# Energy Audit and Survey Report

# St Andrew's Church

*"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 |
|---|---|---|---|
| Marisa Maitland | Matt Fulford | 17th March 2020 | 1.0 |

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# 1. Executive Summary

An energy survey of St Andrew'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 Andrew's Church was originally built in the Norman period, the south aisle was added in the mid-thirteenth century. There was extensive Victorian restoration, including to the Lady Chapel in the south aisle, the north aisle and the nave. An extension to the north side of the building was completed in the latter part of the twentieth-century, including kitchen, toilet and large church room. 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 | Permission needed | CO2 saving (tonnes of CO2e/year) |
|---|---|---|---|---|---|---|
| **Contact suppliers to arrange for the access to the smart meter data** | 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 | N/A |
| **Change existing lighting for low energy lamps/fittings** | 8,912 | £1,301 | £6,031 | 4.64 | List A / List B | 2.74 |
| **Install PIR motion sensors on selected lighting circuits** | 31 | £5 | £80 | 17.78 | List A / List B | 0.01 |
| **Install Endotherm advanced heating fluid into heating system(s)** | 9,305 | £323 | £640 | 1.98 | List A | 1.71 |
| **Insulate exposed pipework and fittings in plantrooms** | 4,652 | £161 | £200 | 1.24 | List A | 0.86 |
| **Fit Quattroseal draft proofing to historic doors** | 1,861 | £272 | £800 | 2.94 | List A / List B | 0.57 |
| **Revise heating circulation and install Hx and sludge filter** | N/A | None (improved operation) | £2,500 | N/A | List A / List B | N/A |
| **Church rooms, add roller blind to windows** | 4,652 | £161 | £1,500 | 9.30 | List B / Faculty | 0.86 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **and electric far IR heaters** | | | | | | |
| **Install 3x 750W far IR panels to chancel** | 6,513 | £226 | £1,000 | 4.43 | List B / Faculty | 1.20 |

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

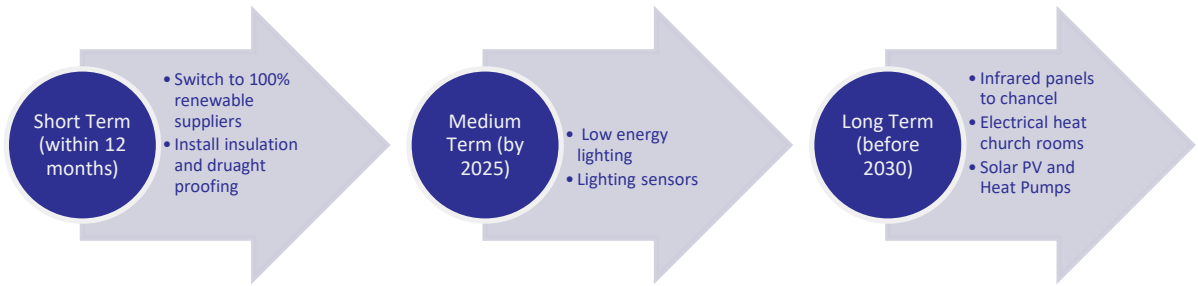
Based on current market prices of 14.6p/kWh and 3.46p/kWh for electricity and mains gas respectively.

**If all measures were implemented this would save the church £2,449per year**.

## 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, and is counting in its approach to net zero each church, cathedral, voluntary aided or diocesan MAT church school, and vicarage. The Diocese of Oxford has also declared a climate emergency and has an ambition to be carbon neutral by 2035.

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



# 3. Introduction

This report is provided to the PCC of St Andrew's Church 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 been aligned with them.

An energy survey of the St Andrew's Church, St Andrews Church, St Andrew's Road, Headington, Oxford, OX3 9DL was completed on the 10th March 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 Andrew's Church** | |
|---|---|
| Gross Internal Floor Area | 451 $m^2$ |
| Listed Status | Grade II* |
| Typical Congregation Size | 80 |

The church typically used for 19 hours per week for the following activities

| | |
|---|---|
| Services | 7 hours per week |
| Meetings and Church Groups | 10 hours per week |
| Community Use | 2 hour per week |

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

The church is open daily and receives a large number of visitors seeking sanctuary from the major hospital complex which is a short walk away. For this missional reason the church wishes to maintain a comfortable environment for visitors during daytime.

# 4. Energy Usage Details

St Andrew's Church uses 14,787 kWh/year of electricity, costing in the region of £2,158 per year, and 93,046 kWh/year of gas, costing £3,226.

This data has been taken from the annual energy costs and consumptions provided by the church. St Andrew's Church has one main electricity meter, serial number E11Z73766. There is one gas meter serving the site, serial number E016K1040515D6.

