Energy Audit and Survey Report

St Matthew's, Oxford

> *"There is a plan to reduce global carbon emissions to net zero by 2050. The plan will work. It involves all of us. We need to begin now, in our homes and workplaces and churches"*
>
> *Revd Dr Stephen Croft, Bishop of Oxford*

Version Control

Author	Reviewer	Date	Version
Paul Hamley	Matt Fulford	6th January 2020	1.0

Contents

1. Executive Summary

An energy survey of St Matthew's, Oxford 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 Matthew's, Oxford is a large Victorian church dating from 1890. It has a relatively simple pitched roof over the nave with gently sloping aisle roofs. A modern two storey church hall is on site, sharing single utility meters. 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.

Short Term: Energy saving recommendation	Estimated Annual Energy Saving (kWh)	Estimated Annual Cost Saving (£)	Estimated capital cost (£)	Simple Payback (years)	Permission needed	To be actioned by who / when?
Purchase a temperature datalogger	5%	£180	£50	<1	None	Warden/technical person
Replace non LED lighting in church and hall	2,000	£260	£15,000 budget	57	Faculty	PCC
Replace any failed double glazing units in hall	8,000	£170	150-200 per unit	-	None	Warden

Medium Term: Energy saving recommendation	Estimated Annual Energy Saving (kWh)	Estimated Annual Cost Saving (£)	Estimated capital cost (£)	Simple Payback (years)	Permission needed	To be actioned by who / when?
Solar photovoltaic panels on church roof	20,000 with large system	See section 8	£28-43k	10-18	Faculty	PCC
Investigate further insulation to hall roof (side room)	4,000 but also avoid overheating	£180	£3,000	17	List B / Faculty	PCC

Long Term: Energy saving recommendation	Estimated Annual Energy Saving (kWh)	Estimated Annual Cost Saving (£)	Estimated capital cost (£)	Simple Payback (years)	Permission needed	To be actioned by who / when?
Air Source Heat Pump for hall	54,000	£3,300 if solar powered	£15 - 20k	5- 8 years	Faculty	PCC

The Church should check any faculty requirements with the DAC Secretary at the Diocese before commencing any works. Based on current contracted prices of 13.0514p/kWh and 2.0758p/kWh for electricity and mains gas respectively. **If all measures were implemented this would save the church over £3,000 per year in operating costs**.

2. Introduction

This report is provided to the PCC of St Matthew's, Oxford to provide them with 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

An energy survey of the St Matthew's, Oxford, OX2 6RX was completed on the 21st November 2019 by Dr. Paul Hamley. Paul is an energy auditor with experience of advising churches and small businesses. He is part of the Diocesan Environment Officers Energy Group developing advice for the Church of England and authored the 2018 "Assessing Energy Use in Churches" report for Historic England. He is a CIBSE Associate member and a Chartered Scientist, with experience of the faculty process gained from chairing the building committee of a Grade I listed church.

St Matthew's, Oxford	627224
Gross Internal Floor Area Including vestry and porch	510 m^2
Listed Status	Not listed
Built	1890
Typical Congregation Size	100

The church is typically used for 11 hours per week for the following activities

Services	5 hours per week
Meetings and Church Groups	3 hours per week
Community Use 3-4 concerts per year Art weeks – two weeks per year Film nights Barn dance Street parties if wet	3 hours per week
Other uses	0 hours per week

Annual use estimate 570 hours. Annual heating hours estimate (x 7/12) = 330 hours plus preheating.

St Matthew's, Oxford	
Gross Internal Floor Area (both floors)	365m^2
Listed Status	Not listed
Built	c. 1990-2000
Typical Group Size	5-50 event dependent

The church hall is typically used for up to 50 hours per week for the following activities

Services	0 hours per week
Meetings and Church Groups	16 hours per week (sample week)
Community Use	27 hours per week (sample week)

Annual use estimate 2600 hours. Heating hours estimate 1700 hours.

3. Energy Procurement Review

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

The current electricity rates are:

Single / Blended Rate	13.0514p/kWh	In line with current market rates [Parish Buying]
Standing Charge	25.0852p/day	N/A

The current gas rates are:

Single / Blended Rate	2.0758p/kWh	Below current market rates [Parish Buying]
Standing Charge	354p/day	High

The above review has highlighted that the current rates being paid are below current market levels and the organisation can be confident it is receiving good rates and should continue with their current procurement practices. The Parish Buying scheme 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	5%	The correct VAT rate is being applied
CCL	Not charged	The correct CCL rate is being applied.

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

4. Energy Usage Details

4.1 Energy Consumption

St Matthews' Oxford, uses in the region of 29,000 kWh/year of electricity, costing £4,000 per year, and uses in the region of 150,000kWh/year of gas, costing in the region of £3,600. The consumption for 2018 was approximately 180,000kWh (based on 11 bills) and 122,000kWh for 2019 (ten months data). The gas rate per kWh is very low, whereas the standing charge of £3.54 per day is high -this may reflect the larger gas use compared to most churches, due to the hall being included.

