Energy Efficiency and Zero Carbon Advice

St John the Baptist Church, Wimbledon
PCC of St John the Baptist Church

Author	Reviewer	Audit Date	Version
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1. Executive Summary

An energy survey of St John the Baptist Church, Wimbledon 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 Baptist Church, Wimbledon is a Grade II listed Victorian church dating from 1875, constructed of brick. The adjacent hall is of recent construction (2017).

There is both gas and electricity 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						
Switch electricity (and gas) suppliers to a Group Purchasing scheme with suppliers which provide 100% renewable (or green gas) supplies	None	10-15% likely from group purchasing	Nil	N/A	None	Offset 4.7 tonnes
Draughtproofing works	2% 2,800	£95	DIY	Immediate	None	0.5
Install under floor insulation from crypt	5% 7,000	£238				1.2
MEDIUM TERM						
Install solar photovoltaic panels on hall roof	12kWp 8,900 max	£1,335 max	£15,600	12	Faculty	1.8
Install under pew heating to selected pews.	140,000 gas Elec used 9,000	£6,400 gas £1,350 cost	£16,450		Faculty	23
Replace boiler with Air to Air heat pump (for rear of nave)	140,000 gas 1,200 used	£6,400 gas £450 cost	£13,500		Faculty	Included above
Combined Heat Pump costs		£4,600 saved	£29,950	6.5		

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

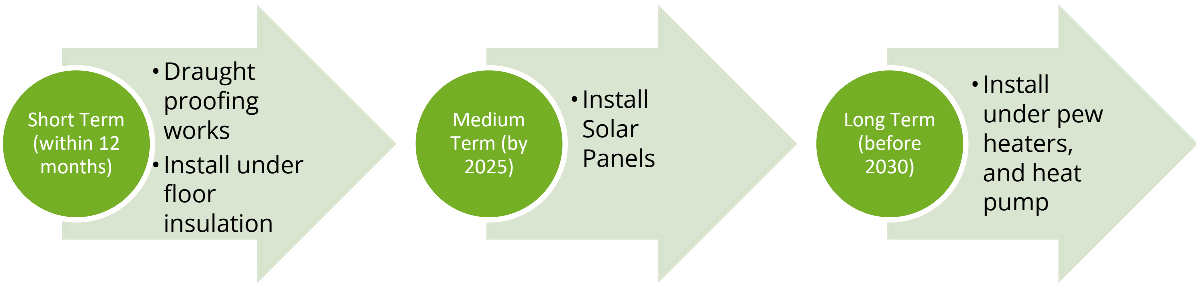
Based on current contracted prices of 15.00p/kWh and 3.399p/kWh for electricity and mains gas respectively.

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 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 Baptist Church, Wimbledon 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 Baptist Church, Wimbledon, St John's Road, SW19 4PH was completed on the 25th November 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 Eco Congregation.

The church was represented by Mike Vernell and Richard Tompkins.

St John the Baptist Church, Wimbledon	CHURCH	HALL
Church Code	637312	
Gross Internal Floor Area	535m^2	160m^2
Volume	5,350m^3	630m^3
Heat requirement	176kW	8kW
Listed Status	Grade II	Unlisted

The church is typically used for 15 hours per week and the hall for 50 hours per week for the following activities:

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	10 hours per week	55 Afternoon Korean congregation ?
Church Meetings and Groups	1.5 hours per week	
Community Use	Average 3 hours per week	20 annual concerts Annual music festival.
Occasional Offices	2 weddings 4 funerals	100 100

Annual Occupancy Hours: Church 800 Hall 2,600

4. Energy Procurement Review

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

The current electricity rates are:

Single Rate	15.00p/kWh
Standing Charge	29.950p/day

Supplier: British Gas.

The current gas rates are:

Single Rate	3.399p/kWh
Standing Charge	£25/month

Supplier: SSE. Contract End Date January 2024

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, Charity Buying Group and the diocese supported Parish Buying scheme, http://www.parishbuying.org.uk/energy-basket.

These schemes offer 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	20% on both electricity and gas	The organisation is understood to be a charity and therefore should be benefiting from only be charged a 5% VAT rate. A VAT declaration should be sent to the supplier to adjust this.
CCL	100% charged	As the organisation is being charged the wrong VAT rate they are also being charged CCL which should not be applied as they are a charitable organisation.

