ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Alban's Church Hall, South Norwood
PCC of St Alban's Church

Author	Reviewer	Audit Date	Version
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1. Executive Summary

An energy survey of St Alban's Church Hall, South Norwood 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 Alban's Church Hall, South Norwood is a late 20th century building. There is both gas and electricity supplied to the site.

The building 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						
Procure electricity and gas supplies via a group purchasing scheme	None	Around 10%	None	Immediate	None	None
Procure 100% renewable electricity (and 20% gas)	None	None	None	N/A	None	0.6
Manage control of hall hot water system using timer	27,000	£672	Zero	Immediate	None	5.0
Install reflective panels behind radiators	2% 2,100	£52	£50	1	None	0.4
Install LED lighting	600	£88	£1,370	15	List B	0.15
MEDIUM TERM						
Install Roof insulation in hall	10% 10,500	£350	£2,375	7	Faculty	1.9
Install solar photovoltaic panels on roof	25,500	£3,470	£43,500	12.5	Faculty	6.4
Replace hall boiler with Air to Air Source heat pump	105,000 gas 26,250 electric use	£2,500 Electric costs part covered by solar	£12,600	5	Faculty	19.3

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

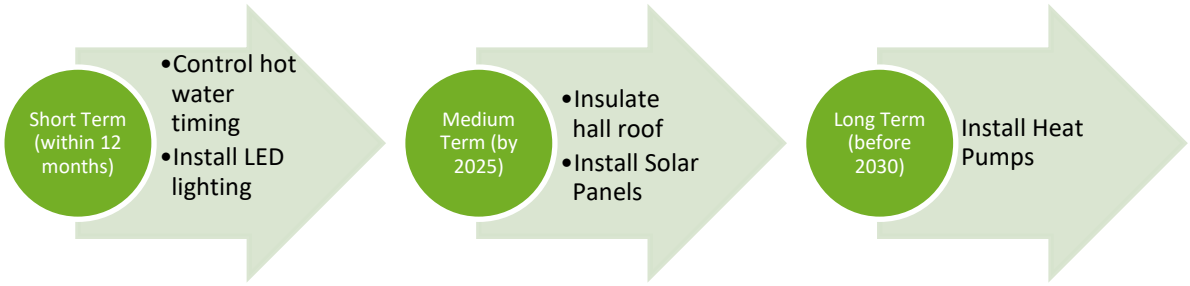
Based on current contracted prices of 14.68p/kWh and 2.488p/kWh for electricity and mains gas respectively.

If all measures were implemented this would save the church the majority of its current £4,000 per year 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 10 years.

This building 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 Alban's Church Hall, South Norwood to give them advice and guidance as to how the church hall 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.

An energy survey of the St Alban's Church Hall, South Norwood, SE25 6RD was completed on the 19th May 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 Jennifer Sturtevant, Church warden.

St Alban's Church Hall, South Norwood	
Church Code	637402
Gross Internal Floor Area	340m^2
Volume	1450m^3
Heat requirement	48kW
Listed Status	unlisted

The church hall is typically used for 66 hours per week for the following activities:

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Church use, Sundays	1 hour per week	30
Commercial nursery hire (separate groups, ground and first floor)	55 hours per week	28 daily
Community Use	6 hours per week	20

Annual Occupancy Hours: 3,400

Estimated Footfall: 11,000

4. Energy Procurement Review

Energy bills for gas and electricity have been supplied by St Alban's Church Hall, South Norwood and have been reviewed against the current market rates for energy.

The current electricity rates are:

Single / Blended Rate	14.68p/kWh	Below current market rates
Standing Charge	25.89p/day	N/A

Supplier, British Gas

The current gas rates are:

Single / Blended Rate	2.488p/kWh	Below current market rates
Standing Charge	200p/day	N/A

Supplier, Crown Gas & Power Contract End Date 24/11/22

The above review has highlighted that when the current contracts expire, there will be opportunities to gain cost savings from improved procurement of the energy supplies at this site using a group purchasing scheme. The current rates are lower than the market rate and should be retained at present.

We would therefore recommend that the church looks into 100% renewable tariffs and obtains quotations for its gas and electricity supplies from group purchasing schemes such as the Big Church Switch scheme 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.

