



Energy Opportunity Survey

Bradford Cathedral, Stott Hill, BD1 4EH

Green Journey

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THE CHURCH
OF ENGLAND

Diocese of Leeds

Energy Opportunity Survey

Green Journey has been appointed by the Diocese of Leeds to carry out energy surveys and provide churches with the opportunity to join the Green Journey energy basket. The aim is to reduce the carbon footprint and energy costs of all churches within the Diocese of Leeds and across the wider Church of England.

Green Journey's buying power allows us to offer renewable energy at a similar, or lower, price to standard energy. This allows all churches opting into Green Journey to practise responsible stewardship, while also making a saving. Green Journey can help you in your stewardship by reducing your electricity and gas bills, whilst also providing a report detailing your church's energy consumption and sustainability, advising on how both can be improved.

“To date, Green Journey has saved the Church of England over £370,000 in energy bills and VAT reclaims.”

Reducing our energy consumption and cutting carbon dioxide emissions is of paramount importance for all, as together we must face the effects of climate change. The Church of England is a leading advocate of sustainability awareness and action, promoting a more environmentally conscious stewardship at local, regional and national levels.

Consumption figures presented in this report are calculated from billing figures and information collected during the energy survey. An estimation of your electricity consumption breakdown is also included, for example lighting could be projected to comprise 60%, kitchen appliances 30% etc. Due care has been given to ensure that these are as close to the observable figure as possible, however these should be considered as calculated approximations only.

Energy Opportunity Survey

Site Summary



Site Overview

Site Address		Site Contact	
Church Name	Bradford Cathedral	Contact	
Town	Bradford	Telephone	
Postcode	BD1 4EH	Email	

Audit Information		Site Information	
Auditor	Mark Rudhall	Annual Operating Hours	2080
Audit Date	21/06/2019	Square Meters	1,808
Audit Time	9.00am		

Report Information	
Report Author	Mark Rudhall
Date	22/08/2019

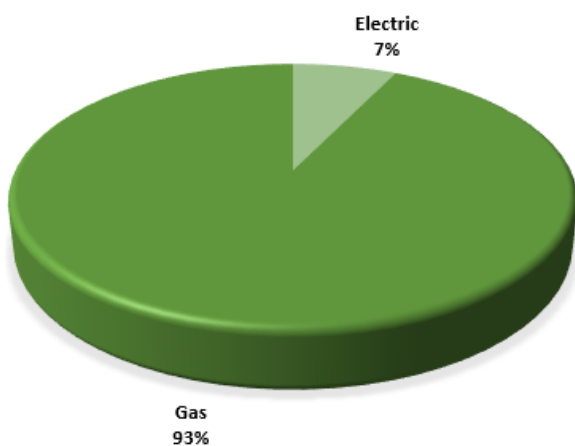
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Energy Overview

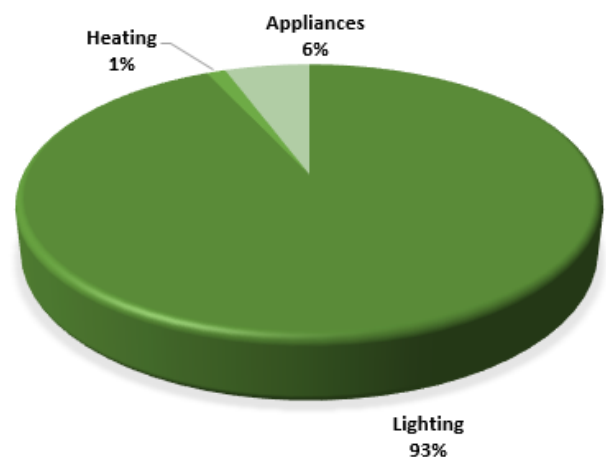
Energy Breakdown

Electricity		Gas	
Period Covered	July 2018–June 2019	Period Covered	July 2018–June 2019
Electricity Usage (kWh)	49,273	Gas Usage (kWh)	637,190
Cost per Annum (£)	6,170.23	Cost per Annum (£)	21,400.82
Meter Quantity	5	Meter Quantity	8

Total Energy Breakdown



Electricity Breakdown



N.B. Breakdowns are based on observations made at the site and discussions with the church representative during the site visit.

