Agenda Item	9.
Report No	CCC/17/24

The Highland Council

Committee: **Climate Change**

Date: **28 August 2024**

Report Title: **Net Zero Audit & Survey Programme Update**

Report By: **Assistant Chief Executive - Place**

1 Purpose/Executive Summary

1.1 The purpose of this paper is to update Members of the upcoming programme of works in relation to the inspection and assessment of the non-domestic property portfolio with respect to the transition to Net Zero carbon emissions.

1.2 The deliverables of this work will not only inform the longer-term transition of the non-domestic estate, but also identify opportunities that cost-effectively reduce energy consumption, reduce emissions and reduce cost.

1.3 For information examples of typical report deliverables are included in Appendices 2 and 3.

2 Recommendations

2.1 Members are asked to:-

i. **Note** the proposed programme of works; and
ii. **Note** the resulting indicative report deliverables.

3 Implications

3.1 **Resource** - The associated staff compliment is not yet fully in place; recruitment activities remain ongoing.

3.2 **Legal** - there are no legal implications arising from this report.

3.3 **Risk** - There is no risk directly relating to this paper.

3.4 **Health and Safety (risks arising from changes to plant, equipment, process, or people)** – There are no implications arising from this project.

3.5 **Gaelic** - There are no Gaelic implications arising from this project.

4 Impacts

4.1 In Highland, all policies, strategies or service changes are subject to an integrated screening for impact for Equalities, Poverty and Human Rights, Children's Rights and Wellbeing, Climate Change, Islands and Mainland Rural Communities, and Data Protection. Where identified as required, a full impact assessment will be undertaken.

4.2 Considering impacts is a core part of the decision-making process and needs to inform the decision-making process. When taking any decision, Members must give due regard to the findings of any assessment.

4.3 Integrated Impact Assessment - Summary

4.3.1 This is an update report and therefore an impact assessment is not required.

5 Background

5.1 This programme is a defined workstream within the Net Zero, Investment and Innovation Portfolio of the Council's Delivery Plan 2024-2027.

5.2 Surveys of the 300 buildings will be undertaken over the subsequent 2-yearr period, with a focus on schools, leisure and larger more energy intensive properties.

5.3 This work requires appropriately skilled staff to undertake technical site surveys and determine feasible solutions on how individual properties can achieve Net Zero, including aspects such as heating systems, lighting, on-site renewable generation, vehicle charging, recycling arrangements, occupant behaviour etc.

5.4 The resultant reporting, information, costings etc will subsequently be utilised within the asset rationalisation considerations, funding applications, capital programmes, maintenance programmes etc., and will contribute to a comprehensive database of costed projects.

5.5 Where appropriate, identified savings opportunities will be progressed promptly to realise immediate cost benefits.

6 Site Prioritisation

6.1 It is important to ensure that buildings are selected not only for their net zero potential, but also that they align strategically with wider Council aspirations and plans.

6.2 Consultation is currently underway with Property, Highlife Highland and the Asset Rationalisation Group to:-

- ensure all appropriate buildings are considered;
- review applied weighting and rationale of scoring metrics;
- provide input with respect to scoring in relation to Asset Rationalisation; and
- provide input with respect to scoring in relation to Strategic (Property, HLH)

6.3 The initial screening of the property portfolio identified 342 potential buildings based upon the following metrics and weightings:-

- heating fuel - presence of fossil fuels;
- asset rationalisation – significant refurbishment planned, disposal etc.;
- relative energy performance – poorly performing;
- energy usage/cost - overall cost and consumption; and
- strategic – strategically important

Metric	Heating Fuel	Asset Rationalisation	Energy Performance	Energy Usage/Cost	Strategic
Weighting	25%	30%	25%	10%	10%

6.4 The 40 sites with the highest prioritisation scores are detailed in **Appendix 1**.

7 Commentary and Next Steps

7.1 Following receipt of feedback from relevant services, the list of sites identified for Net Zero audits will be refined and will continue to be refreshed as required.

7.2 Reports and findings will be shared on an ongoing basis, including to staff and services occupying the relevant building.

7.3 KPI reporting will be undertaken in PRMS in line with stated frequencies.

Designation: Assistant Chief Executive - Place

Date: 28 July 2024

Author: Ronnie Macdonald, Energy Manager

Background Papers: None

Appendices: Appendix 1 – Draft Site Prioritisation List
Appendix 2 – Example Report – Glen Urquhart High School
Appendix 3 – Example Report – Ferintosh Primary School

Appendix 1 – Net Zero Audit & Survey Prioritisation List - Top 40

Site Name	Site Type	Priority Scoring
Nairn Swimming Pool	Sport Centre - Wet	8.3
Durness PS	Primary School	7.4
St Clements Special School	Special Needs Centre	7.4
Kilmuir PS	Primary School	7.2
Dingwall Roads Depot	Depot/Yard	7.1
Dornoch Academy & PS	Secondary School	7.1
Inverness Family Resource Centre	Offices	6.9
Beauly PS	Primary School	6.9
Tain Royal Academy	Secondary School	6.8
Inverness Leisure Centre	Sport Centre - Wet	6.8
Charleston Academy	Secondary School	6.8
Banavie PS	Primary School	6.7
Tigh na Sgire	Offices	6.7
Munlochy PS	Primary School	6.5
Halkirk PS	Primary School	6.4
Spa Pavilion Gardens, Strathpeffer	Visitor Centre	6.4
Tarradale PS	Primary School	6.4
Invergordon Leisure Centre	Sport Centre - Wet	6.3
Thurso Swimming Pool	Sport Centre - Wet	6.3
Lairg PS	Primary School	6.2
North Coast Visitor Centre	Visitor Centre	6.2
Osprey House	Offices	6.2
Inshes PS (PPP)	Primary School	6.1
Inverness Botanic Gardens	Visitor Centre	6.1
Thurso HS	Secondary School	6
Ferintosh PS	Primary School	6
Millbank PS	Primary School	5.9
Auldearn PS	Primary School	5.9
Crown PS	Primary School	5.9
Pulteney House Resource Centre	Residential Home	5.9
Fortrose Academy	Secondary School	5.8
Spectrum Centre	Community/Youth Centre	5.7
St Joseph's RC PS	Primary School	5.7
Auchtertyre PS	Primary School	5.7
Broadford PS	Primary School	5.7
Grantown PS	Primary School	5.6
TEC Services Depot (Inverness)	Depot/Yard	5.6
Lochbroom Leisure Centre	Sport Centre - Wet	5.6
Culloden Academy	Secondary School	5.5
Lochaber HS	Secondary School	5.5

Glen Urquhart High School

Net Zero Audit Report

Climate Change and Energy Team

PPP School Handback

Original			
Version	**Author**	**Note**	**Date**
1.0	Nathan Chaplin	First Draft	28/03/2024
Revisions			
Version	**Author**	**Note**	**Date**
1.1	Nathan Chaplin	Internal Review Updates	09/04/2024
1.2	Nathan Chaplin	Update of Figure 18 and supporting text	11/04/2024

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1 Executive Summary

Table 1 summarises the investment-grade Energy Change Measures (ECM) recommended at Glen Urquhart High School.

Table 1: Capital Cost Recommendations for Glen Urquhart HS

ECM	Estimated Annual Savings (£)	Estimated Cost of Works (£)	£/LTt. CO_2	Carbon Savings (tCO_2)	Simple Payback (years)
Heating Controls	£4,067	£11,500	£583	3.8	2.8
LED Lighting	£6,591	£97,463	£1,775	6.2	14.8
Solar PV (50kW)	£9,804	£71,283	£880	9.3	7.3

Combined they are projected to reduce annual electricity costs and emissions by £20,476 and 19.3tCO_2 respectively.

Table 2 highlights low cost & behavioural recommendations that can be implemented now.

Table 2: Low Cost & Behavioural Recommendations

Improvement Area	Recommendation
Behaviours and Awareness	Support staff and pupil net zero groups to educate and encourage good behaviour practice and activities, e.g. initiatives such as active labelling of light switches and equipment, switching off at end of day
Out of Hours Heating Settings	Ensure all heating time clocks are set for in use periods only and that the charging of storage heaters occurs only the day before heat is needed.
Pump-house Frost Protection	Apply frost protection at appropriate temperature levels
Insulation	Improve thermal envelope and re-position existing ineffective roof insulation

While it's challenging to quantify the savings resulting from these actions, each item will contribute to enhancing the schools Net Zero performance.

Table 3 details additional recommendations that would further improve the schools Net Zero performance however these require further development or integration with other works, e.g. plant replacement schedules, to be progressed in a cost-effective manner.

Table 3: Additional Recommendations

Improvement Area	Recommendation
Air Handling Unit (AHU) – Heat Recovery	Introduce heat recovery during replacement of AHUs
Games Hall – Heat Recovery	Introducing mechanical ventilation and heat recovery to the games hall to improve ventilation and heat loss by removing door vents
Electric vehicle charging points (EVCP)	Site has sufficient electrical capacity to facilitate EVCP, improving travel related emissions

2 Introduction

As a public body, The Highland Council (THC) are legally bound to contribute to Scotland’s Net Zero target by 2045. Our Net Zero strategy requires to define and follow a route map to net zero by 2045, with key interim targets to reduce carbon emissions by 75% by 2030 and by 90% by 2040.

This report directly supports this strategy as 67% of the total highland council emissions are associated with the built estates’ energy usage.

3 Building Overview

3.1 Site Introduction

Glen Urquhart High School was built to the Scottish Building Regulations applicable at the time and opened in August 2002. The school is situated in the rural village of Drumnadrochit, Inverness-shire on the banks of Loch Ness. The school serves approximately 200+ pupils from a wide catchment area ranging from Tomich and Cannich in the West to Invermoriston in the South-West.

Encompassing a total conditioned floor area of approximately 5,200 m^2, the building serves as a multi-functional facility. Inside, the building offers the expected amenities for a modern learning environment: a full range of teaching spaces, toilets and changing areas, a kitchen and canteen, sports hall, an all-weather sports pitch, administrative offices and storage facilities. Beyond its primary function as a secondary school, it also incorporates a nursery, community library and a sports hall, and is used out of core school hours by the community.

Figure 1: Glen Urquhart High School & Site Details

3.2 Fabric

In the absence of definitive information regarding the building's construction, compliance with the 2002 Scottish Building Regulations has been assumed. Accordingly, the following U-values (heat transfer characteristics) are estimated for the building envelope.

