ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St John the Divine Church, Earlsfield
PCC of St John the Divine Church

Author	Reviewer	Audit Date	Version
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Contents

1. Executive Summary

An energy survey of St John the Divine Church, Earlsfield was undertaken by ESOS Energy Ltd to provide advice to the church on how it can be more energy efficient and provide a sustainable and comfortable environment to support its continued use.

St John the Divine Church, Earlsfield is an Edwardian era church dating from 1905. The entrance foyer facing the main road is a later addition and there is a 1980's era hall on the east of the site.

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						
Replace all lighting with LED lamps	840	£437	£150	<1	List B	0.18
Porch Inner Doors replacement [Part of Re-ordering scheme]	2% 1,500	£86	Unknown	Unknown	Faculty	0.27
Install Roof insulation in hall	10%	Unknown	£1.425	Unknown	Faculty	
MEDIUM TERM						
Install solar photovoltaic panels	14,000	£7,300	£39,000 whole site	5.5	Faculty	2.9
Install Roof insulation in church	10% 3,700	£675	£2,850	5	Faculty	0.67
Church windows, upper replaced by double glazing, lower secondary glazed	12% 4,440	£810	£11,500 plus £6,500 main window	22	Faculty	0.8
Replace hall boiler with Air to Air heat pump	Unknown	Unknown	£11,250	Unknown	Faculty	
Replace church gas heaters with Air to Air heat pumps	All gas 27,800	£4,800 With solar panels £2400 without	£19,350	4	Faculty	5.7 with solar 4.7 without solar

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

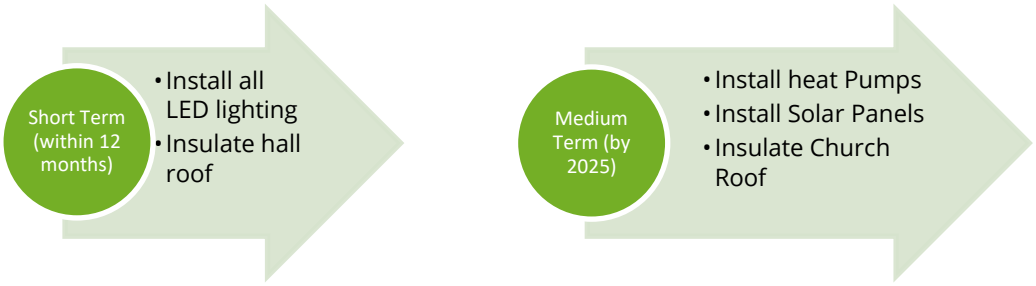
Based on current contracted prices of 52p/kWh and 18.25p/kWh for electricity and mains gas respectively.

If all measures were implemented this would save the church around £5,600 per year in operating costs and reduce carbon dioxide output by around 7 tons.

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 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 John the Divine Church, Earlsfield 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 John the Divine Church, Earlsfield, Garratt Lane SW18, was completed on the 13th September 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 Philip Lyons who is the Inspecting Architect.

St John the Divine Church, Earlsfield	CHURCH	HALL
Church Code	637347	
Gross Internal Floor Area	285m^2	230m^2
Volume	1300m^3	900m^3
Heat requirement	43kW	25kW
Listed Status	Unlisted	Unlisted

The church is typically used for 14 hours per week and the hall for 55 hours per week for the following activities:

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	2 hours per week	20
Church Meetings and Groups	10 hours per week	
Community Use	15 hours per week	
Hall use - Nursery	55 hours per week	

4. Energy Procurement Review

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

The current electricity rates are:

Single Rate	52p/kWh
Standing Charge	35.00p/day

Supplier: EDF

The current gas rates are:

Single Rate	18.25p/kWh
Standing Charge	35.00p/day

Supplier: EDF

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.

We 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, 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.

VAT rate information was not visible on the documentation provided. The treasurer is recommended to check that the VAT declaration (charity registration number) form has been submitted.

