Trefriw Village Hall Energy Audit Overview Report

UK Government Wales
Llywodraeth y DU Cymru

CONWY
CYNGOR BWRDEISTREF SIROL
COUNTY BOROUGH COUNCIL

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Contents

Overview

Conwy Cynhaliol have commissioned Greener Edge Ltd to undertake Energy Audits on community buildings in rural Conwy. The current climate emergency and cost of living crisis present great challenges to community groups running essential community buildings. The energy audits will examine building energy efficiency and provide a report with advice and recommendations that could help community groups reduce their long-term costs and reduce carbon emissions. These Energy audits have been funded through the UK Community Renewal Fund.

This energy audit evaluation was prepared for Trefriw Village Hall for the reporting year 01/01/22 – 31/12/22. The energy audit took place on the 24/11/22.

Organisation Background	Name: Trefriw Village Hall Address: Trefriw Village Hall, Trefriw, LL27 0JH. Contact Person: Vikki Teasdale Contact Email Address: clerk@trefriwcommunitycouncil.co.uk Contact Phone Number: 07305316095 or 01492641251	
Calculated Emissions	Scope 1: Direct Emissions: Scope 2: Indirect Emissions from Energy:	0.00 tCO_2e 0.29 tCO_2e

All information, intensity metrics and recommendations contained within this report are accurate at the date of issue.

Prepared by:

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Date: 09th December 2022

Approved by:

Stu Meades
Date: 09th December 2022

1 Infrastructure and Energy Use

1.1 Building Overview

During the energy audit on the 24/11/2022, the following observations regarding the infrastructure and energy use of the building were made.

1.1.1 Thermal Envelope

The building was refurbished in the 1950’s and is a Grade 2 Listed (Inside and Outside) building. The construction type of walls is solid stone walls. The extensions construction type of walls were cavity walls with reported no insulation.

There are multiple large single-glazed sash windows within the main hall whereas the extensions to the front and back of the building have double-glazed windows.

The floor type is a suspended cavity floor with an unknown insulation level.

The ceiling of the main hall is made up of 600mm ceiling tiles and is believed to have no insulation. Within the loft of the back extension there was no insulation present. Old insulation was observed within the loft above the ceiling but this was minimal.

1.1.2 Heating and Domestic Hot Water

Heating and domestic hot water (DHW) are sourced electrically.

Within the main hall, there was 6 2.1 kW programmable electric radiators. It was noted that even when these are all active, these do not sufficiently heat the space. There were 2 electric radiant heaters on the stage, 2 electric storage heaters within the extension and 2 2 kW electric hot air blowers in the toilets. The hiring of the hall includes 1 hour of pre heating which will be controlled by a member of Trefriw Village Hall.

DHW is accessible within the small kitchen and in the bathrooms. Within the kitchen there is an electric 10L hot water boiler for the DHW and within both toilets there is a Triton electric point of use hot water tap for hand washing.

1.1.3 Cooling

There is no active air conditioning or cooling equipment in the building. The only cooling is passive cooling through opening windows and the thermal inefficiencies of the building.

1.1.4 Lighting

The building had a mixture of LEDs and non-LEDs. The non-LEDs observed during the energy audit were the following:

- CFLs (11W) x 2
- 2D Bulkhead (28W) x 1
- 1800mm T8 Fluorescent Tube (125W) x 2
- 2400mm T8 Fluorescent Tube (165W) x 2

1.1.5 Process and Small Power Equipment

The process and small power equipment within the building was minimal, the equipment of note was the projector, multiple stage lights, speakers and a small standard kitchen including an electric cooker with stove, a small fridge, a small kettle, and microwave.

1.1.6 Renewables and Storage

There were no renewable or storage facilities within the building currently.

1.2 Annual Greenhouse Gas Emissions

1.2.1 Reporting Boundary

The reporting boundary identifies which emission sources have been reviewed.

- Scope 1: Direct Emissions are emissions from operations that are owned or controlled by the reporting organisation.
- Scope 2: Indirect Emissions from Energy are emissions from the generation of purchased or acquired electricity, steam, heating, or cooling generated by a third party and consumed by the reporting organisation.