Table 4: Building Fabric

Element	U-values (W/m2K)
External Walls	0.3
Exposed floors	0.25
Roofs	0.2
Windows	2.2
Doors	2.2

Visual inspection suggests the external walls are of cavity construction, utilising concrete blocks for both inner and outer leaves and insulation infill. The majority of the external walls have a rendered finish with the entrance area incorporating exposed stone finishes.

The roof system comprises a pitched slate tile covering with thermal insulation strategically positioned between the ceiling joists. Double-glazed windows with hardwood framing are employed throughout the building envelope.

3.3 Building Services

3.3.1 Electricity

There is a single electrical supply for the school rated at 655kVA capacity, with the main incoming power supply panel located in the electrical plant room.

3.3.2 Metering

As shown in Figure 2, the main electrical meter is located within the electrical plant room, while the water meter is within the tractor store. The site has no electrical sub-metering present.

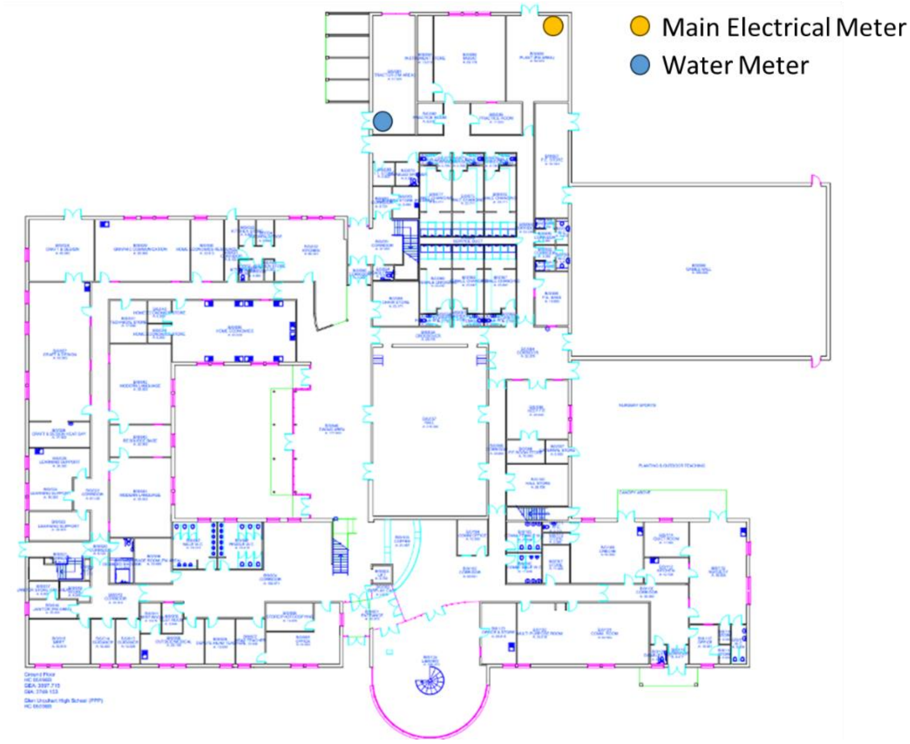


Figure 2: Electrical & Water Meter locations

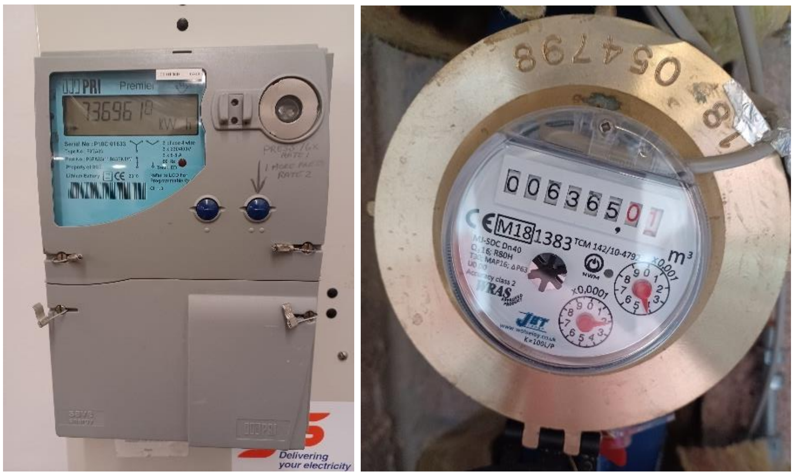


Figure 3: Electrical (left) & Water (right) Meters

3.3.3 Heating

A variety of electrical heating methods are used to maintain a comfortable environment within the school. A breakdown of the specific systems in key areas is presented in Table 5.

Table 5: Heating Strategy

Space	Heating Strategy
Typical classrooms / Nursery/ Changing rooms	Electric radiant panel heaters with black bulb thermostats and storage heaters (Figure 4)
Games Hall	Electric radiant panel heaters with black bulb thermostats (Figure 5)
Main Hall	Variable Air Volume (VAV) supply air-handling unit with electric heater batteries.
Office spaces and smaller classrooms	Electric Storage heaters (Figure 6)
Corridors	Overdoor Air Heaters (Figure 6)
Music room	Originally designed with only storage heaters, it was found to be challenging to maintain comfort and infra-red panels with localised manual control were subsequently added. However, the site confirmed that only half of installed infra-red panel heaters are required to achieve a comfortable temperature.

Figure 4: Typical Classroom Heating – ceiling-mounted electric radiant panel heater (left); electric storage heaters (middle); controls for panel heaters (right)

Figure 5: Games Hall Heating – heating units (left); thermostat control (right)

Figure 6: Small Classroom Heating (left); Corridor Over Door Heater (right)

3.3.4 Domestic Hot Water

For most areas, including classrooms, toilets and changing rooms, DHW requirements are provided by localised 10-15 litre point-of-use water heaters. For the kitchen a dedicated 200-litre calorifier with electric immersion coil, located in the attic plant room, provides all DHW requirements (Figure 7).

Figure 7: Kitchen hot Water calorifier

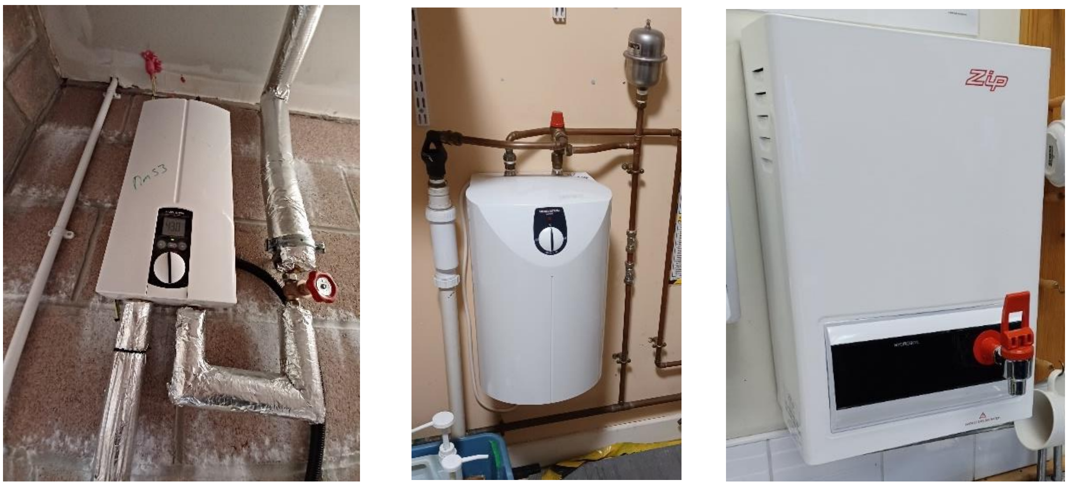


Figure 8: Point of Use Water Heaters (left and middle) & Instant Hot Water ZIP unit (right)

3.3.5 Cold Water

A 9m^3 cold water storage tank located in the roof plant space above the tractor store serves the entire building. Onsite staff reported no issues with elevated (>20oC) temperatures of stored water.

Figure 9: Cold Water Storage Tank

3.3.6 Ventilation

The school utilises a mix of natural and mechanical ventilation systems, as detailed in the following table.

Table 6: Ventilation Strategy

Space	Ventilation Strategy
Classrooms / Nursery/ Games Hall / Offices	Naturally ventilated
Changing rooms	Air-handling unit provides common supply air (Figure 10), with extract provided via individual in-line fans located in the roof space
Toilets / internal spaces / Home Economics	Localised extract units fitted within loft spaces and ceiling voids Controlled via light switch/PIR incorporating an overrun timer
Main Hall / Dining area	Variable Air Volume (VAV) supply air-handling unit with electric heater batteries and extract fan with BEMS control
Kitchen	Air-handling unit for supply and extract (Figure 10)
Under floor	11 Radon sump pumps with external vents and pipework (Figure 11)

Figure 10: Changing Rooms (left) and Kitchen (right) Air Handling Units

Figure 11: Radon Sump Pump Example

3.3.7 Lighting

Most of the school's internal lighting comprises T8 fluorescent and CFL fixtures. However, a transition to LED technology is underway in the transitional areas and toilets, with approximately 25% of the fixtures replaced. External lighting and Multi-Use Games Area (MUGA) pitch have been recently upgraded to LED lighting.

