Energy Efficiency and Zero Carbon Advice

St John's Church, Ealing
PCC of St John's Church

Author	Reviewer	Date	Version
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Contents

1. Executive Summary

An energy survey of St John's 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.

St John's Church is a Grade II listed Victorian church built in 1876 with a tower over the chancel. The roof dates from 1923 after a fire and the area to the west end of the nave under a disused balcony has been converted into a kitchen and office area. The nave is seated with individual chairs. Below the entire footprint of the church is a basement subdivided into about 20 rooms by walling or moveable partitions. Most of this space is in use, with some void areas at the east end. 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. 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)
Window repairs	5%, 7,290	£240	£1000	4	List A	1.3
Draughtproofing of doors	2%, 2,900	96	£100	1	List A	0.5
Purchase Temperature Datalogger (informs *)	Included in items below*		£50		None	
Reduce temperature settings by one degree*	5%, 7,290	£240	zero	Immediate	None	1.3
Stop background heating to 15°C*	10%, 14,580	£480	zero	Immediate	None	2.6
Cease heating earlier in the season (2 weeks)*	5%, 7,290	£240	zero	Immediate	None	1.3
Install reflective panels behind radiators	2%, 2,900	£96	£50	<1	None	0.5
Clean and flush heating system	7%, 10,290	£336	£800	2	List A	1.8
Install heat transfer fluid (church and church rooms systems)	10%, 14,580	£480	£540	>1	List A	2.6
Insulate valves and fittings in boiler room	3%, 4,350	£144	£100	1	List A	0.8

Replace fluorescent tube lighting with LED strip lighting, halogen lamps with LED	15,800 [3/4 reduction in light power]	£2,835	£8,086	2.9	List B	4.0
Ensure water heater units are all switched off, or on a timer	2,000	£260	£100	<1	None	0.5
Install a Ground Source Heat Pump, 60kW	146,000 gas saved Use 25,000 electricity	£4,800 saved Cost £3,200	£60,000	38	Faculty	26.9
Install a new heating / cooling network in basement linked to GSHP	13,000 electricity	£1,700	£10,000	7	Faculty	3.3

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

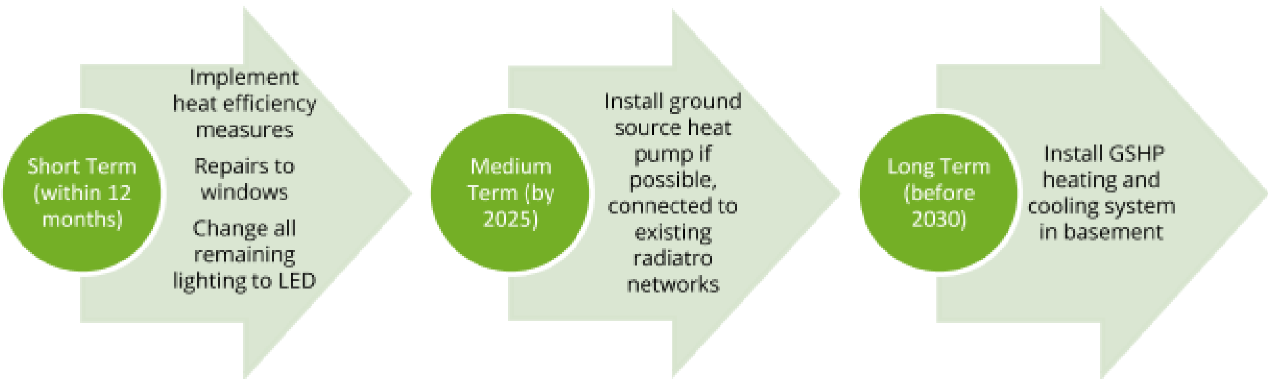
Based on current contracted prices of 14.91p/kWh (day) and 10.49p/kWh (night) and 2.722p/kWh for electricity and mains gas respectively.

If all measures were implemented this would save the church around £7,950 per year in operating costs, approximately 50% of current expenditure.

2. The Route to Net Zero Carbon

The General Synod of the Church of England has indicated that the Church of England should be Net Zero Carbon by 2030. Every church, cathedral, church school and vicarage will therefore need to convert to be a net zero building in the next 10 years

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



3. Introduction

This report is provided to the PCC of St John'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 John's Church, Mattock Lane, W13 9LA was completed on the 2nd November 2010 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 and has been an Eco Congregation assessor.

St John's Church	
Church Code	623446
Gross Internal Floor Area	1,750 m^2
Listed Status	Grade II

The church typically used for up to 70 hours per week for the following activities

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	9 hours per week	CofE service 90 Myanmar fellowship 30
Meetings and Church Groups	14 hours per week	Youth 40 Others 60
Community Use	44 hours per week	Between 10 and 30 depending on event
Occasional Offices (annually)	2 weddings 3 funerals	

Occupancy Hours 3,600 hours

Annual Footfall 23,000

4. Energy Procurement Review

Energy bills for gas and electricity have been supplied by St John's Church and have been reviewed against the current market rates for energy.

The current electricity rates are:

Day Rate	14.91p/kWh	Above current market rates
Night Rate	10.49p/kWh	In line with current market rates
Standing Charge	63.74p/day	Above average

The current gas rates are:

Single / Blended Rate	2.722p/kWh (church) 3.564p/kWh (hall)	Above current market rates
Standing Charge	102.63p/day	N/A

The above review has highlighted that there are opportunities to gain cost savings from improved procurement of the energy supplies at this site. We would therefore recommend that the church obtains a quotation for its gas and electricity supplies from the Diocese Supported parish buying scheme, http://www.parishbuying.org.uk/energy-basket. This scheme only offers 100% renewable energy and therefore it is an important part of the process of making churches more sustainable.

A review has also been carried out of the taxation and other levies which are being applied to the bills. These are:

VAT	Gas 5% Electricity 5 & 20%	The correct VAT rate is being applied
CCL	Charged where VAT is 20%	The correct CCL rate is being applied. (users consuming less than 1,000kWh of electricity and/or 4,397kWh gas per month can obtain the 5% VAT rate.

The above review confirmed that the correct taxation and levy rates are being charged.

5. Energy Usage Details

St John's Church uses more than 57,000 kWh/year of electricity, costing in the region of £10,700 per year, and 146,000 kWh/year of gas, costing £4,800.

This data has been taken from the annual energy invoices provided by the suppliers of the site. St John's Church is supplied with three phases of electricity. There are two gas meters serving the site, one for each boiler serving the church and hall attached to the north east of the building.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	P12C 00165	3 phase 100A Premier Secure Type P3TA23	Yes	Boiler room in basement, in sub room to south side
Gas – Church	M040 K02708	Elster	Yes Elster IN-Z61	Basement
Gas - Hall	G4 K00 13562 14 01			Church Rooms

Meters are AMR connected and as such energy profile for the entire energy usage should be possible.