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 Baptist Church, Wimbledon used 21,350 kWh/year of electricity in the year from October 2021, costing £3,753 for the year.

From February 2021 the yearly gas use was 134,497kWh and over the year from October 2021, 141,978kWh was used. An average of 140,000kWh will be used. Costs are around £6,400 annually. The hall's use was not reported. The total carbon emissions associated with the church building energy use are 29.9 CO_2e tonnes/year.

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

Utility	Meter Serial	Type	Pulsed output
Electricity - Church	K98A 13829		No
Gas – Church	M016 A03240 15 D6	metric	Yes

It is recommended that the church consider asking their suppliers to install smart meters so that the usage can be monitored more closely, and the patterns of usage reviewed against the times the building is used.

5.2 Energy Profiling

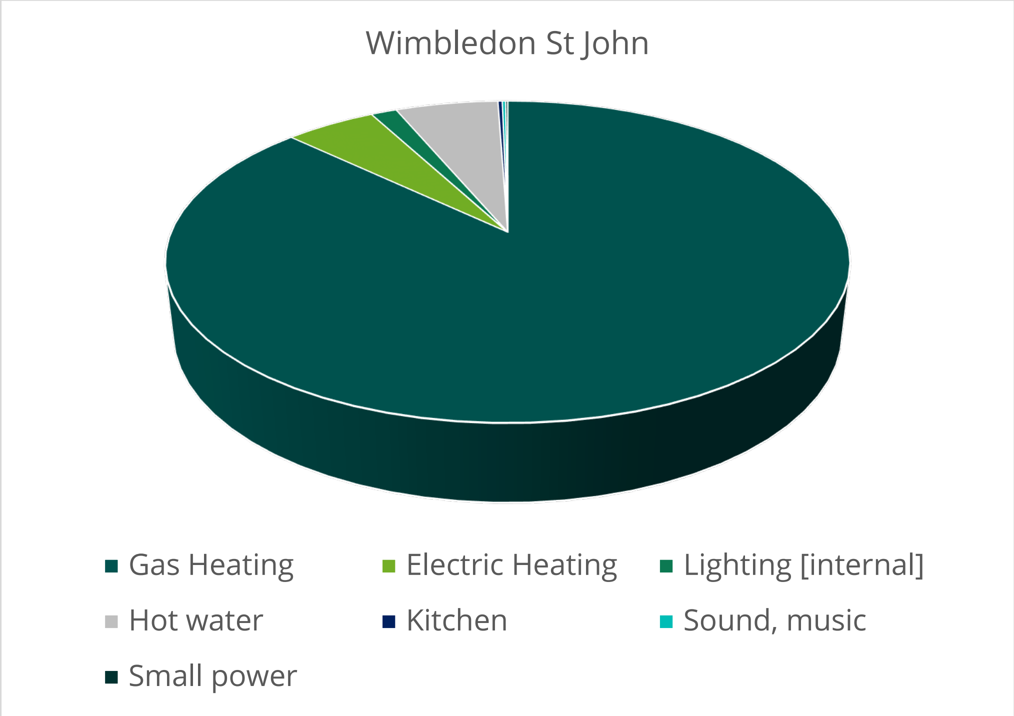
The main energy consuming plant can be summarised as follows:

Hall items are italicised.

	Equipment	Power kW	Annual Consumption kWh	Portion
Heating [Gas]	CHURCH Ideal Concord CX boiler. Installed 2000. 125kW input, 100kW output. [1,120 hours at full power]	125	140,000	87.1%
Heating [Electric]	CHURCH Boiler circulation pump *HALL Electric underfloor heating*	 0.2 *unknown*	 225 *8,000*	5.1%
Lighting [Internal]	CHURCH 800 hours use ALL LED 12 chandeliers x 12 lamps x 6W 4 chandeliers x 8 lamps x 6W CRYPT LED tubes *HALL 2600 hours use* *LED tubes*	 360W 864W 192W 80W *500W*	 1130 220 *1,000* TOTAL 2,350	1.5%
Hot Water [HALL]	*Fixed water heater, Gabarron, 50 litre tank* *Kettle* *Coffee machine* *Dishwasher*	*15* *3* *2* *5*	*6,000* *900* *900* *1,500* *TOTAL 9,300*	5.8%
Kitchen [HALL]	*Oven* *Toaster* *Microwave* *Fridge (on constantly)*	*1* *0.1*	*100* *300* *TOTAL 400*	0.2%
Sound, Music	Sound system Organ	0.5 1	200 100	0.2%
Small Power	Vacuum cleaner	1.5	200	0.1%

Sum of estimates: 20,775kWh

Annual site electricity consumption, 2021: 21,350kWh



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 hot water.

