vicarage will therefore need to convert to be a net zero building in the next 8 years.

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



3. Introduction

This report is provided to the PCC of St Saviour's Church, Guildford to give them advice and guidance as to how the church can be improved to be more energy efficient. In doing so the church will also become more cost effective to run with improvements in 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 Saviour's Church, Guildford, Woodbridge Road, GU1 4QD was completed on the 1st August 2022 by Dr. Paul Hamley. Paul is an energy auditor with experience of advising churches and small businesses. He is part of the Church Energy Advisors Network developing advice for the Church of England and authored the "Assessing Energy Use in Churches" report for Historic England. He is a CIBSE affiliate 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 assessor for EcoCongregation.

The church was represented by Glenn Webster, Operations Manager. Anna Hummel, an architect and member of the Guildford Diocesan Advisory Committee (fabric and buildings advice) also attended.

St Saviour's Church, Guildford	CHURCH	HALL
Church Code	617089	
Gross Internal Floor Area	560m^2	1,300m^2
Volume	5,100m^3	5,000m^3
Heat requirement	168kW	110kW
Listed Status	Grade II	Unlisted

The church is typically used for 13 hours per week and the hall complex for 45 hours per week for the following activities:

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	9 hours per week	280
Church Meetings and Groups	3 hours per week	
Community Use		
Occasional Offices	3 weddings 1 funeral	100 100

The church hall complex is occupied 40 hours per week by up to 12 staff, with regular use of the meeting rooms throughout the week.

Annual Occupancy Hours: Church 680 Hall 2,400

Estimated Footfall: Church 16,000 Hall 14,000

4. Energy Procurement Review

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

The current electricity rates are:

Day Rate	13.4811p/kWh	Below current market rates
Night Rate	10.4843p/kWh	Below current market rates
Standing Charge	234.6394p/day	N/A

Supplier: Total Gas & Power

The current gas rates are:

Single / Blended Rate	1.9530p/kWh	Below current market rates
Standing Charge	511p/kWh	N/A

Supplier: Total Energies

The current rates are lower than the market rate and should be retained at present.

We recommend that the church continues to use a group purchasing scheme offering 100% renewable tariffs and obtains quotations for its gas and electricity supplies from such as the Big Church Switch scheme, Charity Buying group and the diocese supported Parish Buying scheme, http://www.parishbuying.org.uk/energy-basket.

These scheme offers 100% renewable electricity and a proportion of renewable gas and therefore are 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.

Whenever monthly electricity consumption exceeds 1,000kWh, or gas consumption exceeds 4,397kWh (52,000kWh per annum), 20% VAT is charged unless the customer has submitted a VAT declaration form. This should always be done when changing supplier.

