Energy Efficiency and Zero Carbon Advice

St Peter's Church

PCC of St Peter's, Knowl Hill

Author	Reviewer	Date	Version
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1. Executive Summary

An energy survey of St Peter's Church was undertaken by Inspired Efficiency Ltd to provide advice to the church on how it can be more energy efficient and provide a sustainable and comfortable environment to support its continued use.

St Peter's Church is an unlisted 1840 parish church. There is both gas and electricity supplied to the site.

The church has a number of ways in which is can be 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)
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 0.07 tonnes
Install Endotherm advanced heating fluid into heating system	2,227	£67	£240	3.58	List A (None)	0.41
Install a Solar PV array to roof of building (assumed 100% of energy generated used in building)	8,417	£1,787	£16,187	9.06 (if all used in church)	Faculty	2.13
Add or Replace draught strips to external doors	445 (and improved comfort)	£13	£300	22.39	List A (None)	0.08

Change existing lighting for low energy lamps/fittings	52	£11	£556	50.74	Faculty	0.01
Refurbish window ironmongery / draught seals	1,114 (and improved comfort)	£33	£15,000	447.78	List A (None)	0.21
Install a Ground Source Heat Pump to connect to underfloor heating installed as part of reordering	17,816	(provides a carbon saving but not a cost saving)	£30,000	N/A	Faculty	2.98

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

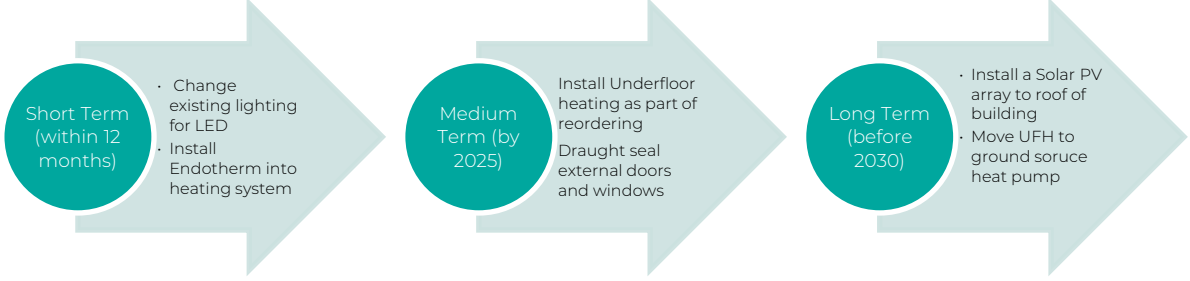
Based on current contracted prices of 21.23p/kWh and 3.01p/kWh for electricity and mains gas respectively.

If all measures were implemented this would save the church £1,636 per year.

2. The Route to Net Zero Carbon

The Diocese of Oxford's Diocesan Synod has set a target of reaching Net Zero Carbon by 2035, or as soon thereafter as is possible. General Synod, meanwhile, has set a target for the Church of England to reach a limited-scope Net Zero Carbon target by 2030. Our diocese will need to respond to the national target. which, as it is presently framed, means that every church, cathedral, church school and vicarage in the C of E will need to reach net zero - or compensate for residual emissions - within the next ten years..

This church has a clear route to become net zero by 2035 by undertaking the following steps:



3. Introduction

This report is provided to the PCC of St Peter's 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 St Peter's Church, Knowl Hill Common, Knowl Hill, Reading was completed on the 9th September 2020 by Matt Fulford. Matt is a highly experienced energy auditor with over 15 years' experience in sustainability and energy matters in the built environment. He is a chartered surveyor with RICS and a CIBSE Low Carbon Energy Assessor. He is a Member of the DAC in the Diocese of Gloucester and advises hundreds of churches on energy matters.

St Peter's Church	
Church Code	627380
Gross Internal Floor Area	260 m^2
Listed Status	Unlisted

The church typically used for 2 hours per week for the following activities

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	2 hours per week	12
Meetings and Church Groups	-	-
Community Use	-	-

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

There are currently major considerations about the church becoming a community building with extensive use by the neighbouring church school for its hall, this would significantly change the usage of the building and its heating needs.