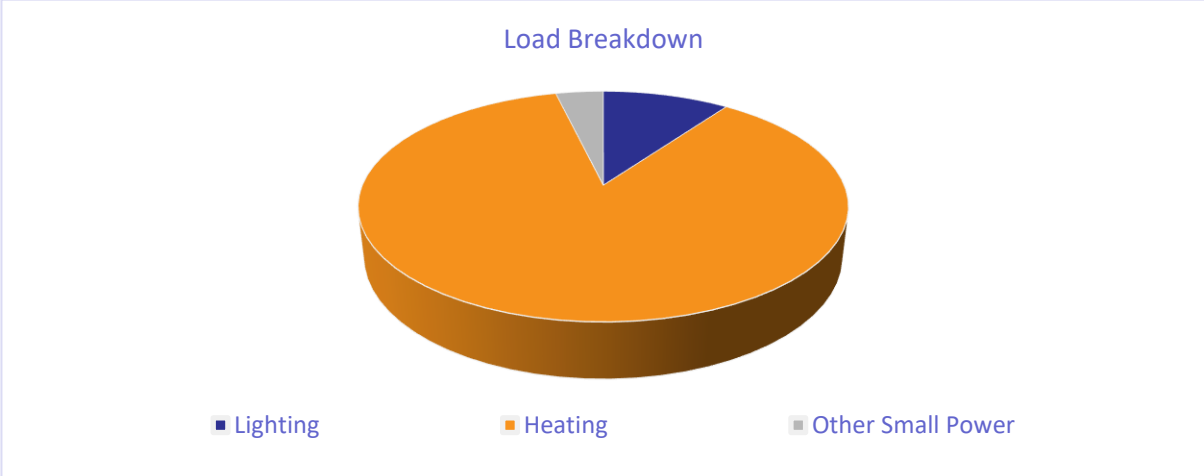
| Utility | Meter Serial | Type | Pulsed output | Location |
|---|---|---|---|---|
| **Electricity** | E11Z73766 | EDMI Atlas10D | Full AMR Connected | South wall by door |
| **Gas** | E016K1040515D6 | MDK16 BK-G10E | Full AMR Connected | Churchyard wall |

All the meters are AMR connected and as such energy profile for the entire energy usage should be possible. No Half hour meter data has been provided for the purpose of this report and it is suggested that the church contact their suppliers to ensure that they have access to the full meter data that should be available.

## 4.1 Energy Profiling

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

| Service | Description | Estimated Proportion of Usage |
|---|---|---|
| **Lighting** | Mainly halogen lighting on high spec lighting control system in church with ancillary fluorescent lighting in other areas | 10% |
| **Heating** | Heating provided from 2 gas fired condensing boilers to church and church rooms | 86% |
| **Other Small Power** | Office and kitchen appliances including hot water, organ, sound system and the like | 4% |




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.

## 4.2 Energy Benchmarking

In comparison to national benchmarks for Church energy use St Andrew's Church uses 64% more electricity and 38% more heating energy than would be expected for a church of this size.

| | Size ($m^2$ GIA) | St Andrew's Church use kWh/$m^2$ | Typical Church use kWh/$m^2$ | Efficient Church Use kWh/$m^2$ | Variance from Typical |
|---|---|---|---|---|---|
| **St Andrew's Church (elec)** | 451 | 14,787 | 32.80 | 20.00 | 64% |
| **St Andrew's Church (heating fuel)** | 451 | 93,046 | 206.36 | 150.00 | 38% |
| **TOTAL** | 451 | 107,833 | 239.16 | 170.00 | 41% |

# 5. Energy Saving Recommendations

## 5.1 Lighting (fittings)

The lighting makes up a relatively small overall energy load within the building, and all areas are lit by moderately inefficient but relatively recent and good condition fittings. The ceiling uplighters in the nave are AR111 halogen lamps. There are good quality direct LED replacement lamps which can fit into the existing fittings https://www.lighting.philips.co.uk/prof/led-lamps-and-tubes/led-spots/master-ledspot-lv-ar111 and are dimmable. These retrofit lamps should be reviewed with the lighting control specialist company and, if relevant, trialled in a number of a fittings to see if they offer a suitable lower energy solution without major adaptation to the existing lighting control system.

The downlights in the chancel are GU10 halogen spotlights. For the spot lights the Megaman range of LED spot (reflector) lights https://www.megamanuk.com/products/led-lamps/reflector/ provides some very suitable substitutes to the current lamps.

It is recommended that all of the fittings, scheduled in Appendix 1, are changed for LED.