This data has been taken from one energy invoices each for electricity and gas plus monthly payment records provided by the church.

The church is used for around 570 hours per year, of which about 7/12ths are the heating season (330 hours), but with preheating 500-600 heating hours, 120kW gives 60,000 to 72,000kWh.

The remainder for church hall consumption is between 60,000 and 108,000kWh; the boiler input is 48kW, giving between 1250 and 2250 heating hours. An annual use estimate of 2600hours suggests 1700 heating hours (81,600kWh). Using the median figures gives: Total annual use 150,000kWh; church 66,000kWh, hall heating 81,600kWh, hall cooking 2400kWh.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	E14UP12212	EDMI Atlas Mk10D	2 pulses	Cabinet in south west corner of church
Gas – Church	M040 K02612 14 D6			Cabinet outside middle of south aisle

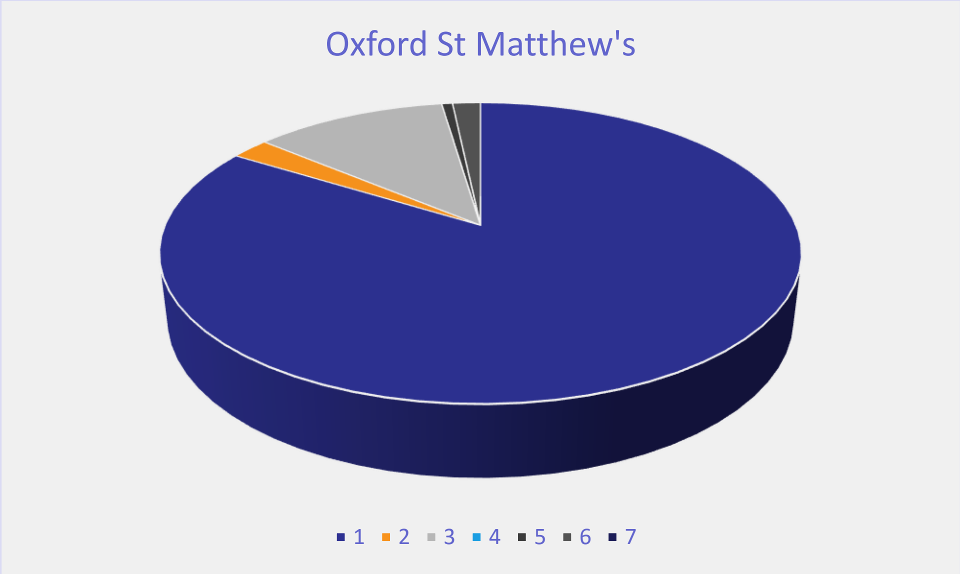
It is recommended that the church consider asking their suppliers to install smart meters so that the usage can be monitored more closely, and the patterns of usage reviewed against the times the building is used.

4.2 Energy Profiling

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

Service	Description	Power	Annual Use/ kWh	Estimated Proportion of Usage %
Heating	Gas Central Heating Boiler: Ideal Concord CXA [80% efficiency] Church heaters 13 x 8.9kW + 5KW 550 hours	48kW input 120kW	81,600 66,000	
Cooking [Hall]	Gas cooker and hob: Moorwood Vulcan Estimate 240 hours annual use		2,400	
Total Gas use			150,000	
Heating - fans	Grundfos boiler pump Church heater fans 14 x 500W	150W 7kW	255 3850	
Lighting Church **Hall Office**	Nave 18 LED uplights x 25W 37 lights switched from panel including some floodlights Vestry, entrance and kitchenette lighting 570 hours TOTAL 5.5kW 2600 hours TOTAL 6.7kW	450W 4800W 250W	3135 17,600	
Hot Water [Hall]	**Kitchen** Wall mounted: Heatrae Sadia Supreme 215 Coffee Machine: Technivorm (hour per day) Kettle (35 boils/ week x 3 mins	2.5kW 2kW 2kW	250 728 180	
Other Small Power [Hall]	**Kitchen** Dishwasher (hour per day) Microwave: Sharp R209 Fridge/freezer Toaster **Office** Computer Photocopier Shredder Sound system TOTAL	4500W 900W 300W 2000W 300W 500W 500W 1kW	1640 10 600 24 100 50 10 570 3000	
Organ				

Estimated annual electricity consumption: 29,000kWh



Unified data, church plus hall

KEY 1 Gas use 2 Electric heat (fans and pumps) 3 Lighting

5 Hot water 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 load is lighting.

4.3 Energy Benchmarking

In comparison to national benchmarks for Church energy use St Matthew's, Oxford uses more electricity than would be expected for a church of this size due to regular use of the hall.

St Matthew's, Oxford uses an average amount of gas – as the hall is of relatively new construction this contributes to preventing high consumption.

	Size (m^2 GIA)	St Matthew's, Oxford use kWh/m^2	Typical Church use kWh/m^2	Efficient Church Use kWh/m^2	Variance from Typical
St Matthew's, Oxford (elec)	865	33.5	20	10	+67%
St Matthew's, Oxford (heating fuel)	865	153	150	80	+1%
TOTAL	865	186.5	170	90	+9%

There is no benchmark data available which takes hours of use and footfall into account.

