ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Mary's Hall, Goldington
PCC of St Mary's Church

Author	Reviewer	Date	Version
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1. Executive Summary

An energy survey of St Mary's Hall, Goldington 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 Mary's Hall, Goldington is a brick built single story building constructed in 1965 with a flat roof. A small extension was added in 2015 to the same profile. 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)
Contact suppliers to arrange for the meters to be changed to smart meters	None	None	Nil	N/A	None	N/A
Improve draughtproofing of entrance doors by adding an upstand to the flooring	1% 320	£32	£300	10	List B	0.06
Install roof insulation. [Planned to coincide with a need to re-roof the structure]	8% 2,560	£256	£6,500	25	Faculty	0.4
Install Cavity wall insulation	10% 3,200	£320	£5,250	16	Faculty	0.6
Install Air to Air heat pump system	32,000 gas Electric use 8,000	£3,200 - £2,560 Savings £640	£12,000	19	Faculty	4.0
Install solar photovoltaic panels	12,000	£3,840	£19,500	5	Faculty	2.5
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.

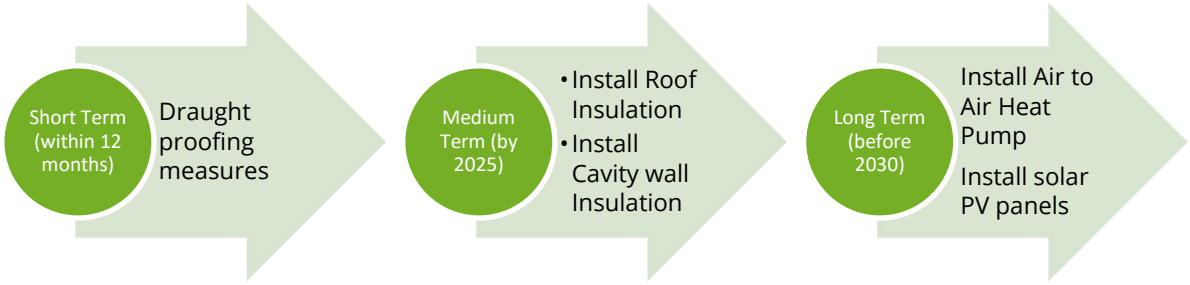
Figures in the table are based on current contracted/market prices of 30p/kWh and 10p/kWh for electricity and mains gas respectively. The carbon figures are based on the DEFRA 2022 carbon emission factors of 0.21107 for electricity, 0.18 for gas and 0.27 for oil. Do note that as energy prices increase, 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 Mary's Hall, Goldington 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 Mary's Hall, Goldington, Bedford MK410AP was completed on the 16th January 2023 by 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 Mary's Hall, Goldington	
Gross Internal Floor Area	325m^2
Volume	950m^3
Heat requirement	27kW
Listed Status	Unlisted

The hall is typically used for 32 hours per week, mostly for regular bookings with party bookings on many Saturday afternoons, church use on Sunday mornings and monthly on Sunday afternoons.

4. Energy Procurement Review

The current electricity rates are:

Day Rate	30.41p/kWh
Night Rate	22.56p/kWh
Standing Charge	39.868p/day [£36.38 / quarter]

Supplier: SSE Scottish Hydro (50.4% renewable).

The current gas rates are:

Single / Blended Rate	3.172p/kWh
Standing Charge	100.78p/day [£91.96 / quarter]

Going onto a fully renewable tariff is an important part of the process of taking churches towards net zero. The church is therefore encouraged to consider procuring its electricity from suppliers that offer 100% renewable electricity, and in some cases 'green' or 'carbon neutral' gas.

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.

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.

This should always be done when changing suppliers.

5. Energy Usage Details

St Mary's Hall, Goldington used 4,533 kWh/year of electricity during 2022, costing £1,381 per year, and 32,000 kWh/year of gas, costing around £1,600. The total carbon emissions associated with this energy use are 6.1 CO_2e tonnes/year.

This data has been taken from a summary of bills compiled by the church covering 1/1/22 to 25/11/22 and adjusted to 365 days.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Hall				Not observed
Gas - Hall	44479816 S	UGI Imperial, cubic feet	No	Boiler room

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.