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Sustainability Overview

The following paragraphs contain information on the energy efficiency and sustainability of your church. This draws on observations made on, but is not limited to, building structure, lighting and space heating (such as boilers, electric heating). All recommendations provided within the report are intended to help your church streamline its energy consumption, reducing costs and ensuring the sustainability of your church is as near to what is deemed to be practically feasible. For example, churches that replace inefficient lighting with LED fixtures have observed on average, an 80% saving in lighting costs.

If you would like further advice on any of the recommendations made here, please get in touch and we will be happy to assist. We advise that you also speak with either the DAC Secretary or your Archdeacon to ascertain if a Faculty decision will be required, and if so to find out how your

Main Heating

It is often challenging to find the correct temperature to heat your church. The following guidelines are provided based on our experience and if followed can help preserve the long-term structural integrity of your church.

Occupancy	Temperature (°C)	Comments
During a church Service	18-21°C	Most suitable temperature for the congregation during a service
Open Door (if the church remains open to the public throughout the day)	12°C	Comfort Temperature
Vacant/Overnight	8°C	Minimum temperature for reducing surface and interstitial condensation of the church building

However, it is acknowledged that financial restraints may not allow for a minimum background temperature of 8°C to be followed at all times.

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Balance and Temperature

Balancing Energy Consumption, Comfort and Conservation

Balancing the conflicting requirements of occupant comfort, protection of historic fabric and energy consumption can be challenging. Historic buildings are sensitive to changes in environmental conditions. This is particularly true in those that contain organic materials in their construction or contents such as furniture, pictures, timber panelling and leather components such as those found in church organs.

The most important environmental parameter in a historic building is relative humidity (RH), which should ideally be in the 40-65 per cent range. When RH is too low, cracks can form in organic materials and furniture joints tend to become loose. When RH is too high there is an increased risk of mould growth, dry rot and insect infestation.

Understanding the prevailing conditions in a building is key to providing effective control. Factors such as moisture entering the building due to poor maintenance of rainwater disposal will affect the internal environment.

Temperature, Humidity and Comfort

If a volume of air is cooled, its relative humidity will rise up to the point of 100 per cent RH, which is known as its dew point, and further cooling will cause the water vapour to condense out. This is demonstrated when warm air touches a cold single glazed window in the winter months and condensation forms on the surface of the glass.

The external environment changes during the seasons, being generally cold in winter with lower RH and warm in summer with higher RH. When buildings are heated in winter to make them more comfortable for the occupants, the general RH in the space is reduced below the ideal humidity range for conservation and this presents an increased risk to organic contents and fabric.

One approach that is often used in historic buildings is 'conservation heating'. It has been found that heating the internal space of a building to a few degrees above the external ambient air temperature generally maintains the internal relative humidity within the ideal range.

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Types of Heating

Central Heating

Central heating is designed to provide even heat distribution within the whole building, at the same time supplying heat to the building envelope. It is used to reach the desired comfort level, or to provide background heating to the building in order to prevent very low temperatures and frost. The most common use is for large building volumes, and the most popular systems are radiators, warm-air heating, natural or forced-air convectors, electric or fuel stoves and underfloor heating.

Central heating requires a huge amount of energy, a part of which is wasted through thermal bridges, leakage and storage in the building envelope. Typically historic churches are not energy-efficient buildings and their scope for improvement can be limited. Being based on the dispersion of heat, central heating is not very effective in this type of building, where there are so many potential sources of heat loss.

Local Heating

Local heating is designed to produce the best radiant temperature only in the occupied parts of the building, with some local increase in air temperature and a minimum of draughts. The rest of the church volume remains almost unaffected and preserves its historical climate, or departs from it only slightly. Local heating is most commonly used for small congregations and building volumes, for example small churches or specific parts of them which are in use. The most popular systems are radiant heating from infrared (IR) emitters located overhead, on side walls or at floor level; and pew heating using electric panels, tubular heaters, water pipes or radiators, or heated carpets.

This type of heating system disperses a small amount of heat in targeted areas, while the building envelope and historic furnishings or artworks are exposed to little or no change in temperature. Outside the moderately heated occupied area, the RH remains almost unaffected.