[1] CofE Shrinking the Footprint – Energy Audit 2013

5. Energy Saving Recommendations

5.1 Lighting (fittings) - Church

The church is lit by a mixture of 18 uplights attached to the pillars plus two in the chancel, and a number of downlights which are reported to have low lifespan and give very poor lighting levels.

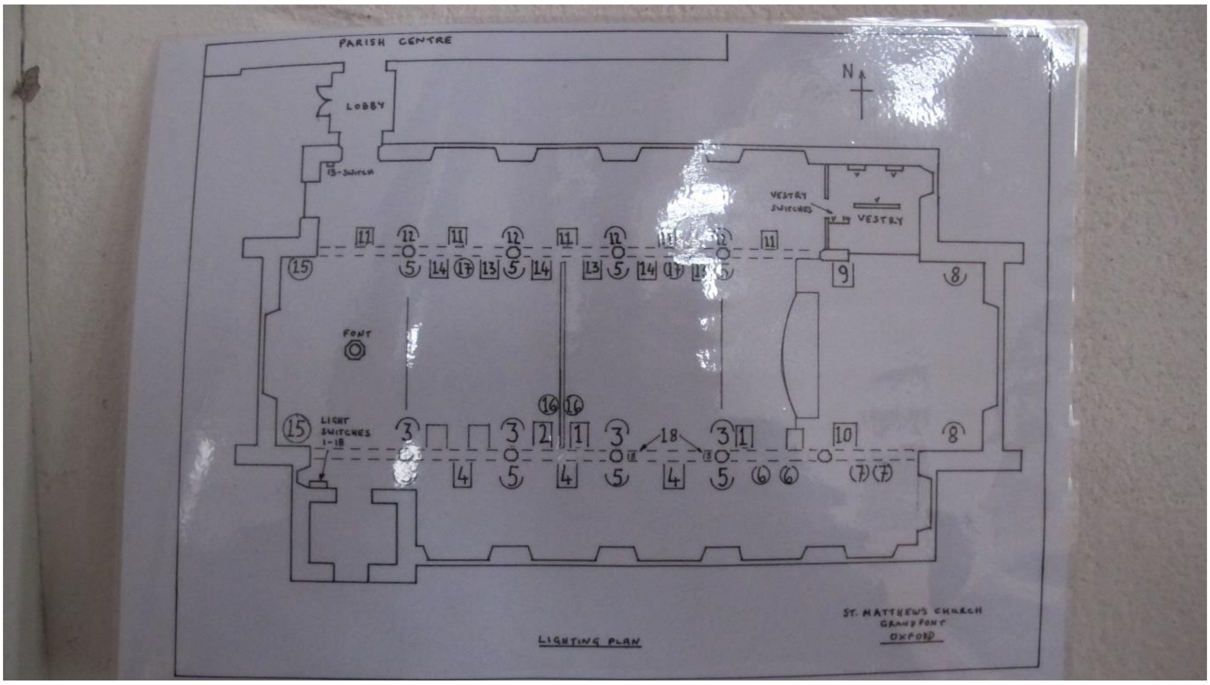
During the audit, held on a dull overcast day, Lux levels of between 30-50 were recorded in the seating area, with 100 at the altar and 100-150 in the music area where lighting was focussed.

A lighting contractor, R.T. Harris Electricians has been engaged to advise on replacement of the downlighters with a more energy efficient and effective system.

It is recommended that all of the downlights are changed for LED with appropriate luminaires (holders).

5.2 Lighting (control) – Church

Installation of a switching system which allows individual lights or groups of lights to be switched independently to create various lighting effects or to only light a portion of the church if used by a small group is recommended.



3,5,8 and 12 are uplights.

5.3 Lighting (fittings) – Hall

The main hall space is well lit with Lux levels of 300-320 recorded. Lighting is provided by mostly fluorescent tubes such as D shaped tubes in circular diffusers and T8 strip lights in the office.

Any T12 fluorescent tubes (1-inch diameter) should be replaced by high frequency T8 tubes (which are more efficient, without flicker).

5.4 Lighting (control) – Hall

It is recommended that a motion sensor is installed on lighting circuits for the individual rooms, corridors and toilets in the hall 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 (commonly called PIRs) 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.

Depending on the type of light fitting installed it is normally recommended that areas such as storerooms and cleaners' cupboards switch off after just 1 minute, corridors and stair lobbies after 2 minutes and WCs after 5 minutes. Generally lighting levels should be around 300lux but it is highly dependent on the use of 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.

The careful optimisation of the existing lighting controls can be undertaken by Inspired Efficiency (contact matt@inspiredefficiency.co.uk, 07971 787363) without any disruption to the use of the building.