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

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

5. Energy Usage Details

5.1 Annual Consumption

St Alban's Church Hall, South Norwood used 2.432 kWh/year of electricity in 2021, costing in the region of £430 per year, and 104,769 kWh/year of gas, costing around £3,500.

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

Utility	Meter Serial	Type	Pulsed output	Location
Electricity - Hall	K11UP 05529	Elster A5230	Yes	Electrical cupboard, corner of foyer corridor
Gas - Hall	M016 K04438 10 D6	Elster Bk-G10	Yes	Boiler room

All the meters are AMR connected and as such annual energy use profiles for the site could be obtained from the suppliers.

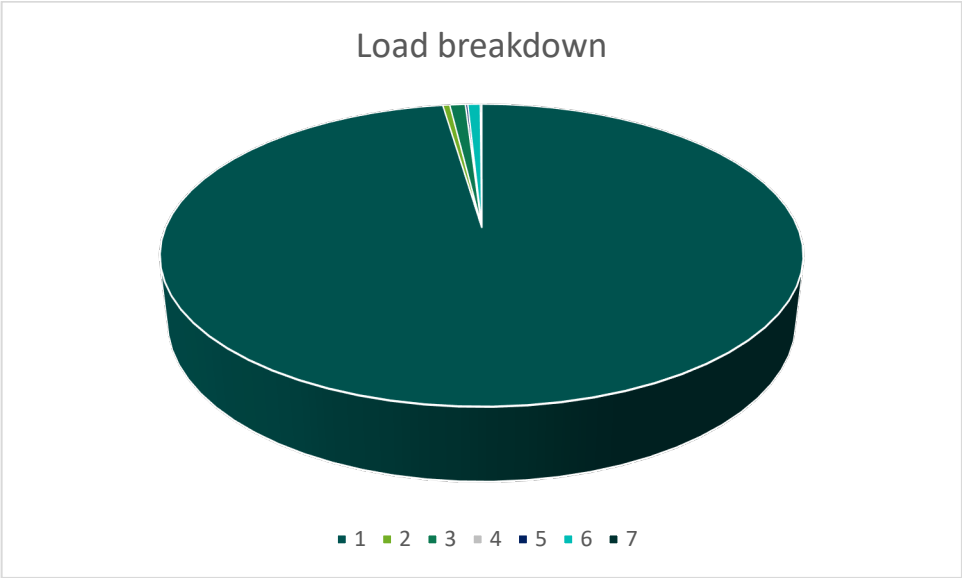
5.2 Energy Profiling

The main energy consuming plant can be summarised as follows:

	Equipment	Power kW	Annual Consumption kWh	Portion
Heating [Gas]	Worcester Greenstar 28CDi condensing combination boiler	28	105,000	97.7%
Heating [Electric]	Boiler pump Portable convector heaters (use when very cold only)	150W 6	50 400	0.4%
Lighting [Internal]	16 x fluorescent T8 x F58W 4 halogen x 100W 4 recessed x 80W 7 x 40W TOTAL	1900W	1000	0.9%
Lighting [External]	3 security lights, PIR control	120W	10	0.009%
Hot Water	Kettles	3	150	0.1%
Kitchen	Electric cooker Microwave Fridge (on constantly)	3 1 0.1	400 100 300	0.7%
Small Power	Vacuum cleaner	1.5	100	0.09%

Sum of estimates: 2,400kWh

Annual site electricity consumption, 2021: 2,432kWh



KEY *1 Gas heating* *2 electric heating* *3 Lighting internal* *4 Lighting external*

5 Hot water *6 Kitchen* *7 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 lighting and kitchen.

5.3 Energy Benchmarking

In comparison to national benchmarks for church energy use[1] St Alban's Church Hall, South Norwood uses less electricity and more heating energy than is average for a church of this size.

There is no data available for church halls to make a detailed comparison.

	Size (m^2 GIA)	Annual Energy Usage (kWh)	Actual kWh/m^2
St Alban's Church Hall, South Norwood (elec)	340	2,432	7.1
St Alban's Church Hall, South Norwood (gas)	340	105,000	309
TOTAL	**340**	**107,432**	**316**

There is currently no benchmark data available which takes hours of use and footfall into account.

