ESOS-ENERGY
Energy efficient solutions

Energy Efficiency and Zero Carbon Advice

St Mary Church
2buy2 Church of England Audits

Author	Reviewer	Date	Version
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Contents

1. Executive Summary

An energy survey of St Mary 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 Mary Church is a Grade II listed rural parish church dating back to 1878 and used mainly for Sunday services only. There is both oil and electricity supplied to the site with the oil heating boiler dating from 2007 and used to heat the church for 5 hours for the Sunday services only.

The church should be commended for already operating to a high standard of energy efficiency, but it does have 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)
Optimise control system settings	391	£39	Nil	N/A	List A (None)	0.07
Consider using HVO in lieu of fossil fuel oil	-	-	-	-	-	-
Replace heating system for electrical based heating solution	-659	-£1,604	£35,508	-22.14	List B	0.32
Consider installing Electric Vehicle Charging Points	0	N/A	£7,500	0.00	List B	-
Insulate exposed pipework and fittings in plantrooms	469	£47	£500	10.66	List A (None)	0.08

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

Based on current contracted prices of 30p/kWh and 12p/kWh for electricity and oil respectively.

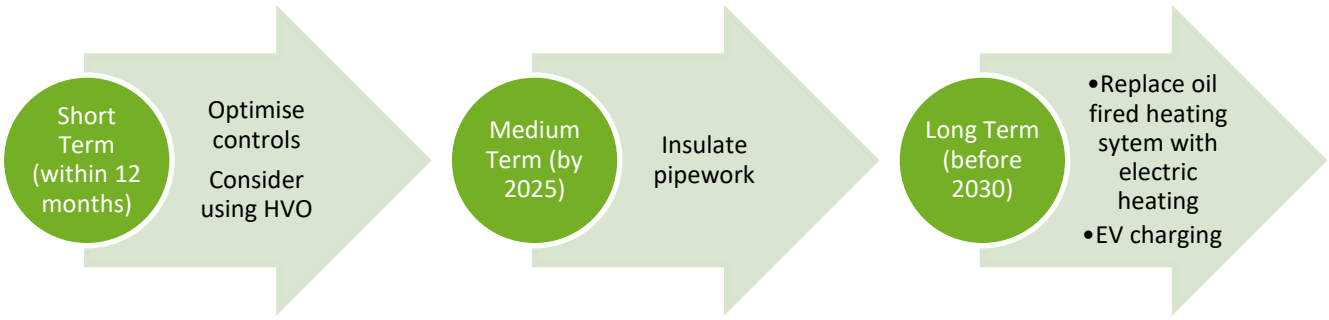
If all measures were implemented this reduce its carbon footprint by 0.9 tonnes (36%). This would be 100% and obtain Net Zero Carbon if the electricity supplies were purchased from a 100% renewable supplier.

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 Mary 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 Mary Church, Totter Bank, Crosthwaite, Kendal LA8 8HR, was completed on the 7th of December 2022 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 Mary Church	
Church Code	607207
Gross Internal Floor Area	303 m^2
Listed Status	Grade II

The church typically used for 7 hours per week for the following activities

Type of Use	**Hours Per Week (Typical)**	**Average Number of Attendees**
Services	6 hours per week	20
Meetings and Church Groups	0 hours per week	
Community Use	1 hour per week	

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

4. Energy Usage Details

St Mary Church uses 1,570 kWh/year of electricity, costing in the region of £471 per year, and 7,811 kWh/year of oil, costing £937. The total carbon emissions associated with this energy use are 2 CO_2e tonnes/year.

This data has been taken from the annual energy invoices provided by the suppliers of the site. St Mary Church has one main electricity meter, serial number D14W164867.