5.5 Refrigeration controls

To reduce the electrical consumption of these appliances it is recommended that they are all fitted with a SavaWatt unit. These units work by automatically detecting the load of the compressor and turning down the power when it is not in full load. This reduces the energy consumption of the refrigeration unit by around 18% while maintaining the cooling of the appliance. It does this by reducing the voltage delivered to the unit when it is idling but allowing the full energy to the unit when it is required.

Supply and installation and further details can be undertaken by SavaWatt directly http://savawatt.com/. The installation does not cause any significant disruption to operations and can be undertaken during normal operating times.

6. Energy Saving Recommendation (Heating)

6.1 Heating System and Strategy

The church currently uses gas heating to heat the church and hall.

The church is equipped with 13 Temcana Kestrel 250S powered flue fan assisted heaters. These are direct gas heaters supplying hot combustion gases into the building. They are supplied with air from outside of the building, which accounts for the pipework (incoming air, and gas). In addition, there is one Temcana Kestrel 150 unit in the vestry. They have an input of 120kW (presumed to include the electric fans) and output of 100kW.

The Ideal Concord CXA boiler located under the church has a heat output rating of 40kW. This is presumed to supply the hall only (365m^2) and is fairly small for a building of this size. However, high power is only needed for rapid heating; for the church hall which is used daily, regular heating of a well insulated building means heat input balances heat leakage.

The boiler's age is unclear. Current efficiency standards are 93% for an optimised condensing boiler. The data panel indicates maximum 83% efficiency when new. Due to its age, it is wise to consider planning for replacement as part of re-ordering.

Section 6 details efficiency improvements for the present system.

Section 7 looks at alternatives for church and hall; electrical heating for the church, and an Air Source Heat Pump directly replacing the boiler.

If the gas boiler is replaced, it should be with a model which is hydrogen ready. Hydrogen is due to be added to the gas grid over the next five year period. If plans to decarbonise the gas grid are implemented; the hydrogen mix will eventually exceed 20% and a hydrogen compatible boiler (and piping) will be required. The transition will be overseen by the regulatory bodies in a similar way to that between town gas and North Sea gas.

The church plus hall annual gas use is around 150,000kWh (180,000kWh for 2018 and 120,000kWh for 2019). The church is used for around 570 hours per year, of which about 7/12ths are the heating season (330 hours), but with preheating 500-600 heating hours, 120kW gives 60,000 to 72,000kWh.

The remainder for church hall consumption is between 60,000 and 108,000kWh; the boiler is 48kW input, giving between 1250 and 2250 heating hours. An annual use estimate of 2600hours suggests 1700 heating hours (81,600kWh). Using the median figures gives: Total annual use 150,000kWh; church 66,000kWh, hall heating 81,600kWh, hall cooking 2400kWh.

6.2 Optimising Church Heating

With a direct gas system, there are no efficiency losses except for electric fans – all of the gas is converted to heat.

Timings may be optimised using a temperature datalogger; one which also records humidity will indicate if there are any problems from the moisture from combustion. Relative Humidity should not exceed 75% to prevent problems with damp or mould.

A suitable model retailing for around £50 is https://www.lascarelectronics.com/easylog-data-logger-el-usb-2/

6.3 Boiler Timing Optimisation

Radiator systems with hot water remain hot for several hours after the boiler is switched off – experiments in the Diocese of Lichfield at over 50 churches have established that hot water radiator heating can be optimised by being switched off 45 minutes before the end of the service.

Purchasing of a temperature datalogger will allow the time for the hall to heat (in different weather conditions) to be understood, as well as the time to switch off to be optimised for each of the three zones. This would require someone with a computer to plug in the device and download the readings.

6.4 Thermostatic Radiator Valves (TRVs)

Radiators in the hall foyer and some area have TRVs fitted (all areas were not observed)

Any radiators not fitted with TRV's should be. TRV's can be installed on the existing radiator and allow the users of the room to have some element of control over the temperature in the room and prevent over-heating which often leads to situations where the heating is on and the windows are open. It also allows un-used spaces to have the heating in them turned down.

It is recommended that TRVs are installed on all radiators and users advised as to the best way to operate these once they have been installed. TRV's can be supplied and installed by any good heating engineer.

6.5 Boiler Maintenance; Clean / Flush Existing Heating System

To ensure longevity, the system should be periodically flushed and cleaned to remove any scale and corrosion. The church should have a record of when this was done last.

It is strongly recommended that the heating system is cleaned to remove 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 turn 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 occupants.

The boiler does not appear to be fitted with a magnetic particle filter. This apparatus catches any rust or metal particles and prevents them being deposited on the boiler heat exchanger. They should be installed if it is planned to continue using the water heating systems long term. Corrosion inhibitor should be added to the system when your boilers are serviced annually.

6.6 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.

6.7 Insulation of Pipework and Fittings

The pipework within the plant 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 wasted 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 expose pipework and fittings are insulated with bespoke made flexible insulation jackets. These wrap around the various elements but can be removed and then replaced for any servicing activities.

A free survey and quotation for the supply and installation of insulation of pipework fittings can be arranged through ESOS Energy Ltd (contact Adrian Newton 0117 9309689, adrian@esos-energy.com).