[1] CofE Shrinking the Footprint – Energy Audit 2013.

6. Efficient / Low Carbon Heating Strategy

6.1 Reducing Environmental Impact

The energy used for heating a church hall typically makes up around 80% to 90% of the overall energy consumption. Heating 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. One way to achieve this is to consider a transition to electrical heating where this also represents a more efficient and comfortable solution.

6.2 Forward Planning

Whilst there are plans to add hydrogen to the network, and "green" gas from anaerobic digestion; some suppliers offering up to 20% "green gas" tariffs, the majority of the gas supply will continue to be fossil fuel for the next decade. The economics of hydrogen production and the need to replace some pipework make full decarbonisation of gas unlikely.

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

The church should develop a boiler replacement plan, by obtaining detailed quotations for the options presented in this report. Where electric heating can be obtained at similar or lower operating cost, this is recommended.

6.3 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
Main hall, double glazed	790	0.029	23
First floor, double glazed	90	0.030	2.7
Ground floor	90	0.028	2.7

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

The hall uses around 105,000kWh of gas yearly. This is 3,750 hours if the boiler is always at full output.

The boiler timings are as follows

M-F	0500-1700	12hrs
Sat	1000-1400	4 hrs
Sun	0840-1830	10hrs

74 hours per week x 50 weeks = 3700hours

The hot water controls were found to be set to continuous, so this is likely to be the reason for the high consumption as it is not expected that the heating will be kept running throughout the summer, and unlikely for more than 40 weeks.

Cost per hour = Boiler power 28 kW x gas price 2.488p/kWh = 69.7p/hour

[Useful for comparison between different heating methods when the total number of hours is either uncertain, or may change with modified building use].

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7. Improve the Existing Heating System

In the years before the replacement of the existing heating system it is recommended that measures are taken to improve the efficiency of the existing heating system, this should include:

7.1 Radiator Reflective Panels

The building is heated by radiators served from the boiler. These radiators are located on the external, uninsulated walls and have no reflective or insulated surfaces directly behind them at present. They therefore lose much of their heat into the masonry of the wall behind the radiator rather than giving it out into the body of the church.

In order to improve the insulation directly behind the radiators, a reflective panel can be installed. This helps to make sure more of the heat from the radiator goes into the space and requires less overall heating from the boiler to achieve the set point. There are a wide variety of reflective panels for installing behind radiators on the market. It is recommended that these panels are installed behind all radiators within the building

The installation of radiator panels can be carried out by anybody competent in basic DIY and does not require the radiators to be removed.

8. Future Heating Options

8.1 Heat Pump Overview

Heat Pumps are a low carbon method of creating heat.

As the hours of use of a building increase, so do heating costs.

The efficiency advantages of heat pumps mean that in some circumstances they can work out at equivalent or cheaper operating cost than gas despite the higher cost of electricity per kWh. This effect is increased if electricity is generated on site by solar power.

Electrically operated heat pumps can provide between 2.5 times and 5 times the amount of heat in kW which they consume in electricity (This is termed the Coefficient of Performance, CoP). When replacing gas boilers directly, sometimes larger radiators are required, or fan assisted radiators, or running the system for longer periods to achieve the same temperature (but at less power input).

With electricity prices now only three times more per kWh than gas (it was about four times), heat pumps are becoming steadily more cost effective. Refrigeration technology is mature and reliable; the units appear to offer lower maintenance costs compared to gas boilers.

Heat pumps generally deliver water at around 55^{o}C (although there are higher temperature ones on the market which require more energy to run); thus are compatible with a building which is regularly used and can be supplied with constant, medium heat, rather than a full power heat up on Sunday mornings.

Air source systems deliver between 2.5 and 3 times the amount of heat in kWh to water that they consume. A new installation of larger radiators may be required.

Ground Source Heat Pumps supplying water at around 50^{o}C are more efficient than their Air Source equivalent (since the average ground temperature is higher than the average air temperature), but require either a borehole, or extensive trench digging. Higher capital expense but lower running costs.

Where a site has a daily requirement for heat (and thus high daily expenditure), the lower operating costs of a ground source pump outweigh the higher capital costs.

