Energy Efficiency and Zero Carbon Advice

St Botolph's Church, Aspley Guise
PCC of St Botolph's Church

Author	Reviewer	Audit Date	Version
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Contents

1. Executive Summary

An energy survey of St Botolph's Church, Aspley Guise 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. This audit has been provided in conjunction with 2buy2, the Church of England's Parish Buying scheme provider and is subsidised from Total Gas & Power, the Parish Buying schemes principal energy suppliers.

St Botolph's Church, Aspley Guise is a Grade II* listed church originating in the 14th century with extensive Victorian rebuilding. It has a small hall and facilities attached to the north, constructed c. 1995. There is both gas and electricity supplied to the site.

The church has a number of ways in which it can be more energy efficient and a clear path towards net zero carbon. 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 and the route to net zero carbon diagram below are used as the action plan for the church in implementing these recommendations over the coming years.

Energy and decarbonisation recommendations	Estimated Annual Energy Saving (kWh)	Estimated Annual Cost Saving (£)	Estimated capital cost (£)	Payback (years)	Permission needed	CO2 saving (tonnes of CO2e/yr)
Draught proofing works	1% 1,400	£140	£250	2	Consult DAC	0.25
Flush and clean central heating system	7% 10,000	£1,000	£500	0.5	List B	1.8
Install Magnetic Particle Filter, if keeping radiators	N/A	N/A	£500	N/A	List B	-
Install a point of use boiling tap	200	£64	£300	5	List B	0.04
Install secondary glazing in Link Room	10% 7,000	£700	£100 acrylic	<0.5	List B	1.2
Install roof insulation in Link Room	10% 7,000	£700	£2,000	3	Faculty	1.2
Install heat pump for Link Room	70,000 gas 17,500 electric use	£1,500 with Air to Air Heat Pump	£3,825	3	Faculty	8.9
Install Under Pew heating in church	70,000 gas 53,000 (full) or 21,000 (40%) electric use	£5,400 £6,400 (40% of pews fitted	£35,000 £14,000 (40% of pews fitted)	6.5 2.5	Faculty	1.4 8.1
Consider registering for Eco Church	The Eco Church programme, which is recommended by the Church of England, helps congregations care for the environment in all aspects of church life. The programme is free; you can, however, make a donation to A Rocha UK towards its costs.					

Create a procurement policy for appliances (and other goods)	Commit to buying only appliances with the new energy efficiency ratings of A, B or C at the lowest when those you currently have reach the end of their useful life. (NB ovens, air conditioners and space or water heaters are still on the older rating scale, so for these, try for A+++.)

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

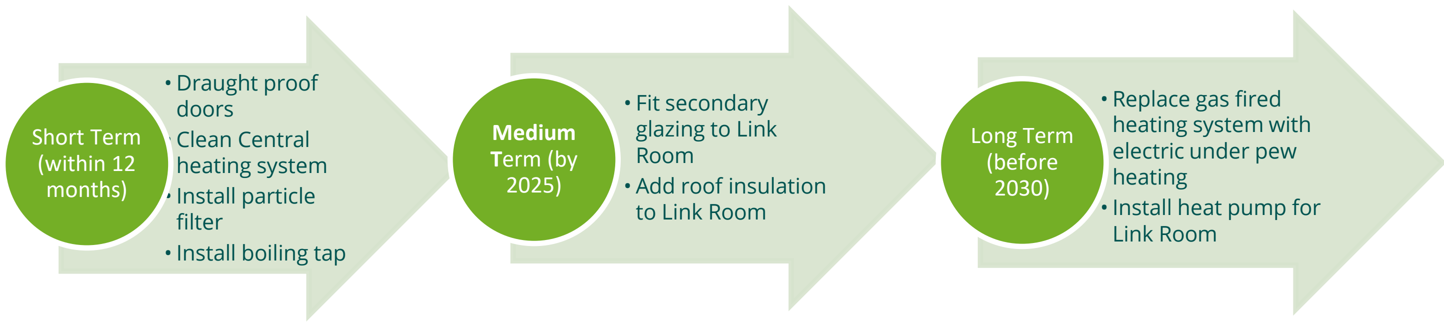
Figures in the table are based on current contracted/market prices of 32p/kWh and 10p/kWh for electricity and mains gas respectively. The carbon figures are based on the DEFRA 2022 carbon emission factors of 0.211 for electricity, 0.18 for gas and 0.27 for oil. Do note that as energy prices increase, payback periods decrease.