4. Energy Usage Details

St Peter's Church uses 286 kWh/year of electricity, costing in the region of £60 per year, and 22,270 kWh/year of gas, costing £670.

This data has been taken from the annual energy invoices provided by the suppliers of the site. St Peter's Church has one main electricity meter, serial number K77C0312001. There is one gas meter serving the site, serial number M016A0156800A6.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	K77C0312001	Type C1182	No Pulse or AMR	Kitchen
Gas – Church	M016A0156800A6	Unknown	Not Seen	Not Seen

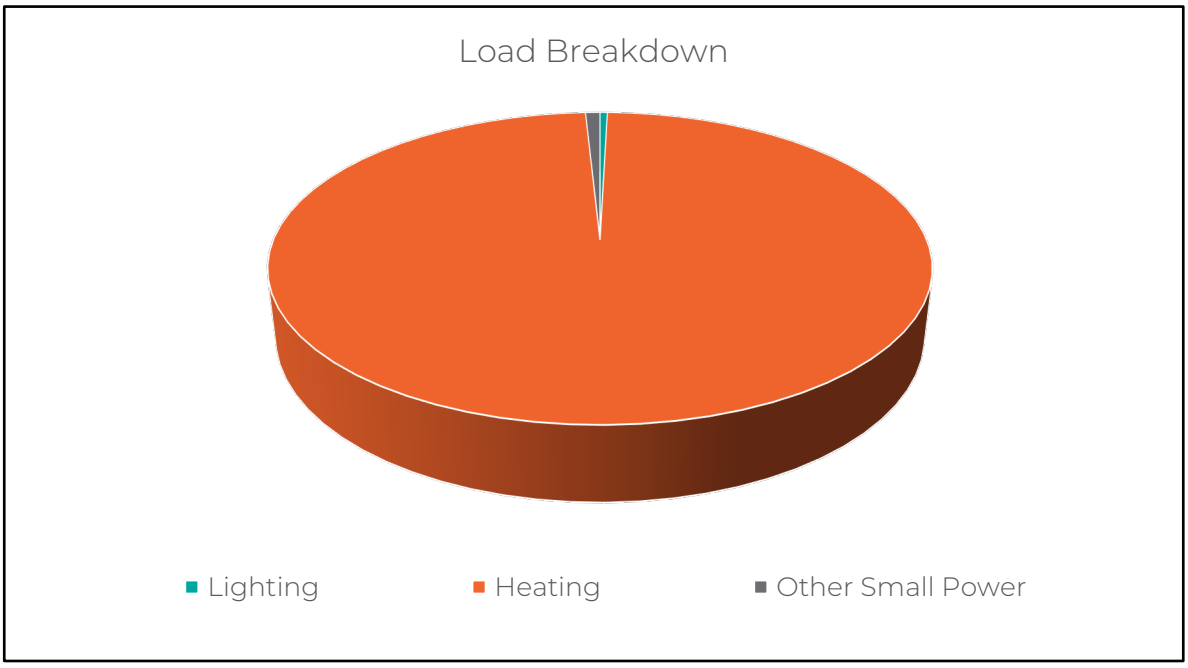
It is recommended that the church consider asking their suppliers to install smart meters so that the usage can be monitored more closely, and the patterns of usage reviewed against the times the building is used.

The existing electrical supply is a single phase 100A supply. There is an electricity pole in the grounds of the church (near the front boundary with the school) which appears to have a 3 phase supply on it and could be easily taken off to replace the existing overhead supply into the church. The potential and costs of this upgraded supply should be investigated with SSE so that the costs and feasibility is known.

