ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

Emmanuel Church
PCC of York

EMMANUEL
CHURCH

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Contents

1. Executive Summary 3
2. The Route to Net Zero Carbon 4
3. Introduction 5
4. Energy Procurement Review 6
5. Energy Usage Details 6
   5.1 Energy Profiling 7
   5.2 Energy Benchmarking 8
6. Efficient / Low Carbon Heating Strategy 9
   6.1 Air to Water Source Heat Pumps 10
   6.2 Install an Overdoor Heater 12
7. Energy Saving Recommendations 12
   7.1 Insulation of Pipework and Fittings 12
   7.2 Timers on Fuse Spurs to Water Heaters 13
   7.3 Cavity Wall Insulation 13
   7.4 Insulation to Roof 14
8. Other Recommendations 14
   8.1 Electric Vehicle Charging Points 14
9. Renewable Energy Potential 15
10. Funding Sources 16
11. Faculty Requirements 17

1. Executive Summary

An energy survey of Emmanuel Church 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.

Emmanuel Church is a modern church located in the small seaside town of Bridlington. The church was opened on the 29th of March 1998 and is primarily constructed of brick as per the regulations of the time. The building is a unique design, meant to mimic a wave. Internally there are chairs set up which can be moved to suit the needs of the space, both in the main hall and across the many versatile spaces across the church. 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
Switch electricity (and gas) suppliers to ones which provide 100% renewable (or green gas) supplies	None	None	Nil	N/A	None	Offset 2.12 tonnes
Improve pipework lagging and insulation on existing boiler	1,250	£150	£751	5.0	List A	0.23
Timers on fuse spurs to water heaters	219	£66	£650	9.9	List A	0.04
Install an overdoor heater	N/A	N/A	£1,200	N/A	List B	N/A
Replace gas-fired kitchen equipment with electric replacements	1,391	-£341	£2,500	N/A	List B	0.22
Upgrade cavity wall insulation	5,980	£718	£12,821	17.9	Faculty	1.09
Upgrade roof insulation to 270mm	5,265	£632	£28,250	44.7	Faculty	0.96
Replace heating system for electrical based heating solution (AWSHPs)	64,286	£1,286	£238,091	185.2	Faculty	11.35

Install solar photovoltaic panels	9,055	£2,717	£42,375	15.6	Faculty	1.75
Install battery storage for solar photovoltaic panels	N/A	N/A	£6,000	N/A	Faculty	N/A
Electric vehicle charging points	N/A	N/A	£2,500	N/A	List B	N/A
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.

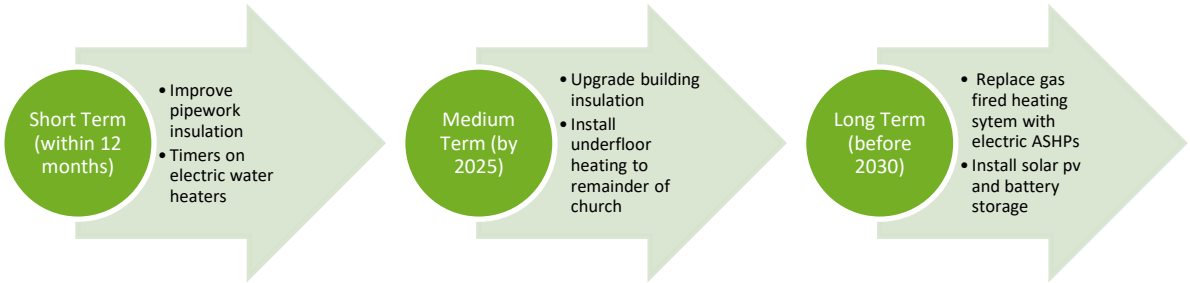
Figures in the table are based on current contracted/market prices of 30p/kWh and 10p/kWh for electricity and mains gas respectively. The carbon figures are based on the DEFRA 2022 carbon emission factors of 0.21107 for electricity, 0.18 for gas and 0.27 for oil. Do note that as energy prices increase, 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 Emmanuel Church 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 Emmanuel Church, 70 Cardigan Rd, Bridlington YO15 3JT was completed on the 16th November 2022 by Nathan Tonkin. Nathan is an experienced energy auditor with over 4 years' experience in sustainability and energy matters in the built environment.