1.2.2 Data Collection

Data was collected by the responsible party of the community building and reviewed by Greener Edge. All emissions were calculated by Greener Edge. The calculation method that has been used for quantifying the emission inventory was the emissions source activity data multiplied by the emissions factor as shown in the formula below:

$$Tonnes\ CO_2e = \sum ghg\ activity\ \times EF$$

Where $\sum ghg\ activity$ equals the sum of greenhouse gas activity and EF equals the emissions factor for the greenhouse gas activity. Multiplying these gives the total quantity of greenhouse gas emissions (kg CO_2e) per activity. For example, 4000 kilowatt hours (kWh) of electricity (the greenhouse gas activity) is multiplied by 0.00019 (the emission factor, tCO_2e per kWh of electricity) to equal 0.388 tCO_2e.

1.2.3 Emissions

As heating and DHW was sourced electrically there were no sources of Scope 1: Direct Emissions at the building.

The dual reporting methodology has been used to report the associated emissions from electricity consumption. This reports two different figures; one figure using the location-based method, the other figure using the market-based methodology. The location-based method calculates the emissions using a national average emission factor for a specific geographic boundary that relates to the grid on which energy consumption occurs over a specific time-period. This reveals what the company is physically putting into the air. The market-based method calculates the emissions from supplier-specific data in the form of contractual instruments, such as REGOs (Renewable Energy Guarantees of Origin) and this reveals the emissions the company is responsible for through its purchasing decisions.

Data for electricity consumption has been provided for 299 days of the year (29/01/22 – 24/11/22). For the remaining 66 days of the year, we have extrapolated the data. The total annual electricity consumption for the reporting year was 1,506.39 kWh. The building is on a standard tariff, therefore the electricity consumption accounted for 0.29 tCO_2e emissions.

Scope	Activity	Quantity (kWh)	Calculated Emissions (tCO_2e)	
			Location-Based Total	Market-Based Total
Scope 2: Indirect Emissions	Purchased electricity	1,506.39	0.29	0.29

Total	**1,506.39**	**0.29**	**0.29**

Table 1: Trefriw Village Hall's Scope 2: Indirect Emissions from Energy

1.2.4 Key Metrics

During the energy audit, we were able to take measurements of the main hall to calculate the total floor area and volume of the room.

It was noted that the previous EPC of the building had the total floor area of the building which we have been able to use to calculate the floor area of the extensions and hence the total volume of space within the building.

Below are the building measurements:

Reference	Measurement	Data Source
Total Floor Area (m^2)	193.00	EPC.
Hall Floor Area (m^2)	131.00	Measurements taken during energy audit.
Hall Ceiling Height (m)	4.59	Measurements taken during energy audit.
Extensions Floor Area (m^2)	62.00	Post energy audit calculations.
Extensions Ceiling Height (m)	2.40	Assumed average ceiling height following observations during energy audit.
Total Building Volume (m^3) (Usable Space – excluding loft spaces)	**750.09**	**Post energy audit calculations.**

Table 2: Building Measurements

Based on these measurements and the calculations in section 1.2.3 we have been able to calculate the following building metrics.

The heating (kW and BTU) metrics below have been calculated using a simple online calculator and are indicative in nature. They should not be relied upon for design purposes.

Metric Category	Intensity Metric	Calculation Method
Building Emissions Rate per Cube Meter of Usable Space	0.38662 kg CO_2e / m^3	Based on building measurements and carbon emission calculations
Electricity Consumption per Cubic Meter of Usable Space	2.00828 kWh / m^3	Based on building measurements and energy bills
Calculated Current Required Heating Output in Main Hall (BTUs)	84,888.00	BTU Calculator | Find The Perfect Radiator Size For Room (heatadviser.co.uk)
Calculated Required Heating Output across Extensions (BTUs)	18,927	
Calculated Required Heating Output in Main Hall (kW)	24.88 kW	BTU to watts (W) conversion calculator (rapidtables.com)
Calculated Required Heating Output across Extensions (kW)	5.55 kW	
Calculated Total Building Required Heating Output (kW)	30.43 kW	Calculated based on above.