If all the lights were changed the total capital cost (supplied and fitted) would be £6,031. The annual cost saving would be £1,301 resulting in a payback of around 4.6 years. If successfully trialled, many of the lights could be self-installed and therefore cost much less than the supply and fit cost above. In this case the £150 grant available through this process could be very usefully employed to fund the purchase of replacement LED lamps which the church installs themselves or to fund the initial trial.

## 5.2 Lighting (control for internal lights)

There is an existing lighting control system within the main nave of the church but the church have indicated that it would benefit from some minor adjustment to add on some motion sensors to automatically turn off lights when not visitors are present. The use of sensitive microwave sensors may be most appropriate and the sensor options should be discussed with the lighting control company who undertake the maintenance. In addition, a simple sensor on the lights to the first floor office and ground floor sacristy area would be beneficial.

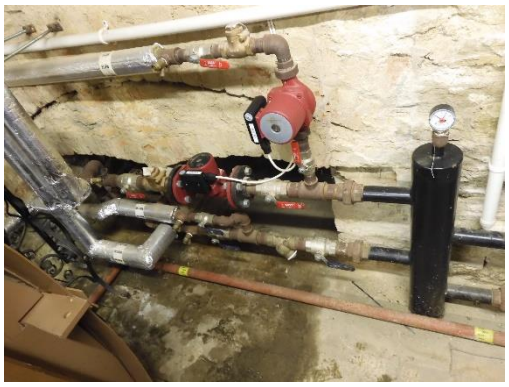
## 5.3 Endotherm Advanced Heating Fluid

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.

## 5.4 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.

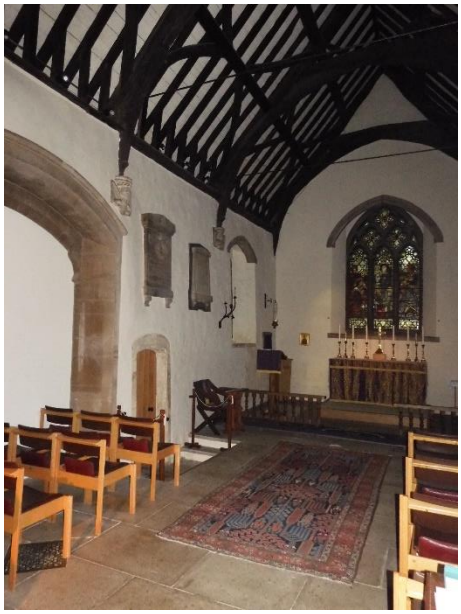
A free survey and quotation for the supply and installation of insulation of pipework fittings can be arranged through ESOS Energy Ltd (contact Adrian Newton 0117 9309689, adrian@esos-energy.com).

## 5.5 Revise Heating Circulation

The heating is run off a relatively new boiler but this has recently had to be replaced as the initial boiler failed prematurely. The installation of new large pieces of equipment such as boilers has a large carbon impact from the manufacture and installation works required. The cause of the issue appears to be due to contamination from the underfloor heating pipework into the new boiler. It is therefore recommended that the current distribution pipework is reviewed so that the common low los header is removed and replaced with a plate heat exchanger. This will physically separate the water circulating in the underfloor pipework from that circulating in the boiler. There should also be

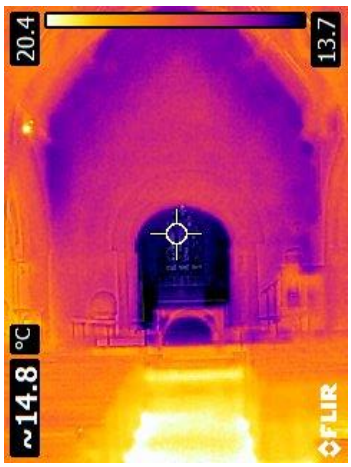
a magnetic side stream sludge filter such as a magna clean, fitted on the return pipework coming back from the underfloor heating system to help keep the new plate heat exchanger clean.

## 5.6 Use of Electric Panels for Heating Specific Areas only

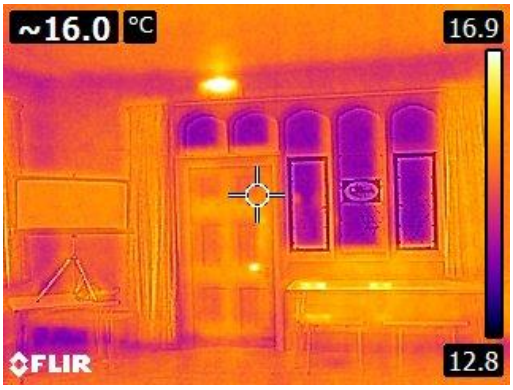


The chancel area is currently largely unheated. Therefore, when this area is used for the mid-week services, the whole of the church has to be heated up to provide some degree of comfort. To avoid having to heat up the entire church building for these smaller mid-week services it is recommended that the PCC consider installing electrical panel heaters in this area on a time delay switch to the chancel which will provide a more comfortable environment and avoid the need to raise the temperature in the rest of the church for these smaller services.