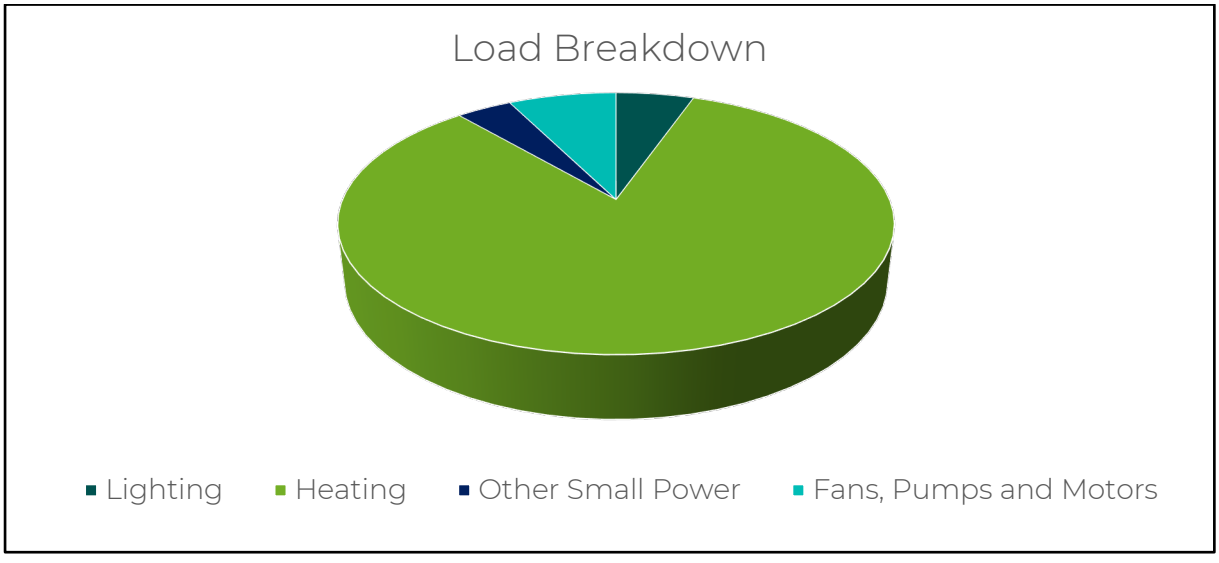
Utility	Meter Serial	Type	Pulsed output	Location
Electricity	D14W164867	1 phase 100A	No but capable	Back of kitchen cupboards

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

4.1 Energy Profiling

The main energy consuming plant can be summarised as follows:

Service	Estimated Proportion of Usage
Lighting	5%
Heating	83%
Other Small Power	4%
Fans, Pumps and Motors	7%



As can been seen from this data, the heating makes up by far the largest proportion of the energy usage on site.

4.2 Energy Benchmarking

In comparison to national benchmarks for church energy use St Mary Church uses 74% less electricity and 83% 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 Mary Church (elec)	303	1,570	5.18	20.00	-74%
St Mary Church (oil)	303	7,811	25.78	150.00	-83%
TOTAL	**303**	**9,381**	**30.96**	**170.00**	**-82%**

5. 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 biogas 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 existing oil boiler was installed in 2007 and can be expected to last for around a further 10 years. It is used efficiently and therefore a change in heating system should be considered when the boiler reaches the end of its life and given the usage of the church, electric under pew heating is recommended as detailed below. In the meantime the church should consider using Hydrogenated Vegetable Oil (HVO) instead of fossil fuel oil. This is a direct replacement for Kerosene and is become more widely available. The existing mineral oil should be used up first and the burning nozzles on the boiler will need to be changed to use HVO effectively.

The various options for a decarbonised heating solution have been reviewed in the table below:

Decarbonized Heating Viability	Feasibility	Notes:
Air to Water Source Heat Pump	No	Unsuited to current heating pipework and heat emitters
Air to Air Source Heat Pump	No	Does not suit use of building
Water Source Heat Pump	No	No water source locally
Ground Source Heat Pump	No	Significant archaeology
Under Pew Electric Heating Panels	Yes	Would be suitable to use when boiler reaches end of life
Electric Panel Heaters (to provide supplemental heating only)	Yes	Can be used to provide heat to areas without pews
Over door air heater (to provide a warm welcome at the door)	Yes	Could be added to reduce heat loss and warm rear area
Overhead Infra-Red Heaters	No	Visual intrusion to the church would do harm, least preferred heating source due to comfort
Heated chair cushions	No	Other solutions preferred

The recommendation is therefore that the church consider installing under pew electric heaters and electric panel heaters. As described below.

5.1 Install Electric Under Pew Heaters

Electric under pew heaters provide a high level of thermal comfort to people sat in the pews. They are not installed to try and heat the entire air volume of the church, instead thermal comfort is achieved through a flow of warm air rising past the person in the pew. This means that the heaters should be installed under the entire length of all the pews that are likely to be used.