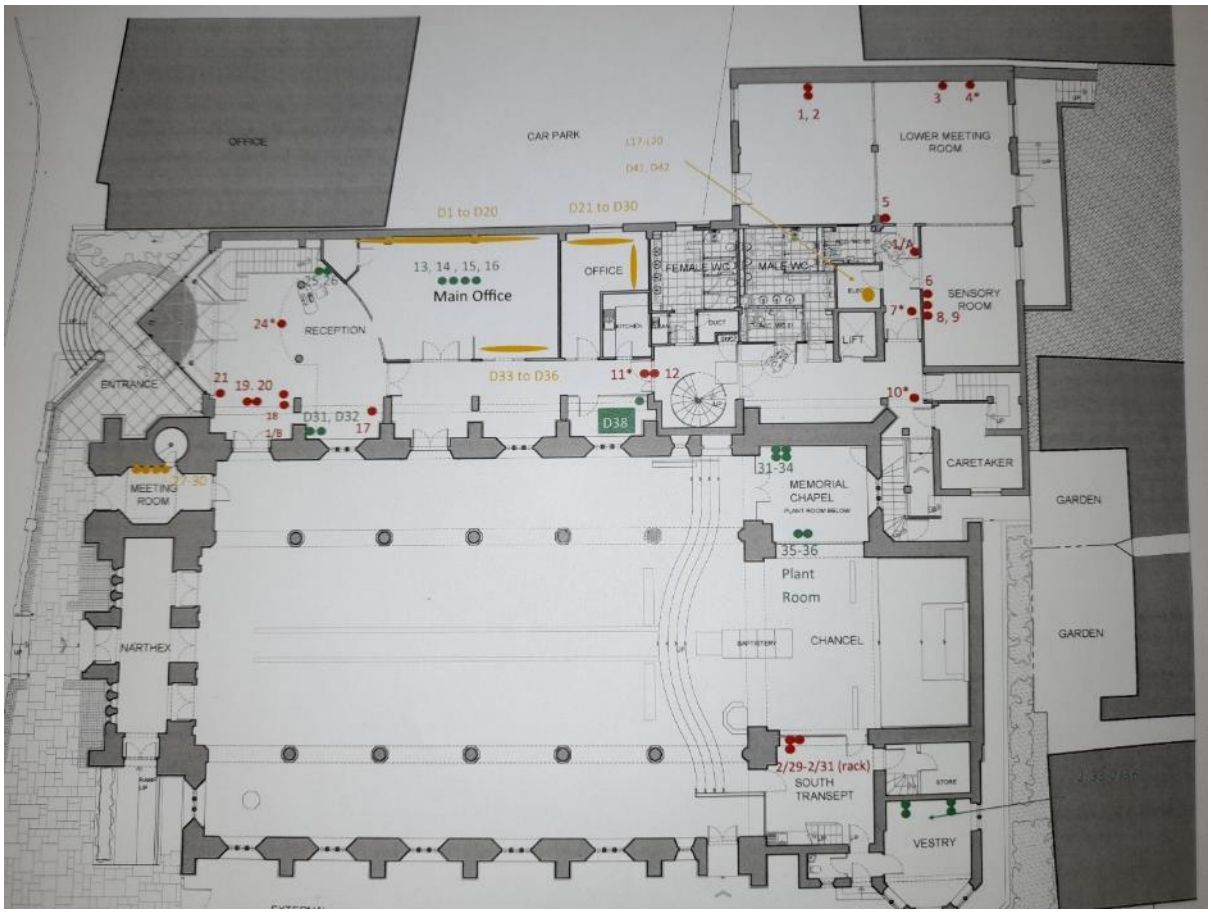
The church is a charity and therefore can claim VAT exemption status.

Excess VAT paid can be reclaimed for the past three years.

VAT declarations are available from the suppliers website and can usually be found by typing the suppliers name followed by "VAT Declaration Certificate" into most website search engines.

A detailed explanation is available here: https:// perfect-clarity.com/vat-on-church-utility-bills/#:~:text=There%20is%20no%20VAT%20chargeable%20on%20Church%20water%20bills

Site layout



Plan view of St Saviour's site with three storey hall complex above.

5. Energy Usage Details

5.1 Annual Consumption

St Saviour's Church, Guildford [Church and hall] used 104,682kWh/year of electricity from May 2021 to April 2022, costing £17,517 for the year. Gas use for the church and hall was 228,585kWh over the same 12 month period to the end of April 2022. Costing £7,080.

This data has been taken from monthly electricity and gas bills provided by the church.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity - Whole site	E13Z 055357	EDMI Atlas Mk10A	Yes	Hall ground floor, rear, electrical switch room
Gas – Whole site	K04634 14 D6			

All the meters are AMR connected and as such an annual energy use profile for the site could be obtained from the supplier.

5.2 Energy Profiling

The main energy consuming plant can be summarised as follows:

Hall items are italicised

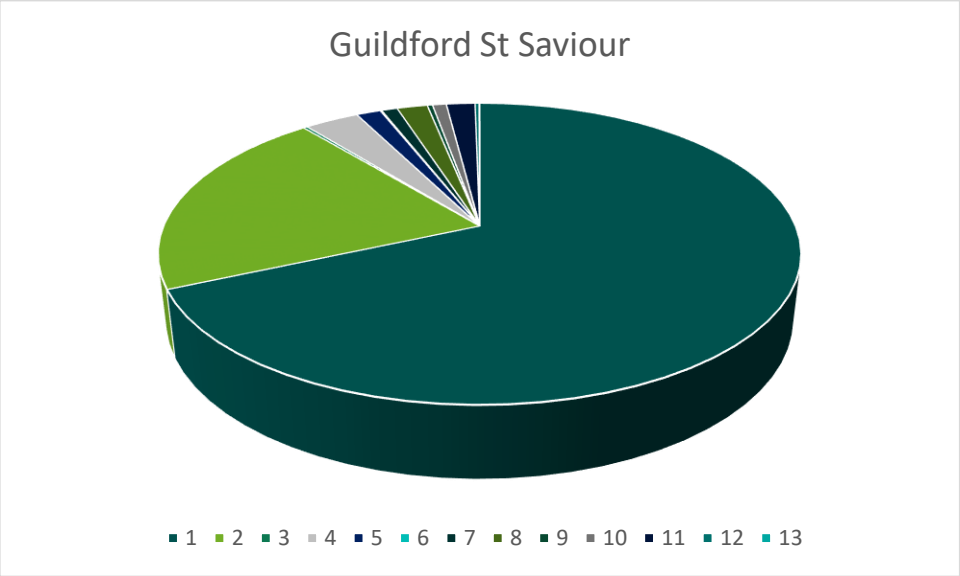
	Equipment	Power kW	Annual Consumption kWh	Portion
Heating [Gas] Whole Site	CHURCH (567 hours if at full power) Was 5 x 80kW (consumption data) New 2 x 110kW 12 gas cooking rings, use 8h/week?	400	227,000 1,585 228,585	68.9%
Heating and Ventilation [Electric]	*3 x Air Handling units, on constantly [8760 hours]* *Warm air blower, Upper Meeting Room (low use)* *Air conditioning unit, Second floor office* *3 x Air Source Heat Pumps (Vicar's office, 2 in staff office).* *4 x floor mounted convector heaters, toilets* *Toilet extraction fans* *12 x Toilet hand dryers Dyson airblade 5 hours/ week* *2 x Infra red heaters, toilets*	7kW calculated unknown 3 3 x 2 1 total 1 3 each 3 each	If 7kW, 63000 500 600 (200h) 2400 (400h) 120 700 750 1000 TOTAL 69,000	20.8%
Water pumping	Boiler circulation pumps Waste water pumps	0.5 1	280 500	0.24%
Lighting [Church]	CHURCH 680 hours Mostly non LED 140 x AR111 75W spotlights 2 x towers of 20 x 50W halogen 1 strip of 10 x 50W halogen 5 x theatre lights x 250W 6x LED cluster multielement, 100W 80 x pendant bulbs, 5W Narthex, 24 x 5W Prayer chapel 5x halogen 75W 4x halogen strip uplights Estimates based on all lighting in use	 10500W 2000W 500W 1250W 600W 400W 120W 375W 400W	 7100 1360 340 850 408 272 82 255 273 TOTAL 10,940	3.3%

Lighting [Hall]	*Mostly LED, 2018* *Upper Meeting room 57 x F40W fluorescent* *Upper Lounge 38 x 18W CFL*	5.4	4,900	1.5%
Lighting [External]	Floodlights, SON 250W (rarely used) Entrance lighting (winter use)	2 0.5	100 200	0.1%
Hot Water	*2 x Coffee machines, regular use* *4 x Urns. 3 x used 9hours/week* *Industrial Dishwasher, 3.5h/week* *Domestic dishwasher, staff kitchen, daily use.*	*2x3* *4x2* *7.1* *3*	*600* *500* *1,300* *780* *TOTAL 3,180*	1.0%
Kitchen [Commercial spec]	*Microwave* *5 x Freezer, full height* *2 x freezer, half height* *2 x fridge, commercial spec*	*1* *5x 500W* *2x720W* *2x 250W*	*60* *4380* *4200* *1460* *TOTAL 6,100*	1.8%
Kitchenettes	*3X Fridges* *Food warming cabinet* *Microwave oven*	*3x 100W* *1* *1*	*900* *50* *100* *TOTAL 1,050*	0.3%
Offices	*2 printers, daily use* *Ground floor office, 8 workstations* *Second floor office, 3 workstations*	*2x 0.5* *1* *375W*	*500* *2080* *200* *TOTAL 2,780*	0.8%
Sound, Music	2 x Sound system racks (12 hours/week) Server Instruments	2 0.5 0.5	1250 4400 100 TOTAL 5,750	1.7%
Other Plant	*Hydraulic lift motor (1 hour/week)*	14.7	800	0.25%
Small Power	Vacuum cleaner 2 hours/week	1.5	150	0.04%

Sum of electricity estimates: 103,000kWh

Annual site electricity consumption, 2021-22: 104,682kWh

This list can be optimised, if desired by the church, if detailed records of hours of use are collated over time.