7. Alternative Heating Systems

7.1 Church

A church with low hours of use per week will always fall back to “base” temperature between heating events (it may take around 24 hours for the temperature to fall). A system which can heat rapidly, without sending most of the heat to the ceiling first, and in addition can be configured to heat small areas independently for small services or midweek meetings will be more efficient than one which seeks to heat up the whole volume.

If the current direct gas heating system is considered effective, then reasons to replace it are

i) Any problem with the moisture it produces
ii) To reduce carbon footprint by replacement by renewable electricity

Currently, one kWh of gas produces 0.18kg CO_2, whereas one kWh or electricity is responsible for 0.25kg CO_2 (this figure has reduced drastically as the UK switches from coal to wind based generation). A church already on a renewable tariff will be buying 100% renewable electricity; the Parish Buying scheme provides this.

Alternatives include:

Radiant Electric heating

Under pew heating (requires fixed pews)

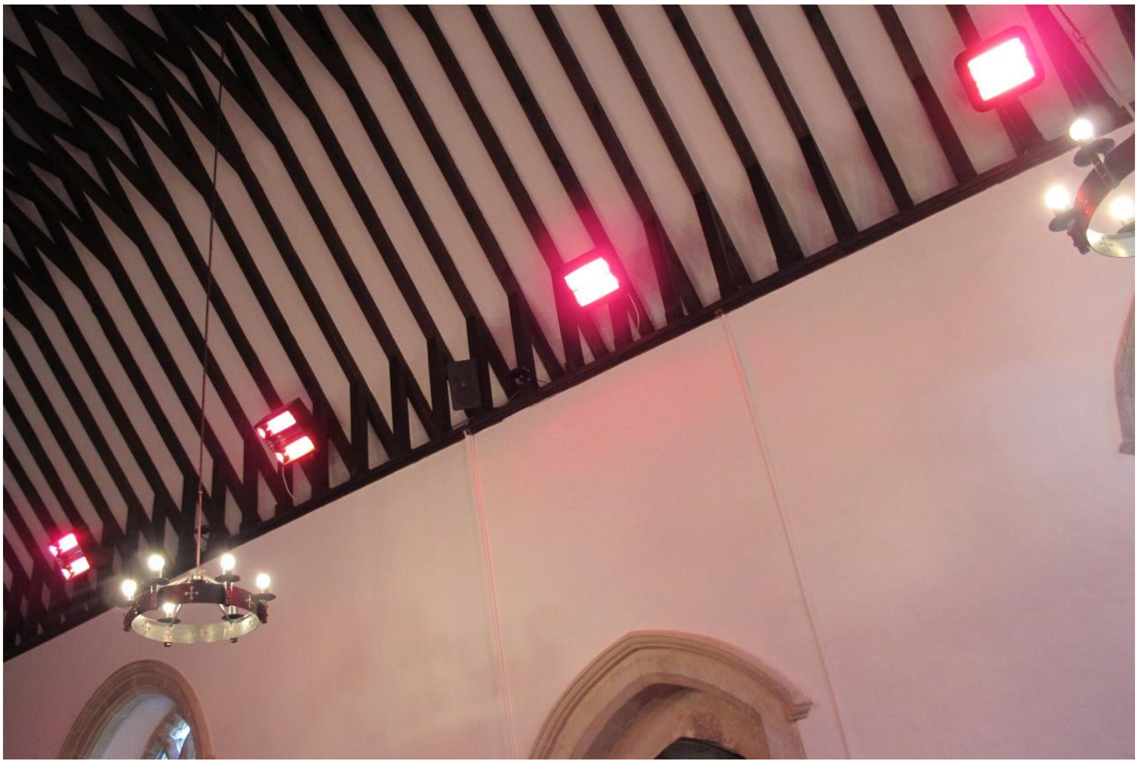
Underfloor heating (powered by a heat pump)

7.2 Electric Radiant Heating

Use of electric radiant heating is compatible with buildings such as churches which have an infrequent on/ off use pattern. Heaters may be rectangular far infra-red panels, mounted on the ceiling or on walls above furniture level, or of the incandescent bar type. The latter can be considered unsightly when mounted on walls; however, they have been successfully used suspended from chandeliers as at St Catherine’s, Faversham as seen below. This means the heaters can be positioned closer to the congregation than wall or ceiling mounted panels, thus reducing the power required.

St Catherine’s Faversham installed radiant heating in 2019 at a cost of around £22k (42 elements).

St Catherine’s, Towersey has a mix of under pew “cooltouch” and high-level radiant heating.



If chandelier heating was installed at St Matthews, suspended from the centres of six arches nearest the seated area, 6 x 8 1kW heaters giving 48kW, based on Faversham’s costs would be in the region of £25k installed.

The optimum solution for the church will depend on the planned uses and frequency of occupation of the building.   Suitable electric panel heaters would be far infrared panels such as these 550W panels retailing at £275:   https://www.warm4less.com/infrared-heaters/ceiling-panels/ .

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.