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

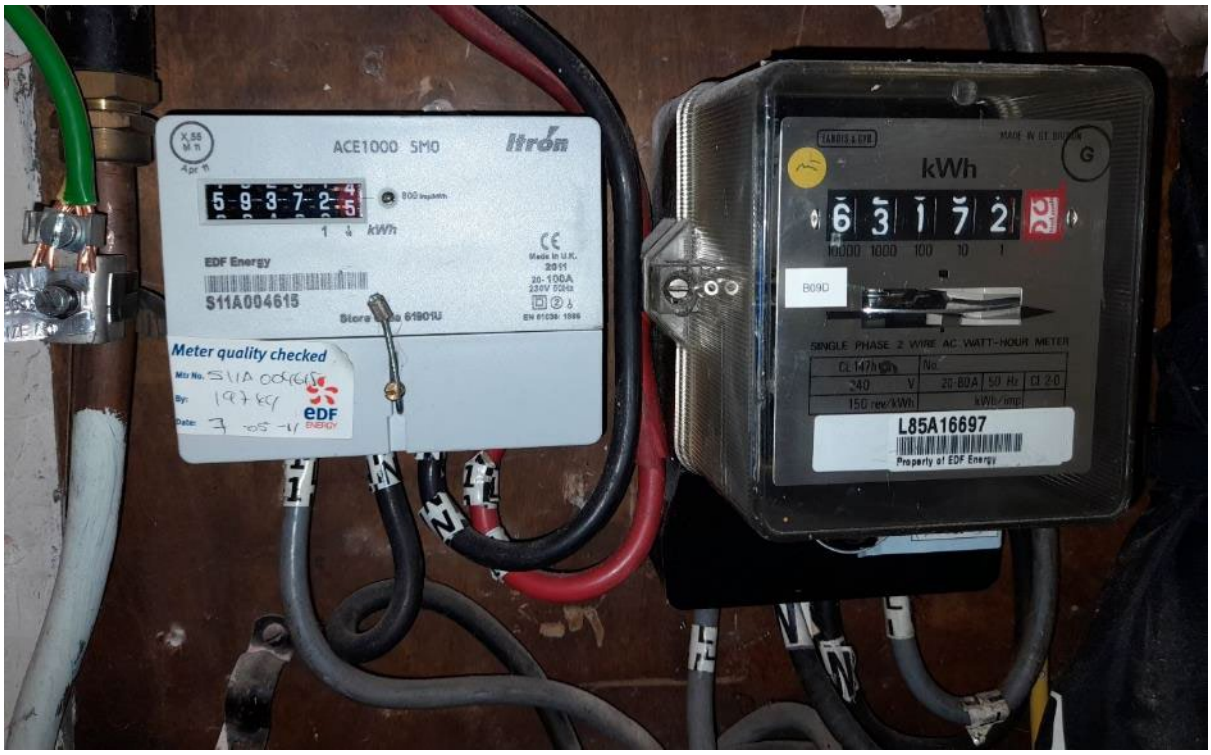
St John the Divine Church, Earlsfield [Church only] used 1,800kWh/year of electricity from 8 April 2021 to 7 April 2022, costing £600 for the year. [At new rates, which have been used for calculations in this report, the cost would have been £1,117]. Gas use was 37,000kWh for the same period, costing £2,600 [£7,224 at the new rates]

The hall utility use (which is largely by the nursery) was not reported.

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

Utility	Meter Serial	Type	Pulsed output	Location
Electricity - Church	L85A 16697	Single phase	No	Electrical cupboard, SW corner of church
Electricity - Hall	S11A 004615	Itron ACE1000 Single phase	No	As above
Gas – Church	8000701 S	Schlumberger Cubic feet	No	Adjacent to electrical cupboard in church
Gas - Hall				Not observed

It is recommended that Smart meters are fitted. This would allow more accurate meter readings to be provided together with detailed consumption data which can be requested from the supplier.



