ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Paul's Church
PCC of St Paul's

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1. Executive Summary

An energy survey of St Paul'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. 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 Paul's Church was built in 1850 with an extensive addition in 2009 to the North side comprising large lobby, toilets and meeting space. The church is located in central Salisbury adjacent to a main road junction. It is constructed from limestone/spar and is solid wall with lead single glazed windows in stone mullions within the original building. The church is heated by a gas boiler to underfloor heating throughout. Pews have been removed in favour of flexible seating. 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 and the route to net zero carbon are 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)
Consider install Electric Vehicle Charging Points	N/A	N/A	£2,500	N/A	Faculty	N/A
Install SavaWatt devices on fridges and freezers	140	£18	£50	2.77	List A (None)	0.04
Insulate exposed pipework and fittings in plantrooms	6,900	£307	£1,000	3.26	List A (None)	1.27
Fit timed fused spurs to hot water heaters	162	£21	£90	4.30	List A (None)	0.04
Add or replace draught strips to external doors	2,346	£104	£450	4.32	List A (None)	0.43
Move hot water from centralised system to electric point of use	16,561	£736	£4,200	5.71	List B	3.06
Change existing lighting for low energy lamps/fittings	2,704	£349	£3,973	11.38	Faculty	0.68
Install PIR motion sensors on selected lighting circuits	210	£27	£997	36.80	List B	0.05

Install an Air Source Heat Pump into the building to replace existing heating system	82,114	£670	£72,000	107.42	Faculty	12.74

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

Based on current contracted prices of 12.91p/kWh and 4.45p/kWh for electricity and mains gas respectively.

If all measures were implemented this would save the church £2,233 per year and reduce its carbon footprint by 18.32 tonnes (58%).

2. The Route to Net Zero Carbon

Our Government has committed to move towards Net Zero Carbon – the point at which we have reduced emissions as much as we can and then balanced any residual emissions through removal of carbon from the atmosphere. They have done this as part of a worldwide agreement which aims to limit global warming to well under 2 degrees Celsius, with an aim of keeping it below 1.5 degrees Celsius. This will help protect all of us from the impacts of climate change.

In February 2020, the Church of England's General Synod set its own Net Zero Carbon target. The first stage of this target covers energy used by churches, cathedrals, schools, vicarages, other church buildings, as well as emissions caused by reimbursed transport. The target date is 2030.

This church has a clear route to become net zero by 2030 by undertaking the following steps:

3. Introduction

This report is provided to the PCC of St Paul'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 Paul's Church, Fisherton Street, Salisbury, SP2 7QW was completed on the 14th June 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 Paul's Church	
Church Code	634441
Gross Internal Floor Area	724 m^2
Listed Status	Grade II

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

Type of Use	Hours Per Week (Typical)	Average Number of Attendees
Services	8 hours per week	327
Meetings and Church Groups	1 hour per week	15
Community Use	10 hours per week	Variable

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 Paul's Church and have been reviewed against the current market rates for energy.

The current electricity rates are:

Day Rate	14.085 p/kWh	In line with current market rates
Night Rate	11.928 p/kWh	In line with current market rates

The current gas rates are:

Single / Blended Rate	4.445 p/kWh[1]	Above current market rates

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	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.

[1] On latest bill provided, previous rate was 2.132p/kWh, in line with market rates

5. Energy Usage Details

St Paul's Church uses 23,585 kWh/year of electricity, costing in the region of £3,045 per year, and 138,007 kWh/year of gas, costing £6,134. The total carbon emissions associated with this energy use are 31.44 CO_2e tonnes/year.

This data has been taken from the annual energy invoices provided by the suppliers of the site. St Paul's Church has one main electricity meter, serial number L20C00125. There is one gas meter serving the site, serial number M025K03706 14D6.