2. The Route to Net Zero Carbon

Our Government has committed to move towards Net Zero Carbon – the point at which we have reduced emissions as much as we can and then balanced any residual emissions through removal of carbon from the atmosphere. They have done this as part of a worldwide agreement which aims to limit global warming to well under 2 degrees Celsius, with an aim of keeping it below 1.5 degrees Celsius. This will help protect all of us from the impacts of climate change.

In February 2020, the Church of England's General Synod set its own Net Zero Carbon target. The first stage of this target covers energy used by churches, cathedrals, schools, vicarages, other church buildings, as well as emissions caused by reimbursed transport. The target date is 2030.

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 St Botolph's Church, Aspley Guise 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 and seek to improve 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 Botolph's Church, Aspley Guise, Church Street MK17 8HN was completed on the 27th January by Dr Paul Hamley. Paul is an energy auditor with experience of advising churches and small businesses. He is part of the Diocesan Environment Officers Energy Group developing advice for the Church of England and authored the "Assessing Energy Use in Churches" report for Historic England. He is a CIBSE Associate member and a Chartered Scientist, with experience of the faculty process gained from chairing the building committee of a Grade I listed church.

St Botolph's Church, Aspley Guise	Church	Link Room
Church Code	632255	
Gross Internal Floor Area	315m^2	165m^2
Volume	2,020m^3	380m^2
Heat requirement	66kW	11.5kW
Listed Status	Grade II*	
Average Congregation Size	30	

The church is typically used for 5 hours per week and the *Link Room* for the following activities

Type of Use	Hours Per Week (Typical)
Services	3 hours per week
Meetings and Church Groups	*Occasional socials and meetings*
Community Use	*Bridge, craft group, Rainbows*
Occasional Offices	4 Weddings 12 Funerals

4. Energy Procurement Review

Energy bills for gas and electricity have been supplied by the church.

The electricity rates applying in December 2021 were:

Single Rate	24.255p/kWh
Standing Charge	37.415p/day

The gas rates applying in February 2022 were:

Single Rate	4.23p/kWh
Standing Charge	39.3p/day

Supplier: EOn

The electricity is supplied by Opus Energy, and is purchased on a renewable tariff. The church would be congratulated for procuring its supplies from a 100% renewable tariff and is encouraged to continue this.

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.

The church is a charity and therefore can claim VAT exemption status. This should always be done when changing supplier. 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.

5. Energy Usage Details

5.1 Annual Consumption Data

St Botolph's Church, Aspley Guise used 2,870kWh of electricity in 2021, costing £680, and approximately 141,850kWh of gas [scaled from 190,040kWh over a 489 day period from 29/09/2020 to 01/02/2022, costing £6,466.

The total carbon emissions associated with this energy use are 31 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	Location
Electricity – Church	E15BG01588	EDMI Atlas Mk7c Single phase	Yes	Cupboard, west end of north aisle
Gas – Church	M016 A11529 01 A6	Schlumberger metric	Yes	Link building, main room

All the meters are AMR connected and as such obtaining an energy profile for the entire energy usage from the suppliers should be possible.

5.2 Energy Profiling

The main energy consuming plant can be summarised as follows:

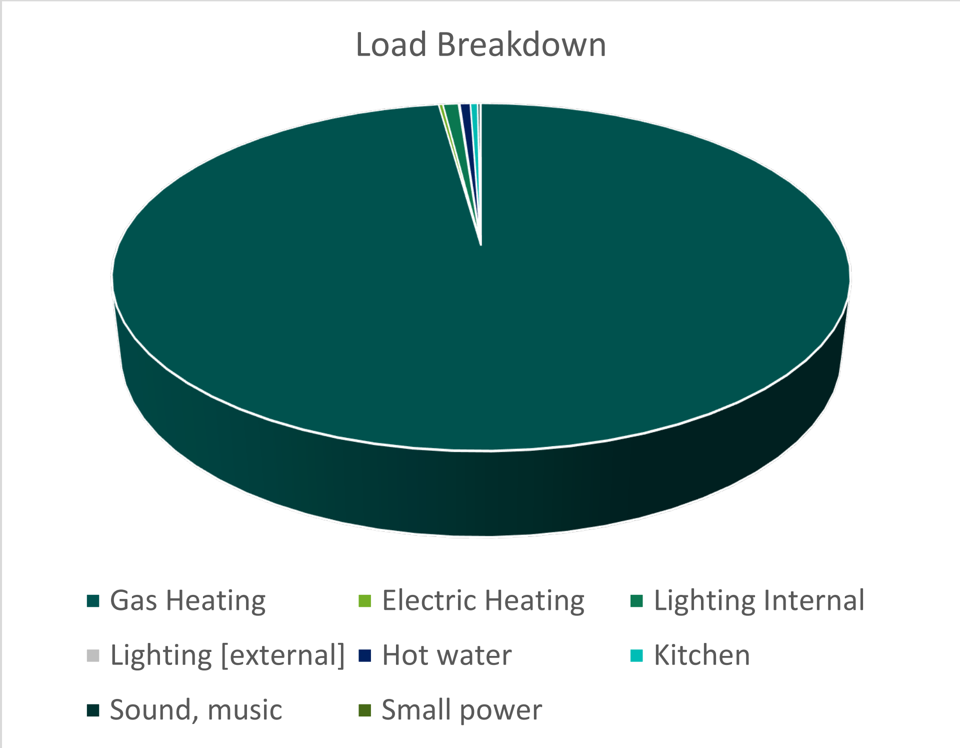
	Equipment	Power kW	Annual Consumption kWh	Proportion
Heating [Gas]	Ideal Concord CX boiler, 88kW input, 70kW output [1,600 hours operation]	88	141,850	97.7%
Heating [Electric]	Boiler circulation pump [1,600 hours] Portable heater (recent use only to dry out Trinity Rooms after a water leak).	200W 3	320 Not included in annual totals	0.22%
Lighting [Internal]	Church 720 hours use LEDs 42 x 6W LED spotlights 6 x 10W Link Rooms Fluorescent 2 x 58W LED recessed 18 x 5W Bulkhead 7 x 28W	 252W 60W 116W 90W 196W	 940 240 TOTAL 1180	0.81%
Lighting [External]	Pathway pedestal lighting	100W	100	0.07%
Hot Water (electric)	Fixed water heater under sink - normally turned off Kettle Dishwasher (domestic), 2 hours / week	3 3 3	200 300 300 TOTAL 800	0.55%
Kitchen	Oven Extraction fan Microwave oven Fridge	3 0.2 1 0.15	70 10 20 450 TOTAL 550	0.38%
Sound, Music	Organ Sound system	1 0.5	100 100	0.14%
Small Power	Vacuum cleaner	1.5	50	0.03%

Sum of electricity use estimates: 3,200kWh

The kitchen is used for warming food only, and the lighting is LED. Estimating use of the wall mounted convector heaters in the toilets and occasional use of the wall mounted fan heaters informs that the storage heaters are the major users of electricity on the site.

Annual church electricity consumption, 2021: 2,870kWh

Annual church electricity consumption, reported in application (2022?): 3,209kWh



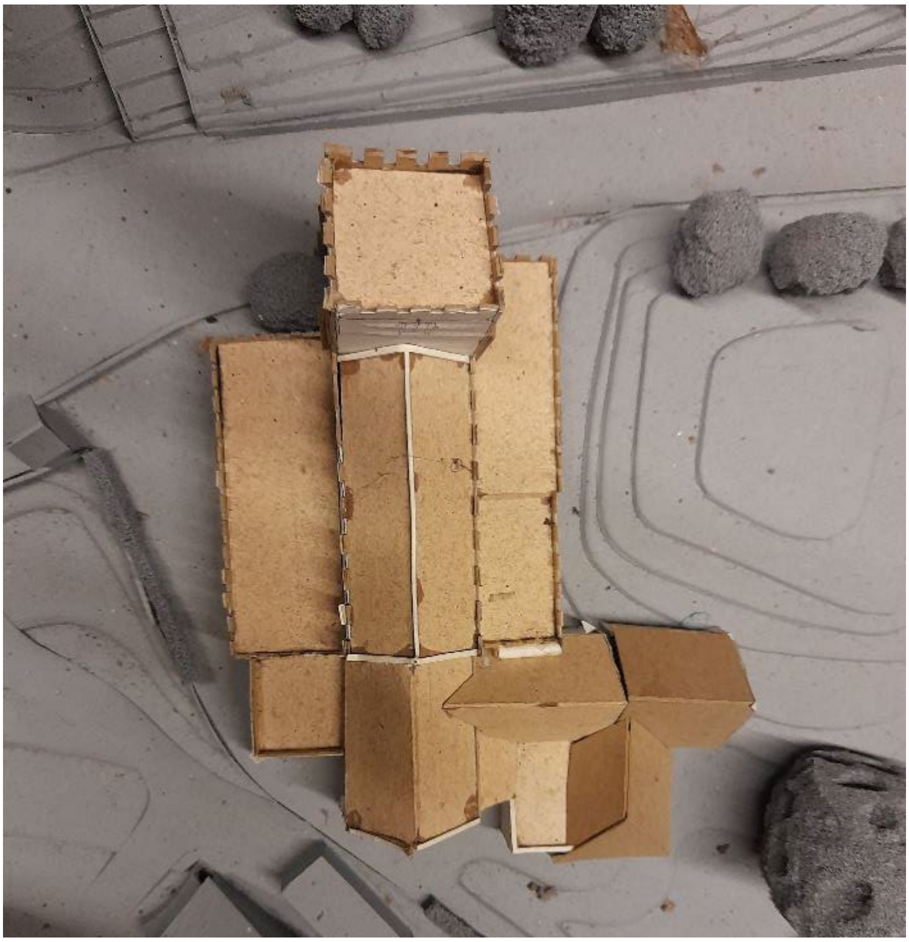
As can been seen from this data, the heating makes up by far the largest proportion of the energy usage on site.

