ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Andrew's, Charmouth
PCC of St Andrew's

THE CHURCH OF ENGLAND
DIOCESE OF SALISBURY

Author	Reviewer	Date	Version
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1. Executive Summary

An energy survey of St Andrew's was undertaken by ESOS Energy to provide advice to the church on how it can be more energy efficient and provide a sustainable and comfortable environment to support its continued use. This audit has been provided in conjunction with 2buy2, the Church of England's Parish Buying scheme provider and is subsidised from Total Gas & Power, the Parish Buying schemes principal energy suppliers.

St Andrew's was entirely rebuilt in 1836 in the Gothic Revival Style. The church is heated by gas boilers to fan convector heaters. There are also a number of electric wall heaters in the café/meeting space and the gallery. The lighting is a mix of SONs, halogens and fluorescent lamps. 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)
Install a Solar PV array to roof of building (assumed 100% of energy generated used in building)	5,180	£ 838	8,633	10.30	Faculty	1.31
Install Endotherm advanced heating fluid into heating system	1,246	£38	£640	16.86	List A (None)	0.23
Fit 270mm of insulation into the roof space	1,246	£ 38	£3,000	79.02	Faculty	0.23
Install Draughtproofing to External Doors	374	£11	£2,400	210.72	List B	0.07
Change existing lighting for low energy lamps/fittings	104	£17	£12,977	772.61	Faculty	0.03
Replace heating system for electrical based heating solution	8,831	-£ 208	£13,738	-66.04	Faculty	1.38

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

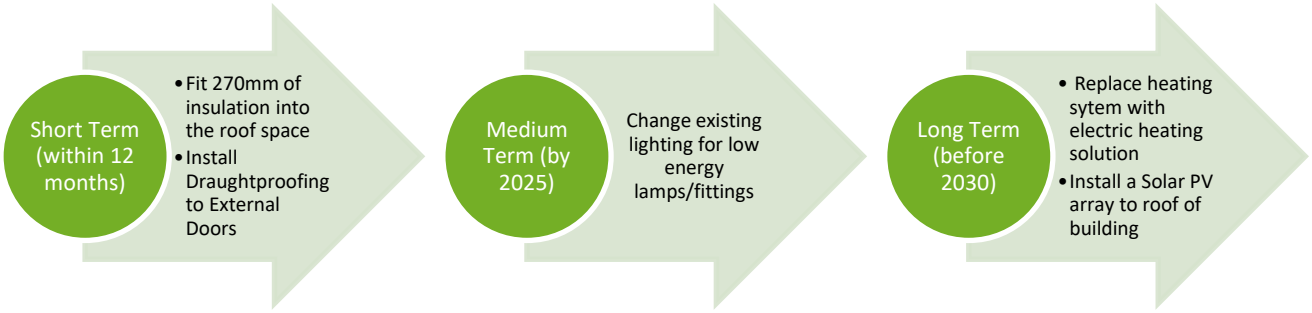
Based on current contracted prices of 16.18p/kWh and 3.05p/kWh for electricity and mains gas respectively.

If all measures were implemented this would save the church £734 per 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. Every church, cathedral, church school and vicarage will therefore need to convert to be a net zero building in the next 10 years. Furthermore, the PCC of St Andrew's has also declared a climate emergency and has an ambition to be carbon neutral by 2035 and has recently implemented a policy that will not allow the replacement of oil heating systems.

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 Andrew's 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 Andrew's, The Street, Charmouth, Dorset DT6 6QH was completed on the 11th March 2021 by David Legge. David is an experienced energy auditor with over 10 years' experience in sustainability and energy matters in the built environment. David is a fully qualified ESOS lead assessor with CIBSE and a CIBSE Low Carbon Consultant and a fully qualified ISO50001 lead auditor.

St Andrew's	
Church Code	634083
Gross Internal Floor Area	255 m^2
Listed Status	Grade II

The church typically used for 4.5 hours per week for the following activities

Type of Use	**Hours Per Week (Typical)**	**Average Number of Attendees**
Services	3 hours per week	34
Meetings and Church Groups	1 hours per week	<15
Community Use	0.5 hour per week	Various

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

4. Energy Procurement Review

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

The current electricity rates are:

Weekday Rate	17.6p/kWh	In line with current market rates
Weekend Rate	15.1p/kWh	Below current market rates
Standing Charge	30.1p/day	N/A

The current gas rates are:

Single Rate	3.04p/kWh	Below current market rates
Standing Charge	40.78p/day	N/A

The above review has highlighted that the current rates being paid are in line or below current market levels and the organisation can be confident it is receiving good rates and should continue with their current procurement practices.