Table 3: Building Metrics

2 Roadmap

2.1 Target

Target: Optimise the energy performances and efficiencies of the systems and building and reduce financial costs of running the building.

We believe this can be achieved by Trefriw Village Hall through undertaking the recommendations made below.

2.2 Recommendations

To decrease Trefriw Village Hall's energy consumption and optimise the energy performance of the building, short-, mid- and long-term recommendations have been made which look at all areas within the building.

2.2.1 Short-term

Electricity Tariff Review

It is recommended that when the electrical supply contract is renegotiated a 100% REGO backed renewable tariff is selected. Through making this change, Trefriw Village Hall would have zero associated emissions with electricity consumption. Although this does not decrease energy consumption, it would decrease the emissions associated with the community building and is more sustainable.

Customer Engagement

We recommend having informative posters/stickers across the building at energy use locations. For example, next to every plug socket, a note to say turn off when not in use and to unplug from the wall as this save's energy also, this could save up to £30 in energy costs a year. (Energy Saving Trust)

Another example, as there are no measures to stop customers changing the individual radiator settings, it providing recommended radiator settings to reduce the associated emissions.

We recognise that having informative posters/stickers across the buildings doesn't appeal to everyone. In this case, we recommend compiling an energy use booklet for the building which customers can view whilst in the building. It's important to provide both examples and benefits of saving energy to reduce fuel and energy bills, as well as the buildings carbon footprints.

Energy Saving Trust provide free resources for employee/customer engagement on saving energy and energy efficiencies in the work place. Below is a list of this resources:

Employee-Engagement-Posters-energy-saving-trust.pdf (energysavingtrust.org.uk)

Employee_engagement_guide_2022v2.pdf (energysavingtrust.org.uk)

Energy-checklistv3.pdf (energysavingtrust.org.uk)

Employee-engagement-with-sustainability_presentation.pptx (live.com)

EE-stickers-small-1-page.pdf (energysavingtrust.org.uk)

Heating and DHW System

We recommend a multi-phase plan of review for the heating and DHW within the building with the idea to make these systems as efficient as possible.

The first phase of this would require undertaking condition and life cycle appraisals on all the current heating infrastructure. Along with this, we recommend a feasibility survey is undertaken for either an air-source or ground-source heat pump (ASHP or a GSHP). The condition and life-cycle appraisals will reveal an estimate of when the current heating infrastructure will become insufficient and defective, and will allow for future planning. This will prevent the case that when the infrastructure becomes defective, an urgent like-for-like replacement isn't installed, and instead the optimum system for the building is designed, planned and installed at the right time.

The second phase of this would be to review heating controls. Currently, heating is all manually controlled on each radiator/heater and requires onsite operation.

Based on the outcomes of the first two phases, we believe the building has the following options for improving and optimising the efficiency of the heating and DHW system.

1. For DHW, maintain the electric hot water boiler and point of use hot water taps. For heating, upgrade all radiators and heaters to programmable electric radiators which are networked together that can be programmed remotely. This way, a member of Trefriw Village Hall would not be required onsite and could activate the heating when needed from home.
2. Install a heat pump (either ASHP or GSHP) for both heating and DHW. This would come with a higher financial cost however would be a more suitable option in the long-term of the building. In order for a heat pump to be efficient, it must be ensured the building itself is thermally efficient and well insulated.

Both these options would be implemented as a mid- or long-term installation as further work to the thermal retention of the building is required initially.

Thermal Retention

Review Ground Floor

It was noted during the energy audit that the floor within the main hall has a wooden surface and is constructed of cavity floor with an unknown level of insulation, however is suspected to have none. Up to 10% of heating from a building can be lost through an uninsulated ground floor. We believe that the building and comfort of activities within the building could benefit from installing insulation.

Initially, we recommend installing a rollout thermal carpet/matting to cover the floor as a short-term low-cost solution. Following this, as a mid- to long-term recommendations, either:

1. Add insulation to the surface of the current floor by either attaching wood sleepers to the floor, filling the gaps with rigid-foam insulation, and then apply a hard finish flooring, or cover the floor with rigid-foam insulation, add two layers of plywood and then add the hard finish flooring. Both methods will raise the floor however we believe there is plenty of height within the space for this to have minimal impact. This method is easiest to implement however does not have the long-term view of the building in mind.