5.3 Energy Benchmarking

In comparison to national benchmarks for church energy [1] use St Botolph's Church, Aspley Guise uses 65% less electricity and 99% more heating energy than would be expected for a church of this size. It should be noted that the national benchmarks do not make any specific adjustment for the amount of time the church is used and the usage of this church will therefore affect how it performs against this benchmark.

	Size (m^2 GIA)	St Botolph's Church, Aspley Guise use kWh	St Botolph's Church, Aspley Guise use kWh/m^2	Typical Church Use kWh/m^2	Percentage compared to Typical
Electricity	480	3,200	6.7	19	35%
Heating Fuel	480	141,850	295	148	199%
TOTAL	480	145,050	302	167	181%

1 Shrinking the Footprint, Church of England report, 2013. Data for medium sized churches.



Model of church showing the Link Room and kitchen bottom right.

6. Efficient / Low Carbon Heating Strategy

6.1 Overview

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 near future. 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' in the foreseeable future.

It is therefore important to review and set out a plan to make heating more efficient and less carbon intensive. One way to achieve this is to consider a transition to electrical heating where this also represents an efficient and comfortable solution for churches. 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 oil and coal-fired power stations.

6.2 Present Heating System

The church is currently heated by a gas fired Ideal Concord CX70 non condensing boiler of 88kW input, 70kW output. This is around 20 years old and can be expected to require replacement within the next few years.

The boiler provides heating to eight cast iron column radiators located around the interior of the church, mostly near columns. The number of radiators may be insufficient to deliver heating at more than a very slow heat up rate. The image below shows small diameter pipework, which may be a factor in the poor performance of the system. Heating is normally on from 03:00 on a Sunday and from 18:00 the previous day when cold. 16 hours heating is reported to be needed to reach 17ºC. A combination of poor heating performance and a frugal approach to expenditure resulted in temperatures on the day of the visit inside the building varying from 2.8ºC (south wall) to 4ºC (floor). If the church heating circuit contains much narrow diameter pipework, this may be preventing sufficient water flow and mean that the effectiveness of any new boiler is significantly reduced.

The Link Rooms (Meeting room, kitchen, upper room) are heated by twin wall pressed steel radiators on a separate heating circuit supplied by the same boiler.

6.3 Future Heating Options

The church has low hours of use, three hours on most weeks, which argues against installation of a heat pump system (there are insufficient hours of operation for a defrost cycle to work with not enough heat stored in the building. It would be inefficient / expensive to run the system for many more hours than the building is occupied). Also the radiator and piping network are unsuited to the lower temperature water supplied.

The Link rooms have been hired out for three or more meetings per week. It has been proposed to increase their use with a weekly food and warm space event, and creating office space with space for 2 to 3 desks in the first floor room. The latter would require regular heating. The existing twin wall radiators should be evaluated for use with an Air to Water Heat Pump system and detailed quotes obtained to compare this with an Air to Air system.

The various options for a decarbonised heating solution have been reviewed in the table below.