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. 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.

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

<u>Insulation Factors</u>

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	5,350	0.033	176
Hall Constructed 2017 to current building standards	630	0.013	8

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

7. Improve the Existing Heating System

The present Ideal Concord CX boiler was installed c. 2000. It has a maximum efficiency of 80% and is non condensing.

The heating is delivered entirely via cast iron pipes running in trenches, which offers a relatively slow heat up time.

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 Magnetic Particle Filter

It is recommended that if the church chooses to retain the boiler and radiator network in the long term then a Magnetic Particle Filter is fitted to protect the boiler and system against build-up of magnetic sludge.

8. Future Heating Options

8.1 Options Overview

The church is currently seated using pews in the nave, with a capacity for 280 people. The foremost central pews can be removed, and the rear pews are often turned to face the rear. The sets of pews on each side are attached to the walls.

The boiler can be replaced by a combination of fitting under pew convector heaters to selected fixed pews to cater for the regular congregation and Air to Air heat pump system for the rear portion of the nave which is a circulating area used for coffee after services. There are locations for the external heat pump plant along the bottom of the south facing wall which is shielded from public view by the new hall building.

The church is used for around 15 hours per week, around 11 hours for services and choir practice, with monthly concerts and occasional weddings and funerals. The concerts attract a large number of attendees including a music festival in winter. It would be both expensive to fit heaters under every pew, plus some are moveable and all have closely spaced supports at 83cm (dictating the more expensive per kW output smaller heaters), it is suggested that 50 are installed. More could be added at a later date if necessary. Extra heat could be provided by either retaining a gas system (for occasional use only during the coldest periods), or installation of a heat pump for the area at the rear of the church.

The church boiler is an Ideal Concord CX dating from around 2000, which has a maximum efficiency of only 80% (125kW input, 100kW output). This could be replaced by a condensing boiler offering 93 to 95% efficiency.

8.2 Install Electric Under Pew Heaters

The church is fitted with three rows of pews seating the north aisle, centre and south of nave. Under pew heating is suggested for selected pews to reflect the average congregation size. The pews are supported at approximately 83cm intervals, dictating the use of short heaters – they could be placed in alternate spaces.

The congregation is normally 40 to 50 people.

Fitting 50 heaters between alternate vertical supports in the central and south sets of pews [Three to the 6m long central pews and two to the 3.4m long south pews, ten rows C to M]

Example: Using BN Thermic BN45 450W heaters (702mm)

Total output	22.5kW
Installed costs (2018 data, £329)	£16,450

Operating costs: heating for 400 hours use = 400h x 22.5kW x 15 p/kWh = £1,350

The output of 22.5kW is lower than the figure calculated by model for space heating, or the present boiler output of 100kW – but the model assumes that heat circulates around the whole building – heat from radiators or pipes begins by rising to the ceiling. Heat supplied directly to the congregation does not have to fill the volume of the church first.

System advantages include:

- Individual switching of each unit – useful for small meetings
- The ability to run all units to preheat the building when it is very cold.

Brown BN Thermic 650W under pew heaters fixed to underside of pew seats for pews which have no solid backs

Black 650W Norel under pew heaters fitted to solid pew backs.

8.3 Air to Air Source Heat Pumps

In order to heat the circulating area at the west end of the nave, it is suggested that either the existing system is kept (with eventual new boiler), or Air to Air Heat Pump system installed. Apart from the environmental advantage of moving away from fossil fuels, a fan system would deliver heat to the rear of the building more quickly.

Air-to-Air Source Heat Pumps (AASHP) work by having an external unit which sucks air in and extracts the heat from it. The pumps concentrate this heat and put 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; they therefore have a Coefficient of Performance (CoP) of 4.5.

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, which condenses and sometimes freezes 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.