5.1 Energy Profiling

The main energy consuming plant can be summarised as follows:

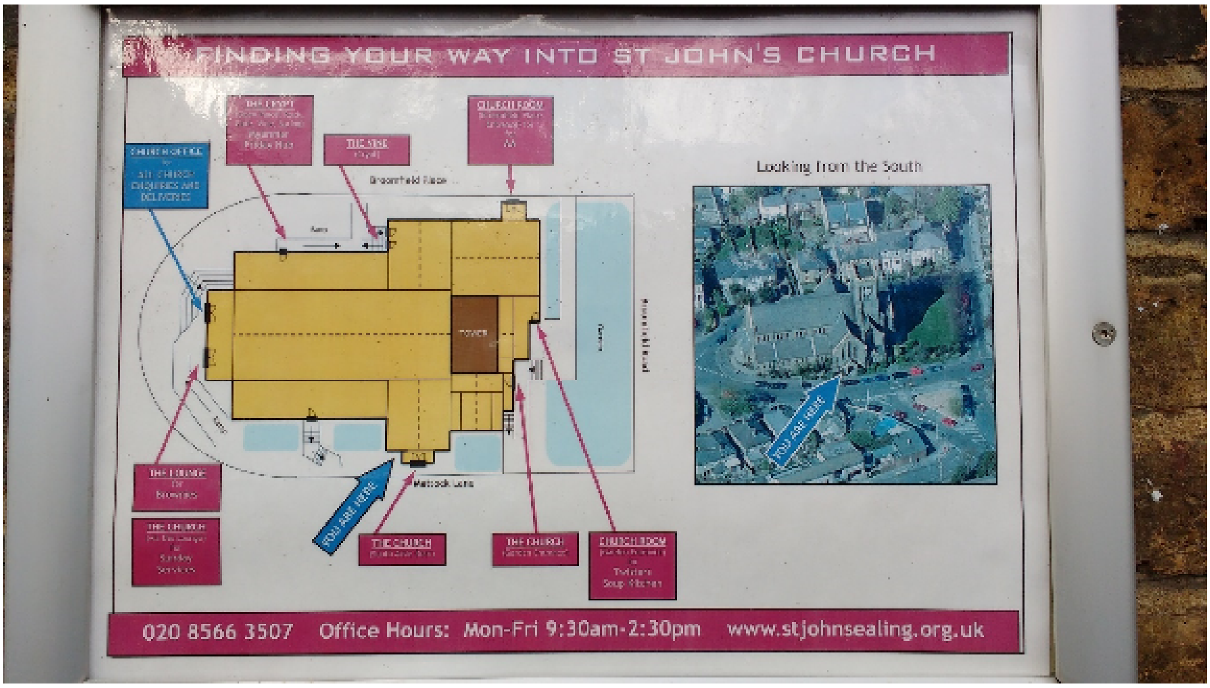
Service	Description	Annual use kWh	Estimated Proportion of Usage
Gas Heating	Ideal Harrier ES11 boiler, thought to be 140kW Located in church basement Church room boiler, thought to be 30kW Gas fired wall mounted water heater, church kitchen sink.	128,000 15,700 TOTAL 145,745	72%
Electric Heating	Six Timer controlled wall mounted heaters in various basement locations. Uncertain hours of use when main church heating is off. Office heater timed use 25 hours per week. Electric Hand Dryer 3kW	Office 3,000 Others (estimate) 6,000 TOTAL 9,000 + BASEMENT 20,000	14%
Hot Water	Church kitchen; 4.9kW dishwasher (2 uses per week) 2 x 2.1kW coffee machines 1.65kW portable urn 2kW fixed urn Basement kitchen; 4.9kW dishwasher (3times/week) 2.1kW coffee machine 2kw kettle Water heater in basement WC, 3kW	260 320 170 200 390 320 200 200 TOTAL 2,000	1%
Lighting	Church estimate 11,340W, 1,000hrs Basement Estimate 5,290W, 1,100hrs Church rooms estimate 720W, 1,900hrs	11,340 5,819 1,322 TOTAL 18,481	10%
Other Small Power	Heating pumps 300W	300	2.7%

	Basement extraction fans 500W x 1,100 hours	660	
	Sound systems (3 x 1 kW)	1000	
	Office equipment (2 offices)	1000	
	Vacuum	250	
	Ovens (2 x 3kW)	150	
	Microwaves (2)	100	
	Fridges (4)	1800	
		TOTAL 5,500	

Annual electricity consumption for 2019; 57,469kWh

Estimated total for electricity 35,000kWh + basement heating

Whilst gas consumption is clear, the very high electricity consumption is not. If electric heating of the basement rooms is regularly resorted to, this may explain the shortfall. Other options include the lighting being on for more hours than the building is used.