KEY *1 Gas heating* *2 Electric Heating, Ventilation, Air Conditioning* *3 Water pumping* *4 Lighting – Church* *5 Lighting – Hall* *6 Lighting - external* *7 Hot water* *8 Kitchen* *9 Kitchenettes* *10 Offices* *11 Sound, music* *12 Lift motor* *13 Small power*

As can been seen from this data, the heating makes up by far the largest proportion of the energy usage on site. The other significant loads are HVAC and church lighting which is not LED.

5.3 Energy Benchmarking

In comparison to national benchmarks for church energy use St Saviour's Church, Guildford uses double the amount of electricity and 21% less heating energy than is average for a church of this size.

The air handling units are the likely cause of high electricity consumption.

	Size (m^2 GIA)	Annual Energy Usage (kWh)	Actual kWh/m^2	Benchmark kWh/m^2	Variance from Benchmark
St Saviour's Church, Guildford (elec)	1,860	104,682	56	27	+100%
St Saviour's Church, Guildford (gas)	1,860	228,585	123	156	-21%
TOTAL	1,860	333,267	179	183	-2%

There is currently no benchmark data available which takes hours of use and footfall into account. [1] CofE Shrinking the Footprint – Energy Audit 2013.

Church centre entrance. First floor meeting space, (below left) and foyer with office to right

Commercial spec kitchen

View from rear section of hall showing main section of hall to left. Commercial premises to right.

Second floor Upper Meeting Room, above. Upper Lounge, below

The rear of the hall is sunken one storey below the car park.

6. Efficient / Low Carbon Heating Strategy

6.1 Reducing Environmental Impact

The energy used for heating a church typically makes up around 80% to 90% of the overall energy consumption. Heating also often uses gas or oil as its primary fuel, these are fossil fuels with high carbon emissions and little opportunity to decarbonise in the future. Electricity currently has carbon emissions of around the same level as mains gas but the carbon emissions associated with electricity are reducing rapidly as the UK builds more renewable energy and decommissions its remaining coal fired power stations. Mains gas does have some potential to reduce its carbon content through the use of bio gas and hydrogen but these are less developed solutions and will be unable to deliver 'zero carbon mains gas'.

It is therefore important to review and plan to increase building efficiency and become less carbon intensive.

The church has engaged with heat pump installers but did not find a solution which was technically and financially viable. The church administrator has a background in the air conditioning industry and a high degree of knowledge of the field.

It is likely that capital costs for heat pumps will reduce over the coming decade and their use will be established in large volume buildings and so become viable for future use.

The church is in the process of replacing 5 x 80kW boilers (400kW) with 2 x 110kW boilers (220kW) which are expected to run for a greater number of hours per week. There should be small efficiency savings of around 5% from more modern boilers, but they must be run in condensing mode, with return water temperature below 55°C. Opportunities for optimising heating timing should be taken,

The high electricity use can be reduced by two main interventions. Although the hall lighting has been changed to LED, the church is lit by a very large number of lamps, seen to be AR111 units of 75W each. There is also a large amount of "mood" lighting provided by a combination of theatre lamps and rows of 35W/50W GU10 spotlights (50 lamps) which could be changed for 4 or 5W LED units.

The roof of the hall building contains three air handling units. It has not been possible to ascertain the power rating of the devices. The volume of the building (5000m^3) and the requirement for 4 (minimum) air changes per hour [ACH] for offices, greater for public spaces, 15-20 ACH/hr for kitchens suggests an air supply rate of 30,000m^3/hr. The fan power required can vary very widely (between 1 and 100kW) dependent on the pressure drop; (longer, smaller pipes carrying air further distances increasing the pressure).