5.2 Energy Profiling

The main energy consuming plant can be summarised as follows:

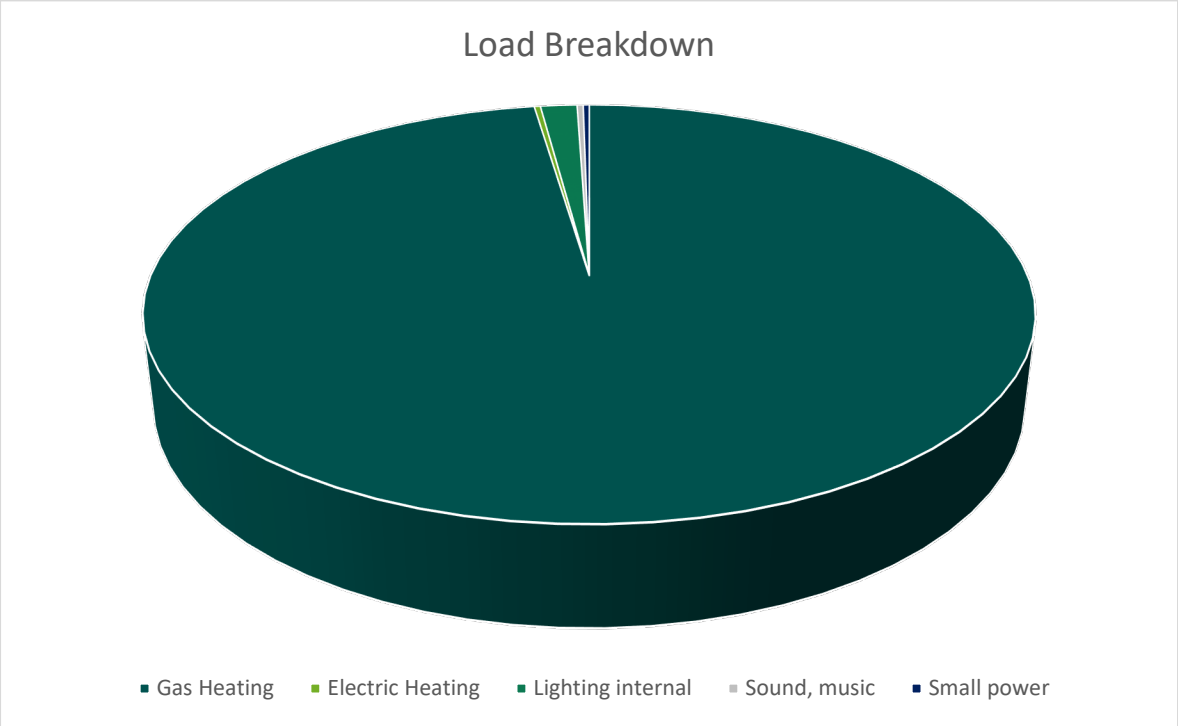
Hall items are italicised

	Equipment	Power kW	Annual Consumption kWh	Portion
Heating [Gas]	CHURCH 6 x Rinnai 1001T heaters, 11.3kw input, 9.5kW output. 545 hours use annually *HALL Worcester boiler*	68 *25*	37,000 *unknown*	%
Heating [Electric]	Portable electric heater, midwinter use	3	100	0%
Lighting [Internal]	CHURCH 1,400 hours use 20 spotlights, most LED 3 bulkhead 1 CFL HALL 2,900 hours use *10 Fluorescent 4 foot, F36W*	 300W 120W 25 *360W*	 420 140 40 TOTAL 600	%
Sound, Music	Sound system Organ	0.2 0.5	30 70	%
Small Power	Vacuum cleaner	1.5	100	%

Sum of estimates: 900kWh

Annual CHURCH ONLY electricity consumption, 2021-22: 1,800kWh

The difference may arise from recent installation of LED lamps which has lowered the calculated consumption, greater hours of building use than reported or significant use of the portable electric heater.



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 load is lighting.

6. Church Re-ordering and Refurbishment Proposals

The church was constructed in 1925 and consists of a solid walled structure with single glazed metal framed windows and a trussed roof with metal tie bars. The adjacent hall dates from the 1980s and has cavity walls. The amount of insulation in the walls or roof of the hall is unknown.

Consideration is being given to fabric refurbishment and to significant re-ordering.

6.1 Church Refurbishment

Refurbishment of the church to enhance it's energy efficiency by insulation of the roof, external walls and installing double or secondary glazing is proposed. Roof installation, if applied from the outside involving re-roofing, must be conducted before any solar panel installation.