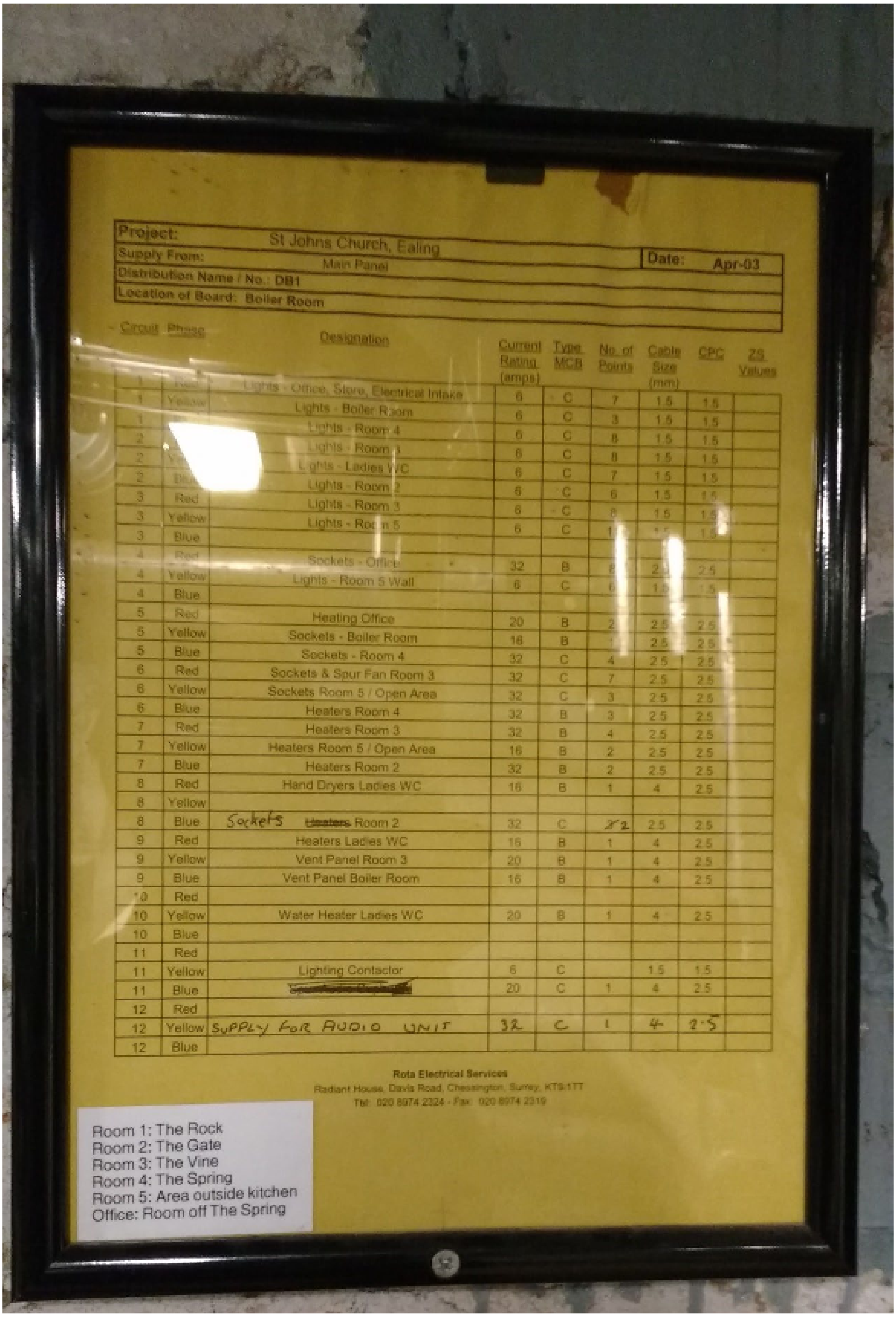
5.2 Items Contributing to High Energy Use

A potential source of high energy use are the stored theatrical floodlights in the basement – if these are used for events they will consume a large amount of electricity.

The basement is fitted with three ventilation / extraction fans in the west end plant room, plus one at the north east corner.

Power ratings could not be identified on two of the three extraction fans in the plant room. One is rated at 100W.

300W VentAxia extractor fan in store room adjoining "The Vine"



Project: St Johns Church, Ealing

Supply From: Main Panel | Date: Apr-03

Distribution Name / No.: DB1

Location of Board: Boiler Room

Circuit	Phase	Designation	Current Rating (amps)	Type MCB	No. of Points	Cable Size (mm)	CPC	ZS Values
1	[illegible]	Lights - Office, Store, Electrical Intake	6	C	7	1.5	1.5	
1	Yellow	Lights - Boiler Room	6	C	3	1.5	1.5	
1	[illegible]	Lights - Room 4	6	C	8	1.5	1.5	
2	[illegible]	Lights - Room [illegible]	6	C	8	1.5	1.5	
2	[illegible]	Lights - Ladies WC	6	C	7	1.5	1.5	
2	[illegible]	Lights - Room 2	6	C	6	1.5	1.5	
3	Red	Lights - Room 3	6	C	8	1.5	1.5	
3	Yellow	Lights - Room 5	6	C	[illegible]	[illegible]	1.5	
3	Blue							
4	[illegible]	Sockets - Office	32	B	[illegible]	[illegible]	2.5	
4	Yellow	Lights - Room 5 Wall	6	C	[illegible]	[illegible]	[illegible]	
4	Blue							
5	Red	Heating Office	20	B	2	2.5	2.5	
5	Yellow	Sockets - Boiler Room	16	B	[illegible]	2.5	2.5	
5	Blue	Sockets - Room 4	32	C	4	2.5	2.5	
6	Red	Sockets & Spur Fan Room 3	32	C	7	2.5	2.5	
6	Yellow	Sockets Room 5 / Open Area	32	C	3	2.5	2.5	
6	Blue	Heaters Room 4	32	B	3	2.5	2.5	
7	Red	Heaters Room 3	32	B	4	2.5	2.5	
7	Yellow	Heaters Room 5 / Open Area	16	B	2	2.5	2.5	
7	Blue	Heaters Room 2	32	B	2	2.5	2.5	
8	Red	Hand Dryers Ladies WC	16	B	1	4	2.5	
8	Yellow							
8	Blue	Sockets ~~Heaters~~ Room 2	32	C	2	2.5	2.5	
9	Red	Heaters Ladies WC	16	B	1	4	2.5	
9	Yellow	Vent Panel Room 3	20	B	1	4	2.5	
9	Blue	Vent Panel Boiler Room	16	B	1	4	2.5	
10	Red							
10	Yellow	Water Heater Ladies WC	20	B	1	4	2.5	
10	Blue							
11	Red							
11	Yellow	Lighting Contactor	6	C		1.5	1.5	
11	Blue	[illegible]	20	C	1	4	2.5	
12	Red							
12	Yellow	SUPPLY FOR AUDIO UNIT	32	C	1	4	2.5	
12	Blue							

Rota Electrical Services
Radiant House, Davis Road, Chessington, Surrey, KT9 1TT
Tel: 020 8974 2324 - Fax: 020 8974 2319

Room 1: The Rock
Room 2: The Gate
Room 3: The Vine
Room 4: The Spring
Room 5: Area outside kitchen
Office: Room off The Spring