Air to Air systems deliver warm air through indoor fan units and have a CoP rating of up to 5 and they can also provide cooling. They require an external unit (as do all heat pumps), but would be connected to a network of internal fan units which could provide heating or cooling. Fan heaters would be required for instance in the present radiator locations. Capital costs similar to air to water; lower running costs similar to ground source. It is likely that several internal units could be coupled directly to external units on the opposite side of the walls.

Some of the extra electricity required to run heat pumps can be obtained from solar PV panels. Some types of heat pump can provide cooling – solar powered cooling in summer is very efficient. The small available area of the south aisle roof means that the majority of electricity will still be required from the grid.

8.2 Replace Hall Boiler with a Heat Pump

If the heating power is the same as the current boiler, a 28kW output Air to Air Source Heat Pump system operating at CoP 4 requires 7kW of electricity.

74 hours per week use x 35 weeks = 2,600hours

At a rate of 14.68p/kWh, this will cost 7kW x 2,600 x 14.68 = £2,672

Current annual gas costs

2.488p/kWh x 28kW x 2,600hours = £1,811

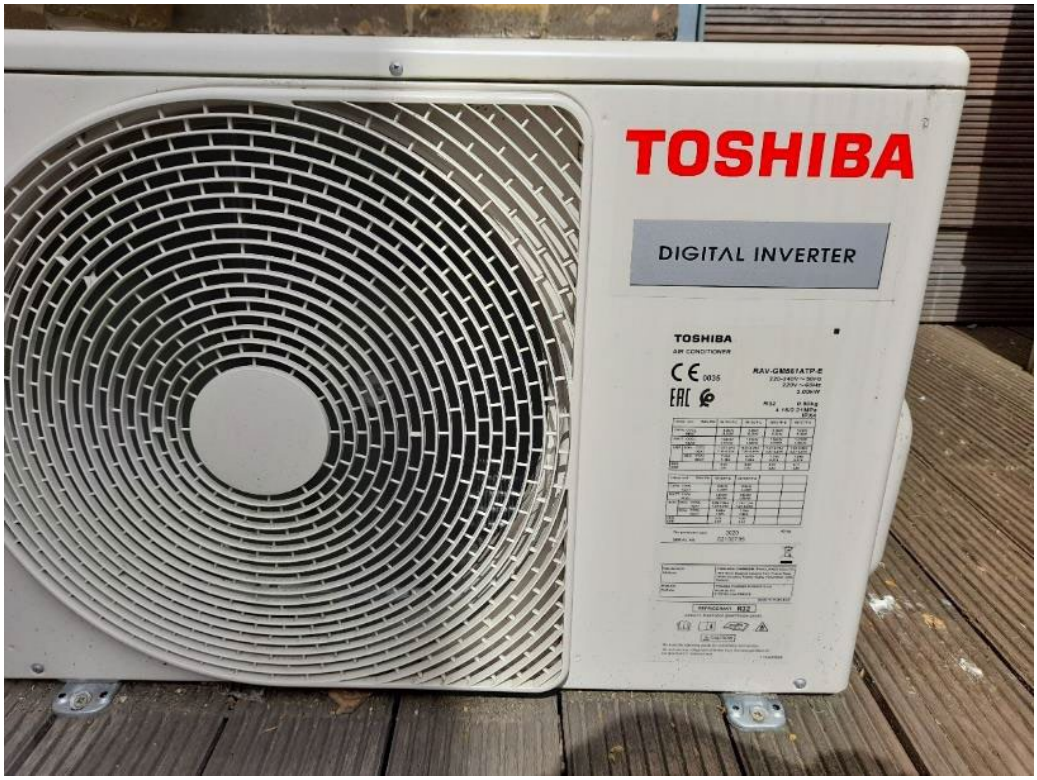
Despite the cheaper cost of gas at current rates; this should be revisited once utility prices have stabilised.

8.3 Air to Air Source Heat Pumps Overview

Air to Air Source heat pumps require internal fan units, blowing warm air, connected to external units – they do not require radiators. Systems provide summer cooling as well as winter heating and can deliver up to 4 to 5 times the amount of heat which they consume in electricity.

It is probable that the heat requirements of the main hall end of the building can be met by two or three units located in the same positions as the existing heaters.