2. Install underfloor insulation by filling the cavity with insulation. This would require taking up the floor boards and relaying the floor. This would maintain the current floor height.
3. Alternatively, as a potentially more long-term efficient solution, underfloor heating could be installed with insulation. This would be a more efficient heating system for the space and would provide a comfortable activity space. This solution will have a longer return of investment (ROI) however is a far more efficient solution in the long-term and will be compatible with a heat pump.

Lighting Upgrade

We propose that the following replacements:

Number of Fittings	Current Light	Proposed Replacement Light
2	CFL Bulbs (11W)	4pin/2pin Retrofit Lamp (10W)
1	2D Bulkhead (28W)	LED Disc Luminaire (15W)
2	1800mm T8 Fluorescent Tube (125W)	LED IP65 1800mm (36W)
2	2400mm T8 Fluorescent Tube (165W)	LED IP65 2400mm (48W)

Table 4: Light Replacement Proposal.

It is anticipated that the energy consumption from non-LED lighting will be reduced from 1,270 kWh per annum to 410 kWh per annum based on assumed average lighting use. This represents a potential saving of 860 kWh, a 68% reduction in current non-LED lighting energy use, or up to a 54% reduction in overall electricity use.

An indicative cost for the supply and installation of the LED lights was sourced to be circa £950 inc VAT.

It is recognised that the electricity savings will not reduce the carbon emissions associated with the site but will generate cost savings.

2.2.2 Mid-term

Renewables and Storage

Preliminary desktop surveys indicate that there is potential for a roof-mounted solar PV array of approximately 14 kWp in size on the main roof space of circa 70m^2 and an array of approximately 8 kWp in size on the extension roof space of circa 40m^2 which may be more efficient due to the orientation. (see below)

Figure 1: Proposed PV array location.

Indicative costs for PV installation are approximately £1,250 - £1,500 per kWp installed, meaning that the installations would be in the region of £27,500 - £33,000 + VAT. For the main roof space installation individually, the cost would be circa £17,500 - £21,000 and for the extension roof space installation, the cost would be circa £10,000 - £12,000.

It would be reasonable to expect an average yield of approximately 22,000 kWh per annum from both arrays, or 14,000 kWh per annum from the main roof array and 8,000 kWh per annum from the extension roof array. All of which are far greater than the annual average consumption of the building which is estimated to be in the region of 1,506 kWh.

Reviewing the proposed PV array on the extensions roof, a surplus of circa 6,500 kWh would be exported to the grid.

The Feed in tariff payment for the sale of surplus electricity has now been replaced by the Smart Export Guarantee.

Rates for this vary between different suppliers and it is possible to receive in the region of 5 to 7pence per kWh exported. For the PV installation on the current structure, this would mean a potential revenue of £325 - £455 per annum.

We believe an array of this size is over-scaled based off of the buildings annual energy consumption and needs to be scaled down appropriately, however we believe in combination with an appropriate level of battery storage it is possible to completely reduce the buildings need for grid-based electricity. We recommend an electrical profile monitoring over a 28 day "average" period to understand the buildings usage better, to ensure the array isn't over-scaled and achieve optimum balance of CAPEX versus return.

Any potential PV installation may need permission under planning regulations and independent planning advice should be sought as a first step in the process. A PV installation will also need permission to be granted by the Distribution Network Operator (DNO) to ensure that there is capacity in the grid to accept a complete export from the site.

The DNO covering the site is Scottish Power Energy Networks, their website is available at https://www.scottishpower.com.

We also recommend that a site-based feasibility survey for PV solar panel installation is undertaken for the roof mounted array to allow formal quotations for installation to be generated and returns on investment to be calculated. This will include a formal measurement of electrical consumption and modelling of current and future demand.

Thermal Retention

Review Windows

It was noted during the energy audit that all the windows within the main hall were old single-glazed sash windows which are inefficient for retaining heat.