Utility	Meter Serial	Type	Pulsed output	Location
Electricity – Church	L20C00125	3 phase 100A	Yes but not fully AMR connected	West corner - cupboard
Gas – Church	M025K03706 14D6	Elster BK-G16M	Yes but not fully AMR connected	Boiler room

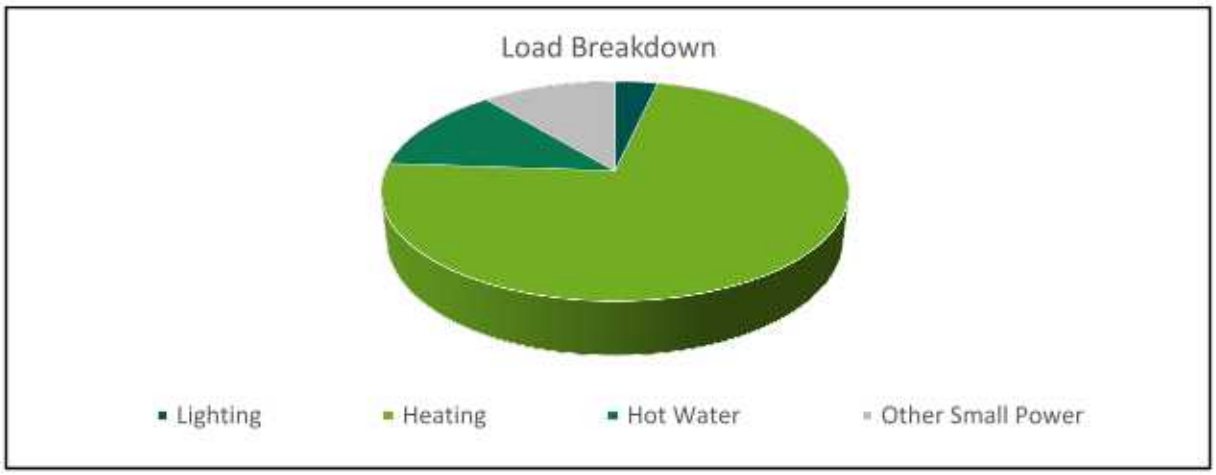
It is recommended that the church consider asking their suppliers to install smart meters so that the usage can be monitored more closely, and the patterns of usage reviewed against the times the building is used.

5.1 Energy Profiling

The main energy consuming plant can be summarised as follows:

Service	Description	Estimated Proportion of Usage
Lighting	Predominantly LED lighting with a mixture of 2D fittings, halogen spotlights and T8 fluorescent tubes.	4%
Heating	2no. Remeha gas fired condensing boilers providing heat to underfloor and radiator circuits.	73%
Hot Water	Indirect gas 210 litre calorifier providing hot water to kitchen and WCs	13%
Other Small Power	Kitchen appliances, sound system, AV equipment and other plug loads	11%

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.



5.2 Energy Benchmarking

In comparison to national benchmarks for church energy use St Paul's Church uses 63% more electricity and 27% more 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 Paul's Church (elec)	724	23,585	32.58	20.00	63%
St Paul's Church (gas)	724	138,007	190.62	150.00	27%
TOTAL	724	161,592	223.19	170.00	31%

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 current heating arrangement was introduced in 2009 with the majority of the site heated via underfloor heating to an open church (pews have been removed for flexible seating arrangements) from two Remeha condensing gas-fired boilers. These boilers should have a serviceable life of 20 years and therefore be in use until 2030. At this point (or earlier should the PCC wish to decarbonise earlier), it is recommended that an air source heat pump (ASHP) is installed which would work very well with the underfloor heating system installed.

Prior to their replacement, the indirect hot water calorifier should be replaced with electric point of use water heaters. For the smaller midweek services, it is recommended that a smaller space

(NW corner room for example) is used and that far IR panels (4no.) are installed for this purpose to avoid heating the whole church for a small number of people.