Table 7: Lighting Strategy

Space	Lighting Strategy
Typical classrooms / Nursery/ Games Hall/ Office/ Changing rooms/Toilets	Ceiling panel/ceiling mounted T8 fluorescent with PIR control
Games Hall/Kitchen/Craft & Design/ Home Economics/ Stores/Roof voids	T8 fluorescent with manual control
Main Hall	T8 fluorescent with manual control & stage lighting
Kitchen	T8 fluorescent
Corridors	LED ceiling panels with manual control
External Building Lighting	LED with photocell control
MUGA pitch	LED with manual control

Figure 12: Typical Classroom Lighting – Ground Floor (left) and First Floor (right)

Figure 13: Games Hall (left) and Main Hall (right) Lighting

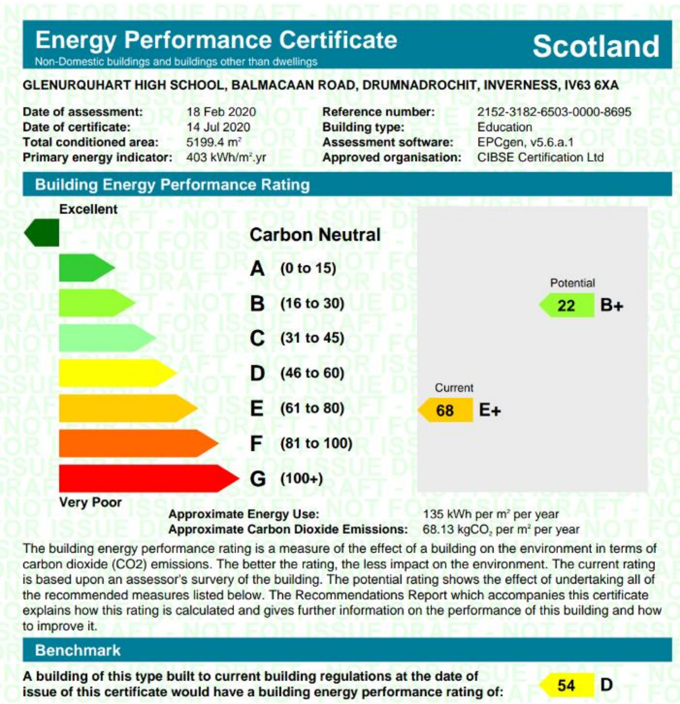
Figure 14: LED Lighting in Corridor (left), Library (middle) and Dining Hall (right)

Figure 15: MUGA Lighting

3.4 Building Performance

3.4.1 Energy Performance Certificate

An Energy Performance Certificate (EPC) was commissioned by Mitie in 2020 confirming a performance rating of E+ with associated emissions of 68kgCO_2/m^2.



Energy Performance Certificate — **Scotland**
Non-Domestic buildings and buildings other than dwellings

GLENURQUHART HIGH SCHOOL, BALMACAAN ROAD, DRUMNADROCHIT, INVERNESS, IV63 6XA

Date of assessment:	18 Feb 2020	Reference number:	2152-3182-6503-0000-8695
Date of certificate:	14 Jul 2020	Building type:	Education
Total conditioned area:	5199.4 m²	Assessment software:	EPCgen, v5.6.a.1
Primary energy indicator:	403 kWh/m².yr	Approved organisation:	CIBSE Certification Ltd

Building Energy Performance Rating

Excellent
Carbon Neutral
A (0 to 15)
B (16 to 30)
C (31 to 45)
D (46 to 60)
E (61 to 80)
F (81 to 100)
G (100+)
Very Poor

Potential 22 B+
Current 68 E+

Approximate Energy Use: 135 kWh per m² per year
Approximate Carbon Dioxide Emissions: 68.13 kgCO₂ per m² per year

The building energy performance rating is a measure of the effect of a building on the environment in terms of carbon dioxide (CO2) emissions. The better the rating, the less impact on the environment. The current rating is based upon an assessor's survery of the building. The potential rating shows the effect of undertaking all of the recommended measures listed below. The Recommendations Report which accompanies this certificate explains how this rating is calculated and gives further information on the performance of this building and how to improve it.

Benchmark

A building of this type built to current building regulations at the date of issue of this certificate would have a building energy performance rating of: 54 D

Figure 16: 2020 EPC

The recommendations report associated with the EPC identify actions capable of increasing the buildings performance from its current E+ to B+, are discussed in Table 8.

Table 8: EPC Recommendations

EPC Recommendation	Comments
Replace existing lights with LED	Partially progressed
Replace AC units in IT classroom and tech room with a split unit AC	AC systems are rarely used within Scottish buildings and across THC building stock. In discussion with the space users these units are rarely used, and THC would not recommend taking this forward.
Replace electrical heating throughout with variable refrigerant flow system	Although this would improve efficiencies, significant works would be required to route refrigerant pipe work and install ceiling cassettes across the building as significant cost. Not supported
Install a heat exchanger within the AHU for main hall/sports hall	The sports hall is naturally ventilated therefore a new AHU would be a requirement. Alternatively, we would recommend consideration of installing a heat exchanger on the existing main hall AHU.
Install heat recovery ventilation across the building	Installing heat recovery would require significant, costly and disruptive building works to run ductwork. Not supported

3.4.2 Utility Consumption

The consumption for 2022-23 financial year is shown in Table 9 along with the associated annual emissions.

Table 9: Utility Consumption and Emissions

Utility	Consumption 22/23	Cost 22/23	Annual Emissions (tCO_2e)
Electricity	560,249 kWh	£107,628	145
Water	1,424 m^3	£4,342	0.6
LPG (Kitchen/ Home Economics)	63kg (805kWh)	£78	0.2

3.4.3 Energy Breakdown

Due to the absence of sub-metering, a precise breakdown of the school's electrical consumption isn't possible. Figure 17 offers an estimated breakdown based on standard heat loss patterns and industry guidance (CIBSE Guide F-2016).

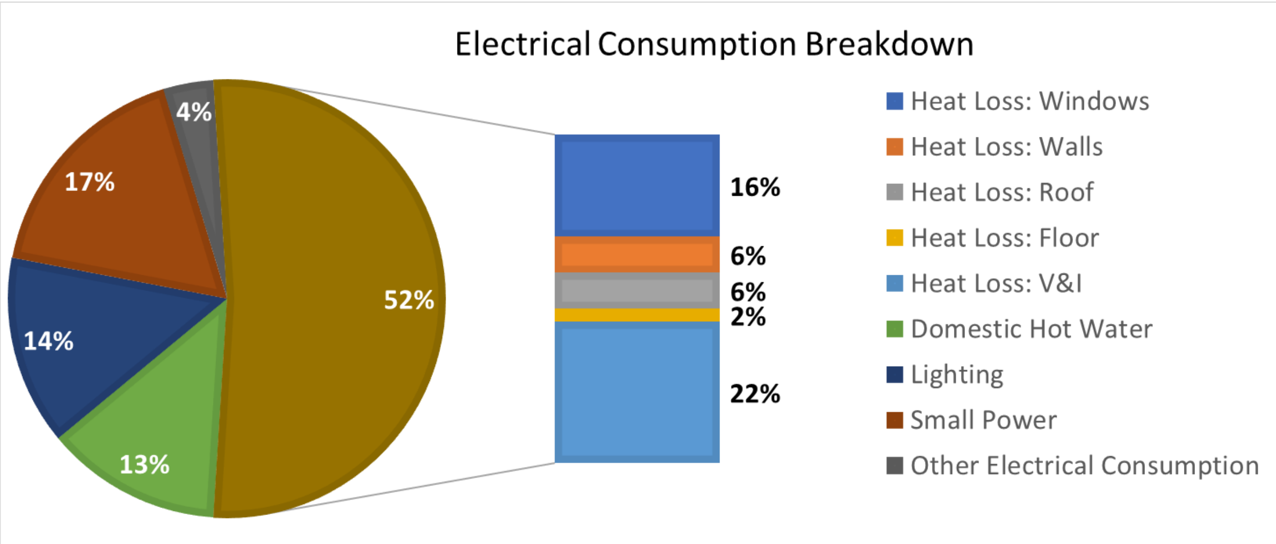


Figure 17: Electrical Consumption Breakdown

This analysis reveals that the provision of space heating contributes to the majority of electrical consumption (52%) at the school. Focusing efforts on reducing heat loss and improving heating control will likely have the most significant impact on improving overall energy efficiency.

Figure 18 illustrates the typical weekly electricity demand patterns observed during summer, winter, and on average, based on half-hourly data from 2023.

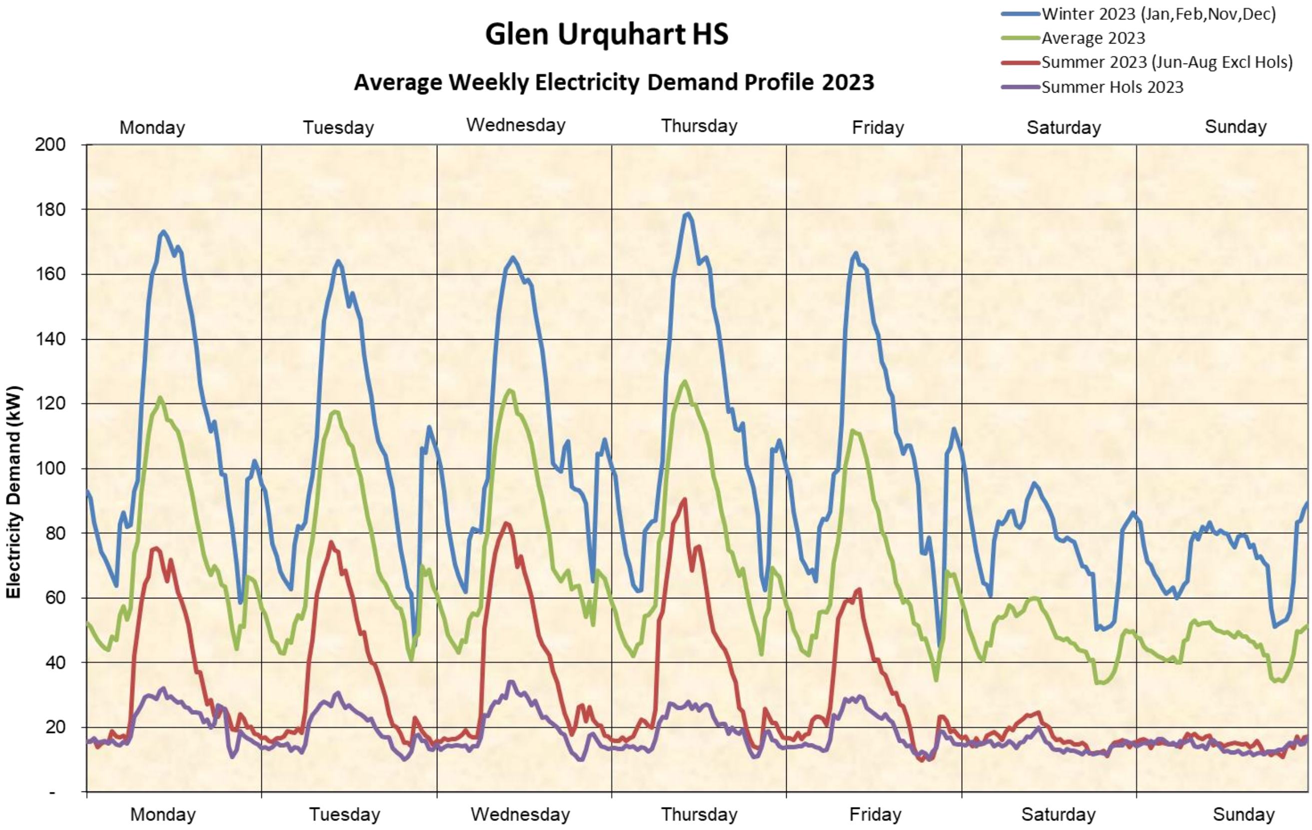


Figure 18: Average Weekly Electricity Demand Profile 2023-24

The weekly electrical consumption patterns shown in Figure 18 resemble those of a typical electrically heated school, with higher consumption during weekdays, and further, during the winter heating season.