Decarbonisation Heating Solution	Viable
Air to Water Source Heat Pump	Church: No – unsuited to current heating pipework and heat emitters and very low hours of use Link Rooms - yes
Air to Air Source Heat Pump	Church: No – low hours of use Link Rooms - yes
Water Source Heat Pump	No – no water source locally
Ground Source Heat Pump	No – significant archaeology, low hours of use
Under Pew Electric Heating Panels	Yes
Electric Panel Heaters (to provide supplemental heating only)	No – not required
Over Door Air Heater (to provide a supplemental warm welcome at the door only)	No – architecture around door would not permit unit to be fixed
Overhead Infra-Red Heaters	No – visual intrusion to the church would do harm, least preferred heating source due to comfort
Heated Chair Cushions	Possible to offer “top up” heating

The recommendation is therefore that the church consider Installation of under pew heaters and compare quotations for heat pumps for the Link Rooms as described below.

6.4 Install Electric Under Pew Heaters

Electric under pew heaters provide a high level of thermal comfort to people sat in the pews. They are not installed to try and heat the entire air volume of the church, instead thermal comfort is achieved through a flow of warm air rising past the person in the pew. This means that the heaters should be installed under the entire length of all the pews that are likely to be used.

These heaters warm up almost instantly and a flow of warm air over the pew area is created within around 15 minutes of their being turned on. This significantly reduces the amount of preheating required before each use of the building and can make electric heating cost competitive with gas. It is important that this reduced 'on time' is properly reflected in any comparisons with other types of heating.

We would therefore suggest that the following works could be considered:

Install under pew heaters suspended from brackets from the underside of the pew seat as follows:

There are 40 pews in total

North aisle, 8 pews of 1.84m, (<90cm spaces) x 2 450W heaters

3 pews of 3.06m x 2 650W heaters

Centre 6 pews of 1.98m x 2 650W heaters

9 pews of 4.60m x 4 650W heaters

South aisle, 13 pews of 1.67m x 2 450W heaters

1 pew of 4.60m x 5 650W heaters

Capital cost (full installation) 62 x 650W BN65 heaters £21,142 + 42 x 450W BN45 heaters £13,818 = £34,960.

Total power output 59kW. This is with all units on, and they should be individually switched off when pews are empty. Current space heating provision is 70kW at the boiler and less with losses in pipework. Lower output is required from pew heating solutions as they directly heat the people sat in the pew rather than attempting to heat the entire air volume within the church.

This would provide heating in every seating position, seating over 100. The regular congregation of 20 to 30 would not require this level of provision. Installing heaters in 40% of the possible positions would cost around £14,000 with a maximum output (all heaters on) around 24kW. This is less, as the heat is provided directly to the congregation and there is no need for space heating from the ceiling downwards.

This is costed for a full installation, however with the small size of congregation (under 30) a partial installation could be provided, lowering capital costs.

Operating costs: (full installation) 3 hours per week x 30 weeks x 59kW x 32p/kWh = £1,699

(40% installation) 3 hours per week x 30 weeks x 23.6kW x 32p/kWh = £680

Gas cost (at March 2023 rates) *HALF of* 141,850kWh x 10p/kWh = £14,185/2 = £7,092

(split between church and Link rooms uncertain – Link rooms have higher hours but a smaller circuit)

Cable runs to the pew heaters should run along the along the existing routes (all cabling should be in armoured cable or FP200 Gold when above ground) to both rows of pews. Each pew heater to be switched with a neon indicated fused spur located underneath the pew seat.

A case study of a church which has adopted this solution is available at https://www.churchofengland.org/about/environment-and-climate-change/st-andrews-chedworth-electric-heating

Photos of installations are shown below. In addition, several churches have recently installed such systems. If you would like to find out about churches whom you could ask about their experiences, please contact the diocese.

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.

6.5 Air to Water Source Heat Pumps

Air-to-Water Source Heat Pumps (AWSHPs) work by having an external unit which sucks air in and extracts the heat from it. 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 to 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. AWSHPs provide around 3 units of heat for every 1 unit of electricity used in the heat pump; they therefore have a Coefficient of Performance (CoP) of 3.

The Centre for Sustainable Energy model[1] 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
Link Rooms	380	0.03	11.5
With added insulation/secondary glazing	380	0.025	8.5

Therefore, a heat pump of 11.5kW output would be required. Less power is required if insulation is added.