We recommend upgrading the single-glazing within the building. Installing double-glazed windows has the potential to reduce the heat loss from each window by up to 74%. As the building is primarily heated electrically this could have significant financial savings. As well as the thermal retention benefits of double-glazing, this will also help to prevent draughts from entering the building and reduce the amount of outside noise heard creating a quieter activity space.

We recognise the building is a Grade 2 Listed building and it may seem not possible to upgrade the windows, however it is possible to install double-glazed sash windows which will not deter from the aesthetics and appearance of the building. Below is one place to acquire double-glazed sash windows.

Sliding Sash Window | JELD-WEN

Review Ceilings

It is estimated that up to 25% of heat within a building is lost through the loft spaces. We were unable to review the level of insulation within the loft of the main hall for safety issues however it was reported that no insulation was present. We were able to review the loft insulation within the stage loft space and the extension loft space. For both spaces there was minimal and no insulation.

We recommend that insulation is installed above the ceiling tiles within the main hall. This will significantly reduce the heating demand of the space and retain heat more efficiently leading to reducing heating costs.

We also recommend that insulation is installed between the joists within the stage loft space and the extension loft space. The recommended level of loft insulation for new builds is 270mm which is what we encourage is installed. It's important to insulate all ceiling spaces to ensure there are minimal heat loss opportunities and to optimise the thermal retention of the building.

Review Walls

We recommend installing internal wall insulation as this will increase the efficiency of the thermal retention of the building whilst lowering the heating demand. The installation of internal insulation is expected to cost circa £4,000 - £12,000. For an accurate cost, an inspection would be required. The installation of internal insulation would remove a marginal volume of space within the building however would have significant benefits and savings.

2.2.3 Long-term

Heat Management

Following the improvements of the efficiency of the buildings thermal retention, it would be appropriate to upgrade the heating system for either an ASHP or GSHP. The type of heat pump would depend on the outcome of the heat pump feasibility survey and would have to be weighed up financially as well as on the efficiency of each system.

The coefficient of performance (COP) of an ASHP is 2.5, which implies for every 1 kW of energy in, 2.5 kW of heat is outputted. Whilst the COP of a GSHP is 3.5 which implies for every 1 kW of energy in, 3.5 kW of heat is outputted. However, the cost associated with the installation of a GSHP is far greater than an ASHP. Both have a far greater COP than the current electric radiators which is 1.0.

Currently, the main hall is heated by 6 2.1 kW radiators which have a total heating output of 12.6 kW, however it was noted the room is rarely sufficiently heated. We have undertaken an indicative calculation of heating load required. We believe circa 25 kW of heating output is required within the main hall considering the single-glazed windows. If these were upgraded to double-glazing, then we believe the heating output required is circa 22kW. With further improvements to the insulation of the building this is likely to decrease the heating load further. We have also calculated an indicative heating output requirement of circa 6 kW for the extensions although recognising the lavatories don't necessarily need heating, this could be significantly lower. This has been calculated recognising the double-glazing present in the extensions.

Based on the current required heating demand of circa 25 kW for the main hall, it would be reasonable to assume, that a 10 kW ASHP would need to be installed to match the current heating output or a 7 kW GSHP would need to be installed to match the current heating output. If the extensions were to be included, then it would be reasonable to assume a 12 kW ASHP would be required or a 9 kW GSHP would be required.

However, taking into considerations the proposed improvements of thermal efficiencies within the building, the heating demand would be lower and these specifications for heat pumps would be the maximum energy demand.

To further optimise the heat pump system, we recommend adding weather compensation controls and local time control. Weather compensated heating systems use a small outdoor sensor to adjust the system controls to compensate for changes in outdoor temperature automatically. As the weather gets colder the system works harder and produces more heat to the radiators, and as the weather warms up the system reduces the temperature to the radiators. The system runs more consistently feeding energy into the building gradually and efficiently over a longer period of time. The key benefits of this include,

- The heat source will modulate and run at a lower, more efficient rate.
- It maintains the fabric of the building at a steady consistent temperature and provides the occupants with increased levels of comfort.
- The need to turn off the heating system is removed. The heating will come on as required by the outdoor temperature. This means that on a cool, late summer

evening the heating will automatically come on to provide some heat, and on a warm spring day the heating will not switch on at all.