Four of the units below supply one floor of an office of area 165m^2, which is similar to the total of the main hall, toilets, nursery office and kitchen areas. This gives a heating capacity of 21kW for an electrical load of around 1.5kW. The CoP is between 3.2 and 3.9 depending on the type of internal unit chosen.



There are a wide variety of internal units for ceiling, high wall and low wall mounting.

8.4 Air to Air Source Heat Pumps Costs

Pumps to supply 28kW of heat (with capital cost estimated at £450 per kW output: £12,600) would deliver the same amount of heat annually as the current system.

Costs may be less as only direct connections through the wall between external and internal units are likely, minimising piping costs.

9. 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.

9.1 Hot Water: Boiler Timer Control

The Honeywell boiler CHRCK controller hot Water control was found to be set to continuous. This should be changed to timer control; <AUTO> by pressing the respective grey push button.

The current times are programmed as follows:

M 0500-2130

Tu-F 0630-0930, 1000-1600, 1700-2230

S-Su 0630-0930, 1000-1600, 1700-2230

9.2 New LED Lighting

The lighting makes up a relatively large proportion of the electricity used within the building, and most areas are lit by relatively inefficient fluorescent fittings, with additional halogen bulbs in the main hall.

It is recommended that all of the fluorescent strips are changed for LED strip lights. The complete unit should be changed, not just the element. 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/

If the 16 fluorescent lights were changed on a simple “like for like” the total capital cost (supplied and fitted) would be £1,370. The annual cost saving would be £88 resulting in a payback of around 15 years. This estimate includes for the supply of the lights, the labour to install them and the access required. It does not include for any upgrade to the wiring or a new lighting design both of which the church may wish to consider.

There are some fittings such as the 4 spotlights and possibly the 4 recessed lights in the main hall where the existing fitting can be made more efficient by simply changing the bulb/lamp within the existing fitting to a 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.

9.3 Lighting Controls (Internal)

The toilets, entrance area and stairwell will be used regularly, but not constantly.

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 within 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 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). 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.

10. Energy Saving Recommendations – Building Fabric

10.1 Insulation to Roof

The ceiling/roof of a building is the largest contributing area to heat loss from a building as heat rises. The insulation of such spaces can therefore have a dramatic impact on both the efficiency of the heating system and the temperature of the space below.

In all cases where there is 100mm or less of insulation within accessible roof spaces it is recommended that insulation be added to prevent heat loss and create a more comfortable environment for the occupants of the building.

A survey of the roof will be necessary to conform it's strength for the (small) extra load and the method of installing the insulation.

Ceiling insulation for an area of 250m^2 would cost approximately £2,375.

Cost £9.50/m^2

11. Saving Recommendations (Water)

11.1 Tap Flow Regulators

These are recommended where there is frequent use of toilets and washing facilities by children. 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.

12. Other Recommendations

Loss of material of the concrete lintels has occurred on the building façade, leading to exposure of the reinforcing bars. These are made of steel and have begun to rust and expand, which will result in further concrete loss from the surface. The surface should be professionally repaired before damage becomes greater – contact your inspecting architect for advice.

13. 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	Yes for hall
Ground Source Heat Pump	No (lack of space)
Air to Air Source Heat Pump	Yes

13.1 Solar Photovoltaic Panels

The roof offers potential for the installation of solar photovoltaic panels, but the strength of the structure to support extra weight and wind loading will need to be considered.

The angle of the roof is approximately 10^{o}, with a maximum area of $250m^2$. Skylights and walkway requirements are likely to reduce the available area to around $200m^2$.

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 Hall	200	30	90 degrees / 10^0 0.85	1	25,500

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 maximum potential generation is much greater than the church centre's annual recent electricity use (2.432kWh in 2021). If no heat pumps are installed, the system should be sized appropriate for current electricity consumption. The ability to generate electricity on site to power heat pumps for heating (with some grid electricity required in winter) and summer cooling gives the potential for reduction in operating costs.

If heat pumps were installed, this would require extra power. With a current gas use of 105,000kWh, if heat pumps achieved an average of CoP 4 this would require 26,2500kWh of

electricity, so there would still be reliance on grid electricity (which should be sourced from a 100% renewable supplier).

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 30 kWpeak system would cost £43,500.

14. 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 .

15. 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.