Emmanuel Church	
Church Code	643248
Gross Internal Floor Area	946 m^2
Listed Status	Unlisted
Average Congregation Size	70-80

The church typically used for 40 hours per week for the following activities

Type of Use	**Hours Per Week (Typical)**
Services	8 hours per week
Meetings and Church Groups	17 hours per week
Community Use	15 hours per week

There is additional usage over and above these times for festivals, weddings, funerals and the like

4. Energy Procurement Review

Energy bills for gas and electricity were not supplied by Emmanuel Church so no analysis of energy bills or any review of the taxation and other levies which are being applied to the bills.

The church should be aware of the following rules:

The church is a charity and therefore can claim VAT exemption status. As such the PCC of Emmanuel Church should send the supplier at VAT declaration confirming this and check all supplies on other sites. 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

Emmanuel Church uses 10,960 kWh/year of electricity, costing in the region of £3,288 per year, and 104,214 kWh/year of gas, costing £12,506. The total carbon emissions associated with this energy use are 21.14 CO_2e tonnes/year.

This data has been taken from a summary document of invoices provided by the church. Emmanuel Church has one main electricity meter, serial number E17BG09122. There is one gas meter serving the site.

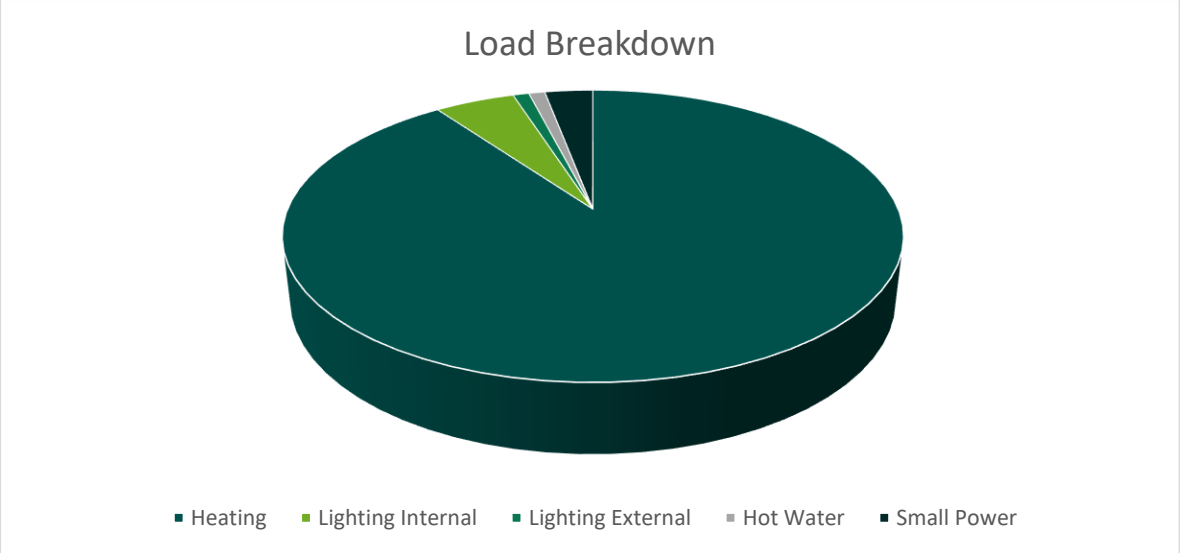
Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	E17BG09122	3 phase 100A	N but capable	Plant room

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:

Service	Description	Estimated Proportion of Usage
Lighting	**Main Church** >60 LED lamps and strips covering communal areas and halls **External** <10 lamps on external walls	6%
Heating	**Main Church** 1x Worcester GB162 100kW input	90%
Hot Water	**Main Church** 1x IMI Waterheating 10L under-sink hot water heater supplying toilets 1x Kingspan Ultraflow 5L under-sink hot water heater supplying kitchen sink	1%
Other Small Power	AV equipment, other IT equipment, small power devices connected in kitchen	3%



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.

5.2 Energy Benchmarking

In comparison to national benchmarks for church energy use Emmanuel Church uses 42% less electricity and 27% less 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.

Due to the modern way the church is heated, along with the low amount of IT equipment and efficient bulbs, the church is using its energy more effectively.

	Size (m^2 GIA)	Emmanuel Church use kWh	Emmanuel Church use kWh/m^2	Typical Church Use kWh/m^2	Variance from Typical
Electricity	946	10,960	11.59	20	-42.07%
Heating Fuel	946	104,214	110.16	150	-26.56%
TOTAL	946	115,174	121.75	170	-28.38%

6. Efficient / Low Carbon Heating Strategy

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.