6.2 Site Heat Demand

The Centre for Sustainable Energy model[2] can be used to estimate heat load for the building.

Heat Load (kW) = Volume V (m^3) x Insulation Factor

Insulation Factors

Condition	Factor kW/m^3
Poorly insulated with open or broken windows, draughty doors (add 5%)	0.034
Poorly insulated (assume no interventions)	0.033
Some insulating features	Estimate value
Well insulated	0.022
Insulated to 2010 regulations	0.013

Area	Volume m^3	Insulation Factor kW/m^3	Heat Required (Space heating) kW
Church	5100	0.0033	168
Hall	5000	0.0022	110

2 www.cse.org.uk/local-energy/download/estimating-the-heat-demand-of-a-hypothetical-community-building-79

6.3 Management of New Heating System

The Church has established a committee to review technology and make decisions on the new heating system, etc.

It is recommended that the church join the EcoChurch scheme and that this committee takes forward the recommendations proposed in this report.

The new heating system will have a control system which it is proposed can be operated by a number of staff, to avoid reliance on one staff member and build in management resilience.

However, it is important to establish a control methodology and a policy for setting temperatures. For a church, it is recommended that this is set from its underlying theology and in particular the Fifth Mark of Mission.

The church/ committee should decide how far it can go in reducing energy use and how this will impact on comfort of the various groups which use the site:

- Staff who are on site for 8 hours daily
- Toddlers who may engage in energetic activity, or spend time on the floor
- Room hirers

Where there are opportunities to improve the performance of the church, e.g. through increased draught proofing or insulation, these should be taken.

Regularly used office buildings, if reasonably insulated, need little heat when the external temperature is 16°C or above; as heat from the occupants, services, lighting and computers, etc can raise temperatures by up to 3°C.

Cooling through air conditioning should not be actioned until interior temperatures exceed 23°C.

Technical options are discussed below.

7. Energy Saving Recommendations - Equipment

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

7.1 Hot Water Supply

A 250 litre hot water tank is located in the basement boiler room, run off the heating system for 5 months and from electric immersion heaters for 7 months. Hot water is required for showers as some staff cycle to work.

Large hot water tanks require a regular energy input to maintain water temperature above a safe level (for Legionnaire's disease prevention) and suffer heat loss through the connecting pipework.

The church has looked into replacing by a smaller unit [100/150litres]; this was too expensive.

Calculation

Showering is estimated to use 8 to 12 litres of water per minute, so assuming 50 litres of water per shower, a 250litre tank can deliver three hot showers, and one warm. After this, most of the hot water in the tank will have been replaced by cold.

Standing losses for this size of tank are estimated at 800kWh per year (costing £96), which does not include any losses along the pipework.

It is recommended that the shower is fitted with an electric shower. This would avoid any risk of legionnaires disease and avoid standing losses from storing hot water and transmission losses along pipework. It would also allow more showering than can be provided by a 250 litre tank (4 to 5 showers) should more staff choose to cycle to work in the future.

7.2 Air Handling Units

Three Air handling Units [AHUs] are located in the roof space. They are running constantly to ventilate the office building.

It is recommended that the units are switched off at night.

- Are there periods of the day such as in rush hour when the urban air quality is poor and the air intake should be reduced?
- Can the AHU operation be controlled by a system which measures office CO_2 levels and temperatures?
- Can passive cooling (opening windows at night) be used for night flushing to reduce summer building temperatures?

Controls

It is suggested that a control system is investigated for the AHUs which responds to temperature and CO_2 levels Carbon dioxide levels may be an issue in the ground floor office which has no external windows; this and the main kitchen are the primary rooms requiring ventilation.

Carbon Dioxide Monitor

It is recommended that the church purchase a carbon dioxide monitor, primarily to monitor the staff office which has no outside windows, but can also be deployed to measure other areas. Stand-alone monitors retail for under £200. A control system for the AHU incorporating monitoring for CO_2 level and temperature will be significantly more.

Is there an opportunity for passive cooling through the ventilation system, opening windows, or night flushing (opening windows when the external temperature drops below the building temperature – not insecure ground floor windows)?