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	100% not charged	The correct CCL rate is being applied.

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

5. Energy Usage Details

St Andrew's uses 3,779 kWh/year of electricity, costing in the region of £611per year, and 12,464 kWh/year of gas, costing £379.

This data has been taken from the annual energy invoices provided by the suppliers of the site. St Andrew's has one main electricity meter, serial number E12Z110360. There is one gas meter serving the site, serial number E016K1488915D6.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	E12Z110360	EDMI Atlas Mk10D	Pulse output but no AMR connectivity	Vestry
Gas – Church	E016K1488915D6	Not accessed	Full AMR connectivity	

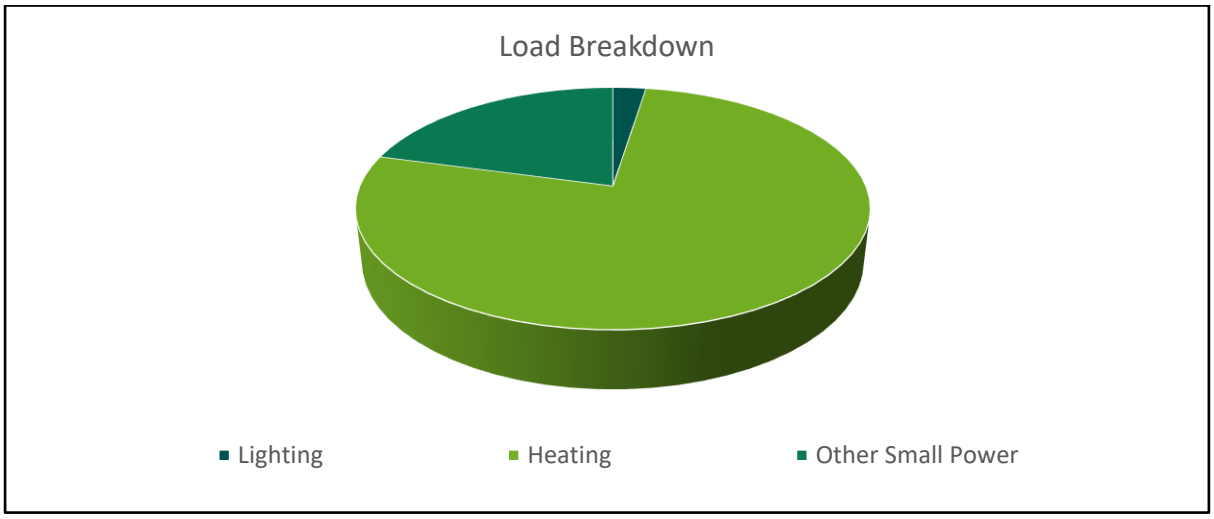
The gas meter is AMR connected and as such energy profile for the entire energy usage should be possible.

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

5.1 Energy Profiling

The main energy consuming plant can be summarised as follows:

Service	Description	Estimated Proportion of Usage
Lighting	A mix of inefficient spotlights, SON floodlights and fluorescent tube fittings	2%
Heating	Provided by 2no. Worcester Bosch gas fired boilers distributed through 5no fan convectors	77%
Other Small Power	Kitchen appliances, heating pumps, sound system, organ, and other plug in loads	21%



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 small power.

5.2 Energy Benchmarking

In comparison to national benchmarks for church energy use St Andrew's uses 26% less electricity and 67% less heating energy than would be expected for a church of this size.

	Size (m^2 GIA)	Annual Energy Usage (kWh)	Actual kWh/m^2	Benchmark kWh/m^2	Variance from Benchmark
St Andrew's (elec)	255	3,779	14.82	20.00	-26%
St Andrew's (gas)	255	12,464	48.88	150.00	-67%
TOTAL	255	16,242	63.69	170.00	-63%

6. Efficient / Low Carbon Heating Strategy

The energy used for heating a church typically makes up around 80% to 90% of the overall energy consumption. Putting in place a heating strategy that is energy efficient and low carbon is, therefore, of the highest priority.

The Church of England is in the process of reviewing its heating guidelines. The process has already established some principles for heating that can help churches as they seek an acceptable combination of comfort, conservation, affordability, and environmental care. The principles can be found at https://www.churchofengland.org/sites/default/files/2020-04/CBC%20Heating%20guidance%20principles%20FINAL%20issued.pdf

As the principles make clear, every church's strategy will be unique to it, informed by many factors, including the nature of its usage, the system it's starting from, the conservation needs of the building, and the resources available. The strategies in this audit are designed specifically for your church.