AWSHPs 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

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

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 AWSHP comprising of three smaller 3kW units of 10kW output and two larger 10kW units of 37.5kW output

One small unit is probably sufficient for the Link Rooms.

Capital costs are around £400 per kW output.

Operating costs (assuming the heat used is 50% of annual gas consumption, so 70,000kWh)

70,000/CoP 2,5 = 28,000kWh x 32p/kWh = £8,960

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

6.6 Air to Air Source Heat Pumps

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. AASHPs 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 up to 4.5.

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
Link Rooms	380	0.03	11.5
With added insulation/secondary glazing	380	0.025	8.5

As above, a heat pump of 11.5kW output would be required. Less power is required if insulation is added.

One small unit is probably sufficient for the Link Rooms, although two units, one each side of the building may reduce pipework complexity and installation costs.

Capital costs are around £450 per kW output.

Operating costs (assuming the heat used is 50% of annual gas consumption, so 70,000kWh)

70,000/CoP 4.0 = 17,500Wh x 32p/kWh = £5,600

This is a cheaper operating cost than gas but would require replacement of the radiator network with new heat emitters.

Internal units come in a variety of styles.

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

FUA-A - Under ceiling cassette air conditioning unit

Unique under ceiling cassettes for high rooms with solid ceilings or false ceilings with a shallow void. Suitable for all types of commercial applications.

The FUA-A range provides comfortable heating and cooling even for rooms with high ceilings and has individual louvre control flexibility to suit every room layout.

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

6.7 Heated Pew / Seat Cushions

Most are now familiar with the concept of heated seats within cars; the same solution is also used in some outdoor venues such as alfresco dining and sports stadiums. These provide a heated cushion to sit on: the direct warmth from the contact areas provides a degree of comfort even when the surrounding space is cold. This can be a useful solution for churches which only have chairs (having removed pews) and/or for small congregations where there are few other alternatives.

There are a variety of heated seat cushions on the market. Some are directly plugged into a power socket (similar to an electric blanket). Others have battery packs, which can be charged and then connected to a seat pad. This makes them more flexible and avoids trailing leads. The more advanced products have a pressure sensor which means heat is only provided when someone is sitting on the cushion. Heated pads for 'benches' can also be used to heat a pew or could even be adapted to form a heated kneeler for the communion rail.

It is recommended that the church consider trialling a small set of heated cushions to provide extra heating for those who feel the cold, as a top up in very cold periods, for smaller services and for use at the beginning and end of the heating season (shortening it).

A case study of a church using heated cushions is available at https://www.churchofengland.org/about/environment-and-climate-change/towards-net-zero-carbon-case-studies/marown-church-tries-new

6.8 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 existing electrical supply from single phase 100A supply to a 3 phase 100A supply.

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

The cost of bringing in a new 3 phase supply can range from £300 to £30,000. The DNO will provide a quotation for free, so it is well worth obtaining a quotation even if plans are not yet certain, so that decisions can be made on a well-informed basis.

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. These should include:

7.1 Discontinue with Background Heating Strategy

This has been implemented and the policy should be maintained.

Most traditional churches were constructed without any form of heating. The modern addition of heating is not needed to preserve the fabric but only to provide thermal comfort to occupants. The previous trend of 'conservation heating' for fabric issues is now largely considered to be unnecessary and is being avoided by the likes of National Trust and English Heritage. The only times when background heating may be required is if there are historic wall paintings or for the preservation of large artefacts such as tapestries. The organ (and other sensitive areas such as historic papers stored in the vestry) may require some local background heating specific to that area. In general, sensitive paper records should be removed for storage in the county archive. Organs can be installed with a local background tube heater within the organ casing in order to provide the heat where it is required. The fabric is often subject to the greatest damage by humidity (which is naturally higher when the air is warmer as warmer air has greater capacity for holding more moisture), as a result of large temperature swings (from central heating systems turning on and off) and from the excessive drying out/baking of timbers where high temperature heating units have been fixed to them (such as overhead heaters fixed to timber wall plates).

Providing constant background heating to the church building as a whole is excessive and wasteful of energy. At the very least we would recommend that this background level is reduced to a maximum of 12°C and ideally avoided all together.

7.2 Clean the Existing Heating System

Magnetic sludge builds up and circulates within heating systems. This will preventing the proper and efficient operation of the system by reducing both the ability of the boiler to heat up the water and the output of the radiators. It is similar to how scale build up can adversely affect kettles and showers.