Night Flushing

It is recommended that the Air Handling Units are not run constantly overnight. Night flushing offers an alternative ventilation and summer cooling strategy. How effective it can be will depend on whether a suitable airflow can be arranged through the building, and where windows are located which can be left open securely without any problem with rain penetration. It offers a good potential for environmentally friendly money saving provided there is an enthusiastic building manager able to experiment and monitor. Sources of advice include:

sustainabilityworkshop.venturewell.org/buildings/night-purge-ventilation.html

7.3 Install new LED Lighting in Church

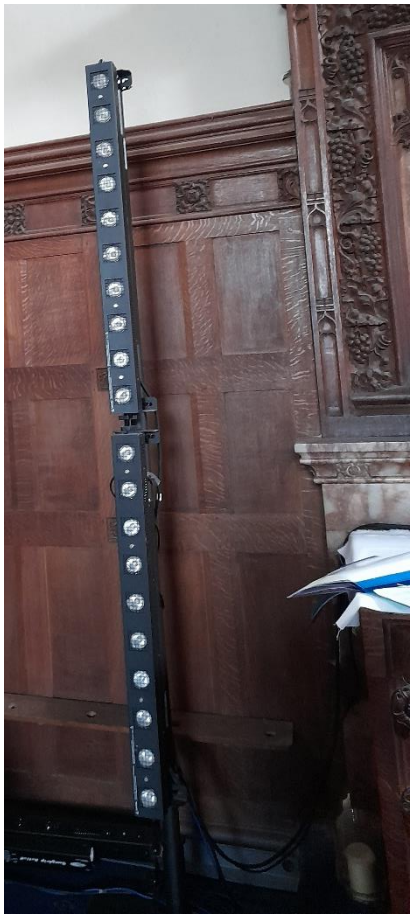
The lighting makes up a relatively large overall energy proportion of the electricity used within the church, which is lit by relatively inefficient halogen fittings.

It is recommended that:

- All the AR111 75W spotlights are changed for LED units. These are located at high level and would require access equipment to reach. The scale of the work indicates that a lighting contractor would be required. It may be found to be cheaper to change the fitting (luminaire) as well as the bulb – if so, the number of actual bulbs could be reduced – the aim being to supply enough light. The existing bulbs are rated at 850 lumens each.
- The GU10 lighting towers at the front of church are changed for equivalent LED bulbs [£250].
- The four uplights in the north chapel are replaced. These are currently 117mm halogen strips. LED replacements which fit the luminaires tend to be of lower power, so complete replacement units should be sought.
- The four recessed dimmable 75W halogen bulbs are replaced by dimmable LED lamps.

There are a vast number of specifications of LED lights on the market but it is recommended that any LED light should come with branded chips and drivers and offer a 5 year warranty. An example of such a range of fittings is available from http://www.qvisled.com/

There are some fittings such as those in the north chapel where the existing fitting can be made more efficient by simply changing the bulb/lamp within the existing fitting to w new LED bulb/lamp. This could be carried out by competent members of the churches internal team, very cost effectively and would be a List A item so no permissions would be required.



7.4 Lighting Controls (Internal)

Toilets should already be fitted with presence detectors (PIR units). There may be additional corridor areas which are only used for a short amount of time and as such, the light does not need to remain on constantly. There are also spaces which benefit from a good amount of natural daylight coming in through the windows where artificial lighting is not required for much of the year during the day.

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

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

7.5 Power Management Settings on Computers

With a large number of office staff it is worthwhile minimising office electricity use.

All computers can be put into a hibernate mode but this is rarely done by users during the day and tends to be limited to an end of day shut down only. This tends to be due to the multi-function process that is required to do this. It is therefore recommended that all computer workstations set to go into hibernate mode after a short period of time of not being used.

This can be set on the computers by going into the Power Options settings on the computers control panel and adjusting the times on the 'change when computer sleeps' option. It is recommended that computers should turn off their display after 2 minutes and put the computer to sleep after 5minutes. Putting the computer to sleep will not lose any unsaved work but will require the user to power up the computer again when returning to their desk. Having shorter hibernate modes not along helps to save energy but also improves security by reducing the time that computers are left on but unsupervised.