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Types of Heating Continued

As we have seen, church heating usually comes in two forms. The most common type of system (**Central Heating**) uses cast iron radiators or large pipes, often located against the external walls but less frequently against internal partitions. Pipes (either elderly cast iron or modern 'finned' pipes which release heat more efficiently) are also commonly found beneath cast iron grilles which run down the aisles. These are usually fed by gas/oil boilers in a semi-underground chamber. Occasionally this is supplemented by the other widely used system (**Local Heating**), electric radiant heating coils fixed beneath the pews or on the walls. These are often used as a primary heat source in smaller churches.

Old churches are seldom insulated and often have large expanses of single glazing. Some heat radiates from the appliances but reaches only a small proportion of the floor area, while the rest circulates through convection currents, and most of the benefit is lost as it cools in the upper voids of the building. Much of the perceived warmth tends to come from the body heat of the people in the congregation, who are usually dressed in outdoor clothing.

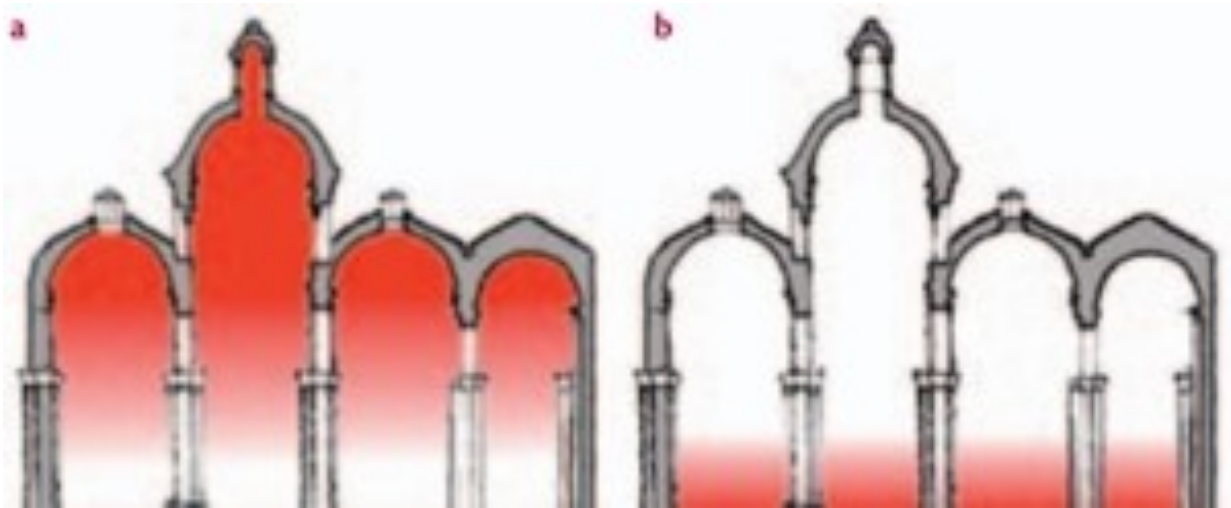
Underfloor heating is usually considered in churches where there is an uninterrupted expanse of flooring and a desire to reduce energy consumption. With a low surface temperature of around 29°C, the primary advantage of an underfloor heating system in a church is that heat is provided evenly across a broad area, enabling an ambient temperature of around 18°C to be maintained up to two metres above the floor and emanating from directly beneath the congregation. This means that the visitors readily perceive warmth on entering the building and can shed their coats. Bradford Cathedral has already installed underfloor heating in the Chancel and is benefitting from reduced energy consumption.

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Types of Heating Continued

Considerable fuel savings can be achieved by installing a dual-fuel system where a ground source heat pump (GSHP) can run the underfloor heating, and gas, where available, can heat the radiators. GSHP is a viable source of energy even at sites with sensitive archaeology as it is now possible to extract heat from ground below the archaeological threshold by using radial boreholes, avoiding long trenches for pipes in the churchyard.

Underfloor heating can also work with solar thermal energy as a source, provided there is space for a large thermal store of warm water, but there are almost always difficulties (ethical and aesthetic rather than practical) associated with installing solar panels on the roof of a historic church. Insulation can also be installed under the floor at the same time as underfloor heating and, in a historic building, this may be the only place where it can be introduced.



The two heating strategies: (a) central heating aims to provide even heat distribution throughout the building while also supplying heat to the building envelope. Most of the heat is accumulated in the upper part of the building (b) local heating aims to produce the best radiant temperature within the occupied area of the church only, with some local increase in air temperature and minimum draughts. The rest of the building remains almost unaffected and preserves or remains close to its historical climate.