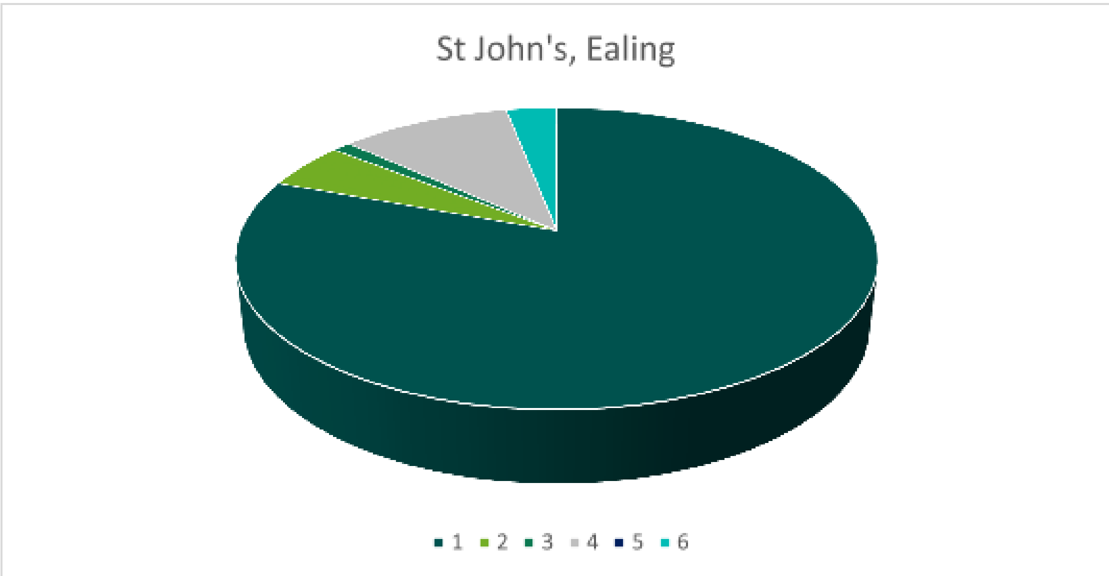
Basement electrical distribution table indicating areas heated by electricity.

Church kitchen (part)

A commercial specification kitchen is fitted in the basement. Kitchens used occasionally make a small contribution to energy use, providing that fixed water heaters, urns and coffee machines, etc are turned off when not in use.

Kitchen in the church rooms

5.3 Energy Use by Category



KEY 1 Gas heating 2 Electric Heating 3 Hot water 4 Lighting (internal)

5 Lighting (external) 6 Small power

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

5.4 Energy Benchmarking

In comparison to national benchmarks[1] for church energy use St John's Church uses 21% more electricity and 2% less heating energy than would be expected for a church of this size.

The basement and offices are heated by electricity, and most lighting is not low energy which accounts for the high electricity figure.

	Size (m^2 GIA)	Annual Energy Usage (kWh)	Actual kWh/m^2	Benchmark kWh/m^2	Variance from Benchmark
St John's Church (elec)	1,750	57,469	32.8	27	121%
St John's Church (gas)	950 church + church rooms area, gas heated	145,745	153	156	98%
TOTAL	1,750	203,214	186	183	101%

1 Energy Audit report 2012/13; Church of England Shrinking the Footprint: Data for large churches (>649m^2).

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 future. Electricity currently has carbon emissions of around the same level as mains gas but the carbon emissions associated with electricity are reducing rapidly as the UK builds more renewable energy and decommissions it remain coal fired power stations by 2025. Mains gas does have some potential to reduce its carbon content through the use of bio gas and hydrogen but these are less developed solutions and will be unable to deliver 'zero carbon mains gas'. It is therefore a critical element to review current energy use and set out a plan to make it more efficient and less carbon intensive.

The heating strategy for a church should be dependent on the pattern of use as well as the type of building and fabric (e.g. if it is fitted with pews). For churches whose use is mainly on Sundays, transition to electrical heating, especially under pew heating can give a benefit in avoiding many hours of preheating the roof space. At the other end of the scale, a church in use for many hours each day of the week may benefit from a constant or semi constant delivery of heat by a heat pump, and possibly underfloor heating if the use is high enough.

St John's appears to have a very high use, between 65-70 hours per week. However, this is split between three different areas:

Area	Hours per week	Heating System	Annual consumption kWh
Church & lounge	9 + office use	140kW gas boiler Offices electric heating	128,000 gas 9,000 estimate
Basement	21	8 Wall mounted electric heaters	20,000 estimate
Church rooms	36	Domestic gas boiler	18,000
Total	67		175,000 heat

Annual use including estimating office use is 3,600 hours.

The church (sanctuary) has a low use which is not enough to justify constant heating. Localised electric pew heating is not possible as it is seated with chairs. In addition, the two offices in the church are in use during the week, they are heated electrically. There is a wall mounted electric heater in the reception area outside the office which is used for a couple of hours per day in winter.

The church is a very large space with a number of hopper windows at high level which could be a source of draughts. There is a disused balcony section at the west end of the nave, above the Lounge.

The church Lounge at the west end of the building is under the (unused) balcony area. This area has a low ceiling and could be heated independently of the much larger main space. This is recommended in order to allow the Lounge to be used as required during the week, with the main space being used (normally) just on Sundays.

This would require using the existing closable shutters across the boundary between Lounge and church. Reduction of background heating would then significantly lower operating costs, see Section 7.3.

The basement has higher hours of use; with many of the individual rooms having electric heating so that they can be brought into use rapidly.

Electric heating is used in several areas of the building; together with mostly non-LED lighting and fans for ventilation of the basement which results in a very high annual electricity use.

Given that the church heating system provides heat for a low number of hours of church use, and many areas have electric heating, it appears very inefficient. It is used to maintain a background temperature of 15^{o}C throughout the church and lounge area (west end of church under balcony).

The church rooms account for much of the hours of building use. They have a separate boiler and gas meter. Only one month's data was provided for the church rooms, consumption has been estimated from the total gas expenditure reported in the Energy Footprint Tool. This is relatively small, around 18,000kWh per annum costing £750. (There is a very high gas price per kWh for this account).

6.2 Overall Strategy

It is proposed that a Ground Source Heat Pump is installed to serve the church and church rooms, replacing the existing boilers. More detail is given in Section 10. This would require a detailed analysis with building heat loss calculations to ensure that a system is designed which is sized correctly.

A future phase could see the system extended to cover the basement, where a heating and cooling system could be installed. A system which included cooling would help to regenerate the ground heat source.

If it is subsequently decided not to proceed with a GSHP system; alternative options for the basement and church rooms are presented in Sections 6.4 and 6.5 respectively.

6.3 Boiler Replacement Option

If a heat pump system is not chosen for the future, the church boiler should be replaced by a highly efficient and hydrogen ready condensing boiler. Heating flow and return temperatures should be chosen to allow condensing to occur, (to recover heat from the exhaust gases when the return temperature is below 55°C). Installation of a heat transfer fluid and system flushing will assist with this.

6.4 Church Rooms Strategy

This building has a regular use profile of over 36 hours a week.

Currently the church rooms are heated by six double pressed steel radiators located on the north and east walls giving an output of around 18kW.

Options are

6.4.1 Connecting the church rooms to the same heat pump system which supplies the church (probably located under the chancel).

If the church rooms are not supplied by a heat pump in the future, options for reducing the carbon footprint of the church rooms include:

6.4.2 Radiant infra red electric panel heaters (wall mounted):

Replacement of gas central heating by 6 x 3kW electric far infra red panel heaters in the same locations (although these tend to be of lower power (up to 1.5kW each) and there is not room to add extra radiators).