In the winter profile, the overnight charging of storage heaters is indicated by the smaller blue peaks. Eliminating the charging of storage heaters on Fridays leading into Saturdays and Saturdays leading into Sundays would result in electricity savings, as the release of this heat wouldn't be required until the school reopens on Mondays.

The building's baseload ranges from 18kW in the summer to 70kW in the winter. By reviewing the operation of equipment during out of hours and minimising unnecessary heating, efforts can be made to reduce this baseload, leading to reduced electricity consumption.

Additionally, the graph shows a small profile is present during the week in the summer holidays, possibly relating to the use of library or sports facilities, however this would need be verified. Reduction of this profile during the week would reduce the electrical consumption over the summer holidays.

3.4.4 Heating Analysis

Figure 19 shows monthly electricity consumptions for 2022 and 2023.

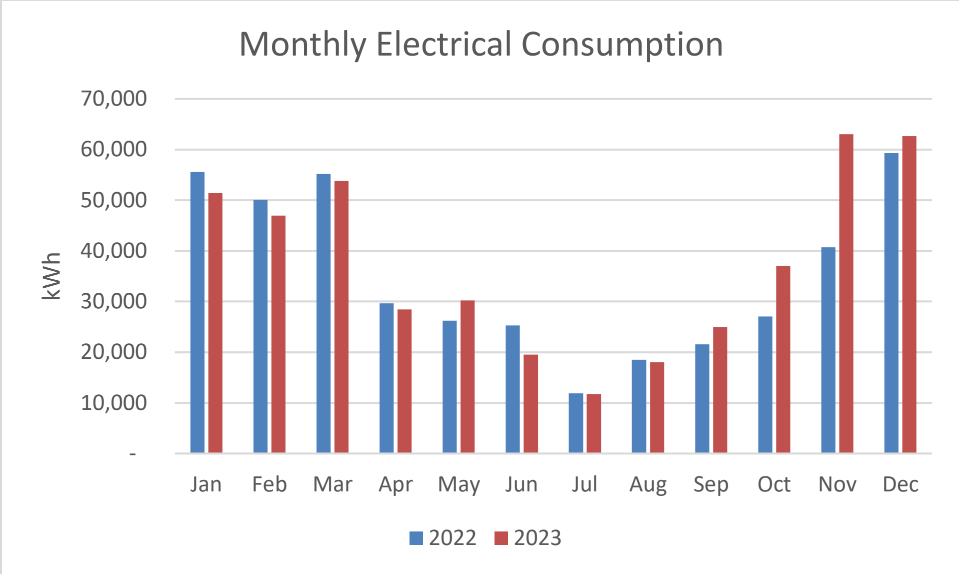


Figure 19: Monthly Electrical Consumption 2022 & 2023

The data reflects a clear seasonal pattern, with higher consumption in the colder months during the heating season. The variation in November consumptions are thought to relate predominately to the much colder external temperatures present in 2023.

The regression analysis in Figure 20 details the relationship between heating consumption and heating degree days. (a measure of the external weather conditions necessitating heating provision)

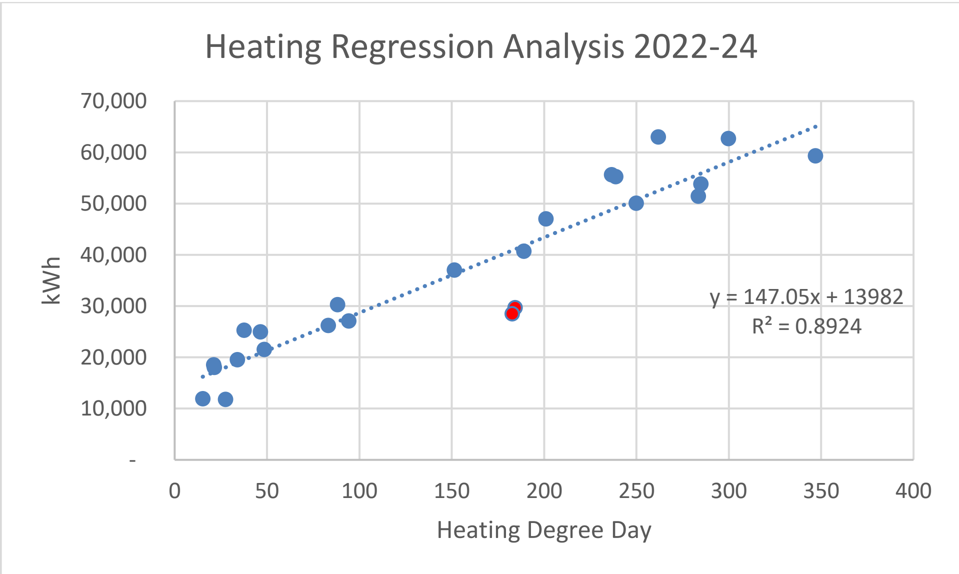


Figure 20: Heating Regression Analysis

The R^2 value of 0.8924 indicates a reasonable to good level of heating control. Some outliers are present, highlighted in red, however, as these align with April holiday periods, it demonstrates good practice in the delivery of a reduced level of heating provision during these periods.

The above profile indicates that the ratio between heated and non-heating consumption is 56% to 44% respectively.

3.4.5 Benchmarking

Benchmarking energy performance is a process that either compares the energy use of a building with other similar structures or how energy use varies from a baseline. It informs organisations about how and where they use energy and what factors drive their energy use. Benchmarking enables energy, building, and asset managers to determine the key metrics for assessing performance, to establish baselines, and to set performance goals.

A snapshot of the school's energy performance is presented in Figure 21. This figure utilises the Highland Council's energy benchmarking tool and compares the school's data to a typical electrically-heated secondary school in Scotland.

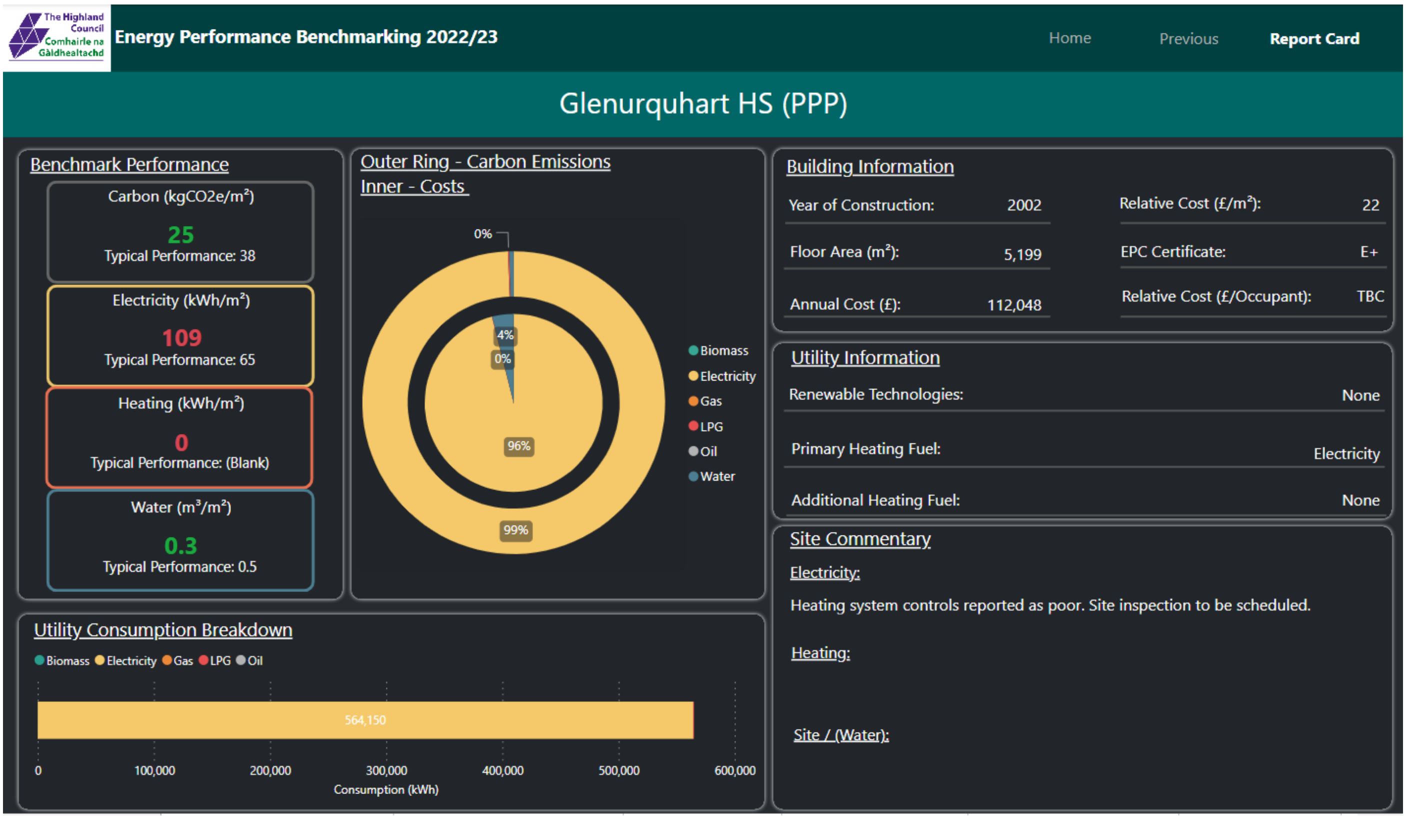


Figure 21: Energy Performance Benchmarking Report Card

The school exhibits a mixed performance. Both water and carbon are lower than benchmark figures, however, as can be seen in the graphic above the electricity consumption is 67% higher than a typical school of this type.

4 Onsite Observations

The following section makes reference to items noted during the survey.