4.1 Energy Profiling

The main energy use within the church can be summarised as follows:

Service	Description	Estimated Proportion of Usage
Lighting	Mix of LED and SON lamps.	0.4%
Heating	Gas boilers serving perimeter pipes and serving and mainly old radiators	99%
Other Small Power	Organ and the like	1%



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

4.2 Energy Benchmarking

In comparison to national benchmarks for church energy use St Peter's Church uses 95% less electricity and 43% less heating energy than would be expected for a church of this size. This is a reflection of this churches very low hours of use.

	Size (m^2 GIA)	St Peter's Church use kWh/m^2	Typical Church use kWh/m^2	Efficient Church Use kWh/m^2	Variance from Typical
St Peter's Church (elec)	260	286	1.10	20.00	-95%
St Peter's Church (heating fuel)	260	22,270	85.65	150.00	-43%
TOTAL	260	22,556	86.75	170.00	-49%

5. Efficient / Low Carbon Heating Strategy

The energy used for heating a church typically makes up around 80% to 90% of the overall energy consumption and in this case is more like 98%. 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 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 it remaining oil and coal fired power stations. Mains gas does have some potential to reduce its carbon content through the use of biogas and hydrogen but these are less developed solutions and will be unable to deliver 'zero carbon mains gas'. It is therefore a critical element to review and set out a plan to make more efficient and less carbon intensive and 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 Church in need of a major refurbishment project with potential to be used by the neighbouring school and wider community. Any refurbishment would involve complete removal of the existing pews and addressing the structural issues with the timber suspended floor which currently drops to the perimeter walls. As part of this floor work it is recommend that full insulation be installed under the floor and an underfloor heating (UFH) system is installed between the replaced floor joists (propriety systems are available). The new UFH could then be connected to the existing gas boilers as phase 1. The existing boilers are new and in good condition and their continued use would be prudent rather than incurring greater environmental impacts in replacing what are perfectly good boilers with a new solution at this present moment in time. It should be noted that at this stage it is unlikely that the UFH system will be able to fully provide the peak heating demands of the church for higher thermal comfort uses such as sit down dinners etc. Therefore, a phase 2 could be to add supplemental radiators to perimeter from gas system and switch UFH to a ground source heat pump system. This would then allow the ground source to efficiently supply and majority of the heat to the building via the under floor heating system and the gas permitter radiators would only be needed occasionally to provide the boost to higher temperatures when required.

Such a proposal is dependent on the church having much higher community and school usage, without this a simple electric under pew solutions should be considered although it was noted that without more extensive community use the future relevance of the church could be in question.

6. Improve the Existing Heating System

In order to improve the current heating system and in preparation of the above strategy the following could be considered.

6.1 Endotherm Advanced Heating Fluid

In order to improve the efficiency of the heating system further it is recommended that an advanced heating fluid (http://www.endotherm.co.uk/) is added to the heating system.

This fluid in in addition to, and complements any existing inhibitors in the heating system and is added in a similar way. The fluid works to improve the ability of the boiler to transfer heat into the heating system and for the radiators and other heating elements to give out their heat into the rooms. It does this by reducing the surface tension of the water and increasing its capacity to transfer and hold heat. Case studies have demonstrated that the addition of this fluid into heating systems reduces heating energy consumptions by over 10% as well as helping the building heat up quicker.

Endotherm can be self-installed.

7. Energy Saving Recommendations

In addition to having a revise 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 New LED Lighting

The lighting makes up a relatively small overall energy proportion of the electricity used within the church, and large areas are lit by relatively inefficient SON fittings.

There are some LED lights installed in the Nave but there still remains a number of inefficient SONs within the Chancel.

It is recommended that the fittings scheduled in Appendix 1 are all 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.

If all the lights were changed on a simple “like for like” the total capital cost (supplied and fitted) would be £556. The annual cost saving would be £11 resulting in a payback of around 50 years. This estimate includes for the supply of the lights, the labour to install them and the access required. It does not include for any upgrade to the wiring or a new lighting design both of which the church may wish to consider.

7.2 Refurbish window ironmongery / draught seals

It was noted that a number of the windows have missing or broken glass quarries.