If a heat pump was not feasible and the other option of upgrading to all programmable electric radiators were to be adopted, this would require a far higher electrical demand of circa 30 kW. This is likely to have a lower installation cost than either an ASHP or GSHP however would not have the long-term view of the building in mind.

Renewables and Storage

We recommend the installation of PV is phased. Initially an array large enough to produce enough electricity to cover the demand. Following this, if the demand increases for new infrastructure within the building, then it may be worth installing a second array to cover the new demand.

If battery storage weren't to be been installed with the initial PV installation, it would be sensible to install appropriate battery storage with the second PV array installation. This is because the heating system would be electrically sourced and at night when the PV isn't generating, the heating could run from the batteries. (See Appendix 1 for batteries)

2.3 Action Plan

Figure 2 below demonstrates the suggested action plan for Trefriw Village Hall to optimise the energy performances and efficiencies of the systems within the building and reduce financial costs of running the building.

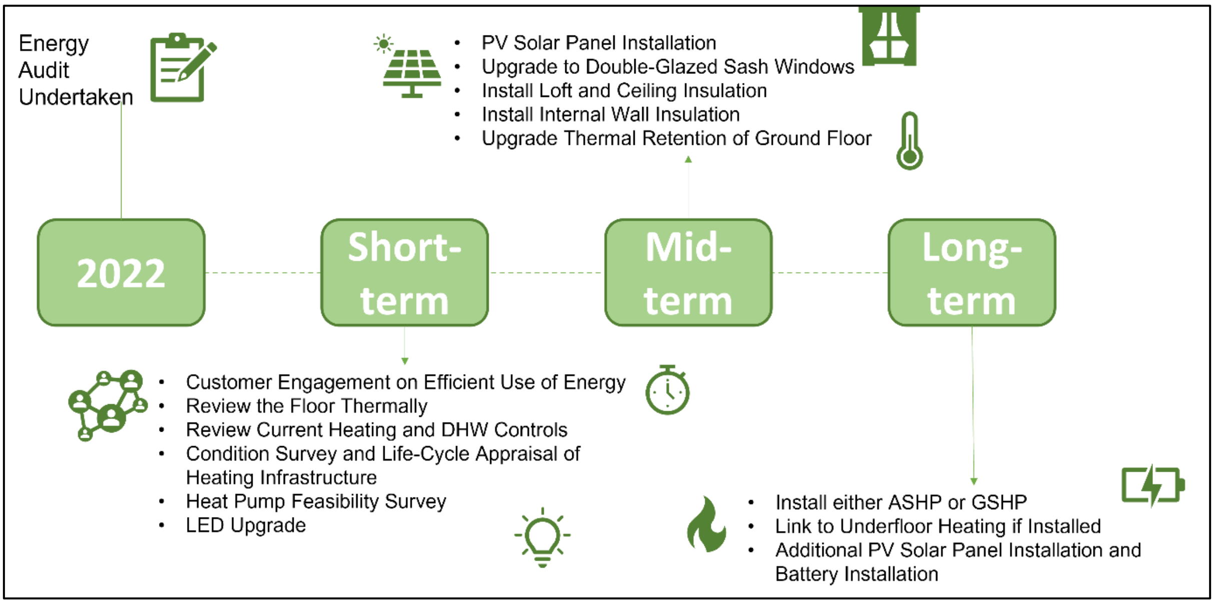

Figure 2: Action Plan.

Appendices

Appendix 1

Battery Storage

Greener Edge performed preliminary market research with a local North Wales provider who came back with the following indicative costs for the three battery storage options listed below.

Data sheets for the products are embedded.

Huawei Smart String Energy Storage System

5kWh Capacity (scalable)

£4,995.00 + vat

Datasheet attached

SolarEdge Energy Bank

10kWh Capacity

£6,995.00 + vat

Datasheet attached

Tesla Powerwall II

13.4kwh Capacity

£8900.00 + vat

8-month Lead Time

Datasheet attached

This document is prepared for information use only. Greener Edge do not endorse or support any product nor do they have any commercial relationships with any battery solution listed.

Prices accurate as of April 2022.

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