Our recommendations on heating generally fall within three major areas. Firstly, for all churches we make recommendations that will help to reduce energy wastage and, as a starting point, to optimise the system that you already have

Secondly, we recommend options for many churches that focus on heating people rather than the full volume of the church. Some of the changes that can help with this will be 'soft' changes – others will relate to the heating system itself.

Finally, we make recommendations about moving away from fossil fuels. Moves away from fossil fuels are key to cutting emissions. For most churches, this will involve moving from gas, oil or LPG to electricity. Electricity currently creates carbon emissions around the same level as mains gas, but the carbon emissions associated with it are reducing rapidly as the UK builds more renewable energy and decommissions its remaining oil and coal fired power stations. 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'. Some local areas may also be considering the option of district heating networks.

While moving away from fossil fuels may not always be possible, as the principles state, "churches should be expected to have at least carefully considered the option of moving away from fossil-fuel based heating (gas and oil boilers) towards electric-based heating." And if such options are not viable now, the churches "can try to be ready for a future retro-fit when technology and the grid has progressed."

The church is considering removing the pews to create a more accessible space. However, there are 2 other meeting halls in the village; both of which are perfectly serviceable and are not full to capacity. It is suggested that the PCC really need to consider the removal of pews and what they will use the space for as there is already an open space to the rear of the nave and it is considered that IF a reordering is completed, the front central bank of 6 rows of pews (central aisle closest to the altar are retained and and the rear rows of pews could be considered for removal to create a partially open space with stackable chairs if required.

Currently, the church is only used on Sundays for service and the congregation size is approximately 15 typically. It is therefore recommended that electric under pew heaters to the front 4 rows of pews which is more than sufficient for the majority of services. Until the boilers reach the end of their

serviceable life, retain existing gas boilers which distribute through fan convectors for larger services/concerts. At the end of life, install electric (far IR panel) heaters as detailed below life whilst retaining under pew heaters and finally install solar PV with battery storage to power heating.

6.1 Install Electric Under Pew Heaters

As outlined in the heating strategy, the installation of electric pew heaters on the front 4 pews at the church will provide a warm zone for the congregation on a typical Sunday morning service. Two of the most popular under pew heaters within churches are BN Thermic PH65 heaters (http://www.bnthermic.co.uk/products/convection-heaters/ph/) or similar from http://www.electricheatingsolutions.co.uk/Content/PewHeating.

We would therefore suggest that the following works could be considered:

Install BN Thermic Under Pew Heaters suspended from brackets from the underside of the pew seat to the Front 4 rows of pews with three heaters in each row between uprights, so 24no. heaters in total.

Cable runs to the pew heaters should run along the along the existing routes (all cabling should be in armoured cable or FP200 Gold when above ground) to the both rows of pews. Each pew heater to be switched with a neon indicated fused spur located underneath the pew seat.

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.

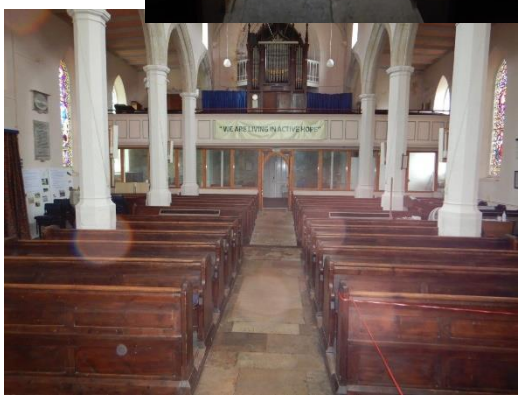
6.2 Install Electric Panel Heaters

It is recommended that the PCC consider installing electrical panel heaters in the main church, once the boilers are at the end of their life, on a time delay switch and remove the existing radiators.

Once the gas boilers have been removed at the end of their life, we suggest the removal of near infrared from altar and for these to be replaced with 2 Electric Far IR Wall Panel 580W on the North and South walls of altar.

In addition to the alter heaters, heaters may be required to be added to the North and South aisles, if fan convectors removed, and instead install 8no. Electric Far IR Wall 1200W Panels to North, South and West walls before the screen.

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). For this reason, these heaters tend to provide a relatively instant sense of heat and comfort within the space and only need to be on for short periods of time. This reduces the amount of preheating required before each use of the building and can make electric heating cost competitive with gas. It also means that the building can rapidly and economically be brought into used for short or unplanned meetings if needed.