The church is currently heated by a gas fired boiler which was installed in 2010 and appears to have a further 5 years serviceable life before requiring replacement. The boilers provide heating an underfloor heating manifold, which serves the central communal areas as well and the main church hall. There are also radiators serving areas not covered by the underfloor heating.

The church makes use of flexible seating in the main hall with comfortable seating around the rest of the church.

The church is used all throughout the week, and on a Sunday for service where the typical congregation size is 70-80. The heating is set to come on several hours earlier in the winter to ensure the church is warm for this service.

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	Yes – existing underfloor heating and usage throughout the week makes this a viable option
Air to Air Source Heat Pump	No – does not suit use of building
Water Source Heat Pump	No – no water source locally
Ground Source Heat Pump	No – no space externally due to location in residential area
Under Pew Electric Heating Panels	No – no fixed pews
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)	Yes – suitable space for heater
Overhead Infra-Red Heaters	No – visual intrusion to the church would do harm, least preferred heating source due to comfort
Heated Chair Cushions	No – other solutions preferred

The recommendation is therefore that the church consider AWSHPs to connect to the existing underfloor heating system. As described below.

6.1 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
Church	2,838	0.033	93.7

Therefore, a heat pump of 100 kW would be required, matching the existing system.

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

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

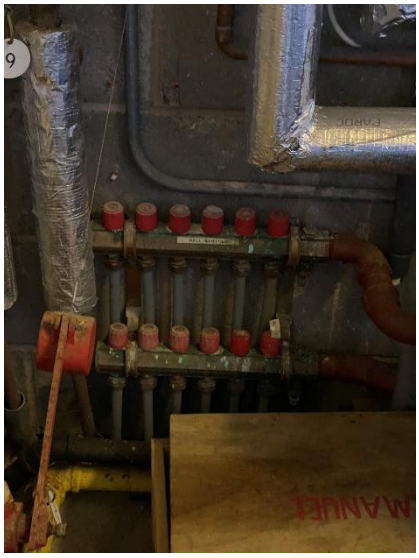


Photo of the existing underfloor heating manifold. The AWSHP can be connected to this system and provide high efficiency heating across the church.

Photo of some existing radiators which will need upgrading or rooms having underfloor heating upgrades made to ensure the whole church is connected to this new, high efficiency system.

6.2 Install an Overdoor Heater

In order to achieve the sense of a 'warm welcome' into the church an over door air heater could be provided. This would also help to provide warmth to the entrance of the church. Such an over door unit must be sized to cover the whole width of the door.

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 Insulation of Pipework and Fittings

The pipework within the boiler room has the majority of its straight lengths insulated, but the more complex-shaped pipework fittings, such as valves, have been left uninsulated. These exposed areas of pipework contribute significantly to heat loss from the system and make the plant room unnecessarily warm. The exposed hot surfaces also represent a health and safety risk of burns for those working in the area.

It is recommended that these areas of exposed pipework and fittings are insulated with bespoke flexible insulation jackets. These wrap around the various elements but can be removed and then replaced for any servicing activities.

7.2 Timers on Fuse Spurs to Water Heaters

There are a number of electric point of use water heaters to provide hot water for hand washing. This only needs to heat the water to the required temperature when the building is in occupation but at the moment this heater is directly wired in without any form of time control and therefore maintains it 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.

7.3 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.

7.4 Insulation to Roof

The loft void above the ceiling was not inspected as part of this audit but is estimated 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.

8. Other Recommendations

8.1 Electric Vehicle Charging Points

The church has a car park to the side of it which serves the church and also the frequently used church hall. 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.

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 – with ASHP there would be sufficient demand
Battery Storage	Yes – output of solar pv would exceed demand during peak generation times

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.

There is potential for a small solar PV array on the south facing curved roof. The church's energy consumption is already very small and the consumption during the daytime when the sun is shining is likely to be very low indeed, therefore while technically viable only a very small number of panels (maximum of around 4) would be worth considering if at all. However after installation of the AWSHPs the church's electricity usage will increase drastically. Therefore, it is recommended that the ASHP system be installed first, so the solar PV generation can be fed into this system.

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.

Satellite photo of area for consideration for solar pv array

Area external to church for consideration for battery storage unit

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.