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 can not be left on accidently after use.



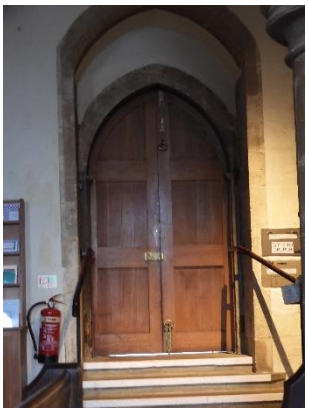
## 5.7 Church Room Improvements




The church rooms are a fantastic space for the church and are heated by their own separate gas boiler located in the kitchen area and serving a few radiators in the hall, WC and entrance area. This is a relatively new construction and appears to have insulation within the walls, floor and ceiling. The space is reported to be cold in winter and thermal imaging of the space highlights that the windows, which are single glazed with metal frames, are the major source of heat loss. The doors are well sealed and do not appear to be a problem. Secondary glazing could be installed on these windows internally but the shape of the stone window surrounds and the sloping nature of the sill makes this a more complex installation. As a more cost effective measure to retaining heat it is recommended that thermal roller blinds are installed to each window. These could be largely hidden through thoughtful adaptation of the existing curtains. These blinds should then have the bottom of them tuck behind the radiators beneath the windows when closed which will make a significant different to the heating system being able to retain heat in the space and lead to a more comfortable and efficient space. If this is successful it is then recommended that the church seek to more away from gas heating in this space and use electric Far IR panel heaters such as those previously recommended for the chancel. Using these on a renewable electricity supply would allow for this space to be heated in a zero carbon manner.

## 5.8 Draught proofing

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



It is recommended that draught proofing is fitted to all external doors.

http://www.theenergysavers.co.uk/application/files/1714/7197/4194/National_Trust_Case_Study.pdf

## 6. 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 tower roof, and possibly on the south facing slope of the nave roof |
| **Battery Storage** | Yes |
| **Wind** | No – No suitable land away from buildings |
| **Micro-Hydro** | No – No water course |
| **Solar Thermal** | No – Insufficient hot water need |
| **Ground Source Heat Pump** | Yes – In time with archaeological consideration |
| **Air Source Heat Pump** | Yes – However would require careful planning |
| **Biomass** | No – not enough heating load as well as air quality issues |

There is potential for a small PV array on the roof of the tower and 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 churches energy consumption is already very small and the consumption during the daytime when the sun is shining is likely to be limited to a few visitor lights and come office load, therefore while technically viable for an installation on the south facing roof of the nave, only a very small number of panels (maximum of around 8) would be worth considering and these could probably be more successfully accommodated on the tower roof which is totally unshaded and hidden from view.

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 but domestic scale battery storage options are now available on the market and would be sensible to install alongside a small PV array as recommended above.

The underfloor heating in the church does suit a heat pump. The main challenge is where to locate a heat pump and how to use it successfully. There could be options to locate an air source heat pump into the hidden valleys or elsewhere into the church but this may struggle in heating a large church held at lower background temperatures. Some innovations for air source heat pumps to work better in these environments are being developed but are not currently mainstream. The use of a ground source heat pump would be more successful but there are serious challenges with installing this on a historic church site with obvious archaeological issues. More modern techniques of radial drilling of the ground piles may provide some solution as these radically minimise ground disturbance and it may be possible to find a low risk area to excavate the main drilling chamber with archaeological attendance and then drill in the piles from the chamber once through the archaeological margin. This is currently all relatively new and unexplored installation practice and the church may either wish to decide to be the innovator in this or wait for others to trial this approach and embrace it once further developed in future years. Given the relative newly installed boiler it may be prudent to wait until the boiler starts to fail in many years time before converting to a heat pump solution.

## 7. 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.

## 8. 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 |
|---|---|---|---|---|---|
| **Nave** | 100 | AR111 LED | £1,039 | £4,454 | 4.29 |
| **Chancel** | 30 | GU10 LED | £221 | £354 | 1.60 |
| **Church rooms** | 6 | Virgo 8W (110m dia) | £19 | £259 | 13.83 |
| **Kitchen** | 3 | 2D LED 11W | £11 | £164 | 14.89 |
| **WC** | 1 | 2D LED 11W | £4 | £55 | 14.89 |
| **Vestry and Sacristy** | 4 | Virgo 15W (190mm dia) | £8 | £185 | 21.93 |