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Main Heating - Gas Boiler

The following information in this section highlights implementations which could be given consideration, in order to improve heating efficiency of your church. Should you wish to act upon any of the following suggestions you should first consult your Diocese Heating Advisor.

Location	Boiler Model	Quantity	Estimated Efficiency	Output (kW)	Condensing
Boiler House	Remeha Eco Pro 160	2	83.5%	160	Yes
Boiler House	Remeha Eco Pro 80	1	83.5%	80	Yes
Boiler Room	Ideal Logic + Heat 30	1	80.9%	30	Yes

N.B. Age and efficiency are based on observations made at the site and discussions with the church representative during the site visit.

We would advise that EndoTherm is regularly added to the water in the radiators of your heating system. This is a liquid that improves heat transfer rate and efficiency, resulting in the system heating up faster and maintaining the determined temperature for longer.

It is our understanding that it can be sometimes challenging to prevent tampering with timers and controls which can therefore result in energy wastage. This can be avoided by appointing an 'energy champion' who is responsible for programming the controls. It may also be necessary to install a tamper-proof box where continual interference is a common theme. In our experience, churches that have followed this advice have benefitted from reduced energy bills.

We would advise that a further investigation be undertaken to determine whether the set flow temperature of your condensing boiler could be reduced. Condensing boilers harness the heat energy encapsulated within the boiler flue gases, however, this cannot happen if the return temperature is above 57°C. As the flow and return temperatures are linked, reducing flow temperature could enable your boiler to achieve greater efficiencies up to and around 90%.

Heating System Solution	Total Cost (£)	Annual saving (£)	Payback (years)
EndoTherm	1,242	3,036	0.41

Note: As your site has four boilers, this has been taken into account in the above costings/savings.

EndoTherm

Awards Won

H&V News Awards 2015 – Domestic H&V product of the year

Ecobuild 2015 – M&S big innovation pitch winner

CIBSE Building Performance Awards 2016 – energy saving product of the year

National Energy Efficiency & Healthy Homes Awards 2017 – product of the year

About It

EndoTherm is 100% organic and saves up to 15% of energy that is used. As well as this it is a non-corrosive substance that works within an hour with a CO2 payback of a day and a ROI of less than a year. EndoTherm works in any sealed, wet heating system.

How It Works

It reduces surface tension of water.

Makes water more 'wet' by breaking up the hydrogen bonds so it is able to reach all the imperfections of the systems surface.

Improves the thermal properties of the water to increase efficiency of the heating system.

Systems heat up quicker.

Stay hotter for longer.

Only need to use a 1% concentration in comparisons to system size.

Independent Studies

Enertek International

- A privately owned R&D company who work on behalf of major multinational corporations, leading private companies, trade associations, and government departments.
- Direct comparison tests with and without EndoTherm in the system water indicate that the gas consumption of the boiler in the heating system can be reduced by up to 15%. "This empirical evidence indicates that the addition of EndoTherm can significantly reduce gas consumption and therefore CO2 emissions".

University of the West of Scotland

- A collaboration between the Innovation & Research Office (UWS), the Institute of Biomedical & Environmental Health Science (IBEHR), and their partners was conducted to investigate the impact of EndoTherm as an energy saving technology.
- Surface Tension measurements using K11 Kruss Force tensionmeters confirmed a reduction in surface tension of over 60%.

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Heating Controls

The overall efficiency of a heating system is based on three factors: the efficiency of the boiler, the type of fuel used and the responsiveness of the controls. It is often the latter of these that gets overlooked. Appropriate controls will ensure that a heating system is only in use when actually needed; saving money, reducing carbon emissions and maintaining the correct comfort level.

There are many varieties of controls, but they all control the timing of the heating system and/or the demand temperature required. Traditionally, a heating system would be fitted with a programmer (a clock device with "on" and "off" periods) and a room thermostat (that monitors the air temperature in the church). There are now many automated devices that can offer these from a remote location, called "smart controls" such as Nest, Hive and Evohome.

In addition to the above, modern controls include thermostatic radiator valves (TRVs), programmable TRVs, zone control, boiler energy managers, weather compensators and load compensators.