Enhanced insulation will lower operating costs and create an environment which is more easily hireable for community events – the church is seated with moveable chairs and offers a large rectangular space. This would in turn increase the potential for community engagement.

The existing vestry has a ceiling which will benefit from insulating above it.

The crypt (storage area) allows for addition of insulating under the floor.

The upper level windows could be replaced by uPVC double glazed units

The lower level windows which are considered to be in a better state of repair could have internal secondary glazing installed in the window recess. These have no opening panels.

The large window facing the road could also be secondary glazed, but if it is incorporated into a new upper level space this may not be necessary – it will depend how the space is to be used.

The current direct flued gas heaters should be replaced by heat pumps.

With no radiator system in place, this building is ideal for the use of Air to Air Heat Pumps. This could be either individual small external units coupled directly through the wall to internal units in the same positions as the present heaters (with the external unit of the east wall unit located on the hall flat roof), or alternatively a whole site system installed using a larger external unit.

Equipment installers should be approached for detailed quotations to compare multiple small external units (each of which supplies one or two internal heaters), or a single unit feeding multiple internal heaters.

The west facing roof offers a location for solar photovoltaic panels.

6.2 Church Re-Ordering

Reordering the entrance area and south part of the nave (ecclesiastical west) is proposed.

This would move the vicar's office to the front of the building for effective interaction with the public, create an entrance to the strip of land the west of the church wall, improve disabled, step free, access and provide replacement doors (thus dealing with existing draughts).

The nave could be partitioned at the position of the second roof truss to create an upper level meeting room, and a ground level storage area / internal entrance lobby. This would require the organ, currently situated in the corner, to be moved forward by about 6m.

An enlarged space for electrical plant could be included to accommodate heat pump and solar photovoltaic equipment and eventually a battery.

6.3 Hall Refurbishment

The hall is a 1980s construction with a sloping roof angled to the west. This is covered in roofing felt which will require replacement within the next decade. There is likely to be some insulation present. Re-roofing presents the opportunity to increase insulation up to the current maximum of 270mm. The expenditure is justified by the 55 hour a week use by the nursery.

Installation of a heat pump (either Air to water or Air to air) should specify a system which can provide summer cooling. This should be powered by solar photovoltaics; probably on the church west facing roof. A potential location for a heat pump plant on the flat roof of the hall kitchen, at the rear, has been found. Again, equipment installers should be approached for detailed quotations to compare multiple small external units, or a single unit feeding multiple internal heaters.

Light pipes could be installed to reduce reliance on electric lighting.

Fluorescent lighting should be replaced by LED strip lighting as part of the refurbishment.

7. Efficient / Low Carbon Heating Strategy

7.1 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. Sourcing electricity from a 100% renewable source is recommended. 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 for churches.

7.2 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 Solid walls, uninsulated	1,300	0.033	43
Hall Cavity walls	900	0.028	25

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

Area	kWh	Heaters / Boiler power kW	Annual heating hours
Church	37,000	68	545
Hall	Unknown	25	

8. Future Heating Options

It is recommended that the church, which currently has flued gas heaters is fitted with Air to Air Heat Pumps. Detailed quotes should be obtained for the hall to compare Air to Air with Air to water systems. The latter would re-use the existing radiators and pipework which would have to be in good order. Air to Air heat pumps for the hall would give an operating expenditure of about 65% of Air to water for around 15 % higher capital cost so are expected to be the cost effective option.

8.1 Air to Air Source Heat Pumps

Air to Air source heat pumps work by having an external unit which sucks air throughout it and extracts the heat from the air. It concentrates this heat and puts it into a refrigeration gas (in the same way as a fridge or freezer works). This refrigeration gas is then piped inside the building in a small pipe where is it then allowed to expand in an internal unit with a fan. This heat is then blown out into the space. This system is identical to an air conditioning system but it works in reverse to heat the space. As warm air is blown into the space this type of system can heat spaces from cold relatively quickly. Air to Air Source heat pumps provide around 4.5 units of heat for every 1 unit of electricity used in the heat pump (it therefore has a Coefficient of Performance (CoP) of 4.5)

Examples of external units for AASHP comprising of three smaller 3kW units (output 10kW each) and two larger 10kW units (output 37kW each).