This would reduce carbon footprint to zero with a renewable tariff, but cost in the order of four times more to run, with an annual operating cost of £2,726 + standing change and VAT at current electricity day rates (figures based on the same annual supply of 18,000kWh of heat).

6.4.3 Ceiling mounted radiant infra red panel heaters.

An alternative would be to replace the central heating radiators with near infra red panel heaters suspended from / built into the ceiling. These are available at higher power; six 3kW units could be evenly spaced to give better distributed heat than at present. However, the operating cost for electricity at around 13p/kWh will be considerably higher than for gas at present at 3.654p/kWh.

6.5 Basement Strategy

The basement could have a zero carbon footprint if a renewable tariff is chosen, as it is currently entirely electrically heated.

6.5.1 Efficiency Improvements – Current Equipment

Electric heater in basement.

Removing the wooden casing from around the existing heaters would allow for more efficient transfer of heat.

6.5.2 Install infra red Electric Panel Heaters

If a GSHP system is not installed in the basement; some of the individual rooms could be heated more rapidly using infra red panel heaters. Many of the existing heaters are surrounded by wooden casings, which will prevent transfer of radiant heat. For the smaller rooms in the basement, installation of wall or ceiling mounted far infra red panel heaters will allow for rapid and efficient heating.

It is recommended that the PCC consider installing electrical panel heaters in the individual basement rooms which may be used for short periods on a time delay switch to replace the existing heaters.

Suitable electric panel heaters would be far infrared panels such as https://www.warm4less.com/product/63/1200-watt-platinum-white- . These can be purchased widely and fitted by any competent electrician. It is recommended that they are fitted with a time delay switch such as https://www.danlers.co.uk/time-lag-switches/77-products/time-lag-switches/multi-selectable-time-lag-switch/159-tlsw-ms so they cannot be left on accidently after use.

These heaters have a strong radiative effect (where heat is reflected to people from the surface) as well as a light convective effect (where air is warmed and moves around to heat the general space). As such these heaters tend to provide a relative instant sense of heat and comfort within the space and only need to be on for short periods of time.

6.5.3 Ground Source Heating and Cooling

If a GSHP system was installed, then this could be extended in the future to serve the basement and potentially supply cooling as well as heating.

Future installation of a Ground Source Heat Pump would be envisaged to serve the whole site. As the power needed to heat the church up from cold is perhaps 100kW, a system which provided heat to the church rooms, lounge and basement during the week, with all heating focused on the Church main space during Saturday and Sunday could be envisaged.

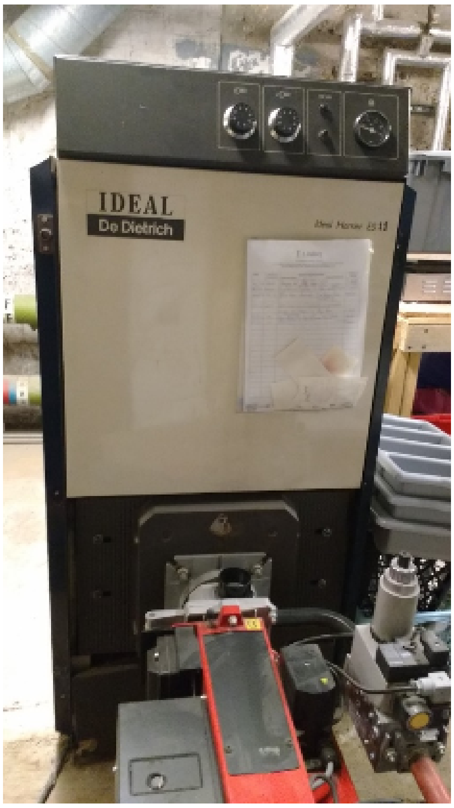
7. Improve the Existing Heating Systems

Church and Church Rooms – Management and Technical Improvements

These efficiency improvements are relevant to both systems.

7.1 Description of Heating System

In the church, the current heating system is the Ideal ES11 boiler (which is either a 105(min)-140(max)kW model or a 140-180kW model). When last maintained it was operating at 88.8% efficiency. Radiators installed in the church are a mixed of double pressed steel and cast iron units.



It is recommended that measures are taken to improve the efficiency of the existing heating system. This system would be retained if a heat pump was fitted (although some larger radiators may be required).

Measures should include:

7.2 Improve Heating Control Settings

The church heating is controlled by thermostat. Use of a temperature datalogger to understand the heat up time of the building which is achievable, plus how quickly it cools and to what the temperature fall is without heating would be helpful in reducing energy requirements.

There are two important principles in setting efficient heating settings to support a comfortable church. The first is that most historic buildings survive very well without being heated and that in a number of cases the later addition of heating has actually cause fabric issues (such as the drying out of timbers, drawing damp through walls into a warmer and drier environment or causing issues beneath metal roof covings where warmer moist air becomes trapped). In most cases the fabric of a historic building would prefer not to be heated and the constant 'yo-yo' up and down of the heating is the most damaging. The second principle is that to provide comfort to occupants one either needs to provide an immediate injection of heat close to where the congregation are heaters (i.e. under pew heaters or radiant heaters) that warm the air around the people but makes no attempt to heat the entire air volume of the church or has a long slow building up of heat within the church building. Having the heating switch on for an hour or two once or twice a day in the mis-conceived idea that it will 'take the cold off the building' is the most damaging heating strategy for the fabric and does very little to provide comfort as the heat is lost before the next heating session. It is better to leave the building unheated when it is not occupied and then have a longer period of heating before the time when there are services or the like. Given this we would advise that the following adjustments are made:

Adjust the set point on the boilers to 75°C flow

Reduce the frost settings to 2ºC as it is needed to prevent freezing pipes only

Adjust the timings to come on 4 to 6 hours prior to a service but to turn off 30mins before the end as there will be sufficient heat left in the system to maintain the warmth (this is based on experiments at over 50 churches in the Diocese of Lichfield).

The adjustment of the heating system should be above to be carried out by any member of the church that is competent in using the controls.

7.3 Discontinue with Background Heating Strategy

The church is currently maintained at 15ºC when closed, this is undoubtedly wasting heat. It is heated to 21º or 22ºC on Sundays and certain other occasions.

The proposed central heating efficiency improvements described in Section 7 have the potential to improve performance by around 17% and reduce heat up time. The large thermal mass of the structure retains heat. Cutting out sources of heat loss such as broken windows, poorly closing windows, large gaps under doors and smaller sources of draught can also make a significant contribution to maintaining a reasonable temperature when the heating is off.

Most traditional churches were constructed without any form of heating. The modern additional 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 to 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 and organs can be installed with a local background tube heater such as https://www.dimplex.co.uk/product/ecot-4ft-tubular-heater-thermostat 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.

