Energy Efficiency and Zero Carbon Advice

Holy Trinity Church, Hurstpierpoint
PCC of Holy Trinity Church

Author	Reviewer	Audit Date	Version
Paul Hamley	Tamsin Hockett	1st June 2022	1.4

Contents

1. Executive Summary

An energy survey of Holy Trinity Church, Hurstpierpoint was undertaken by ESOS to provide advice to the church on how it can be more energy efficient and provide a sustainable and comfortable environment to support its continued use.

Holy Trinity Church, Hurstpierpoint is a Grade II* listed church dating from 1843-5; it was the last church designed by Charles Barry. [Historic England reference 1354863]. Chapels were added during the Victorian period and a north porch in 1908. 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						
Purchase a temperature datalogger, to optimise heating control	10% 10,000 gas	£608	£50	Immediate	None	1.84
Door draughtproofing works	1% 1,000 gas	£60	£200	3	List B	0.18
Install LED lighting throughout	4,000	£543	£10,000 scheme OR £1,000 + labour	~ 5	Faculty	1.01
MEDIUM TERM						
Install solar photovoltaic panels on north chapel and chancel roofs	7,500	£1,027	£13,050	12.7	Faculty	1.90
LONG TERM						
Replace boiler with Ground Source heat pump	c. 100,000 gas	£6,700	£130,000	19	Faculty	18

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

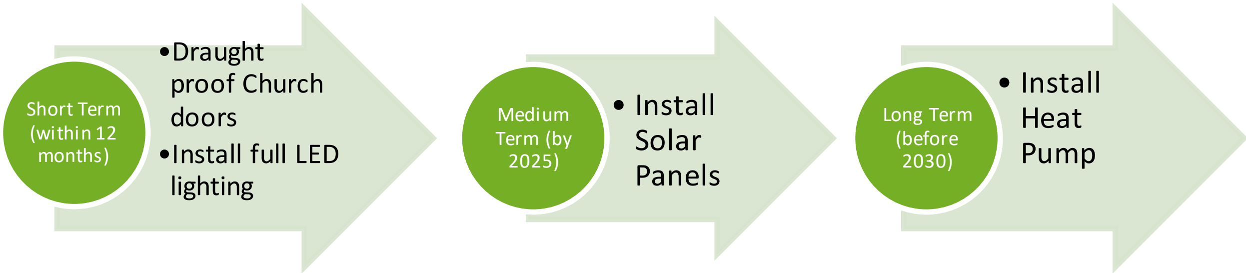
Based on current contracted prices of 13.5743p/kWh and 6.077p/kWh for electricity and mains gas respectively.

If all measures were implemented this would save the church around £9,900 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 2030 by undertaking the following steps:



3. Introduction

This report is provided to the PCC of Holy Trinity Church, Hurstpierpoint 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 Holy Trinity Church, Hurstpierpoint, BN6 9TS was completed on the 1st June 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 Keith Birtles, and Mary Gibbens.

Holy Trinity Church, Hurstpierpoint	CHURCH
Church Code	632250
Gross Internal Floor Area	815m^2
Volume	6665m^3
Heat requirement	210kW
Listed Status	Grade I I*

The church is typically used for 16 hours per week.

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	5.5 hours per week	180
Church Meetings and Groups	2 hours per week	
Community Use	7 hours per week	Annual Festival, Drama club, Pilates group, School visits and 15 annual concerts
Office	24 hours per week	
Occasional Offices	8 weddings 20 funerals	100 100

Annual Occupancy Hours: 860

Estimated Footfall: 20,550

4. Energy Procurement Review

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

The current electricity rates are:

Single / Blended Rate	13.5743p/kWh	Below current market rates
Standing Charge	21p/day	N/A

Supplier Total Gas & Power

The current gas rates are:

Single / Blended Rate	6.077p/kWh	Below current market rates
Standing Charge	87.08p/day	N/A

Supplier: Total Gas & Power

When the current contracts expire, lowest costs will be obtained from continuing with a group purchasing scheme. The current rates are lower than the market rate and should be retained at present.