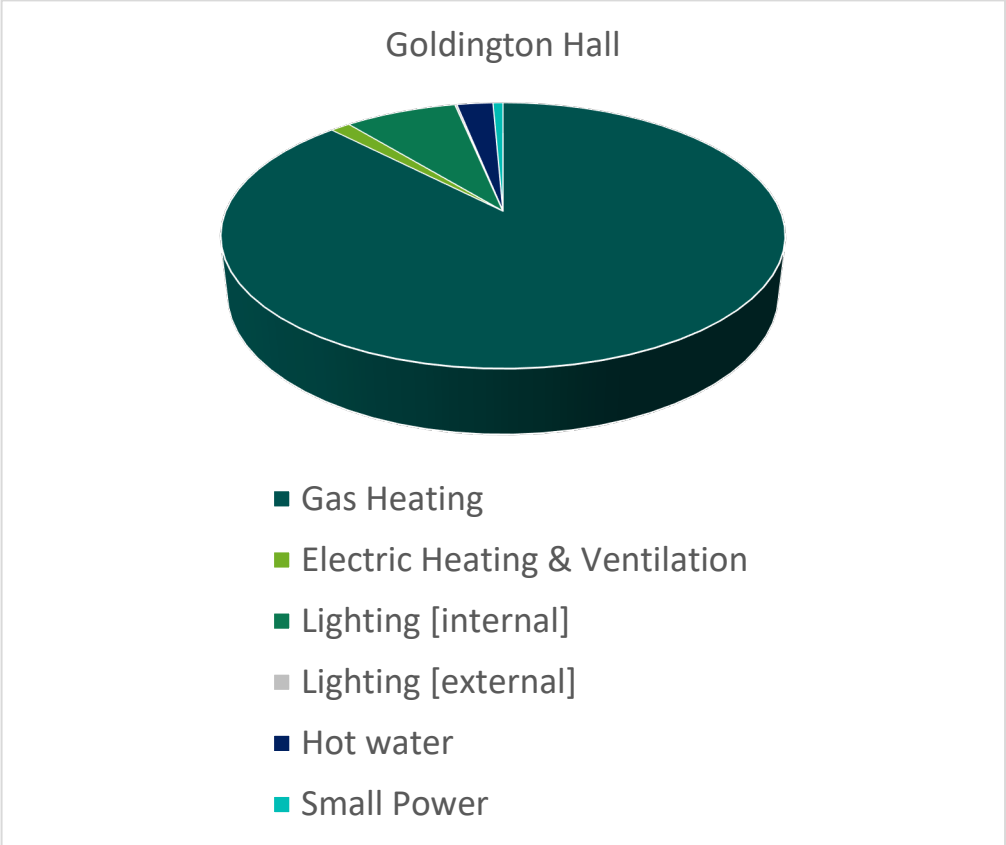
5.1 Energy Profiling

The main energy consuming plant can be summarised as follows:

	Equipment	Power kW	Annual Consumption kWh	Portion
Heating [Gas]	Blown air gas heater - unknown manufacturer. [hours operation] Gas cooker	Unknown	Currently 32,000	87.7%
Heating [Electric]	Portable heaters (2) in office	6	500	1.4%
Lighting [Internal]	Main Hall 20 fluorescent F70W Entrance foyer 3 bulkhead Toilets 4 LED tubes 10W Office 4 bulkhead 28W Kitchen	1400W 84W 40W 112W 100W	TOTAL 2,800	7.7%
Lighting [External]	Security lights		50	0.14%
Hot Water (electric)	Commercial dishwasher 2 uses per week. Kettles	5 3	750 150	2.7%
Small Power	Vacuum cleaner Microwave oven Office equipment	1.5 1	100 50 100	0.68%

Sum of electricity use estimates (church only): 4,500kWh

Annual hall electricity consumption, 2022: 4,533kWh



As can been seen from this data, the heating makes up by far the largest proportion of the energy usage on site. The other significant load is lighting.

6. Efficient / Low Carbon Heating Strategy

Above, main hall

6.1 Overview

The energy used for heating a church hall 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 church halls. 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 hall is currently heated by a gas heating system (below, left) blowing warm air into the main hall via vents at 2m hight level and also through a series of gratings around the perimeter of the floor.

This installation may date from when the building was constructed in 1965 although the heating unit is likely to have been replaced.

Hot water is supplied by a Main multipoint BF gas heater (below, right).