The church should have a record (in the log book) of when the system was last cleaned. If > 5 years ago and the system is to be retained for more than a year, cleaning is recommended.

It is strongly recommended that the heating system is cleaned to remove this sludge from the system. This is done by using a chemical clean and/or power flush procedure in which cleaning chemicals are put into the system, which is then turned on and run through a filter consisting of high-power magnetics to remove the sludge.

The cleaning of a heating system can be carried out by any competent heating engineer and typically increases the efficiency of a system by between 10 and 15%. This can dramatically improve comfort for the congregation.

8. Energy Saving Recommendations

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.

8.1 Timers on Fuse Spurs to Water Heaters

There are various electric hot water heaters and water boilers (for tea-making and the like) located around the church. These only need to heat the water to the required temperature when the building is in occupation but at the moment these heaters are directly wired in without any form of time control and therefore maintain their set temperature 24/7.

It is recommended that the heaters are fitted with a 24 hour/7 day timeclock to replace the fused spur switch. 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.

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

8.2 Draught Proof External Doors

There are a number of external doors in the church. Where doors do not close tightly against the stone surround (as can be seen below), a large amount of cold air will 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.

Such measures should be considered carefully around bat conservation needs to ensure that access points bats use are not disturbed. Check your draught excluding plans with the Bat Conservation Trust's free helpline: 0345 1300 228 https://www.bats.org.uk/

8.3 Secondary Glazing

The windows of the Link Room building are singled glazed with metal frames. Given that the windows to this area is are relatively small and have simple surrounds, and that they are not primary or important windows within the church, they would be suitable to have secondary glazing installed.

Secondary glazing could be installed within the window reveal (the blind could be moved out of the recess and onto the lintel above). This could utilise either glass units (cost estimate around £550/m^2) or acrylic panels. There are several companies who supply these cut to size.

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.

Any possible installation would need to be carefully specified.

8.4 Insulation to Roof

The loft void above the kitchen ceiling was inspected as part of this audit and found to have little or no insulation present. In 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.

Because heat rises, the ceiling/roof of a building is the largest contributing area to heat loss from a building. 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.

This area above is proposed to be developed to a lettable office area. Thus it will be used regularly and should be fully insulated to reduce operating expenditure and increase comfort levels.

9. 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 Photo Voltaic (PV)	Yes, but delay installation
Battery Storage	Only if regular evening use achieved

Now that the Feed in Tariff scheme has come to an end, the installation of solar PV panels in situations where there is not almost full usage of the electricity generated on site is not really viable.

The recent electricity use of 3,000kwh is low. If installation of heat pumps and regular daily use of the Link Rooms occurs, installation of a small solar PV array sized to match demand is recommended. A heat pump supplying 70,000kWh would need 17,500kWh (Air to Air type) or 28,000kWh (Air to water type), with present requirements of the Link Rooms being 2000kWh p.a. and a further 500kWh lighting use added.

The Link room roofs are in the shadow of the church, an installation on the south aisle (relatively flat) roof behind the parapet may be suitable.

The following formula calculates annual generation:

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

Panels mounted in the hall roof could be on supports at the optimum angle. The optimum size of installation may be smaller than the maximum outlined below.

Roof Section	Area / m^2	System Size / kW peak	Orientation factor	Shading factor	Annual Generation, kWh
South aisle	60	9	180 degrees / 10^0 0.93	1	8,370

A 9kW peak system would cost in the region of £11,700.

Battery storage is not strictly a renewable energy solution, but it does provide 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 solar PV is no longer generating. It therefore extends the usefulness of the existing solar PV system particularly in this sort of church. This is a new but fast-growing technology with prices expected to fall substantially over the next 2 to 3 years.

10. Funding Sources

There are a variety of charitable grants for churches undertaking works and a comprehensive list of available grants is available on this Parish Resources page: https://www.parishresources.org.uk/resources-for-treasurers/funding/

11. 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 includes the installation of under pew heaters to pews which are made in or after 1850 and are not of historic interest.

All other works, including the like for like replacement of gas and oil boilers 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. This includes items such as solar PV installations.

12. Offsetting

12.1 Bats in Churches

The Bat Conservation Trust has a project with the Church Buildings Council Natural England, the Church of England, Historic England and the Churches Conservation Trust to address bat issues: *www.churchofengland.org/resources/churchcare/advice-and-guidance-church-buildings/bats-churches*