7. Energy Saving Recommendations

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

7.1 New LED Lighting

The lighting makes up a relatively small overall energy proportion of the electricity used within the church, and large area s are lit by efficient LED fittings, but there still remains a number of inefficient fittings including 2D and T8 fluorescent tubes within the Narthex, WCs and kitchen.

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 £3,973. The annual cost saving would be £349 resulting in a payback of around 11.4 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 the T8 fluorescent tubes in the kitchen where the existing fitting can be made more efficient by simply changing the bulb/lamp within the existing fitting to w new LED bulb/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 would be required.

7.2 Lighting Controls (Internal)

There are several lights which currently remain for longer than necessary in areas such as vestry, porch, Narthex and the like. 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. There are also spaces which benefit from a good amount of natural daylight coming in through the windows where artificial lighting is not required for much of the year during the day.

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 (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.

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.

7.3 Refrigeration Controls

With the church there is a domestic refrigeration unit within the kitchen area. These units run 24/7 and contribute to the baseload electrical consumption of the building.

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.

7.4 Insulation of Pipework and Fittings

The pipework within the boiler 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 a reas 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).

7.5 Timers on Fuse Spurs to Water Heaters

There is a water boiler (for tea making and the like) located in the kitchen area. 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 and therefore maintain their set temperature 24/7.

It is recommended that the heaters are fitted with a 24 hour/7 day timeclock to replace the fused spur switch. An example o f 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.

7.6 Electric Hot Water Generation

The building is currently provided with hot water from a large hot water tank located in the boiler room. This is heated from the gas boiler within the boiler room and it is poorly controlled. As such the hot water is being heated by the gas boilers for long period during the week when there is little demand for hot water which is limited to handwashing, the staff kitchen sink and some of the cleaning.

A far more efficient method of generating hot water would be to remove the centralised large hot water storage tank and to have small, local electric point of use hot water heaters installed within each WC and kitchen area. Units such as https://www.zipwater.co.uk/shop/hot-water/zip-inline-instantaneous-hot-water-heater-6kw-es6 heat the hot water only when the tap is turned on and does not have any stored hot water element. As such it is very energy efficient and it only ever heats the hot water that is required. It has additional advantages that it is 'always on' so does not require to have timings reset for ad hoc uses and as it does not have any stored water element it represents the lowest possible legionella risk profile. Installing electric hot water units will remove the need for the gas boiler and associated pumps to have to operate outside of the heating season and will assist in the transition to net zero carbon as the hot water is no longer served by burning of fossil fuels on site.

The installation of electric point of use hot water units and the removal of the gas hot water system can be undertaken by any competent mechanical engineer.

7.7 Draught Proof External Doors

There are a number of external doors in the church. 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 the draughtproofing around the door is improved and draught strips are added. This could be achieved in a numb er 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 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 and keeping the door maintained in a good condition is important.

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.

8. Other Recommendations

8.1 Electric Vehicle Charging Points

The church has a car park to the side which serves the church. In order to make a visible statement on the churches mission of stewardship and to facilitate more sustainable transport choices by those both visiting the church and using the hall, the church may wish to consider installing an electric vehicle charging point, probably on the side of the church hall to allow visitors to charge their electric car.

Installing a unit such as a Rolec Securi-Charge http://www.rolecserv.com/ev-charging/news/view/Robust-EV-Charging-With-Rolecs-SecuriCharge-EV-Wall-Unit-Coin-Token-PAYG would allow the organisation control over who is allowed to use the unit with a key operated system. Or given the type of use of the building and control over the usage of the car park as a whole a simple 32 amp type 2 wall pod type charger may be most suitable and these

are widely available through many suppliers such as http://www.rolecserv.com/ev-charging/product/EV-Charging-Points-For-The-Home.

Because of the parish office being on site, the church can be considered as a place of work and as such installation grants are available through the work place charging scheme https://www.gov.uk/government/publications/workplace-charging-scheme-guidance-for-applicants-installers-and-manufacturers which will fund 75% of the installation cost up to £500.