AASHPs require the installation of external units which look like air conditioning modules in well ventilated external locations. These external units will need an electricity supply and pipework running from them to the heating system. They will also need a drain nearby as the back of the units can build up moisture condensing and sometimes freezing on the coils. The larger units do create some low level noise and therefore the location and baffling of the units may need to be considered carefully.

Internal units are envisaged to occupy the same locations as the existing heaters. These could be coupled to external units on the walls directly outside on the west side of the building, minimising pipework costs. On the east side, units could be on the roof of the hall on the

church side. If AASHP is chosen for the hall as well, the roof offers a location, as does the area behind the church to the north of the site.

Internal units come in a variety of styles. The most appropriate internal units for most churches are a floor mounted units which looks very similar to a fan convector heater.

FTXM-R - Wall mount air conditioning unit

Attractive, wall mounted design with perfect indoor air quality. 2 area motion detection sensor: air flow is sent to a zone other than where the person is located at that moment; if no people are detected, the unit will automatically switch over to the energy-efficient setting.

FVXM - Floor Mount Air Conditioning Unit

Designed to fit rooms of any size and shape, it blends well with the interior due to the new design which incorporates more flowing lines and softer edges. These units are ideal when it is not possible to fit a high level wall mount unit for aesthetic or practical reasons.

They are suitable for a wide range of applications including domestic, small to medium offices and commercial uses.

All these units do have a fan element within them and therefore a small amount of fan noise is emitted. This tends to be less than a fan convector heater on a boiler based system as is similar to the noise from a fridge or freezer. Air conditioning units are commonplace in hotel rooms so the noise is low enough to be suitable for sleeping environments.

A case study of a church which has installed such a solution is available at [5. Air-source heat pumps at Hethel Church - All Saints Church, Hethel - A Church Near You]

AASHP - Church

Capital cost, 43kW output units: £19.350

Operating cost: 37,000kWh output/CoP 4 = 9,250kWh.

Without solar, 9250kWh x 52p/kWh = £4,810

With solar, assume half of needs from grid during winter, operating cost = £2,400

minus some sale of surplus electricity generated during summer.

AASHP - Hall

Capital cost, 25kW output units: £11,250

Operating cost: hall gas consumption kWh (unknown)/ 4 x 52p/kWh.

8.3 Air to Water Source Heat Pumps

Air to Water source heat pumps work by having an external unit which sucks air throughout it and extracts the heat from the air. It concentrates this heat and puts it directly into water that can then flow through the heating system. They work most efficiently when trying to produce water temperatures in the heating system between 40°C and 50°C. They tend of warm up slowly and steadily and are therefore well suited to situations where the heating is required for long periods of the day and with heating systems that have a low temperature requirement such as underfloor heating systems. As they warm up spaces slowly, it is important that the warmth being slowly emitted is retained within the building so that the overall heat levels build up. This requires good levels of insulation and air tightness to ensure that the heat loss is lower than the heat being emitted. Air to Water Source heat pumps provide around 3 units of heat for every 1 unit of electricity used in the heat pump (it therefore has a Coefficient of Performance (CoP) of 3)

ASHPs require the installation of external units which look like air conditioning modules in well ventilated external locations. These external units will need an electricity supply and pipework running from them to the heating system. They will also need a drain nearby as the back of the units can build up moisture, condensing and sometimes freezing on the coils. The larger units do create some low level noise and therefore the location and baffling of the units may need to be considered carefully.

A case study of a church which has installed this solution is available at Heat pumps and fabric improvements make a rural church warm and well used : St Anne in Ings | The Church of England

ASHP - Hall

Capital cost, 25kW output unit: £10,000

Operating cost: hall gas consumption kWh (unknown)/ 3 x 52p/kWh.

[A 33% higher operating cost than AASHP is expected]

8.4 Upgrade to 3 Phase Electricity Supply

To be able to have sufficient electrical power to supply enough energy into an electrical heating system the church will need to increase the electrical supply it current has coming in from the existing single phase 100A supply to a 3 phase 100A supply.