In real terms, the three most cost effective controls in building's and church halls, depending on the heat demand and budget available are:- boiler energy managers, programmable room thermostats and TRVs.

However, a note of caution. The pipework of old heating systems may not be configured to take modern controls. We would be happy to carry out a detailed survey and advise further, but would also recommend consultation with your Diocesan Heating Advisor.

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Energy Supply and Metering

Switching to a green supply would allow Bradford Cathedral to significantly reduce its carbon footprint and enhance its sustainable image.

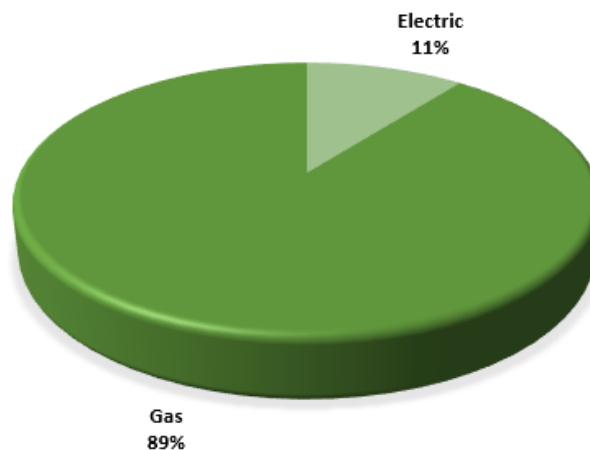
Green Electricity & Carbon Neutral Gas

Currently Bradford Cathedral purchase electricity from SSE (49,273 kWh/annum) and gas from Opus & British Gas (637,190 kWh/annum). Opus has 16% biogas in its gas mix and this has been taken in to account when calculating the gas carbon tonnage.

Electricity SSE g of CO ₂ per kWh	Gas British Gas & Opus g of CO ₂ per kWh
0.310	0.210

Bradford Cathedral electricity supply accounts for 15.27 tonnes of CO₂ per annum, thus it is recommended that the church switches to a 100% green electricity supply.

Bradford Cathedral gas supply accounts for 129.41 tonnes of CO₂ per annum, thus it is recommended that the church switches to a 100% carbon neutral gas supply.



Automatic Meter Reading (AMR)

AMR-metering provides accurate, remotely read data on energy consumption. This allows for analysis of real time half- hourly data for both gas and electric, identifying areas for significant energy savings, such as out of hours consumption.

In addition, AMR metering enables a water consumption profile analysis to be undertaken, allowing for any leaks to be identified.

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Main Heating (Electric)

The church has 6 Dimplex Aircurtain heaters which account for 1% of the total electricity consumption. Electric heating is in use during church services and events throughout winter.

We would advise that timer switches be installed on the heaters in order to reduce energy consumption by ensuring the heater is only operated when required.

We would advise that the scheduled usage of the heaters be examined to identify any potential reductions in electricity consumption. For example, if the church has two events on per week and is otherwise unoccupied, it would be prudent to ensure that the electric heater usage accurately reflects this. By closely coordinating the church's schedule with electric heater usage it may be possible to optimise your heating system and subsequently reduce your consumption.

Warmth is normally retained in buildings by physical barriers. However there are many situations where this is not practicable, such as in a busy shop or restaurant. Air curtains are designed to counteract convection heat losses by using a fan to direct a thin jet of air across the width of the opening. To counter residual heat losses air curtains normally incorporate an internal heat source (typically electric element) to raise the temperature of air that passing through the unit. Air curtains generally have adjustable fan and heat settings which makes them suitable for spring and autumn use as well as mid-winter. In summer they can be operated without heating to improve the efficiency of air conditioning or to reduce levels of airborne nuisance such as small insects or traffic fumes. They are generally designed to be either surface mounted above a door or recessed into either a standard suspended grid or plasterboard ceiling.