4.1 Building Fabric

- **Doors and windows:** Doors and windows were found to be in good condition and with no evident leaks.
- **Insulation**: (See Appendix B for full details)
    - **Missing roof insulation:** Insulation absent on roof void walls next to the games hall and main hall, creating a thermal bridge (an area of easy heat transfer) between heated and unheated spaces
    - **Incomplete ceiling insulation:** Insulation missing in areas of the roof space where it has been lifted for works and not replaced properly
    - **Incorrect ceiling insulation placement:** Insulation positioned one metre above suspended ceiling tiles, which is ineffective. Insulation incorrectly position on a sloped section within an unheated space

4.2 Heating

- **Overdoor heaters:** Overdoor heaters were found to only be controlled only on time, from 8-5pm, regardless of temperature of space served. This is deemed an inefficient approach, especially in areas with additional heating sources present. It was noted that several overdoor heaters were manually turned off at the isolation switch.
- **Dining area:** The dining area had three separate heating systems: radiant panels, overdoor heaters, and high-level electric heaters. This has the potential to create conflicts between controlled and uncontrolled heating systems with an associated detrimental impact on energy efficiency.

4.3 Heating Controls

- **Consistency:** There were approximately 7 timeclocks which apply control to separate zones throughout the school. Alignment to real time varied with a spread of approximately 90min, which could lead to heating activation at incorrect periods. We would recommend that a periodic check is made to ensure alignment of all timeclocks.

4.4 Ventilation

- **Air handling unit (AHU) heat recovery:** It was noted that installed AHUs did not incorporate heat recovery of extracted air. Heat recovery, particularly for an electrically heated school would realise significant energy savings, however the measure is not easy to apply retrospectively.
- **Games hall and radon management:** Vents in the Games Hall fire doors (Figure 22) have been retrospectively installed as part of a radon management approach, however, it also introduces a direct route for heated air to escape in an uncontrolled manner.

Figure 22: Games Hall Fire Doors (grilles for radon ventilation)

4.5 Lighting

- **Lighting:** Approximately 75% of light fittings across the school are T8 fluorescents. Replacement with LED equivalents would not only reduce energy consumption in a cost-effective manner but also reduce associated maintenance requirements.

4.6 Pump House

- **Excessive Pumphouse Forst Protection:** During the inspection, the pumphouse was found to be excessively warm with the space thermostat for frost protection set at 26°C. It was highlighted by the FM team that issues with frozen pipes had occurred previously, leading to a cautious approach.

Figure 23: Inside Pump House (left) Pump House Thermostat 26°C (right)

4.7 Renewable Potential

The site was assessed for the potential installation of a variety of renewable technologies. The results of each are indicated in Table 10.

Table 10: Assessed Renewable Energy Options

Renewable Technology	Commentary	Suitable (Y/N)
Solar PV	Several southernly facing roof spaces and ground space available for PV's. When viewed in conjunction with the electrical load of the school, PV's are a very suitable technology for the school.	Y
Battery Storage	Given the balance of proposed generation against electrical demands, battery storage is not required. However, should additional generation be installed, batteries would be an applicable technology to be considered for periods of low demand.	Y, but not Presently
Air Source Heat Pumps (ASHP)	Sufficient space is available for ASHP units externally, however the school is limited by possible pipe routing options and spacing concerns for radiators and underfloor heating being impractical on the ground floor due to solid concrete.	N
Ground Source Heat Pump (GSHP)	Adjacent grass pitch could be utilised for GSHP bore holes however routing pipework and heat emitters would be the same as ASHP	N

4.7.1 PV

The school presents an ideal opportunity for solar panel installation. Several southward facing roofs offer ample space for panels, with minimal shading apart from a tree line (red outlined area) as illustrated in Figure 24. In addition, there is a south-east facing bank (623.8m^2) that could also be utilised, however this is out with the Council property boundary. Assuming an available roof space of 200m^2, suggests a suitable size of array would be 50kW, generating approximately 35,000kWh annually.

To ensure a safe and efficient installation, any solar PV system should adhere to the Council's Solar PV specification, including a full assessment by a competent designer/contractor encompassing structural elements.

Figure 24: Possible PV Locations

Figure 25 indicates an estimated generation curve for 50kW of PV based on THC generation profiles.

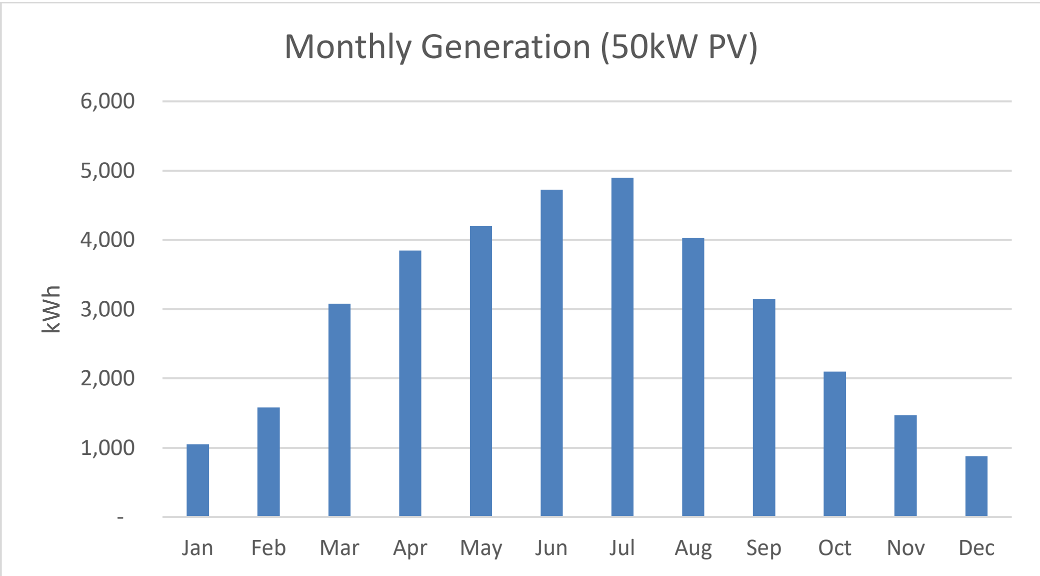


Figure 25: Estimated Monthly PV Generation for 50kW

A 50kW capacity has been chosen based on the existing roof space availability. However, it's worth noting that the school has the potential to utilise up to 100kW of PV generation without necessitating electricity export. This expanded capacity would not only maximise utility bill savings but also improve emission reductions.

5 Energy Change Measures

Table 11 lists the Energy Change Measures (ECM) that were evaluated for their applicability with the school.

Table 11: Energy Change Measures

Building Fabric	Glazing Upgrade/Replacement, Wall Insulation, Roof Insulation, Floor Insulation, Draughtproofing
Heating	Heating Infrastructure, Heating Controls, Hybrid / Bivalent Heating, Heat Pump + Back up, HW Ancillaries, HW Controls, HW Plant Replacement (Heat Storage)
Ventilation	Heat Recovery
Lighting	Lighting (LED Upgrade), Lighting Control
Cooling	Cooling Replacement, Cooling Control
Renewables	Solar PV, Solar Thermal,

Appendix A provides commentary on all ECM's, the ECM's highlighted in Table 12 were selected for further analysis as per section 8

Table 12: Selected Energy Change Measure Results

ECM	Commentary
Roof Insulation	Although the estimated cost in this scenario is high, ensuring insulation is present where required in roof spaces is vital to improving heat loss. Any disturbed insulation should be repositioned, and a complete thermal envelop for the building should be targeted.
Heating Controls	A centralised heating control system would improve energy management and consumption of the school.
LED Lighting	LED replacement is ongoing at the school with replacement of transitory spaces already complete. The focus should now be on replacing high use spaces and higher maintenance lighting such as classroom and sports hall. With the ambition to replace all lighting across the school with LED's
Solar PV (50kW)	Installing up to 100kW of PV is recommended as this would significantly reduce the electrical consumption and would provide a 7.3year payback.

*Saving based upon electricity savings only. It is anticipated that the maintenance related savings would at least match or exceed energy savings

5.1 Behavioural Change Measures

Introducing behavioural changes and awareness programmes presents another avenue in reducing energy consumption within the school. Such initiatives create a collective commitment to sustainability within the school community. By encouraging students, teachers, and staff to adopt simple yet impactful behaviours, it can have a significant impact on energy consumption, and generally have little to no costs attached. Presented below are several effective strategies for implementing behavioural changes in school, along with potential savings opportunities.

Table 13: Behavioural Change Measures

Behavioural Change	Commentary	Potential saving opportunity
Active labelling of light switches	Many schools have excessive installed lighting and multiple light switches in rooms. Mark up light switches that are not required to be on under normal daylight.	As much as 30% of lighting can at times be left off. Up to 12% saving.
Switch off lighting in daylight and when room is unoccupied	Switch off lighting when not required and maximise use of natural daylight. Also check that lights are switched off at breaks etc.	Savings are dependent on existing practices and windows (up to 10% saving).
IT equipment labelling and switch off	The active labelling of all equipment (switches and plugs) can help reduce energy consumption as all school users know what they can switch off.	Up to 5% saving.
Reducing out of hours electrical load	School opening hours can be less than 2,000 hours per year meaning they're unoccupied for 5,000 – 6,000 hours a year. If electrical items such as computers are left on, out of hours, this causes a major waste of energy. Energy Champions and Monitors can help ensure equipment is off at the end of the day/holidays.	Up to 20% saving.
Checking that heating times fit with school usage	Heating accounts for the majority of energy consumption in a school. By making sure occupants are aware of this and reduce thermostats and set local heating controls to only be on when spaces are in use will reduce use of fuels, emissions and costs.	Reducing heating by 1 hour a day can reduce heating costs by 10%.
Keeping windows and doors closed if the heating is on	If the heating system is being run ineffectively rooms can overheat and occupants open windows to reduce the temperature. Thermostats in rooms should be maintained and adjusted to the correct temperature. Recommended temperatures are listed in THC heating policy.	
Dressing appropriately for the weather	Encourage staff and pupils to wear more clothes if they're cold rather than turning the heating up.	Turning the thermostat up by 1°C can increase the heating costs by up to 8-10%.

Note, the percentage figures stated above relate to the consumption of the application or system, not the overall school consumption.

There are a number of online resources that can help schools, pupils and staff become more aware of their energy consumption including Energy Sparks, Eco Schools, National Energy Action and the Energy Saving Trust. They advocate simple no-cost activities such as 'Energy Monitors' and 'Energy Champions' within the school to ensure IT equipment and lighting are turned off out-of-school hours.

5.2 Additional Change Measures

Additionally, the following alterations are recommended, however associated savings are difficult to model accurately.