These heaters warm up almost instantly and a flow of warm air over the pew area is created within around 15 minutes of their being turned on. This significantly reduces the amount of preheating required before each use of the building and can make electric heating cost competitive with gas. It is important that this reduced 'on time' is properly reflected in any comparisons with other types of heating.

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

Install under pew heaters suspended from brackets from the underside of the pew seat as follows:

Area	Type/ Size	Length (mm)	Watts	Area Heated	Number required
Nave	Electric Under Pew 450W	702	450	Pew Only	84
Choir	Electric Under Pew 650W	948	650	Pew Only	12

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 both rows of pews. Each pew heater to be switched with a neon indicated fused spur located underneath the pew seat.

A case study of a church which has adopted this solution is available at https://www.churchofengland.org/about/environment-and-climate-change/st-andrews-chedworth-electric-heating

Photos of installations are shown below.

Brown BN Thermic 650W under pew heaters fixed to underside of pew seats for pews which have no solid backs.

Black 650W Norel under pew heaters fitted to solid pew backs.

5.2 Install Electric Panel Heaters

Electric panel heaters can provide additional heating to areas where there are no pews. Suitable electric panel heaters would be far-infrared panels. 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 a specific space and only need to be on for short periods of time. The heating effect spreads out from the panel by up to 3 meters, although this is reduced by people and furniture. This means that these heaters provide a useful source of supplementary heating or primary heating for some well-defined areas but are not very well suited to providing a complete heating solution for a church without other forms of heating (such as under pew). As these heaters warm up almost instantly, 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 areas using this form of heating can rapidly and economically be brought into used for short or unplanned meetings if needed.

It is recommended that the PCC consider installing supplementary electrical panel heaters in the areas specified in the table below on a time delay switch and remove the existing radiators.

Area	Type/ Size	Length (mm)	Watts	Area Heated	Number required
Front of nave	Electric Far IR Wall Panel 900W	1200	900	13-22 m2	1
Rear area	Electric Far IR Wall Panel 580W	1000	580	7-12 m2	4
Font	Electric Far IR Wall Panel 580W	1000	580	7-12 m2	1

These can be purchased widely and fitted by any competent electrician. It is recommended that they are fitted with a time delay switch so they cannot be left on accidently after use.

If you would like to discuss panel heaters with a church in the diocese that already makes use of them, please contact the diocese.

Electric panel heater installed behind an altar

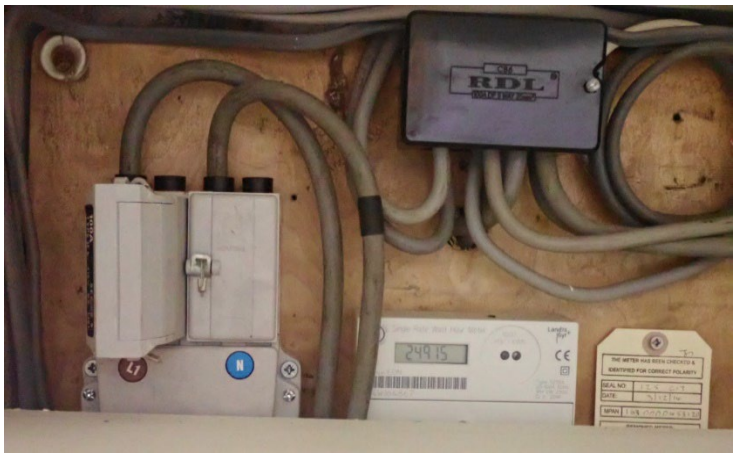
5.3 Install an Overdoor Heater

In order to achieve the sense of a 'warm welcome' into the church an over door air heater could be provided. This would also help to provide warmth to the rear of the church. Such an over door unit must be sized to cover the whole width of the door.

A variety of overdoor air heaters are available on the market and can be installed by an electrician. The heaters that will cover the entire width of the door tend to be larger output units, which will require a dedicated electrical cable of the correct size run to them. The church should resist the temptation to reduce the size and output of the heater to avoid running a new cable, as the output from smaller heaters and of those with insufficient width tends to be disappointing.

Area	Type/ Size	Length (mm)	Watts	Area Heated	Number required
Door	Overdoor air heater 6kW	1105	6000	Entrance Only	1

5.4 Upgrade to 3 Phase Electricity Supply



To be able to have sufficient electrical power to supply enough energy into an electrical heating system the church will need to increase the existing electrical supply from single phase 100A supply to a 3 phase 100A supply.