7.4 Reduce Temperature Setting by one degree

Adjustment of the thermostat by reducing its setting one degree can save between 5-10% of gas use and costs per degree.

Elderly members of the congregation could be seated in areas of the church which are adjudged to be draught free, and warmest. Use of winged armchairs, especially if covered in warmth retaining polyester throws can be of benefit as they will help to retain body heat.

7.5 Turn Heating Off Earlier in the Season

Ending heating a few weeks earlier than "normal" during a period of the year when average temperatures are rising should not lead to a significant fall in temperature, due to the large thermal mass of the building. Allowing the church to cool before the warmest period of the year will retain some "coolth" for longer than with heating right up to May and allow the church to be more comfortable during the early period of summer.

7.6 Clean the Existing Heating System

The church system is not fitted with a magnetic particle filter, thus allowing magnetic sludge to circulate. This will prevent the proper and efficient operation of the system by reducing the ability of the boiler to heat up the water and reducing the output of the radiators. It is similar to how scale build up can adversely affect kettles and showers.

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 where 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 to 15%. This can dramatically improve comfort for the congregation.

7.7 Install a Magnetic Particle Filter

To protect against the above, magnetic particle filters, similar to the one shown should be fitted.

7.8 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, by someone who is familiar with the system and competent to depressurise and repressurise it.

For the church 140-180kW system, approximately 14 litres of the fluid are suggested.

8. Energy Saving Recommendations [Other than heating]

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.

8.1 New LED Lighting

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

This includes some 230W floodlights, below.

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. An example of such a range of fittings is available from http://www.qvisled.com/

If all the lights were changed on a simple "like for like" the total capital cost (supplied and fitted) would be around £8,000. The annual cost saving would be approximately £2,800 resulting in a payback of around 2.9 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.

There are some fittings such as in the basement where the existing fitting can be made more efficient by simply changing the fluorescent tube within the existing fitting to a new LED strip lamp. This could be carried out by competent members of the churches internal team, very cost effectively and would be a List A item so no permissions are required.

8.2 Lighting Controls (Internal)

There are several lights which could benefit from being under control of a person sensor (commonly called PIR). This includes areas such as the foyer, Lounge, kitchens, toilets, stairwells where people visit for short periods, or pass through. With church staff on site during the week there is potential for many lights to be left on with people moving around. Some of these areas are only used occasionally and for a short amount of time and as such the light does not need to remain on constantly.

It is recommended that a motion sensor is installed on these specific lighting circuits so that the lights come on only when movement is detected in the space and turn off approximately two to five minutes after the last movement has been detected (note that the duration of the time lag after which the light goes off needs to be consider alongside the type of light that is fitted. LED lights are much more suited to being switched off after only a short duration than some fluorescent lights). These movement sensors also have light sensors integrated into them so they can be used to make sure that the light does not come on if there is already sufficient daylight in the space.

Your existing electrician or any NICEIC registered electrical contractor can install PIR sensors onto existing lighting circuits. This can be carried out without significant disruption to the use of the space.

8.3 Power Management Settings on Computers

The computers within the church are used by the staff within the parish office. It is therefore recommended that all computer workstations are set to go into hibernate mode after a short period of time of not being used.

This can be set on the computers by going into the Power Options settings on the computers control panel and adjusting the times on the 'change when computer sleeps' option. It is recommended that computers should turn off their display after 2 minutes and put the computer to sleep after 5minutes. Putting the computer to sleep will not lose any unsaved work but will require the user to power up the computer again when returning to their desk. Having shorter hibernate modes not along helps to save energy but also improves security by reducing the time that computers are left on but unsupervised.

8.4 Reflective Radiator Panels

The church is heated by radiators served from the boiler. Several radiators are located on the external, uninsulated walls and have no reflective or insulated surfaces directly behind them at present. They therefore loose much of their heat into the masonry of the wall behind the radiator rather than give out the heat into the body of the church.

In order to improve the insulation directly behind the radiators a reflective panel can be installed, this helps to make sure more of the heat from the radiator goes into the space and requires less overall heating from the boiler to achieve the set point. There are a wide variety of reflective panels for installing behind radiators on the market such as www.heatkeeper.co.uk. It is recommended that these panels are installed behind all radiators within the building. The installation of radiator panels can be carried out by anybody competent in basic DIY and does not require radiators to be removed.

8.5 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. Whilst most were observed switched off, timer switches (or push buttons giving 30 or 60 minutes of power) are advisable.

It is recommended that the heaters are fitted with a 24 hour/7 day timeclock to replace the fused spur switch. An example of such a unit would be a TimeGuard FST77. They should be set up with times to match the times that the building is occupied and 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.

9. Improvements to the Building Fabric

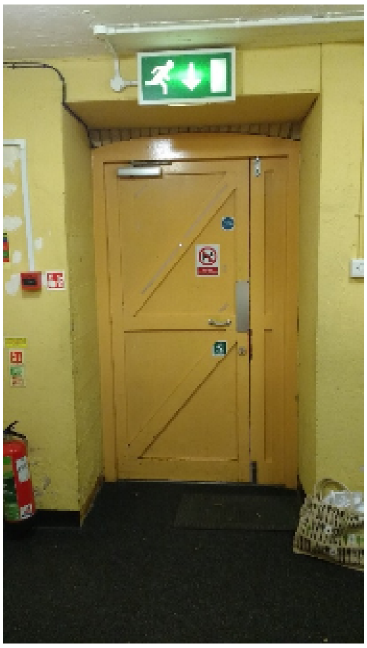
9.1 Draught Proof External Doors

There are a number of external doors in the church and basement. 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 (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.

Basement door on NW side. This has a large gap around the lock plate. All external doors would benefit from upgrading of draught exclusion fitments.