7.3 Under Pew heating

Under pew electric heating requires fixed pews.   It needs little preheating time and delivers heat directly to the congregation.   Although electricity is currently more expensive that gas per kWh; due to the lack pf preheating this is not necessarily more expensive than gas.

Heaters with an output of 300-400W seem to be more suitable than 500W models according to reports from different churches, the installed cost is around £180 per installed heater.

The under pew (see photo below) and panel heaters have been recently installed at St Andrews Church, Chedworth, Gloucestershire, GL54 4AJ. The church is open in daylight hours so can be viewed at any time.

7.4 Under Floor heating

Underfloor heating is only viable if the building is intended to be regularly used, as heat up times are very long. It is unsuitable for a once a week use church. Installation costs are high (around £1000 per square metre); and it would require either a boiler or a heat pump.

Visual inspection suggests that this is technically viable – the floor is carpeted suggesting together with the age of the church that, there did not appear to be any memorial slabs or tombs. It is not believed that there is a vault underneath. Underfloor heating would raise the floor level by 150-200mm.

7.5 Hall – Air Source Heat Pump

The hall has a wet radiator system heated by a 40kW output boiler under the church.

If this were replaced by electric panel heating, 40kW of panels would be required (costing in the region of £20,000 and costing around 6.5 times the cost to run (based on the churches current electricity and gas rates). 81,600kWh of electricity = £10,650 annually. It would require careful calculation to balance the heat requirements of the different rooms.

The hall building is extensively used and is of relatively modern construction, so could benefit from a change to heat pump technology. Heat pumps work best delivering low grade heat – water at around 40^{o}C and not 80^{o}C as in traditional central heating systems (note modern condensing boilers work at 55^{o}C or lower). There is insufficient space for a ground source heat pump (and site access to drill a borehole looks difficult), but there are suitable locations to install air source heat pumps which are not visible from the road, along the outer side wall of the hall multi user space.

ASHPs consume electricity, but deliver between 2.5 and 4 times the amount of heat in kWh that they consume. An Air Source Heat Pump would have a capital cost in the region of £15,000, an annual electricity requirement about 1/3 of the hall current gas use of 81,600kWh = 27,200kWh; so £3,550 grid electricity cost annually. Compared to installing radiant panels in the hall, an ASHP will consume around one third of the electricity, for similar capital cost.

The economics of an ASHP are further enhanced if solar power is generated on site. Although it appears to make the solar power payback period longer as the heat pump cost is included.

The current boiler room site under the church would not offer a site for an Air Source Heat Pump as it would not provide airflow for the heat exchanger.

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 - future
Battery Storage	Yes - future
Wind	No
Micro-Hydro	No
Solar Thermal	Insufficient hot water use
Ground Source Heat Pump	No
Air Source Heat Pump	Yes
Biomass	No - lack of space, urban air quality

8.1 Solar PV potential

The hall uses a considerable amount of electricity during the day for lighting. An Air Source Heat Pump installation would increase electricity consumption and the viability of generating electricity on site.

There is potential for a PV array on the roof of the church. 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. The church and hall electricity consumption is around 29,000 kWh with much usage of the hall occurring during the day (considering the sample week booking sheet); many of the bookings cover the early evening when solar PV would generate in the summer.

The government has advertised a “Smart Export Guarantee” to begin in 2020 which would pay for electricity generated and exported to the grid (the Feed in Tariff having ended). Implementation of an SPV system must wait until the SEG terms are guaranteed to assist financial viability.

The south facing roof of the church offers the best site; it is not very visible from Marlborough Road and is visible from few properties. The south side of the nave roof has an area of around 160m^2, and the relatively flat south aisle roof offers around 80m^2. The hall roof of relatively flat pitch is another option, although it will be overshadowed at low sun angles by the higher church roof so is unsuitable. Either option is subject to structural suitability.

The nave roof could generate 0.15kWpeak/m^2 giving a 24kWpeak system. A 1kWpeak system can generate 800kWh annually, giving a total annual generation of 19,200kWh.

If the whole of the south facing roof, nave plus aisle was panelled, this would give a 36kWpeak system generating 28,800kWh. This is in the same region as the church’s annual electricity use (29,000kWh) – although some of that use will be during the evening and night. Installing a battery so that all of the energy generated can be used may be more cost effective than selling surplus electricity to the grid (the predicted SEG rate is 5.5p/kWh) and then buying grid electricity at 13p/kWh.

At current installed costs or larger systems of £1,200 per kWpeak, 24kWp/160m^2 array would cost £28,800. A 36kWp / 240m^2 system would cost £43,200. This does not include cost of any battery.

An inverter would be required, needing a location. It is probably too large for the existing electrical cabinet at the rear of church, although it could be located in the nearby porch / kitchenette area. Inverter lifetimes are around 15 years (half of the panels). Whilst it would fit within the boiler room, that does not offer the best place for access or maintenance but could be an option if the cable routes passed that way.

The table below assumes that for (A) the nave roof only system, all of the electricity generated is consumed on site and the rest is bought from the grid. A maximum sized system (B) exports overproduction during the day, but still requires the same input during the evenings and overnight.