Group purchasing schemes include the Diocese Supported parish buying scheme, http://www.parishbuying.org.uk/energy-basket and the Charities Buying Group

https://charitiesbuyinggroup.com

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	20%	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	Charged with 20% VAT	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

Holy Trinity Church, Hurstpierpoint used 8,800 kWh/year of electricity in 2021, costing £1,335 per year, and around 100,000kWh/year of gas, costing in the region of £6,700. The gas figure is an average of the three years 2018, 2019 and 2021.

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 - Church	K13B 000523	A1100 Three phase	No	Porch electrical cupboard
Gas – Church	E025 K01131 17 D6	Elster themis Bk-G15E	Yes	External cabinet, west end of building

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

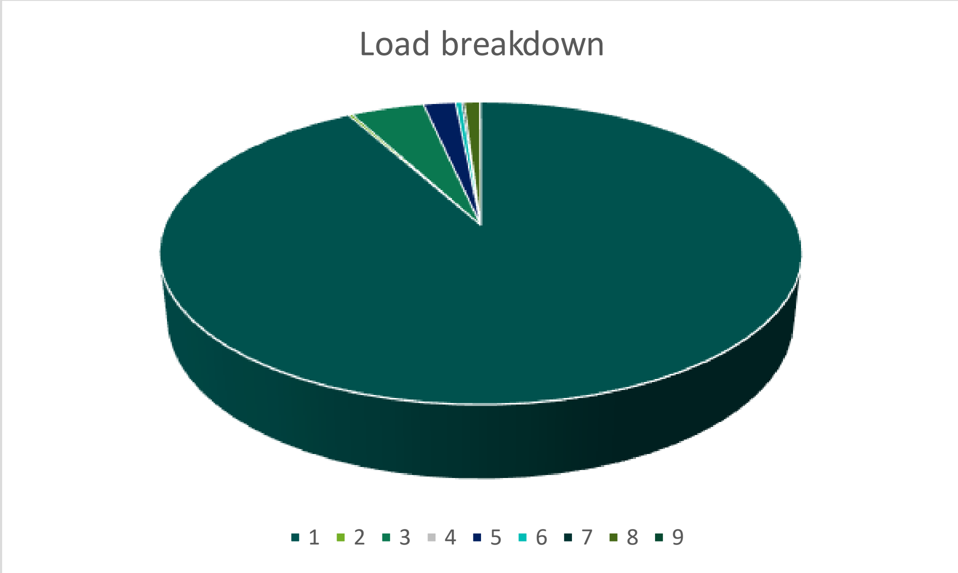
5.2 Energy Profiling

The main energy consuming plant can be summarised as follows:

	Equipment	Power kW	Annual Consumption kWh	Portion
Heating [Gas]	2 x Remeha Quinta Pro 65kW boilers 770 hours operation IF on full power	130	100,000	91.9%
Heating [Electric]	Boiler circulating pumps 2 x 150W Kitchen convector heater (rarely used)	0.3 3	230 20	0.2%
Lighting [Internal]	CHURCH 860 hours use 56 spotlights 30 floodlights Rear Areas and kitchen Office and vestry areas	 4500W 800W 400W	 4000 650 150 TOTAL 4800	 4.4%
Lighting [External]	3 security lights (one each Bulkhead CFL, CFL and LED) PIR control	60	10	0001%
Hot Water	Kettle Urn Fixed water heater, 3 hours/week use Dishwasher, used twice weekly, short cycle Fixed 20L water heater [for toilet taps] recently disconnected. 100W heat loss from copper pipework	3 3 3 5 3	300 300 460 40 1000 TOTAL 2100	 1.9%
Kitchen	Microwave (rarely used) Fridge (on constantly) Large oven and hob (low use) Extraction fan	1 0.1 5 0.2	10 300 60 30 TOTAL 400	0.3%
Office	In use three days per week 1 Workstation Photocopier	 0.1 0.5	 130 30	 0.2%
Sound, Music	Large Sound system(est10 hours/week) Organ Organ humidifier	1 1	530 420 80	0.9%
Small Power	Vacuum cleaner	1.5	50	0.05%

Sum of estimates: 8,800kWh

Annual site electricity consumption, 2021: 8,800kWh



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

5 Hot water *6 Kitchen* *7 Office* *8 Sound, music* *9 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 hot water.

5.3 Energy Benchmarking

In comparison to national benchmarks for church energy use[1], Holy Trinity Church, Hurstpierpoint uses 60% less electricity and 21% less heating energy than is average for a church of this size.