Examples of external units for ASHP comprising of three smaller 3kW units (of 10kW output each) and two larger 10kW units (of 37.5kW output each).

Internal units come in a variety of styles. The most appropriate internal units for most churches are floor mounted units which look 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 and similar to the noise from a fridge or freezer. Air conditioning units are commonplace in hotel rooms, indicating that the noise is low enough even 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

8.4 Air to Air Source Heat Pumps Costs

To heat the rear portion of the nave it is suggested that 30kW output is provided.

Operating at a Coefficient of Performance of 4, an 30kW heat output requires 7.5kW of electricity supply.

Capital cost 30kW x £450/kW = £13,500

7.5kW x 400 heating hours = 3,000kWh electricity used annually.

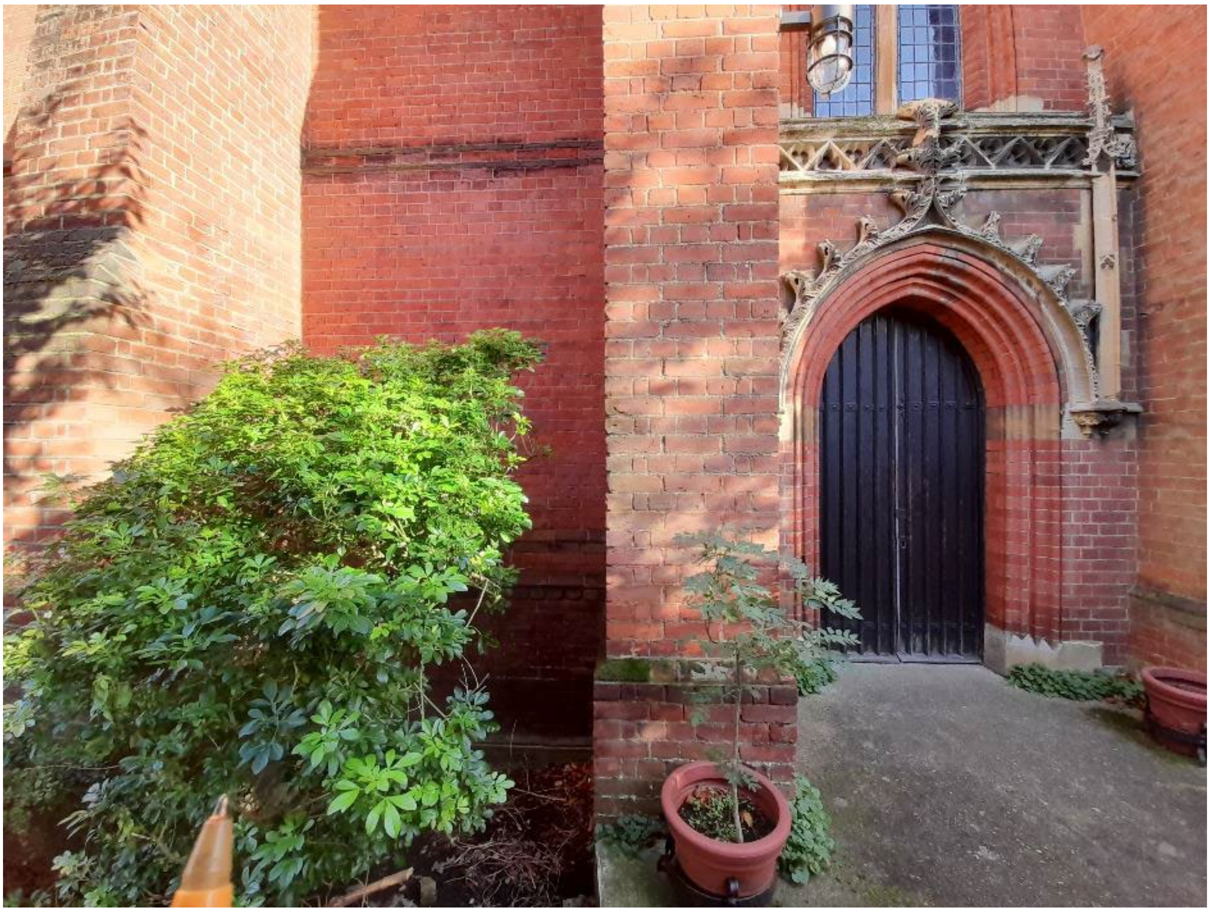
At current costs of 15p/kWh, annual cost = £450.