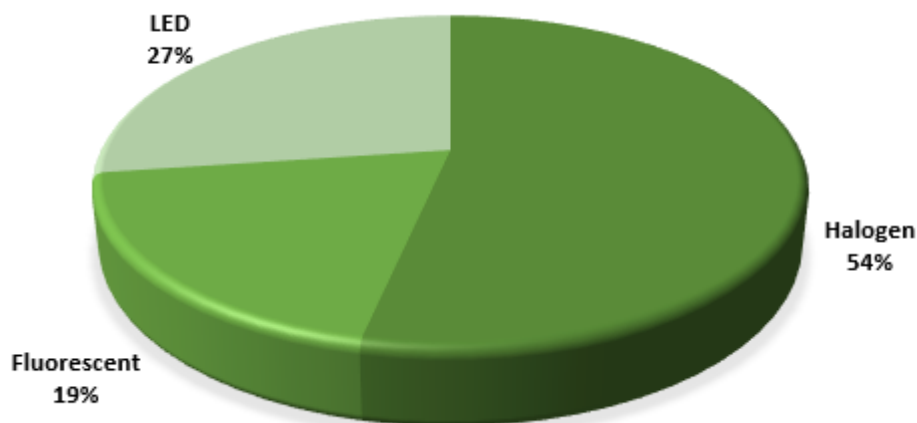
Please note, that if you wish to make any changes to your current heating system you should first consult your Diocese Heating Advisor.

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Lighting

In total, lighting contributes 93% of the site's total electricity consumption. Lighting fixtures within the church are predominantly LED lights. However, there are still a good proportion that are Halogen and Fluorescent for example 61 Halogen spot and floodlights along with 82 fluorescent bulbs.

We would advise replacing the existing halogen & fluorescent light fixtures with light emitting diode (LED) equivalents. This could manifest as a proactive LED retrofit scheme or as a reactive scheme whereby current fixtures are only replaced at the end of their working life.



LED Lighting Savings

Annual costs can also be substantially reduced through lower maintenance costs. During many energy surveys Green Journey has carried out it has often been mentioned to us that light fittings are sometimes left in a state of disrepair until it becomes commercially viable to replace all malfunctioning fittings at the same time. As such, LED lighting represents a sound investment from both an energy saving and a maintenance perspective, especially when taking into consideration its lifespan of up to 50,000 hours. This compares favourably to the 2,000-4,000 hours observed in halogen fittings.

If you would be interested in receiving a bespoke quotation (incl. delivery & installation) for new LED lighting at the church, please call Green Journey on either of the below numbers;

0191 300 6161 or 0333 006 7177

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Renewables Recommendation

Solar Photovoltaic Electricity Battery Storage

Coupling solar batteries with solar arrays is a relatively new practice. The advantage of doing so is three-fold. First, a solar battery stores the energy generated during sunlight hours and makes it readily available for use during non-production hours, such as at night or on cloudy days, essentially enabling your church to run on **100% renewable solar energy** around the clock, as long as electricity demand does not exceed the supply that the battery can provide.

Second, a solar battery storage system can **lower your energy costs significantly**. By charging the solar battery during off-peak hours and discharging it during peak hours, you can avoid paying a lot for electricity from your utility company. The savings from this can serve towards reducing your solar battery storage system costs.

Lastly, by adding a solar panel battery to your solar system, you can choose to be independent from the national grid at any time, thereby ensuring energy security for your church.

Usable Capacity (kWh)	Estimated Cost (Lithium-Ion Batteries)
3–4 kWh	From £3,500
4–7 kWh	From £4,300
7–9 kWh	From £5,200
9–13.5 kWh	From £ 5,950

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Renewables Information

Biomass

When the gas grid is unavailable, particularly in rural areas, wood fuelled systems, called biomass, are often a cost effective and environmentally friendly option.

Biomass is regarded as a low carbon form of heating as the carbon dioxide emitted when the wood is burned is assumed to be the same amount that was absorbed over the tree's life when it was growing. The process is regarded as sustainable if new trees continue to be planted in place of those used for fuel.

Biomass boilers often tend to be more expensive to install compared to their oil-fired equivalents; however, they may attract Renewable Heat Incentive (RHI) payments that could help offset the initial capital cost.

Ground and Air Source Heat Pumps

Heat pumps absorb heat from the air or ground around a property and convert it to usable heat that can be used in radiator, or preferably, underfloor heating systems. Like biomass systems, heat pumps may be a viable option when there's no access to the mains gas grid, however, a reliable electricity supply is essential.

Heat pump systems could qualify for RHI payments and may reduce carbon emissions, depending on which fuel is being replaced.

Green Journey is able to provide specialist advice on the above technologies and RHI payments.