- **Pump House:** Recommend adjusting the thermostat and heater settings to a lower level that maintains adequate frost protection, whilst minimising energy consumption.

6 Travel

6.1 Transport

Transport and active travel aspects were not included within the scope of this study, however comment has been provided below with respect to Electric Vehicle charging.

6.2 Electrical Vehicle charge points

The school has roughly 30 parking spaces. Following the Scottish Government's recommendation, 10% of these spaces, ideally three, should be designated for electric vehicle charge points (EVCP).

Ideally these would be located in the main car park at the front of the school, with the proposed cable routing visualised in Figure 26. The route minimises disruption and costs by digging primarily across soft ground.

Figure 26: Proposed EV Charger Location

Determining the feasibility of installing electric vehicle charging points (EVCPs) requires information about the existing electrical capacity. The substation shown in Figure 26 is a dedicated substation for the school with a capacity of 800kVA.

Ideally, the EVCP setup would include 3off 22kW chargers equating to 132kVA. The school currently has a capacity allowance of 655kVA leaving 145kVA available for EVCPs.

If EV chargers are a consideration moving forward a connection request to SSEN would need to be submitted to confirm this capacity is available.

The introduction of EVCP would have a positive effect to the emissions of those travelling by EV to and from the site.

7 Waste

Waste management, recycling and food waste aspects were not included in the scope of the study.

8 Recommendations

8.1 ECM Recommendations

Table 14 summaries the recommended ECM to be progressed by the school.

Table 14: Recommended ECM's

ECM	Estimated Annual Savings (£)	Estimated Cost of Works (£)	£/LTt. CO_2	Carbon Savings (tCO_2)	Simple Payback (years)
Heating Controls	£4,067	£11,500	£583	3.8	2.8
LED Lighting	£6,591*	£97,463	£1,775	6.2	14.8
Solar PV (50kW)	£9,804	£71,283	£880	9.3	7.3

*Saving based upon electricity savings only. It is anticipated that maintenance related savings would at least match or exceed energy savings

Heating Controls

- Provides a great option in terms of cost-effectiveness and is based on a conservative assumption of a 5% space heating saving
- The low cost per lifetime tonne of CO_2 (£583) indicates that out of all the measures, this provides the highest carbon reduction per pound spent
- A simple payback of 2.8 years indicates a rapid return on investment

LED Lighting

- Significant annual savings are achievable
- The site has already begun the transition to LED lighting. It's recommended to expedite this replacement process, particularly in high use areas, this will maximise financial and carbon-saving benefits

Solar PV (50kW)

- As a minimum it is recommended that 50kW of PV should be installed at the site to reduce annual bills and improve on site emissions.

8.1.1 Forecasting

Annual Energy Costs and Consumption

Figure 27 and Figure 28 highlight the changes in annual energy consumption and energy costs when implementing the ECM's, with doing nothing (red) vs doing something (green). By introducing the recommended ECMs in 2026 and 2027 the annual energy consumption and costs are reduced. Between 2024 and 2045 the estimated cost savings and energy reduction would be £270,559 and 1,997,148kWh.

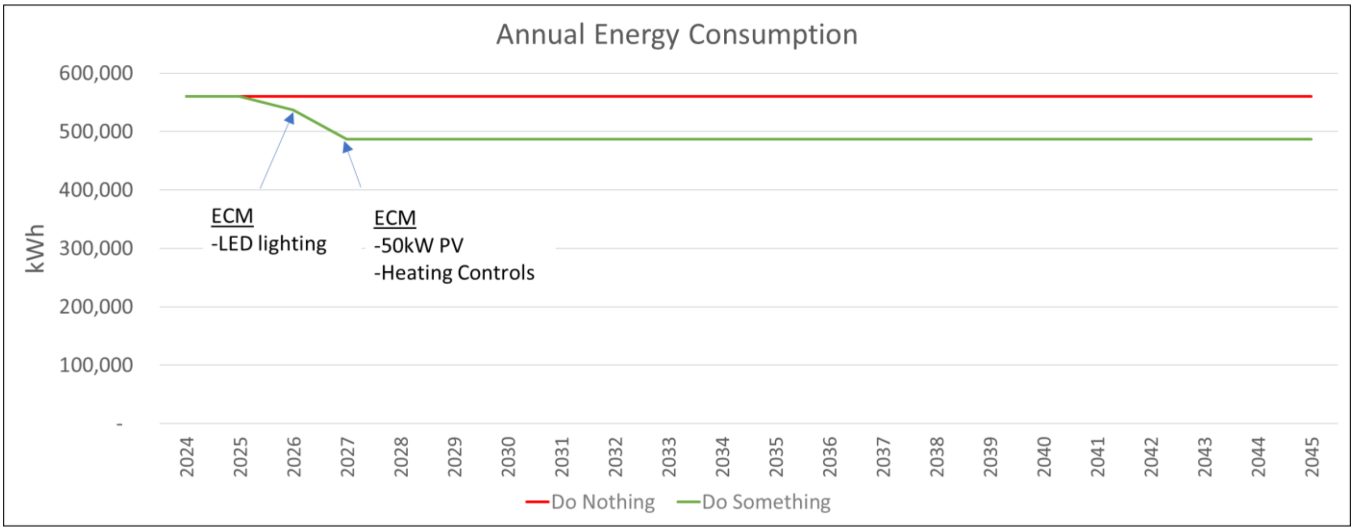


Figure 27: Annual Energy Consumption

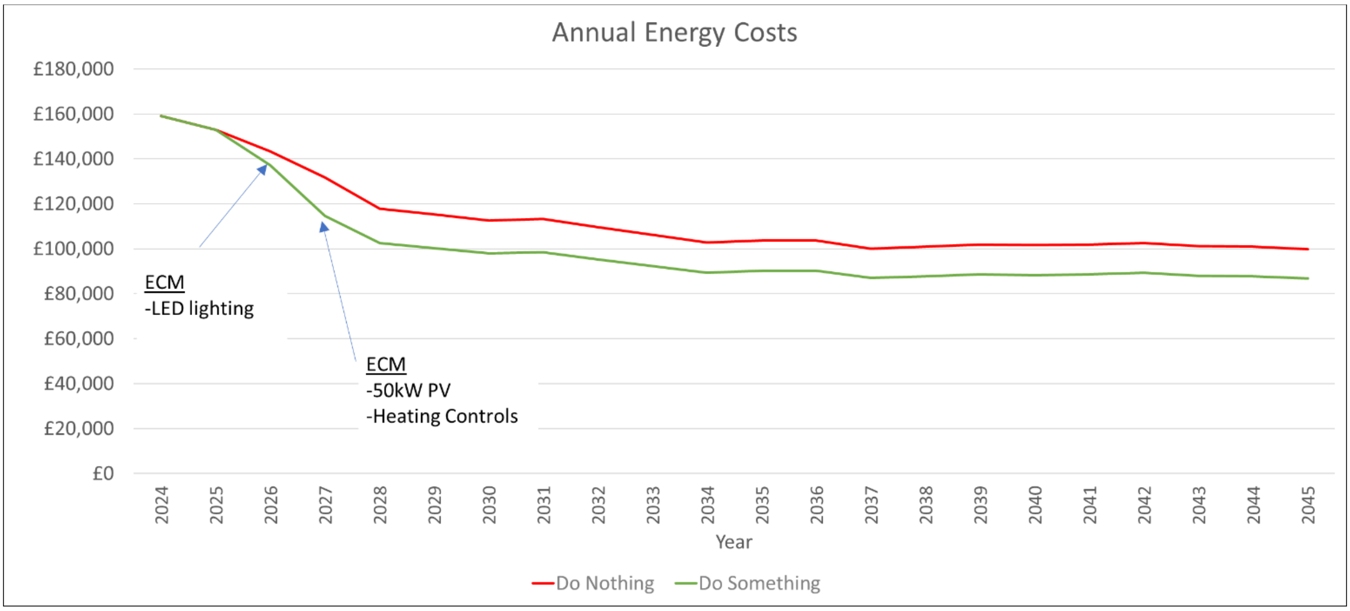


Figure 28: Annual Energy Cost Forecast

Net Zero Emissions Forecast

Figure 29 showcases the projected impact of taking action on the school's carbon footprint. The red line, labelled "Doing Nothing," depicts a business-as-usual scenario with CO_2 emissions reducing only in line with the decarbonisation of the grid. The green line, labelled "Doing Something," represents the positive change achieved by implementing Energy Conservation Measures (ECMs) in 2026 and 2027.

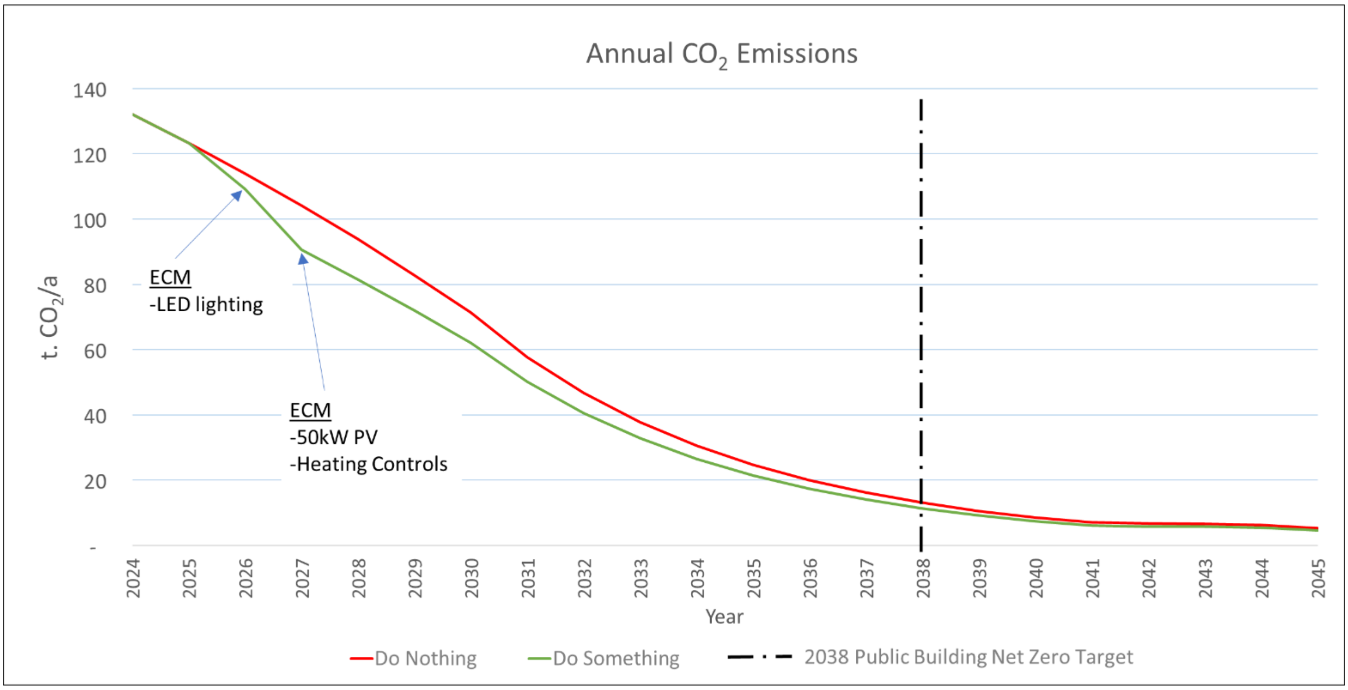


Figure 29: Annual Emission Forecast

As you can see, these proactive steps lead to a reduction in annual emissions. By taking a proactive approach, the estimated reduction in CO_2 emissions between 2024 and 2045 is 90tCO_2e. This reduction is equivalent to 610 cars driving the North Coast 500 route.