The maximum a single phase of power can provide is 23kW.

The upgrade to the supply has to be carried out by the District Network Operator in the areas.

The DNO in your area is UK Power Networks - www.ukpowernetworks.co.uk; 0800 029 4282 (London, South East and Eastern England)

The cost of bringing in a new 3 phase supply can range from £300 to £30,000 but the DNO will provide a quotation for free so it is well worth obtain a quotation in the short term so that decisions can be made on a well-informed basis.

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 New LED Lighting

The church is lighted with 20 spotlights. Some of these are LED units (those with yellow centres) whilst some appear to be older halogen lamps. The halogen lamps, rated at 70 to 80W each should be changed to LED units (of 5 to 10W). The lamps are not dimmed, so the more expensive dimmable LED lamps are not required.

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/

The hall is lit by fluorescent strip lighting installed at high level under the angled roof. It is recommended that these are changed professionally for LED strip lights. This may form part of a re-roofing and insulation scheme for the hall.

10. Energy Saving Recommendations – Building Fabric

10.1 Draught Proof External Doors

As part of the proposed re-ordering of the entrance lobby area, new doors which close in an air tight manner should be installed. The proposal includes creation of a new draught lobby.

10.2 Windows

The high level windows in the church are reported to have frames in a poor state. These should be replaced by double glazed units with uPVC frames (offering lower maintenance). The low level windows are considered to be in good order. Internal secondary double glazing could be installed here.

The lower windows do not have any opening panels. With no trickle vents or similar there is no low level ventilation provided and adequate ventilation should be considered as part of any refurbishment.

The introduction of secondary glazing would considerably reduce the heat loss through the existing windows and improve both thermal comfort and noise levels as well as providing added security.

The following companies cater for heritage buildings, so may be able to provide secondary glazing for arched windows. https://www.selectaglaze.co.uk/heritage-listed-buildings or https://www.stormwindows.co.uk/

10.3 Cavity Wall Insulation - Hall

The hall building is believed to be constructed with Flemish bond appearance brickwork but with an internal cavity. The level of insulation installed at build is unknown.

There are no indications of retrofitting of insulation (brown studs low in the walls).

This information may be accessible from construction drawings which should be available for a building of this age.

10.4 Insulation to Roof – Church and Hall

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.

The church roof has no insulation. This should be considered only if the building is to be regularly used.

The hall roof may be insulated already, but likely only to 50 or 100mm rather than the current standard of 270mm. As re-roofing of the hall is expected to be required, insulation should be added as part of the work.

A cost estimate is £9.50/m^2 x 300m^2 (church) and x 150m^2 (hall) = £2,850 + £1,425 = £4,275

11. 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 radiator network in church
Ground Source Heat Pump	No radiator network in church
Air to Air Source Heat Pump	Yes, with cooling provision

12.1 Solar Photovoltaic Panels

The unlisted building has a west facing roof with an area of around 150m^2 available.

Below, the east facing roof and hall used by a nursery.

The sloping section of the nursery roof offers a further area, 50m^2 may usefully be available. The flat portions of roof are required for heat pump plant.

This could generate 0.15kWpeak/m^2 giving a 30kWpeak 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	150	12.5	270 degrees / 45^0 0.74	1	9,250
Hall	50	7.5	270 degrees / 30^o 0.80	0.8	4,800
Total	200	30			14,050

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 greater than the church centre's annual recent electricity use (1,800kWh in 2019 - hall consumption is unknown). If no heat pumps are installed, the system should be sized appropriate for current electricity consumption.

If heat pumps were installed, this would require extra power. This is estimated at 9,250kWh for the church, with hall needs the total could be 30,000kWh, so a large solar PV system is justified if heat pumps are installed to both buildings. If the hall is fitted with a heat pump system which can provide cooling, then solar power offers free summer cooling. It can be used to supply heat whenever it is daylight in winter but would require additional grid input, obviously after dark.

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 for simple roofs (£1,300 per kWpeak); a 30 kWpeak system would cost £39,000.

12. 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 .

13. 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.