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Appliances

In total, appliances contribute 6% of the site's total electricity consumption. Appliances within the church include Printer/scanner, water heaters, cooker, fridge, freezer, kettles etc

We would advise ensuring that there is at least a 2 inch gap between the wall and your fridge/freezer. This will ensure that the device efficiently releases heat, meaning less energy will need to be used to keep the appliance interior cool.

In order to yield reductions in appliance energy consumption, we would advise that the church ensures that appliances have a scheduled switch off time. This could be achieved by installing plug timers on the wall sockets, this acts as a failsafe should the appliances accidentally be left on.

Furthermore, we would advise that, where finances permit, the church seeks to purchase only equipment which has a high energy efficiency rating. Ratings typically go from "A" to "G" however some appliances, such as fridges and freezers, go up to A+++.

Windows

The windows at the church feature single glazed fittings.

Double glazing reduces the rate of heat loss by up to 65% compared to its single glazed counterpart. It is understood that due to the restrictions on this Grade II/I listed building it is not deemed possible to improve over the current windows without consent, due to the Planning (Listed Buildings and Conservation Areas) Act 1990.

However, it may be possible to improve the areas around the windows. For instance, make sure that there are no gaps between the fixture and the wall as this could be a source of heat loss within the building.

We would advise where possible, that the church installs secondary single glazing. Secondary single glazing adds another single pane to the currently installed fixture. It is possible that secondary single glazing can reduce heating consumption by as much as 10% from current levels.

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Summary of Costed and Non Costed Recommendations

Recommendation	Total Cost (£)	Annual Saving (£)	Payback (years)
Endotherm	1,242	3,036	0.41

Recommendation	Benefit
Investigate the possibility of reducing the set-flow temperature of the condensing boilers	The boilers may be able to achieve greater efficiencies.
Install a tamper-proof box for boiler controls	This will ensure that only authorised people can programme the boilers' timer and thermostat.
Maintain areas surrounding the windows	Ensure that there are no damaged areas around the windows that could be a source of additional heat loss.
Install secondary single glazing	This can yield heat loss savings of up to 10%.
Adopt an energy efficient procurement policy	Replace existing appliances with more energy efficient alternatives at the end of their working life.
Appoint an 'Energy Champion'	Appoint someone to ensure appliances and energy consumers are switched off when not needed.
LED Lighting	Light Emitting Diodes use less electricity and have a lower wattage rating whilst being brighter and lasting up to 50,000 hours.
Battery Storage	Store the energy your panels are producing to be more energy efficient and lower your energy costs.
Car Charging Points	To allow the electricity produced to be used to charge electric vehicles.