The low electricity use is partly due to low "hall" use of kitchen and hot water. Gas use is below average as efficient modern boilers are in use.

	Size (m^2 GIA)	Annual Energy Usage (kWh)	Actual kWh/m^2	Benchmark kWh/m^2	Variance from Benchmark
Holy Trinity Church, Hurstpierpoint (elec)	815	8,800	10.8	27	-60%
Holy Trinity Church, Hurstpierpoint (gas)	815	100,000	122.7	156	-21%
TOTAL	**815**	**108.800**	**133.5**	**183**	**-27%**

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

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

The rear three bays have been adapted as meeting rooms, with underfloor heating.

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.

The current gas fired heating system, installed in 2013 is relatively modern and is efficient.

The church is divided into two heating zones. Zone 1 consists of the meeting rooms and kitchen, which have been created from the west end of the nave by constructing a mezzanine floor over the three west bays and using glass screens. This zone has underfloor heating.

Zone 2 is the rest of the church, including the entrance area and is heated by modern cast iron radiators in the church and pressed steel radiators in the office area.

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
Church	6665	0.0033	220

The rear portion of the nave which is fitted with underfloor heating will have insulation below this; accounting for around 1/8 of the floor area. A 5% saving gives 210kW heat requirement.

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

.

7. Improve the Existing Heating System

Heating is supplied by two Remeha Quinta Pro boilers of 65kW each. These supply an underfloor heating system in the west end of the nave and a network of radiators installed together with the boilers.

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 Purchase a Temperature Datalogger

Purchase of a temperature datalogger will allow an accurate understanding to be built up of the temperatures in the church rooms and church itself and inform when heating should be switched on and off, and thermostat adjustment.

Suitable equipment includes the Lascar Easylog EL-USB-1 or similar products from other manufacturers.

This can be used to monitor the temperature to which the church falls when the heating is off and thus avoid running the heating to maintain 10°C overnight when this is not necessary.

It is suggested that after using the device to identify hot and cold spots around the building, a reference position representative of the temperature in the seating area is chosen, and comparisons are made from the same point.

8. Future Heating Options

8.1 Options Overview – use pattern and seating roof type, building width

The church is currently seated using approximately 100 moveable chairs.

The low hours of use of the church itself of around 16 hours per week is too low for technical success of an Air Source Heat Pump supplying radiators.

The building is too wide for radiant infra red panel heaters to be suitable, and the nave roof height and structure is unsuitable for ceiling mounted radiant infra red units.

Chandelier mounted visible radiant quartz heaters (which are usually, when installed in churches, suspended from arch centres) would only align with a small amount of seating here. It is not normally considered aesthetically suitable to suspend them from high nave roofs. There is always the issue of hot spots.

8.2 Heat Pumps: delivering more kWh of heat than electricity used

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.

Air Source – the low hours of use of the church, around 16 per week are insufficient for this technology. Also, a new installation of large radiators would be required; the existing two are insufficient.

A Ground Source Heat Pump is compatible with the existing underfloor heating and could be configured to operate with the radiator network. Due to the existing zonal system it would be sensible to have two separate networks which are separately optimised.

The heat pump plant could be located in the existing boiler room under the west end of the building. The challenge is to identify a suitable location for boreholes. The churchyard is mostly full of burials so does not offer sufficient area for ground loops.

A town centre location which has successfully installed a ground source heat pump with boreholes radiating from one corner of the churchyard is St Mary the Virgin, central Ashford (NB there are five St Mary the Virgins in the town).

8.3 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.

Electrically operated ground source heat pumps can provide around 4 times the amount of heat in kW which they consume in electricity (This is termed the Coefficient of Performance, CoP). They are compatible with underfloor heating, which typically runs at fairly low water temperatures, but not with high temperature heating systems. 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°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.

If the heating power is the same as the current boiler, a 130kW output Ground Source Heat Pump operating at CoP 4 requires 32.5kW of electricity.

Current costs per hour for gas (assumes boiler operates at full power, which it will when warming the building from cold)

Gas boiler costs 130kW x 6.077p/kWh = 790p/hour

GSHP costs 32.5kW x 13.5743p/kWh = 441p/hour

The heat model, estimating a steady state heat loss rate of 210kW estimates a far greater heat requirement (it is often within 10% of the boiler power installed in a church).