In order to avoid cold external air blowing directly into the church these elements must be repaired as draughts from these broken windows will be making the building very uncomfortable as well as loosing heat. Where there are opening elements to the windows these should be sealed to avoid draughts.

7.3 Draught Proof External Doors

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

It is recommend 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 (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

Simple measures such as having a ‘sausage dog’ style draught excluder 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.

It was noted that the roof of the church has previously been well insulated and therefore no further recommendations are made to the ceiling are.

8. 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 – on the South facing roof of the nave – this would be a visible array but the church is unlisted and this could make a bold statement!
Wind	No – no suitable land away from buildings
Battery Storage	Yes – In conjunction with the PV
Micro-Hydro	No – no water course
Solar Thermal	No – insufficient hot water need
Biomass	No – Issues with boiler size and fuel storage, little advantage given mains gas use.
Air Source Heat Pump	No – insufficient electricity supply
Ground Source Heat Pump	Yes - Potential in future but not currently suitable to integrate well with existing heating system – would be relevant with future under floor heating where the existing gas boiler could go on to serve a boast system via new perimeter radiators.

8.1 PV

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 PV array on the roof of the South Aisle. The current arrangements around solar panels mean that to be financially viable the building on which they are mounted needs to consume the vast majority of the energy that they produce. This would be a visible array which is an unusual recommendation for a church but as this church is unlisted this could create a bold visible statement of its new function and ambition. The use of solar PV panels would coordinate well with a regularly used building with a heat pump but would not suit its current low usage.

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

8.2 GSHP

The building is currently heated from a gas boiler which provides hot water into the heating system. The use of fossil fuels for heating means that it will not be possible to the building to become zero carbon without changing the heating system. A boiler also has heat and other efficiency losses within it which means that the efficiency of a boiler in converting the gas into the heat is typically around 80 to 95% (depending on the age and type of boiler). Ground source heat pumps use electricity to power the heat pump which takes heat from the constant temperature of the ground beneath the surface and puts this into water which can then go into the heating system. A heat pump can create around 4 units of heat for every one unit of electricity.

The existing boilers are of a good efficiency and quite a recent addition to the church. To maximise the efficiency, it is recommended that these are retained, initially used to heat the under floor heating system but in time the underfloor system should be converted to a ground source heat pump to do the vast majority of the heating. The gas boilers should then be switched to heat a new perimeter radiator system which can provide boast heating on the occasions this is required.

A new ground source heat pump is likely to require a heating capacity of around 30kW and could be installed in the area of ground to the side and front of the church. As heat pumps operate on a low temperature basis some of the radiators

and other heat emitters around the site may require upgrading. 3 phase electrical power may also be required to power the units. The installation will involve drilling large boreholes into the ground using heavy equipment so disturbance of the ground is involved.

Good local renewable companies can be contacted for further detailed assessment of heat pumps and quotes.

There are currently government incentives available for installing ground source heat pumps but these are subject to future change and adaption so should be reviewed at the time of implementation.

9. Funding Sources

This audit programme offers each participating church the chance to apply for a grant of up to £150 towards implementing some of the audit's recommendations. An application form is included with this report.

There are a variety of charitable grants for churches undertaking works and a comprehensive list of available grants is available at https://www.parishresources.org.uk/wp-content/uploads/Charitable-Grants-for-Churches-Jan-2019.pdf .

10. 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.

11. Other Observations

The church is currently using gas portable heaters in extreme weather conditions. The church was advised against the use of this system and strongly recommended to ensure that the gas cylinders are removed from the church when not in use.

The church has retained an old oil tank in its ground from before it converted to mains gas. This tank should be removed and safely disposed of to avoid any potential risk of environmental contamination from the oil sludge that is likely to be within the base of this tank.

Appendix 1 – Schedule of Lighting to be Replaced or Upgraded

Room/Location	Number of Fittings	Recommended Upgrade	Annual Saving (£)	Total Cost (£)	Payback
Chancel	4	50W LED Flood	£11	£480	43.83

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