6.3 Future Heating Options

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	No – no radiator network
Air to Air Source Heat Pump	Yes
Water Source Heat Pump	No – no water source locally
Ground Source Heat Pump	No – no radiator network
Electric Panel Heaters	No – hall too large
Over Door Air Heater (to provide a supplemental warm welcome at the door only)	Yes, if required
Overhead Infra-Red Heaters	No – 32 hours use per week mean high operating costs compared to a heat pump

The recommendation is therefore that the church consider an Air to Air Heat Pump system as described below.

6.4 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[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
Main Hall	500	0.025	17
Remainer of building	450	0.025	11

Therefore, a heat pump of 17 kW output would be required for the main hall. The occasionally used office could continue to be heated by electric convector heaters; it would be worth converting to a heat pump if it is to be used regularly. The kitchen can be heated by a plinth heater, or by convection through the hatch from the hall. Foyer and toilet areas could be heated by infra-red heating controlled by presence detectors if they are in sporadic use. More regular occupation of these areas favours a heat pump.

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.

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

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

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.

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

6.5 Install an Overdoor Heater

In order to achieve the sense of a 'warm welcome' into the building an over door air heater could be provided inside the inner pair of doors. Such an over door unit must be sized to cover the whole width of the door. This could heat the whole foyer area. If, however, it is felt that the area will require heating for significant periods of winter, a heat pump solution including this area will be cheaper to run by a factor of four.

A variety of overdoor air heaters are available on the market and can be installed by an electrician. The heaters that will cover the entire width of the door tend to be larger output units, which will require a dedicated electrical cable of the correct size run to them. The church should resist the temptation to reduce the size and output of the heater to avoid running a new cable, as the output from smaller heaters and of those with insufficient width tends to be disappointing.

7. 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.

7.1 Draught Proof External Doors

Where doors do not close tightly against their frames a large amount of cold air can enter buildings. The main entry doors could benefit from a shallow upstand inserted into the flooring to prevent draughts, and also water from being blown in under the doors. Occasionally used doors should also be fitted with draught excluded strips where there is an airflow.

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.

7.2 Cavity Wall Insulation

The church is constructed with a cavity wall method, and the inspection of the wall showed no signs that insulation has been added. Prior to the early 1990's, building regulations did not require walls to be fully insulated and therefore it is likely that there is no insulation present. It could, however, be added through injection into the cavity walls.

It is recommended that cavity wall insulation is considered and added to the walls where appropriate. A survey to check the width of the cavity, exposure of the wall and condition of the cavity should be carried out by a CIGA-approved installer who will then be able to provide you with a quotation to undertake the works. Installing cavity wall insulation will help to reduce heat loss and improve the comfort of the space, but needs to be considered alongside other control measures such as TRV's or room sensors to ensure that the space does not overheat because of the additional insulation.

The perimeter is approximately 70m. 3m high walls at £25/m^2 would cost approximately £5,250.

7.3 Insulation to Roof

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.

If re-roofing were to take place, addition of insulation should be incorporated. 325m^2 of area at £20/m^2 would cost £6,500.

8. Other Recommendations

8.1 Electric Vehicle Charging Points

The church hall has a car park adjacent to it. In order to make a visible statement on the church's mission of stewardship and to facilitate more sustainable transport choices by those visiting the church and/or using the hall, the church may wish to consider installing an electric vehicle charging point, probably on the side of the church hall to allow visitors to charge their electric cars.

Some units allow the organisation control over who is allowed to use the unit with a key operated system. Or, given the type of use of the building and control over the usage of the car park as a whole, a simple 32 amp type 2 wall pod type charger without the need for a key may be most suitable. These are widely available through many suppliers.

Because of the parish office within the building, the church can be considered as a place of work and, as such, installation grants are available through the workplace charging scheme https://www.gov.uk/government/publications/workplace-charging-scheme-guidance-for-applicants-installers-and-manufacturers which will fund 75% of the installation cost up to £500.

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
Battery Storage	Yes (in future)

The hall's current annual electricity use is around 4,500kWh. With 32 hours use per week this gives an average load of 2.7kW. A heat pump supplying 28kW (for the whole building) would require 7kW. It is recommended that solar panels are added after a heat pump system is installed so that the overall electrical load can be understood accurately and the system sized appropriately.

The roof area is approximately 325m^2. An 80m^2 system could generate 12kW peak, costing around £15,600. This would be mounted on supports oriented at the optimum angle.

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	Area / m^2	System Size / kW peak	Orientation factor	Shading factor	Annual Generation, kWh
All	80	12	180 degrees / 35^0 1.0	1	12,000

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*