Recalculating for 210kW of heat

GSHP costs 52.5kW x 13.5743p/kWh = 712p/hour

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 Fixed Water Heater: Timer Control

An Ariston 20 litre water heater is located in a cupboard near the disabled toilet. This has been disconnected.

These kind of tanks are well insulated, the copper pipework is not and is a constant source of heat loss of around 100W (incandescent light bulb) and will waste around 900kWh per year, costing around £150. It is recommended that, if it is to be reused, it is fitted with a 24 hour/7 day timeclock to replace the fused spur switch. An example of such a unit would be a TimeGuard FST77. They should be set up with times to match the times that the building is occupied This will prevent the standing losses from the unit wasting energy during periods when the building is not occupied.

Note that a 20 litre tank will only deliver half this volume of hot water. As the water is drawn, it is replaced by cold, so the second half of the tank will be lukewarm.

An alternative is to replace the whole unit with a point of use water heater immediately in advance of the kitchen tap. This will then heat only the water actually required.

Such units can be purchased at any electrical wholesaler and fitted by your existing electrician or any NICEIC registered electrical contractor.

9.2 New LED Lighting

The lighting makes up a relatively large overall energy proportion of the electricity used within the church. There are a large number of both spotlights and floodlights. Some LED units appear to have been fitted, but the majority of the installation appears to be AR111 halogen bulbs with the lowest rating at 35W.

Some of the lighting in the rear area of glass walled rooms uses CFL bulbs.

It is recommended that all the lighting is changed for LED. 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/

The LED lights chosen must be compatible with the dimming / control system used. As much of the installation is at high level, 5m or above, a lighting contractor with access equipment will be needed. This does not necessarily require an expensive relighting scheme if bulbs compatible with the existing luminaires can be sourced.

9.3 Power Management Settings on Computers

All computers can be shut down or put into a hibernate mode but this is often not 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.

10. Energy Saving Recommendations – Building Fabric

Draught Proof External Doors

There are a number of external doors in the church. These have the original historic timber doors on them, but these do not close tightly against the stone surround and hence a large amount of cold air is coming in to the church around the side and base of these doors.

The door to the south of the south vestry, which is constructed of diagonal planking has a large number of gaps between the planks (the wood may have shrunk). This door may be in need of some conservation work. Whilst small holes and gaps can often be filled with plasticene, the number and regularity of places where light is shining through is worth further investigation.

There is a large gap to the bottom left, due to a hinge. This could be filled with some flexible material such as heavy duty black plastic (rubble sack).

It is recommend that the draughtproofing around doors are 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 (see link below) is often used in heritage environments to provide appropriate draught proofing.
http://www.theenergysavers.co.uk/application/files/1714/7197/4194/National_Trust_Case_Study.pdf

For timber doors that close onto a stone surround more traditional solutions such 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 be used and keeping the door maintained in a good condition is important.

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

11. Saving Recommendations (Water)

11.1 Detergents for Cold Water Hand washing

Use of cold water for hand washing can be just as effective as using hot.

https://www.nhs.uk/news/lifestyle-and-exercise/cold-water-just-as-good-as-hot-for-handwashing/

12. Other Recommendations

12.1 Safety Equipment

It is recommended that a Carbon monoxide monitor is placed in the underground boiler room.

The area is accessed down a vertical metal ladder. There should be two persons present when the area is visited in case of incident.

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	No – low hours of use
Ground Source Heat Pump	Yes

13.1 Solar Photovoltaic Panels

Most of the roof is visible from the ground apart from parts of the valleys each side of the chancel.

The north chapel and chancel roofs offer areas of up to 40m^2 and 30m^2. A 60m^2 system could generate 0.15kWpeak/m^2 giving a 9kWpeak 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
Chancel	35	5.25	190 degrees / 40^0 0.98	0.9	4,630
North chapel	25	3.75	190 degrees / 40° 0.98	0.8	2,940
Total	60	9			7,570

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 lower than the church centre's annual recent electricity use (8,800kWh in 2021). Solar power would run the office and lighting for much of the year apart from the winter.

If heat pumps were installed, this would require extra power, 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 9 kWpeak system would cost £13,050.

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.