The natural downward trend of both “Do Nothing” and “Do Something” is due to the decarbonisation of the grid and the fact that the building is electrically heated and not reliant on any fossil fuels.

8.2 Additional Recommendations

- **Out of Hours Heating:** Ensure all heating time clocks are set for in use periods only and that the charging of storage heaters occurs only the day before heat is needed.
- **Excessive Pump House Heating:** During the inspection, the pump house was found to be excessively warm. Recommend adjusting the thermostat and heater settings to a lower level that maintains adequate frost protection while minimising energy consumption.
- **Insulation:** It is not recommended that a full insulation improvement is undertaken due to its high payback period (30+ years). However, where possible it is recommended that the separation between heated and unheated areas is improved, and any disturbed insulation should be repositioned to be more effective. This will minimise heat loss through the roof which is one of the highest areas of heat loss in a building.
- **Air handling unit (AHU) heat recovery:** Consider adding heat recovery capabilities to the Air Handling Unit (AHU) systems. This could significantly improve overall heating efficiency by capturing and reusing heat from extracted air before it's expelled from the building. Heat recovery on all AHU is considered desirable and cost-effective for energy performance. However, this measure is very difficult to install retrospectively and as such is not currently being proposed. Should replacement of the main AHU’s be undertaken in the future we would recommend that heat recovery is part of any design/specification.
- **Games Hall Heating Loss/Radon Management:** Introducing mechanical ventilation with heat recovery to the games hall along with removing the door grilles may address both unnecessary heat loss and high Radon levels, although it is recommended that specialists in Radon management should be consulted prior to any alterations.
- **Behavioural Changes and Awareness Raising:** Implement behaviour change and awareness raising initiatives such as active labelling of light switches and equipment, and Energy Champions and Energy Monitors to encourage switching off heating, lights and electrical equipment when not in use/out of school hours.
- **EVCP:** The study suggest that spare capacity is available on site for EVCPs. Installing these would help reduce travel emissions for visitors and others travelling to site.

8.3 Additional Considerations:

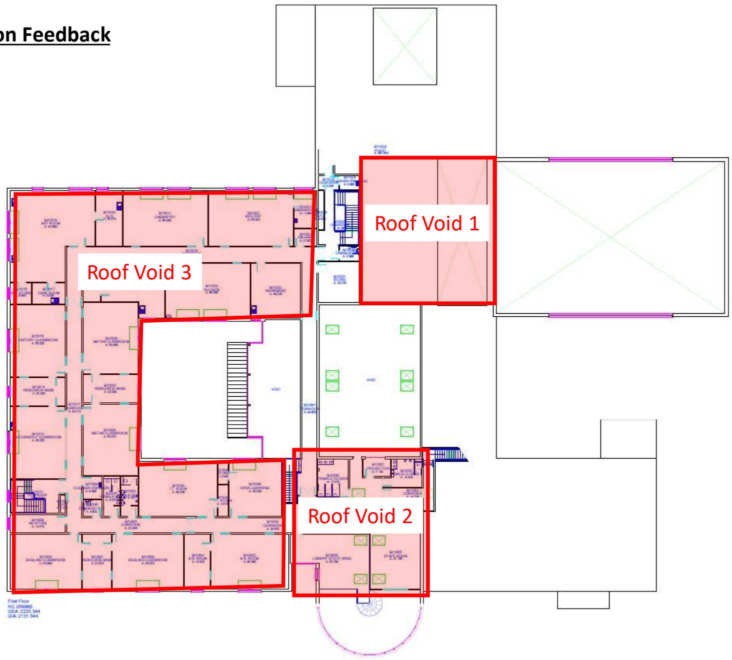
- **Disruption:** All projects will have a degree of disruption, some more than others, however the ECM’s recommended can be easily co-ordinated with the school to minimise impact on service provision.
- **Maintenance Requirements:** Maintenance requirements for new equipment should be identified and included into maintenance schedules and budgets accordingly.

Appendix A -Energy Change Measures

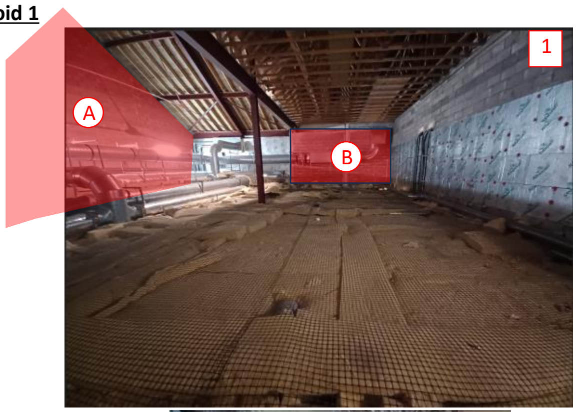
ECM		Comments	Y/N
Building Fabric	Glazing Upgrade/Replacement	Glazing in good condition and not recommended to be replaced	N
	Wall Insulation	Unable to determine exact wall insulation during site visit	N
	Roof Insulation	Various area with	Y
	Floor Insulation	Unable to determine exact floor insulation during site visit	N
	Draughtproofing	No draught issues were highlighted as part of the site visit	N
Heating	Heating Infrastructure	All electrical heating makes this non applicable	N
	Heating Controls	Building currently has zoned control with simplistic time clocks. This can be improved upon by switching to a centralised control system.	Y
	Hybrid / Bivalent Heating	As the school is electrically heated this would require a full heating replacement which is not advised in this scenario.	N
	Heat Pump + Back up	As Above	N
	HW Ancillaries	Hot water is localised with point of use heaters making this N/A for this school	N
	HW Controls	As above	N
	HW Plant Replacement (Heat Storage)	N/A due to localised Point of use hot water systems.	N
Ventilation	Heat Recovery	Introduce heat recover on the three main AHU, serving the main Hall, changing places and kitchen areas. Only recommend when replacement of units is required. No clear way of introducing heat recover in main classrooms.	Y
Lighting	Lighting (LED Upgrade)	Replacement to LED across the site is underway this should be continued across the whole school.	Y
	Lighting Controls	PIR's are located in high use areas and should remain when LED upgrades are undertaken.	N
Cooling	Cooling Replacement	Minimal Cooling equipment present, and minimal savings would be achieved in replacement.	N
	Cooling Control	Localised cooling control on small systems.	N
Renewables	Solar PV	School is ideally suited for Solar PV.	Y
	Solar Thermal	This technology does not lend itself to a school where point of use hot water systems and electric heating is present.	N
	Air Source Heat Pump	Although space is available for this technology, as the school is electrically heated this would require a full heating replacement which is not advised in this scenario.	N
	Ground Source Heat Pump	Although space is available for this technology, as the school is electrically heated this would require a full heating replacement which is not advised in this scenario.	N

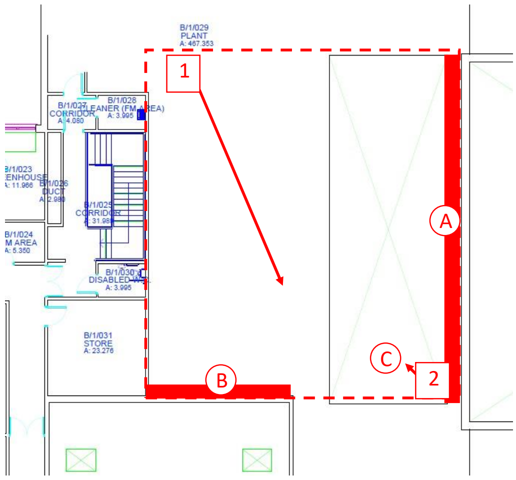
Appendix B -Insulation Observations

Net Zero Audit
Glen Urquhart- Insulation Feedback



Roof Void 1



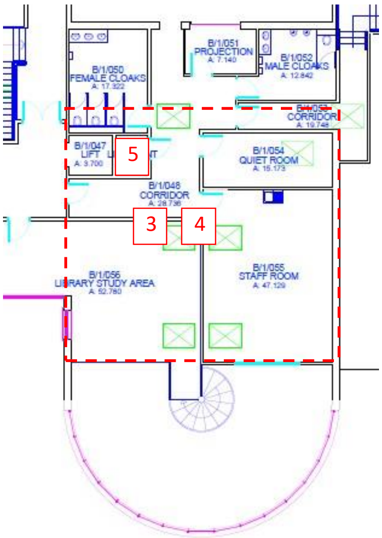


A- Uninsulated thermal envelope as roof void is unheated and games hall (B/0/088) is heated

B- Uninsulated thermal envelope as roof void is unheated and Hall (B/0/05) is heated

C-Missing Insulation

Roof Void 2



3/4 -Insulation is incomplete and is approx. 1m from the suspended ceiling tiles.