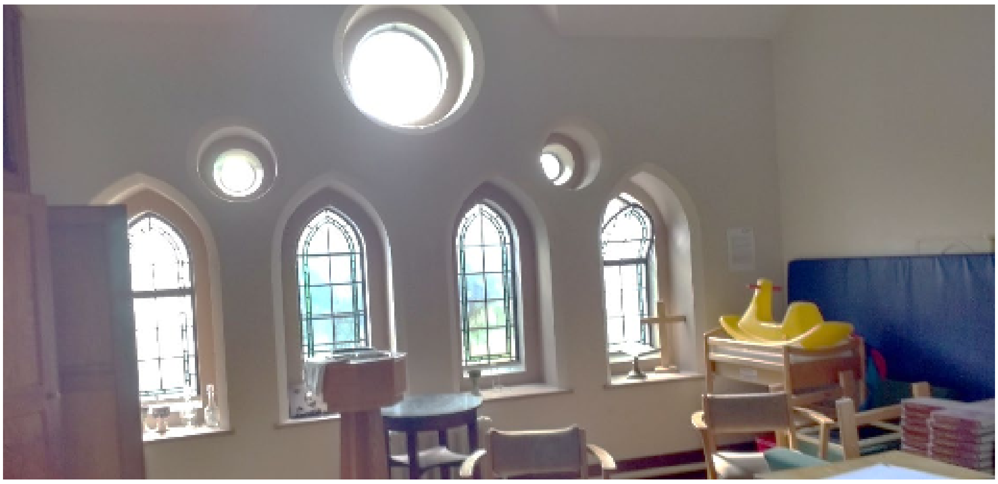


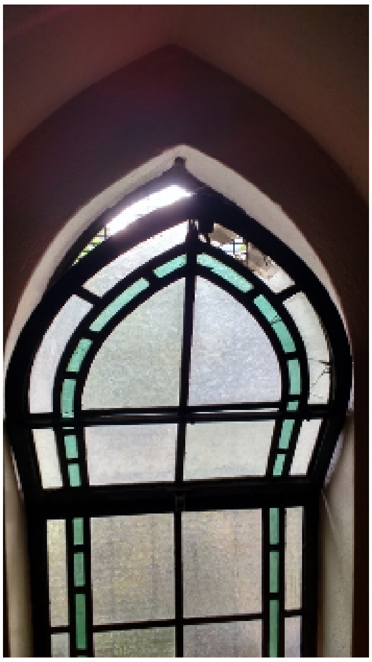
The door at the south east corner has a large gap underneath. There may have been a complete draught exclusion strip installed under the coving. There is now a very large gap, with some cardboard providing an ineffective means to prevent cold air or vermin entering.

9.2 Window Maintenance

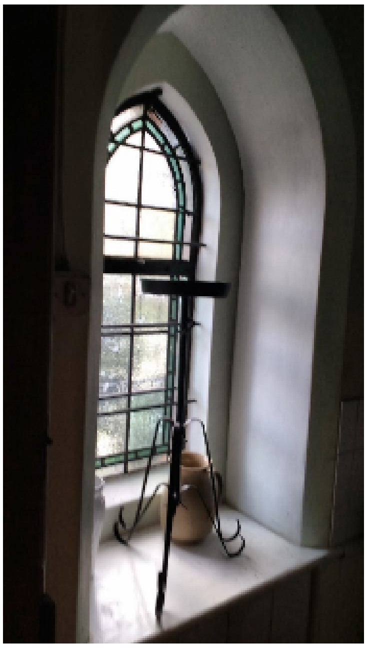
Many of the windows in the church are in poor repair with the result that they are not able to be shut causing constant draughts. As draughts can flow constantly, broken or damaged windows can account for 5% or more of an energy bill. Professional repair is recommended to prevent further deterioration and make all of the broken windows draught proof.

The hopper window opening panels in the former vestry, below, both have broken panes. This is probably because the windows have to be banged shut to engage the latch. Rust and layers of paint are likely to have built up around the hinge at the bottom.

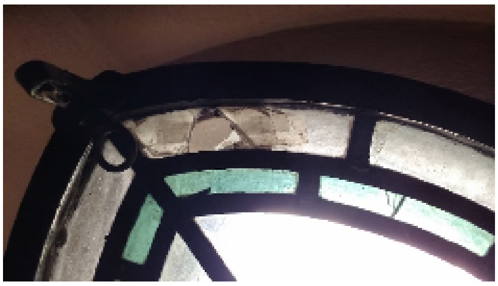




One of the vestry windows, above.



The top corner pane of the toilet window is broken.



Hopper windows in the main church (there are 16) will be a major source of heat loss if they cannot be closed properly. These require professional maintenance – ideally this could be scheduled for the same time as high level light bulb replacement in the church so access equipment could be shared.

Some of the windows in the church rooms cannot be closed because of rust and debris. They cannot be reached from the outside because polycarbonate panels have been fitted. These are not

airtight, so there are permanent large draughts flowing. It is recommended that the exterior panels are removed, the windows repaired, cleaned and repainted and the panels then reattached.

10. Saving Recommendations (Water)

10.1 Tap Flow Regulators

The over provision of water for hand washing is not only a source of excessive water use, but in the case of hot water, it is also a source of wasted energy in the heating that has to go into providing the hot water. With several toilets, and children's groups using the building, flow regulators are recommended.

The flow rate of the taps can be easily regulated by fitting flow regulators within the taps. It is recommended that flow regulators such as those manufactured by neoperl

(http://www.neoperl.net/en/) are fitted into all the viable hand wash basin taps to save on both water and heating of the hot water.

These regulators can be self-installed or by any good facilities staff.

11. Renewable Energy Potential

11.1 Overview

The potential for the generation of renewable energy on site has been reviewed and the viability noted.

Renewable Energy Type	Viable
Solar PV	No – Listed building, visible roof
Battery Storage	No – no viable PV
Wind	No – no suitable land away from buildings
Micro-Hydro	No – no water course
Solar Thermal	No – insufficient hot water need
Biomass	No –air quality issues
Air Source Heat Pump	Lack of suitable site, plus duty required is very large
Ground Source Heat Pump	Potential, to investigate further. Would need a borehole.

The whole of the roof of this Grade II listed building is highly visible, thus it is currently not permissible to install solar panels.

11.2 Ground Source Heat Pump

A Ground Source Heat Pump can achieve a COP of 3.5 year round (often 4, it is largely dependent on the system flow and return temperatures chosen).

The area of land adjacent to the church at the east end is relatively small so there is not considered to be enough area to install ground loop coils, however a borehole system could be possible.

A borehole system has been installed in a mediaeval churchyard with graves in central Ashford (St Mary the Virgin). The individual holes fan out from a hub in the outer corner of the site using a radial drilling technique.

It is envisaged that a GSHP system would supply the church rooms from Monday to Friday, plus the lounge and office areas. With sufficient capacity some background heating could also be supplied to the church.

From Friday evening, all heat would be transferred to a circuit supplying the church radiators, to bring this space up to temperature. On Sunday morning, having heated the church, heat could be switched to all areas to be used. After services, the heat would go back to just heating the church rooms which had cooled over Saturday.

Currently, the basement appears to be largely electrically heated. This could be envisaged as Phase 2 of a GSHP project, with the basement added to the GSHP circuit in the future, although it may be chosen to retain some electric heat only rooms which can be rapidly heated for short, occasional uses.