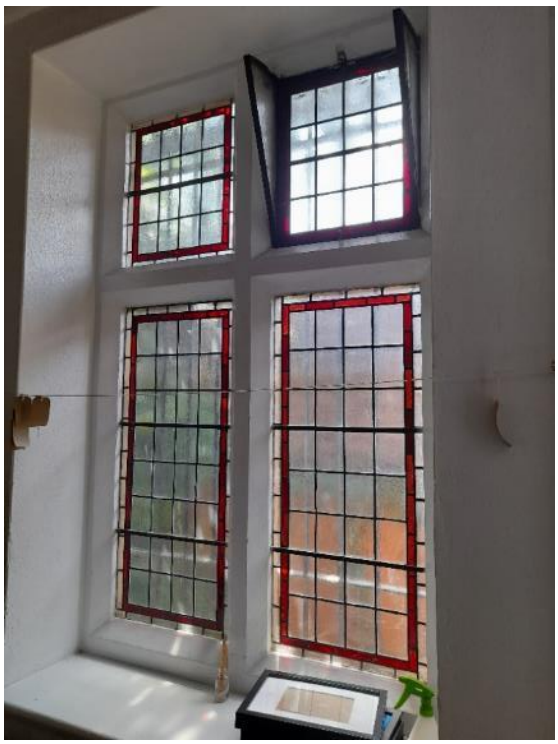
8. Energy Saving Recommendations – Building Fabric

8.1 Draught Proof External Doors

The doors fronting onto the main road from the narthex are aluminium framed.

These door leaves do not meet and there is up to a 10mm gap between them leading to a draught. The doors should be refurbished – movement may have occurred resulting in the two leaves becoming further apart than intended. This may be adjustable by a double glazing installer. Alternatively, if it is not possible to adjust the hinges, additional sealing strips could be fitted to one leaf of each pair of doors to close the gaps.

The original external wooden door adjacent to the prayer chapel should be kept well maintained and draught proofed. If it is only used occasionally, a "sausage dog" type of draught excluder, filled with pea gravel or equivalent to give sufficient weight should be used.



8.2 Windows

The windows in the prayer chapel include opening hopper sections. Where these are draughty and do not close properly, black plasticene can be used to close gaps. Any rust should be treated and removed since it expands and causes distortion of the frames leading to further leaks.

9. Saving Recommendations (Water)

9.1 Tap Flow Regulators

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.

These regulators can be self-installed or by any good facilities staff.

10. Future Heating Options

10.1 Prayer Chapel

This room is used infrequently, and for short periods when in use. Running a space heating system is inefficient and slow to respond.

It is recommended that an instantaneous electric heating system is installed consisting of one or more radiant (non glowing) infra red panels which can be affixed to one wall or the ceiling.

This should be controlled by a timer push switch. This could either be a simple unit offering only 15 minutes of heat, or a 15/30/60/120 minute version.

An example is www.danlers.co.uk/products/switches/time-lag-switches/tlsw-ms1246

10.2 Church and Hall Heating Options Overview

The hall complex and the church have different patterns of use.

The hall is in use for over 40 hours per week; thus sufficient hours for any kind of heat pump system. The church, at 13 hours is considered too low.

The previous and new systems both use the same boilers to heat both buildings.

This could be perpetuated in a future heat pump system, with heat flow diverted from the hall to the church for part of Saturdays and all of Sundays, to avoid having to install a larger output system which would be oversized for most of the week. However, this would mean that there would be insufficient heating capacity should the church building become used more intensively.

Infra Red heating for the church: whilst suitable for rarely used church buildings is unsuited to regularly used building on the grounds of high operating costs. The same amount of heat would be required costing 13.48p/kWh electrically compared to 1.95p/kWh for gas).

The nave is too wide for wall mounted panels to be effective in the centre.

Other direct electric heating methods are not recommended, also on operating cost grounds.

10.2.1 Heat Pumps – Hall

The existing comprehensive and recent radiator system in the hall argues for retention of these radiators, and installation of an Air to Air system would require considerable costs to install refrigeration pipework throughout the hall building.

An Air Source system operating at CoP 2.5 would result in higher operating costs and the need to add extra radiators, especially in church.