The first two columns are for current electricity consumption (29,000kWh).

Column C looks at the effect of adding an Air Source Heat Pump for the hall, giving the same annual heat output, which requires around a third of electricity input; 27,200kWh. It is assumed that 67% of this occurs in daylight, given the use pattern of the hall.

The effect of adding a battery would be to increase the capital cost and reduce the amount paid to the grid. The table below assumes that for (A) the nave roof only system, all of the electricity generated is consumed on site and the rest is bought from the grid. A maximum sized system (B) exports overproduction during the day, but still requires the same input during the evenings and overnight.

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The effect of adding a battery would be to increase the capital cost and reduce the amount paid to the grid. There would then be no SEG income.

	A	B	C
System size / kWpeak	24	36	36
Installed Cost at 2018 prices	£28,800	£43,200	£43,200 + ASHP £15,000
Area required / m^2	160	240	240
Annual generation estimate, kWh	19,200	28,800	28,800
Annual use / kWh	29,000	29,000	56,200
Amount consumed during daylight / kWh	19,200	20,000	38,000
Amount exported to grid / kWh	0	8,800	0
S E G income at 55p/kWh	0	£484	0
Grid Electricity still required (includes evening and nights)	10,000	9,000	18,200
Grid cost at 13p/kWh	£1300	£1170	£2366
Annual saving (electricity, based on £4000 pa current cost)	£2700	£3314	£1634
Annual saving (gas use, hall)	£0	£0	£1700
Total annual saving	£2700	£3314	£3334
Payback period	10.6 years	13 years	17.5 years

Sources: Inspired Efficiency

Building Research Establishment. Tables H3 & H4, SAP 2009, http://www.bre.co.uk/filelibrary/SAP/2009/SAp-2009_9-90.pdf

https://www.theecoexperts.co.uk/solar-panels/cost

Fully detailed PV design and calculations and quotation can be obtained from Batchelor Electrical, contact Stuart Patience on 01202 266212; 07793 256684; stuart@batchelor-electrical.co.uk.

8.2 Battery Storage

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 therefore investment into this may be worth delaying at this stage.

If solar PV is planned, a future add on battery should be considered as part of the installation.

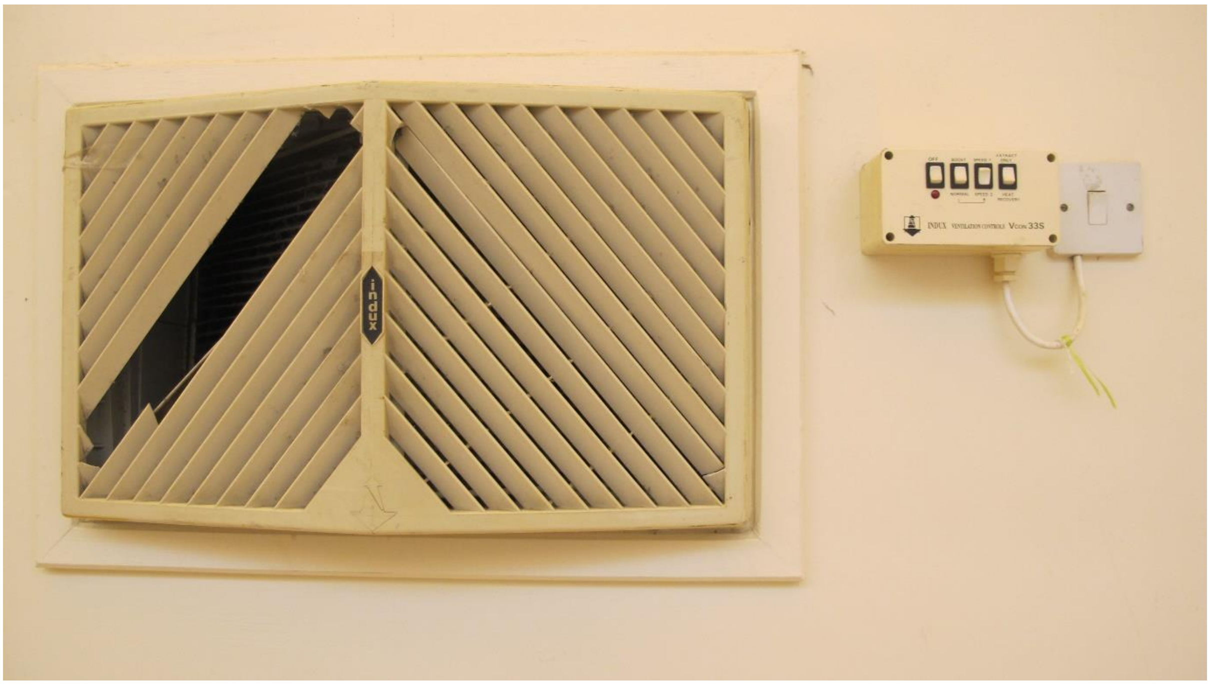
9. Energy Saving Measures (Building Fabric)

9.1 Insulation

The first floor room located on the south side of the hall has a large expanse of glazing

Is the metal roof insulated? Can this be improved? Some double glazing units appear misted so are failing.