One of the issues to discuss with GSHP providers is the adequacy of the heat source for continuous use. Addition of a basement circuit could involve a joint heating or cooling installation. This would require a more complex pump installation since it would have to run in reverse to provide cooling in the summer. This would be advantageous in the long term as it will help to replenish the ground heat reservoir in the ground.

As there are four ventilating fans for ventilation / cooling installed in the basement, installing a GSHP system which could provide cooling would lessen the need for fan operation for cooling and cut costs.

12. Cost Comparison

12.1 Capital Cost

The current 140kW boiler is thermostat controlled. Over 30 weeks use per year, the 128,000kWh total gas use is estimated to be split between 40 x 5 hour heating episodes at 140kW (28,000kWh) and 5000 hours maintaining 15^{o}C at 20kW average (100,000kWh).

At 89% efficiency, this delivers around 114,000kWh of heat.

A heat pump of maximum output 60kW could deliver 40 x 11.7 hour heating episodes to deliver 28,000kWh for weekly warming of the main church. For the rest of the time, the heat output could be split between delivering 20kW of heat to the church as at present, and 20kW heat to the church rooms. There is then some spare capacity for either heating the basement or the Lounge.

Note that these estimates are not based on detailed heat loss calculations, radiator sizing and efficiency which will be required to accurately size a heat pump system. Some radiators may need replacement by those of larger surface area.

Item	Installed Cost
6 x 3kW near infra red electric panel heaters [Church rooms], £563 installed	£3,378
New condensing boiler, around 100kW	£30,000
OR	
Ground Source Heat Pump 60kW	£60,000
Additional or larger conventional radiators	£2,000

12.2 Operating cost

These figures are based on several assumptions. The size of a heat pump (operating constantly to maintain a temperature) will be related to the heat loss from the building. Ideally this requires heat loss calculations for the building – it is known that window repairs, draught proofing measures and system efficiency improvements such as a system clean, heat transfer fluid and pipe fitting insulation will make heat pumps more efficient and increase viability.

The current boiler appears to be sized to heat the building from cold, but a lower average power is used. Costs are based on a price of 13p/kWh, averaging out present costs (Day 14.91p/kWh, night 10.49p/kWh.

It is possible to cut heating energy requirements by a third.

Technology	Use Pattern	Annual Hours	Installed Power kW	kWh	Operating Cost
Gas Central Heating (current)	15°C maintained, 21°C for services	5,200	140 (maximum) Average power 20kW 89% efficiency	128,000 gas used	£3,468 [£4,037 with VAT, etc]
Gas Central Heating, System cleaned, heat transfer fluid installed	As above	5,200	17% saving	106,240	
Gas Central Heating as above, window repairs + pipe fitting insulation + reflective film behind radiators		5,200	10% saving [5% + 3% + 2%]	95,616	
Gas Central Heating as above without background heating	Temperature in church allowed to drop (but it does not fall as much as it would at	5,200	10% saving	86.054	

	present due to window repairs)				
			Calculations below assume that efficiency savings above have been made		
GSHP, 60kW heat supply. COP = 3.5 17kW electricity requirement		5,200	470hours at 60kW output requiring 17kW electricity 4,730 hours at 12.3kW output requiring 3.5kW electricity, of which 1,900 is for church rooms	86.054 Heat 24,587 electricity	£3,196 [£3,748 with VAT etc]
Gas Heating, Church Rooms		1900		18,285	£651, £760 with VAT etc.
Electric far infra red panel heating, Church Rooms		1900	Price of 13p/kWh used to average out day and night rates.	18,285	£2,377 £2,500 with VAT etc
GSHP, link to church system		1900		18,285 heat requiring 5,225 electricity	Cost included in GSHP above
				Total cost present gas	£4,800
				Estimated electric cost for GSHP system	£3,800

COP = Coefficient of Performance (how many kW of heat are produced for each kW of electricity used to run the heat pump). These numbers are reasonable estimates. Detailed calculation and design by a supplier is needed to produce accurate figures.

Savings of around £1,600 per year appear feasible with a GSHP costing £3,200 to run replacing £4,800 total gas costs. The standing charge for electricity will be payable anyway. This gives a payback period of around 38 years. However, there is a long term expected increase in gas prices (partly as North Sea gas runs out, replaced by imports, partly a gradual rise planned to encourage transition to electric heating), so the actual payback period is likely to be shorter

Electricity costs have the potential for a 20% reduction with a cheaper tariff, also reducing the payback period.

All the electric heating options can be zero carbon with a fully renewable tariff.

13. Funding Sources

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 .

14. 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.

Appendix 1 – Schedule of Lighting to be Replaced or Upgraded

Room/Location	Number of Fittings	Recommended Upgrade	Annual Saving (£)	Total Cost (£)	Payback
Chancel spotlights	4 x 205W	LED, R63 15.5W each	£177	£86	0.5
Transept spotlights	8 x 100W	LED, R63 15.5W each	£172	£172	1
Nave spotlights	8 x 100W	LED, R63 15.5W each	£172	£172	1
Nave floodlights	16 x 230W	LED, 50W each	£689	£1,920	2.8
Aisle floodlights	10 x 230W	LED, 50W each	£430	£1,200	2.8
Kitchen	6 x T12, 80W fluorescent	LED strips, 24W each, 5' double	£80	£288	3.6
Offices	14 x T8, 58W fluorescent	LED strips, 24W each, 4' doubles	£114	£595	5.2
Prayer Room	4 x T8, 58W fluorescent	LED strips, 24W each, 2 x 4' doubles	£32	£170	5.5
Prayer room corridor	1 x T8, 58W fluorescent	LED strips, 24W each	£8	£72	9
Current total	11,340W	2,760W	Current operating cost	£1,474	
Annual consumption	11,340kWh	2,760kWh	Projected operating cost	£359	
		TOTALS CHURCH	**£1,874**	**£4,675**	**2.5**
Basement	65 x T8, 58W fluorescent	LED strips, 24W each, 4' doubles	£316	[85 each] £2,805	8.9
Basement toilets	6 spotlights, halogen, 50W	LED, 5W each	£5	£30	6
Current total	5,290W	3,080W	Current operating cost	£757	
Annual consumption	5,819kWh	3,388kWh	Projected operating cost	£440	
		TOTALS BASEMENT	**£321**	**£2,835**	**8.9**
Church Rooms	12 x T8, 58W fluorescent	LED strips, 30W each, 5' doubles, 6 required	**£640**	[96 each] **£576**	**1**
Annual consumption	1,322kWh	684kWh			
GRAND TOTAL	**18,481kWh current**	**6,832kWh LED upgrade**	**£2,835**	**£8,086**	**2.9**

Currently there are also around 26 short length low energy uplight bulbs rated at 18W each and 21 bulkhead lights installed in the basement.