Air to Air source heat pumps do not require water radiators. The existing underfloor trenches may offer a route for pipework.

8.5 Extension Heating

The church is proposing to add extra facilities including toilets at the west end adjoining the west

door, below. This area could also be heated by an Air to Air Heat Pump system, with external units located at the base of the south wall between church and hall.



9. Energy Saving Recommendations – Building Fabric

9.1 Under Floor Insulation

The south side of the nave is built over a crypt used for storage which is 3.3m wide. The crypt under the chancel is separate with a higher veiling level and is used by the nursery.

The nave crypt is well ventilated with 8 ventilation slots in the brickwork. There are gaps in the floorboards allowing significant draughts (the crypt lights can be seen from above at certain angles).

It is recommended that the floor is insulated from below and sealed to prevent draughts.

This would use loft type insulation but incur slightly higher costs as it will need supporting under the floor beams. Cost estimate $120m^2$ at £15/m^2 = £1,800

9.2 Draught Proof External Doors

There are a number of external doors in the church. Often historic timber doors do not close tightly against the stone surround and hence a large amount of cold air can enter the church around the side and base of these doors.

It is recommended that the draughtproofing around the door is improved and draught strips are added. This could be achieved in a number of ways:

For timber doors that close onto a timber frame a product called QuattroSeal is often used in heritage environments to provide appropriate draught proofing.

For timber doors that close onto a stone surround, traditional solutions can be used such as brush draught strips rebated into the edge of the door by a skilled joiner. Other traditional methods such as using hessian or felt pads tacked to the door could also be used. Keeping the door maintained in a good condition is also important.

It is necessary to check with the DAC before undertaking any form of draughtproofing that involves work on the fabric of the door.

Simple measures such as having a 'sausage dog' style draught excluder laid along the base of a door (it needs to be sufficiently heavy to stay in place), using plasticine of the right colour to fill gaps where daylight can be seen, and putting painted fridge magnets over large keyholes can all be simple DIY measures which are effective.

9.3 Windows

Several of the windows have opening panels at high level which can be a source of draughts.

Where problems are identified, these should receive maintenance so they can be closed securely, as constant draughts are a major source of heat loss. Any rust should be treated, as it expands causing frames to distort and water ingress.