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Green Journey Contacts

Administration

Craig Hogg

Church Liaison Officer

Email: craig@greenjourney.org

Telephone: 0333 006 7177

Surveying & Reporting

Mark Rudhall

Development Manager

Email: mark@greenjourney.org

Telephone: 0333 006 7177

Diocesan Coordinator

Peter McGirr

Project Director

Email: peter@greenenergyconsulting.co.uk

Telephone: 0191 300 6161

Diocese of Leeds - Diocese Environmental Officer

Jemima Parker

Diocese Environmental Officer

Email: Jemima.parker@leeds.anglican.org

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Appendices

Appendix 1 – Exterior



Appendix 2 – Interior



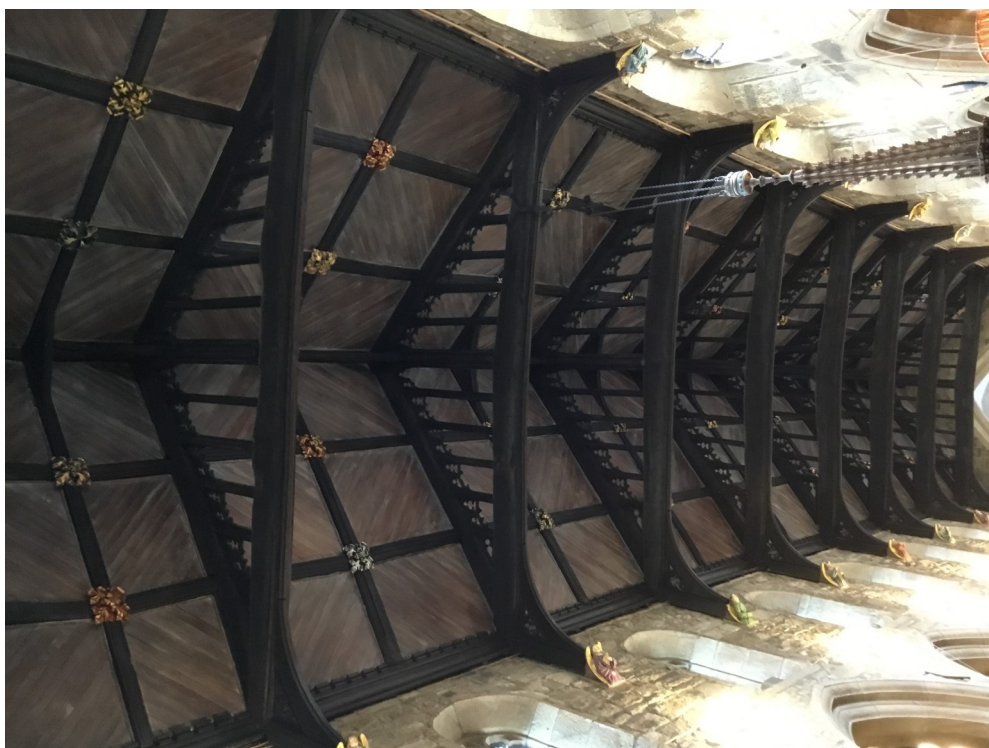
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Appendices

Appendix 3 – Windows



Appendix 4 – Cathedral Ceiling



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Appendices

Appendix 5 – Cathedral Boilers



Appendix 6 – Radiators



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Appendices

Appendix 7— Cathedral Lighting



Appendix 8 — Warm Air Curtains



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Appendices

Appendix 9 – Chapel Lighting



Appendix 10– Chancel & Sanctuary Lighting



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Water Overview

As of 1st April 2017, the water market in England became deregulated. This allows non-domestic entities to switch water suppliers. Green Journey is delighted to be able to provide water efficiency and procurement services to churches. It is important to note that your church's water consumption will be billed based on one of the two tariffs outlined below:

- **Non-metered Value** – In this case, your consumption is estimated based on an estimated water consumption, in addition to a Rateable Value (RV) attributed to your church. RV is a value given to all churches in the U.K based on the area and operation of the church.
- **Metered Value** – In this case, volumetric consumption data can be recorded and transmitted to your water supplier, this may also extend to surface water/sewerage charges, where a secondary water meter exists.

For more information on the above, please get in touch with Green Journey whom can help you secure the most competitive water rates. In the meantime, there are a number of ways your church can improve its water consumption, as detailed below.

Rainwater Harvesting - This involves rain water being collected in outside tanks, which can then be reused. This will reduce the volume of water the church uses, as they can harness rainwater for usage in urinals/toilets and other greywater facilities. As such, your church will require less water by volume, allowing it to improve its water efficiency.

Tap Aerators - Tap aerators can reduce water supply rates by as much as 60% per minute. Older taps, such as those installed within church's, supply water at an average rate of 15 l/m, compared to 6 l/m when having an aerator installed. This will reduce your annual water consumption, especially where your kitchen and toilet areas are in frequent use. Aerators can be installed on most taps; Green Journey can facilitate this should your church wish to go ahead with it.

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There are an array of funding mechanisms available to churches to make alterations to its building structure, undertake crucial maintenance work and to improve on current energy efficiency. Our in-house team can assist your church in applying for such funding, ensuring that you will have the best chance of being successful in your application.

Listed Places of Worship (LPW) Grant Scheme

This scheme allows eligible churches to claim back VAT on qualifying services and products it purchases. It is only aimed at listed church buildings which provide public religious services at least six times each year. Qualifying services and products are detailed in depth in LPW guidance, however the key areas that qualify for this grant are identified as: electrical (including energy efficiency improvements) and structural works, aesthetics improvements, plumbing (including heating systems). Funding is accessible via two separate routes:

- Projects with a value of £500-£1000 (only one application can be submitted per year)
- Projects >£1000 (an unlimited number of applications can be submitted in this category)

Heritage Lottery Funding

Available since September 2017, this supersedes the “Grants for Places of Worship” programme. 100% of funding can now be applied for via:

- “Our Heritage” scheme (up to £100k)
- “Heritage Grants” (up to £5million)