9.2 Hall Multi user space ventilators



The main room in the hall was built with sports in mind – to provide the necessary air changes per hour, four ventilators are fitted to the north wall. They appear to be fitted with a form of mechanical heat recovery. None of the ventilators are in working order, one being blocked with cardboard. If the church is not going to use the hall for sports at any point, these units could be removed – however, your architect should be consulted regarding implications for the building's ventilation and humidity.

10. 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 .

Trust for Oxfordshire's Environment (TOE) does have some funds available (over and above the small implementation grants of £150 available through this scheme) to support energy efficiency improvements in community facilities. If your church is used by the wider community, visit www.trustforoxfordshire.org.uk or contact admin@trustforoxfordshire.org.uk to find out if your project is eligible for a grant of up to about £5,000.

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 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 –Lighting to be Replaced or Upgraded

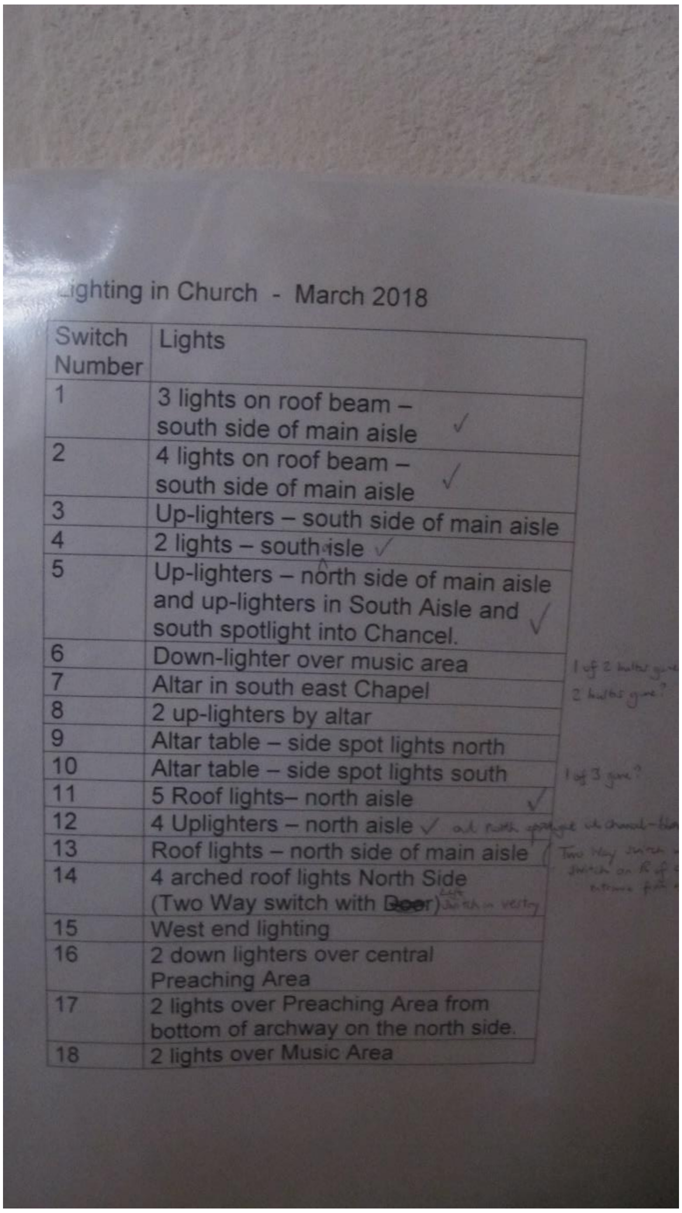
The church is to ask a lighting contractor to investigate downlights. Lighting controls may be replaced as part of this upgrade.

As part of the audit, Lux values were measured in the church during daylight (dull weather).

Values between 30 and 35 Lux were recorded in the seating area – this is a low value.

The music group area is sufficiently lit at 100-150 Lx and the altar at 110 Lx.

If the congregation need to read, especially Bibles, a lux value of 100 is recommended. To achieve this, either more powerful lights, or more lights are required.



ighting in Church - March 2018

Switch Number	Lights
1	3 lights on roof beam – south side of main aisle
2	4 lights on roof beam – south side of main aisle
3	Up-lighters – south side of main aisle
4	2 lights – south isle
5	Up-lighters – north side of main aisle and up-lighters in South Aisle and south spotlight into Chancel.
6	Down-lighter over music area
7	Altar in south east Chapel
8	2 up-lighters by altar
9	Altar table – side spot lights north
10	Altar table – side spot lights south
11	5 Roof lights– north aisle
12	4 Uplighters – north aisle
13	Roof lights – north side of main aisle
14	4 arched roof lights North Side (Two Way switch with Door)
15	West end lighting
16	2 down lighters over central Preaching Area
17	2 lights over Preaching Area from bottom of archway on the north side.
18	2 lights over Music Area