10. Renewable Energy Potential

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

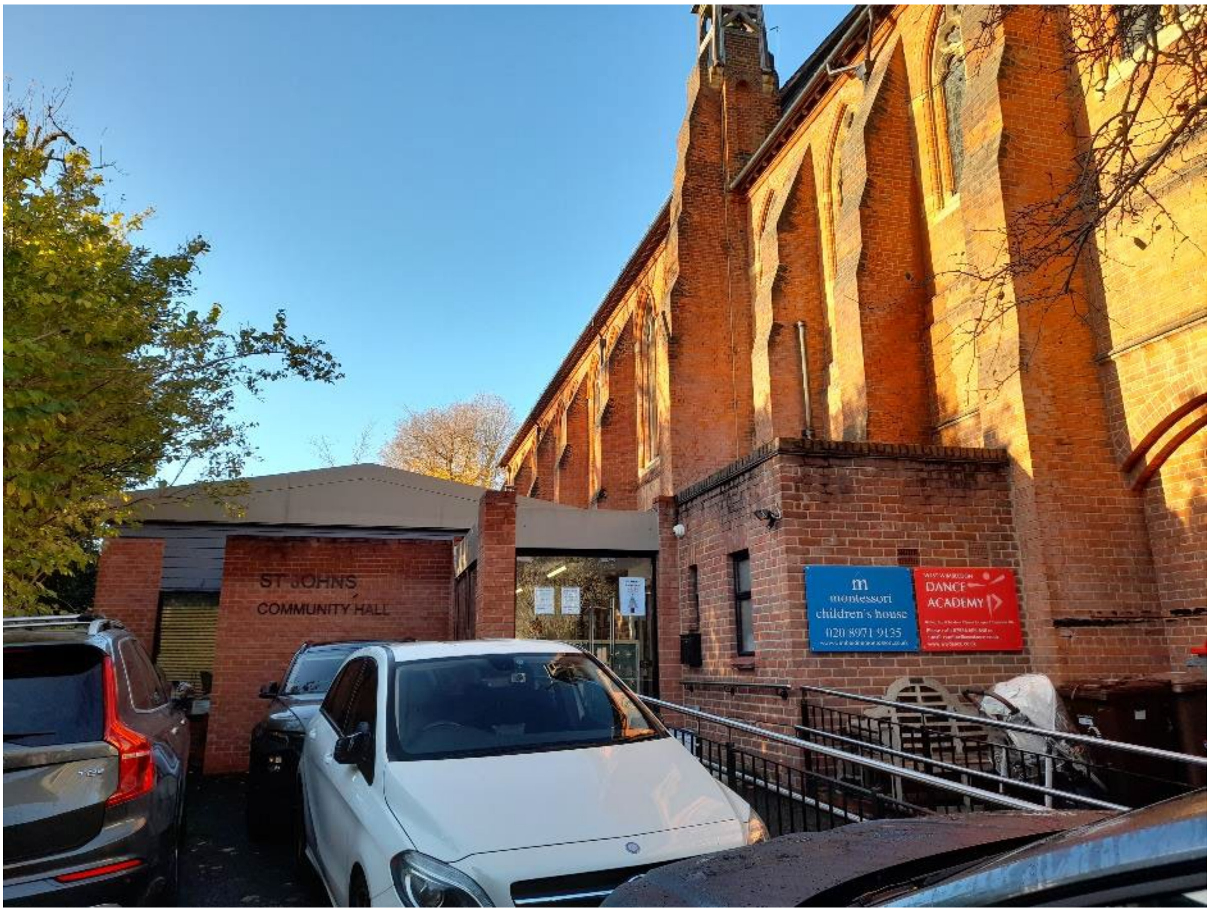
Renewable Energy Type	Viable
Solar PV	Yes, for hall roof
Battery Storage	Future potential
Wind	No – no suitable land away from buildings
Micro-Hydro	No – no water course
Solar Thermal	No – insufficient hot water need
Biomass	No – not enough heating load as well as air quality issues
Air Source Heat Pump	Yes for hall
Ground Source Heat Pump	No suitable land
Air to Air Source Heat Pump	Possible for church – rear area

10.1 Solar Photovoltaic Panels

The roof of this Grade II listed building which is situated on a south facing hill is visible from the ground, thus is considered unlikely to receive permission for installation of panels on the church roof. The church is currently used for around 11 hours per week on a Sunday with little other regular use – most generation would occur when the building is out of use.

The hall, constructed in 2017 is in regular daily use by a commercial nursery. It has relatively low electricity needs. A suitably sized solar PV installation could meet the majority of the needs except in low light conditions in winter. The hall is understood to be served by the same electricity meter as the church (via a submeter) and it is therefore possible for electricity generated at the hall to be supplied to the church – particularly for the crypt lighting, which is also in nursery use.

Furthermore, any future replacement of the small hall 15kW boiler by a heat pump could allow solar powered cooling in summer.



The hall roof offers a south facing area of around 80m^2. This could generate 0.15kWpeak/m^2 giving a 12kWpeak 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
Hall	80	12	180^o, 10 degree slope 0.93	0.8 (trees, nearby houses)	8,900

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 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 access (£1,300 per kWpeak); a 12 kWpeak system would cost £15,600.

11. 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 .

12. Faculty Requirements

It must be noted that all works intended to be undertaken should be discussed with the DAC at the Diocese.

Throughout this report we have indicated our view on what category of permission may be needed to undertake the work. This is for guidance only and must be checked prior to proceeding as views of different DACs can differ.

Under the new faculty rules;

List A is for more minor work which can be undertaken without the need for consultation and would include changing of light bulbs within existing fittings, repair and maintenance works to heating and electrical systems and repairs to the building which do not affect the historic fabric.

List B is for works which can be undertaken without a faculty but must be consulted on with permission sought from the Archdeacon through the DAC. This includes works of adaptation (but not substantial addition or replacement) of heating and electrical systems and also the replacement of existing boilers so long at the same pipe work, fuel source and flues are used. It can also be used to replace heating controls.

All other works will be subject to a full faculty.

Works which affect the external appearance of the church will also require planning permission (but not listed building consent) from the local authority and this will be required for items such as PV installations.