7. Improve the Existing Heating System

In the years before the replacement of the existing heating system it is recommended that measures are taken to improve the efficiency of the existing heating system, this should include:

7.1 Install Endotherm advanced heating fluid into central heating system(s)

In order further to improve the efficiency of the heating system it is recommended that an advanced heating fluid (http://www.endotherm.co.uk/) be 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 reduces the surface tension of the water and increases its capacity to transfer and hold heat; this in turn works to improve the ability of the boiler to transfer heat into the heating system and the ability of the radiators and other heating elements to give out their heat into the rooms. 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.

8. Energy Saving Recommendations

In addition to having a revise heating strategy there are also a number of other measures that can be taken to reduce the amount of energy used within the church.

8.1 New LED Lighting

The lighting makes up a relatively small overall energy proportion of the electricity used within the church, and large areas are lit by relatively inefficient mix of inefficient spotlights, SON floodlights and fluorescent tube fittings within the church and meeting room.

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, including a move away from the existing large sodium discharge lighting to a more suited 3 spot track light system; the total capital cost (supplied and fitted) would be £12,977. The annual cost saving would be £17 resulting in a payback of around 772 years; a like for like replacement would offer lower capital costs and associated paybacks. 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.

8.2 Draught Proof External Doors

There are a number of external doors in the church. The historic timber doors 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.

The new glazed doors to the North porch are good but do not meet the worn stone floor. The West tower door and vestry door could also benefit from better draught proofing.

It is recommended that the draughtproofing around the doors are improved and draught strips 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

For timber doors that close onto a stone surround more traditional solutions such as brush draught strips rebated into the edge of the door by a skilled joiner. Other traditional methods such as using hessian or felt pads tacked to the door could be used. Keeping the door maintained in a good condition is also important.

Simple measures such as having a 'sausage dog' style draught excluder laid along the base of a door (it needs to be sufficiently heavy to stay in place), using plasticine of the right colour to fill gaps where daylight can be seen, and putting painted fridge magnets over large keyholes can all be simple DIY measures which are effective.

8.3 Insulation to Roof

The roof is in poor condition and needs work to seal off water ingress, which is very evident in several areas. We strongly recommend only installing insulation to the main roof once it is damp proofed. On inspection, there is no loft insulation and the damp needs resolving prior to any insulation being installed.

In all cases where there is 100mm or less of insulation within accessible roof spaces it is recommended that insulation be added to prevent heat loss and create a more comfortable environment for the occupants of the building.

Because heat rises, the ceiling/roof of a building is the largest contributing area to heat loss from a building. The insulation of such spaces can therefore have a dramatic impact on both the efficiency of the heating system and the temperature of the space below.

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

9. Renewable Energy Potential

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

Renewable Energy Type	Viable
Solar PV	Yes- South aisle roof
Wind	No – no suitable land away from buildings
Battery Storage	No – no viable PV
Micro-Hydro	No – no water course
Solar Thermal	No – insufficient hot water need
Biomass	No – not enough heating load as well as air quality issues
Air Source Heat Pump	No – insufficient electricity supply
Ground Source Heat Pump	No – archaeology in ground and radiator system

Now that the Feed in Tariff scheme has come to an end the installation of solar PV panels in situations where there is not almost full usage of the electricity generated on site is not really viable. Therefore, it is only suggested that PV is installed following any move to electric heating and that panels and associated storage are optimally sized at this stage.

There is potential for a small PV array on the roof of the South Aisle. The current arrangements around solar panels mean that to be financially viable the building on which they are mounted needs to consume the vast majority of the energy that they produce. The church's energy consumption is already very small and the consumption during the daytime when the sun is shining is likely to be very

low indeed, therefore while technically viable only a very small number of panels (maximum of around 4) would be worth considering if at all.

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.

10. 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 .

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 – Schedule of Lighting to be Replaced or Upgraded

Room/Location	Number of Fittings	Recommended Upgrade	Annual Saving (£)	Total Cost (£)	Payback
Nave/aisles	6	R63 LED	£7	£129	18.38
Nave/aisles	6	GU10 LED	£12	£376	32.42
Side aisles	6	3 Spot Track lights	-£5	£6,000	-1269.94
Gallery/balcony	4	3 Spot Track lights	-£11	£4,000	-365.05
Café/meeting space	3	5ft Single Proteus LED	£11	£382	34.58
Lectern	1	LED GLS	£3	£24	8.40