The upgrade to the supply has to be carried out by the District Network Operator in the areas.

The DNO in your area is thought to be Electricity North West - www.enwl.co.uk; 0800 048 1820 (North West England)

The cost of bringing in a new 3 phase supply can range from £300 to £30,000 but the DNO will provide a quotation for free so it is well worth obtain a quotation in the short term so that decisions can be made on a well-informed basis.

6. 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:

6.1 Improve Heating Control Settings

The church's heating is controlled by a Hive controller located in the Main Boiler Room.

The timings and settings on this were reviewed as part of the audit. Based on this review, there are opportunities to adjust these controls to provide more efficient energy usage of the building and a more comfortable environment for the congregation.

There are two important principles in setting efficient heating settings to support a comfortable church. The first is that most historic buildings survive very well without being heated and that in a number of cases the later addition of heating has actually cause fabric issues (such as the drying out of timbers, drawing damp through walls into a warmer and drier environment, or causing issues beneath metal roof covings where warmer moist air becomes trapped). In most cases the fabric of a historic building would prefer not to be heated, and the constant 'yo-yo' up and down of the heating is damaging. The second principle is that to provide comfort to occupants one either needs to provide an immediate injection of heat close to where the congregation are, such as under pew heaters or radiant heaters, that warms the air around the people but makes no attempt to heat the entire air volume of the church. Having the heating switch on for an hour or two once or twice a day in the misconceived idea that it will 'take the cold off the building' is the most damaging heating strategy for the fabric and does very little to provide comfort as the heat is lost before the next heating session. It is better to leave the building unheated when it is not occupied and then have a longer period of heating before the time when there are services or the like. This is generally the strategy adopted by the church.

Having reviewed the heating set up we would advise that the following adjustments are made.

That the boiler flow temperature is increased in colder weather and decreased in warmer months by adjusting the dial on the front of the boiler. This should then allow the warm up period to be reduced.

The adjustment of the heating system should be above to be carried out by any member of the church who is competent in using the controls. It is recommended that the heating settings are recorded, and a copy posted next to the control system, together with the name and phone number of a person to contact if there is a problem.

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 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 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.

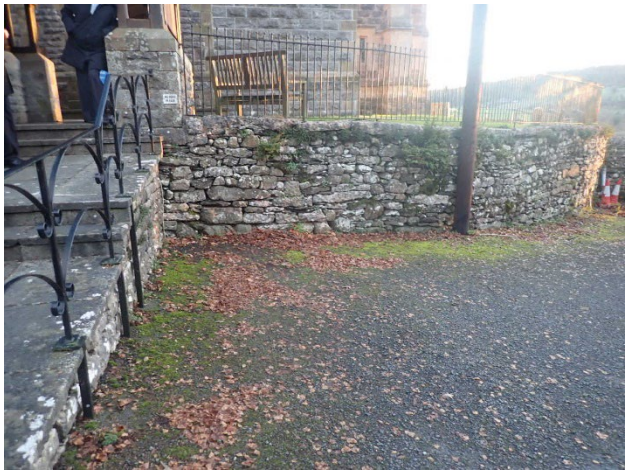
It is recommended that these areas of exposed pipework and fittings are insulated with bespoke flexible insulation jackets. These wrap around the various elements but can be removed and then replaced for any servicing activities.

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).

8. Other Recommendations

8.1 Electric Vehicle Charging Points

The church has a car park on site. In order to make a visible statement on the churches mission of stewardship and to facilitate more sustainable transport choices by those visiting the church and/or using the restaurant next door, the church may wish to consider installing an electric vehicle charging point, probably to the side of the entrance gate to allow visitors to charge their electric cars. This should be a chargeable unit and may allow an small income to be generated.



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
Battery Storage	No – no viable PV

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.

Having reviewed the site it is not considered that there is good viability for any renewables and instead a good clear focus on reducing the energy demand of the building should continue with a targeted approach on reducing the heating energy.

10. Funding Sources

There are a variety of charitable grants for churches undertaking works and a comprehensive list of available grants is available on this Parish Resources page:
https://www.parishresources.org.uk/resources-for-treasurers/funding/

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.