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	No – not sufficient demand, visible 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	Yes
Ground Source Heat Pump	No – more capital cost and minor efficiency

9.1 Air Source Heat Pump

The building is currently heated from a gas boiler which provides hot water into the heating system. The use of fossil fuels for heating means that it will not be possible for the building to become zero carbon without changing the heating system. A boiler also has heat and other efficiency losses within it, which means that the efficiency of a boiler in converting the gas into the heat is typically around 80 to 95% (depending on the age and type of boiler). Air source heat pumps use electricity to power the heat pump which takes heat from the air and puts this into water which can then go into the heating system. A heat pump can create around 3 units of heat for every one unit of electricity.

The existing boiler will approach the end of its serviceable life in the next 10 years and it is therefore recommended that the replacement of the existing boiler for an air source heat pump is considered at this stage.

A new air source heat pump is likely to need a heating capacity of around 180kW and could be located to the rear of the church. As heat pumps operate on a low temperature basis some of the radiators and other heat emitters around the site may require upgrading. 3 phase electrical power may be required to power the units, which is already on site.

Good local renewable companies can be contacted for further detailed assessment of heat pumps and quotes or contact www.yourfutureenergy.co.uk

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

9.2 Solar Photovoltaic (PV)

When an ASHP is installed, there may be the potential for a PV array on the flat roof of the new building. The economics of installing panels mean that is it best considered when almost all of the electricity would be used on site. There is a constant base load for electricity which could be met in part by solar PV panels so an installation would be viable and would typically pay back in 8 to 12 years. The roof appears sound and in good condition and capable of taking panels with no shading issues. This could be installed in conjunction with battery storage.

Whilst battery storage is not strictly a renewable energy solution, it does 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 any PV system and should be considered if a PV array were to be installed.

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

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.

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.

12. Offsetting

As you take action to reduce your emissions, you may also wish to offset those that you cannot yet reduce. If you would like to engage in offsetting, it is important to use a reputable scheme. The Church of England recommends Climate Stewards, which has a simple calculator that can help you to work out how much you would need to offset. https://www.climatestewards.org/

Climate Stewards encourages people to 'reduce what you can and offset the rest' as part of your journey to Net Zero carbon emissions. They provide training and resources to help you understand climate change and its impacts, and to calculate the carbon footprint from your activities including travel, energy, expenditure, and food. Their online carbon calculators for individuals and smaller organisations are free to use, and they provide bespoke carbon footprint audits for larger organisations.

Having reduced as much of your organisation's carbon footprint as you can, there will always be unavoidable emissions from your work and travel. Carbon offsetting allows you to compensate for the negative impact of your carbon emissions by funding projects which take an equivalent amount of CO_2 out of the atmosphere. These either involve locking up ('sequestrating') CO_2 as trees grow, or reducing emissions by using low-carbon technology such as fuel-efficient cookstoves or water filters.

Climate Stewards has a close relationship with all their project partners in Ghana, Uganda, Kenya, Tanzania, Nepal and Peru. They work closely with them to design, develop, implement and monitor projects which will not only mitigate carbon, but also bring tangible benefits to the local community - including improved health, savings in time and money previously spent on buying or collecting fuel, and improvements in local biodiversity. Each project is assessed using their Seal of Approval protocol which enables us to assess and monitor carbon mitigation and ensure robust, sustainable and transparent partnerships.

Appendix 1 – Schedule of Lighting to be Replaced or Upgraded

Room/Location	Number of Fittings	Recommended Upgrade	Annual Saving (£)	Total Cost (£)	Payback
Narthex	28	2D LED 11W	£75	£1,646	22.03
Vestry	1	2D LED 11W	£10	£59	5.63
Vestry	2	2D LED 11W	£5	£118	24.73
Porch	1	LED GLS	£8	£12	1.54
WCs	16	2D LED 11W	£43	£941	22.03
Kitchen	2	5ft Single LED	£29	£176	6.13