A Ground Source system could have plant installed in the existing boiler room and would require boreholes. These would have to be located in the limited outside space, so result in temporary loss of car parking spaces.

10.2.2 Heat Pumps - Church

Low hours of use (under 20) argue against ASHP systems as there is insufficient heat stored in the building to operate the defrost cycle. There is also the issue of having radiators of sufficient surface area, and heat up times which are much longer than most heat pump systems are designed for due to the large volume.

An Air to Air system may be feasible, giving a higher CoP than Air to Water. A location for the external unit is problematic given the very limited amount of outside space available.

Both for the church and the hall, the technical options should be kept under review with the intention of switching away from gas heating when the newly replaced boilers reach the end of their life in 15 to 20 years.

11. Other Recommendations

11.1 Electric Vehicle Charging Points

The church has a small car park to the rear of the site which serves the hall, for staff parking.

In order to make a visible statement on the churches mission of stewardship and to facilitate more sustainable transport choices for staff, the church may wish to consider installing an electric vehicle charging point, to allow staff 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 organisation control over who is allowed to use the unit with a key operated system. Or given the type of use of the building and control over the usage of the car park as a whole a simple 32 amp type 2 wall pod type charger may be most suitable and these are widely available through many suppliers such as http://www.rolecserv.com/ev-charging/product/EV-Charging-Points-For-The-Home.

12. 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
Battery Storage	Future potential
Wind	No – no suitable land away from buildings
Micro-Hydro	No – no water course
Solar Thermal	No – insufficient hot water need
Biomass	No – not enough heating load as well as air quality issues
Air Source Heat Pump	No
Ground Source Heat Pump	Future potential for hall
Air to Air Source Heat Pump	Future potential for church

12.1 Solar Photovoltaic Panels

It is recommended that solar photovoltaic panels are installed on the south facing roof of the church.

The church is listed, but visibility of the south roof to the public is extremely limited, being restricted to the small gap between the church and the adjacent office, with only a glimpse of the roof obtained.

Much, but not all of the roof can be seen more clearly from a car park to the south of the church and a small number of offices. The church is surrounded by a variety of late 20th century buildings of varying styles.

A quotation of £50,000 has been received from an installer. At 2019 prices, this would be for a 34.5kWpeak system of 230m^2 and indicates coverage of most of the useable roof area.

An area of 230m^2 could generate 0.15kWpeak/m^2 giving a 34.5kWpeak system. A 1kWpeak system can generate up to 1000kWh annually.

Assuming that the maximum amount of roof space could be, and was used for panels, the following formula calculates annual generation.

Annual Generation (kWh) = Area x 0.15kWp/m^2 x 1000kWh/kWp x Orientation Factor x Overshading Factor.

Roof Section	Useable area / m^2	System Size / kW peak	Orientation factor	Shading factor	Annual Generation, kWh
Church	230	34.5	170 degrees / 40^0 0.95	0.8 (buildings)	26,220

This is the maximum likely figure, which may be reduced by factors such as the weight of panels (due to roof strength), access space between panels. The ability of the roof structures to support the extra loads should be discussed with the church's inspecting architect.

The site has a high annual electricity use, around four times the amount a maximum dimension solar PV system can generate. A load of 10A / 2.3kw is reported for weekday use and 55A / 12.6kW for Sundays (extra lighting). Without installation of heat pumps, a maximum sized system appears to be oversized for daily / summer use. Careful monitoring of loads during the week is recommended (taking hourly readings from the ammeter) to ensure a system is optimally sized. A system could be installed sized to provide all the daily requirements of the site with grid electricity required for Sundays.

The system should be specified for future addition of a battery, when battery costs reduce as this would extend system usefulness into the evening.

Battery Storage is not strictly a renewable energy solution but provides 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.

Using average 2019 installation costs (£1,450 per kWpeak); a maximum sized 34.5kWpeak system would cost £50,025.

13. Funding Sources

There are a variety of charitable grants for churches undertaking works and a comprehensive list of available grants is available at www.parishresources.org.uk/resources-for-treasurers/funding/

This includes a 77 page guide to funders and their criteria:

https://www.parishresources.org.uk/wp-content/uploads/Charitable-Grants-for-Churches-Jan-2020.pdf .

14. 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.