5 –Roof hatch area uninsulated

Roof Void 3

Missing Insulation in various areas

Insulation on slope is ineffective and should be move to Flat roof area below

The Highland Council
Comhairle na Gàidhealtachd

Ferintosh Primary School

Net Zero Audit Report

Climate Change and Energy Team

Original			
Version	**Author(s)**	**Note**	**Date**
0.1	Laura Barnfield; Nathan Chaplin	First Draft	29/07/2024
Revisions			
Version	**Author(s)**	**Note**	**Date**
0.2	Laura Barnfield; Nathan Chaplin	Amendments following internal review	07/08/2024
0.3	Laura Barnfield; Nathan Chaplin	Amendments following internal review. For issue	14/08/2024

Table of Contents

1 Executive Summary

Recommendations	Estimated Annual Savings (£)	Estimated Cost of Works (£)	£/LTt. CO_2	Carbon Savings (tCO_2)	Simple Payback (years)
Glazing Replacement	£1,201	£74,825	£757	3.7	62.3
Draughtproofing	£323	£1,208	£43	1.0	3.7
Roof Insulation*	£610	£11,500	£214	1.9	18.9
Air Source Heat Pump (ASHP)	-£2,560	£222,643	£911	13.6	N/A
External LED Lighting	£393	£759	£232	0.3	1.9
Solar PV	£1,373	£7,128	£789	1.2	5.2

*Assumed roof insulation needs upgraded based on similar schools in the area.

Table 1 details the measures identified from the Net Zero Audit & Survey at Ferintosh Primary School, undertaken on the 23rd July 2024.

For this site, the conversion from oil-based heating system to an electric heating system is critical to achieving net zero.

Recommendations	Estimated Annual Savings (£)	Estimated Cost of Works (£)	£/LTt. CO_2	Carbon Savings (tCO_2)	Simple Payback (years)
Glazing Replacement	£1,201	£74,825	£757	3.7	62.3
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External LED Lighting	£393	£759	£232	0.3	1.9
Solar PV	£1,373	£7,128	£789	1.2	5.2

*Assumed roof insulation needs upgraded based on similar schools in the area.

Table 1: Recommendations for Ferintosh Primary School

Combined they are projected to reduce annual energy and emissions by 21.6tCO_2. The associated level of cost savings range from £1,340 to £4,865, dependent upon which measures are progressed.

The outcome of applying these recommendations is a near net zero building by 2038 (1.1tCO_2e) reducing further in 2045 to 0.4tCO_2e.

Table 2 details low cost and behavioural recommendations suitable for immediate progression.

Improvement Area	Recommendation
Water efficiency	Opportunities to improve water efficiency include, e.g. fixing leaking tap in Girls WC, and optimising urinal auto flush settings.
Hot water usage	Insulate DHW pipework; improve DHW settings and controls to ensure water heating corresponds with occupancy usage.
Behaviours and Awareness	Support staff and pupil net zero groups to educate and encourage good behaviour practice and activities, e.g. initiatives such as active labelling of light switches and equipment, switching off at end of day, water usage on site.
Out of Hours Heating Settings	Ensure all room thermostats are reduced when school is unoccupied.
New electrical equipment	Any new or replacement equipment to be energy efficient models.

Table 2: Low Cost and Behavioural Recommendations

While it's challenging to definitively quantify the savings resulting from these actions, each item will contribute to enhancing the school’s Net Zero performance.

Table 3 details additional recommendations that would further improve the school’s performance however further development or integration with other works is recommended.

Improvement Area	Recommendation
Electric vehicle charging points (EVCP)	Adding charging would improve travel related emissions for staff and visitors

Table 3: Additional Recommendations

2 Introduction

As a public body, The Highland Council (THC) are legally bound to contribute to Scotland’s Net Zero target by 2045. Our Net Zero strategy defines a route map to net zero by 2045, with key interim targets to reduce carbon emissions by 75% by 2030 and by 90% by 2040.

This report directly supports this strategy as 67% of total Council emissions are associated with the built estates’ energy consumption.

3 Building Overview

3.1 Site Introduction

Ferintosh Primary School (Figure 1) is situated in the rural village of Easter Kinkell and is in the wider Associated School Group (ASG) of Dingwall. The school has a capacity for 50 pupils with a recorded school roll of 13 during the school year 2023-24. It has six permanent staff (mix of part and full time).

The gross internal floor area is approximately 365m^2 and includes teaching spaces, toilets and changing areas, a canteen with some catering facilities, library area, office areas, staffroom and storage facilities. There are 3 main elements to the building – the main area being built in 1900s, an extension including the WCs in 1955, and a further separate demountable building was installed to provide canteen facilities in 1990.

The building is single-storey throughout, with the original building incorporating storey-and-a-half spaces. The site is not listed nor located in any Protected Areas.

Figure 1: Ferintosh Primary School & Site Details

3.2 Fabric

In the absence of definitive information regarding the building's construction, U-value calculators and estimations based on rdSAP values have been used. Table 4 outlines the estimated U-values (heat transfer characteristics) for the main building envelope (built 1900).

Element	Primary Construction	U-values (W/m2K)
External Walls	Solid sandstone walls (approx. 710mm thick) w’ lath and plaster/timber panel internal finish and rendered external finish	1.03
Exposed floors	Suspended timber, no insulation w’ underlay and carpet/vinyl (timber floorboards exposed in Staffroom)	0.17
Roofs	Pitched slate tile roof, no insulation w’ internal plasterboard finish	1.51
Windows and Doors	Approx. 70% timber framed sash and case single-glazed; 30% uPVC/timber framed double-glazed with tricklevents. All wood panel doors.	5.8

Table 4: Building Fabric

The 1955 extension is believed to be brick cavity wall construction (insulation unknown) with rendered finish, suspended timber floor (assumed no insulation) and both flat roof with single ply roof membrane and monopitch standing seam metal roof. Windows are mix of single and double-glazed, with a steel framed single glazed rooflight and external doors which are painted solid core plywood with glazed panels.

The 1990 demountable canteen building is believed to be timber clad timber frame construction (insulation unknown) with single ply roof covering (insulation unknown). Windows are uPVC framed double glazed units and doors are plywood glazed units.

Rainwater goods are a mix of cast iron and uPVC.

Onsite Observations

Walls

- Some crumbling render on main building exposing stone.
- External cladding on demountable Canteen building (now over 30 years old) showing signs of deterioration, which is likely to impact on the airtightness of the building.
- Proliferation of moss growth on walls and roof of Canteen suggest prolonged exposure to damp.
- *Level of insulation in extension and Canteen building unknown due to lack of access.*

Roof, ceiling and gutters:

- Some fascia boards and eaves rotten enabling potential water ingress into roof spaces (e.g. **external door next to Girls WCs**; above secure gate).
- Evidence of previous water ingress and some plaster repair on ceilings.
- *No access to roof space to inspect insulation levels.*

Doors and windows:

Condition of existing single glazed units, draughtproofing and frames (including rooflight in Library area) considered poor, potentially indicating need for replacement within short to medium term.

- Double glazed units appear in good condition with tricklevents present.
- No curtains or blinds on large south-facing windows (good for solar gain in summer but will increase heat loss during winter months).

Figure 2: Single glazed rooflight with cracked panes (left); single glazed windows with rotten/flaky paint frames (centre); blinds removed from south-facing double height windows (right)

Figure 3: Broken fascia board (left); moss and lichen on roofs and walls (left and right); moss in gutter (right)

3.3 Building Services

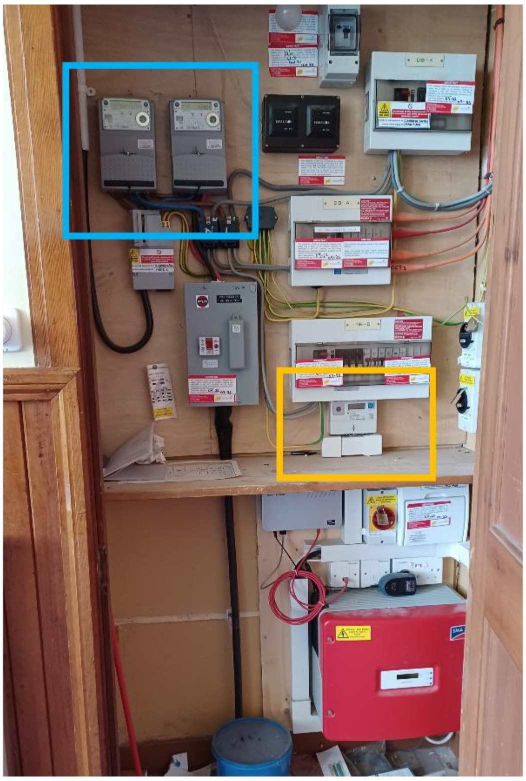
3.3.1 Electricity

There is a single electrical supply for the school with an available capacity of 46kVA, providing day and night metering. The main incoming power supply panel is located in the electrical services cupboard, along with the solar PV generation meter and inverter (Figure 4).

Currently the max demand figures for the building are unavailable. As such, any recommendations that involve changes to electrical demand and capacity requirements requires further investigation.

3.3.2 Metering

As shown in Figure 5, the main electrical meters (day and night) and main water meter are located within the site boundary. The site has no electrical sub-metering present. However, the solar PV generation meter can also be found in the electrical services cupboard.



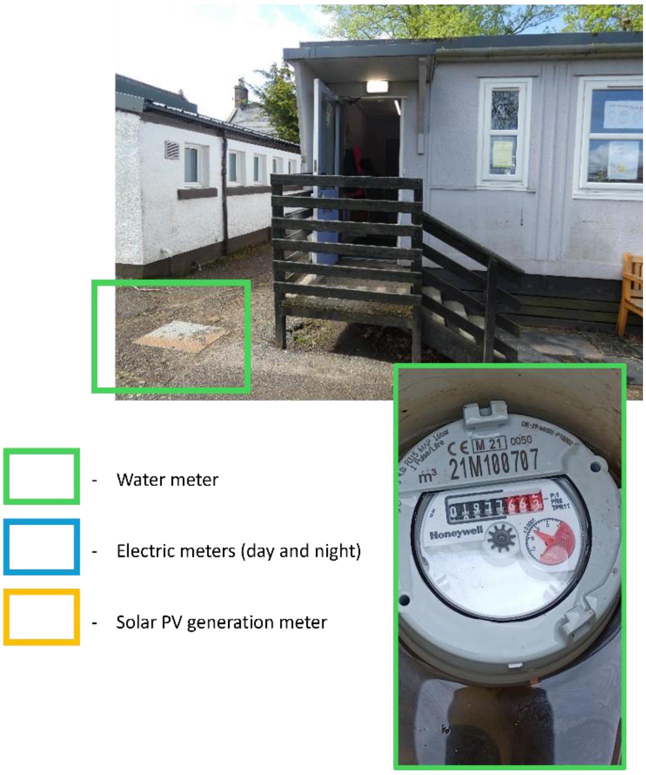


Figure 4: Electrical and water meters

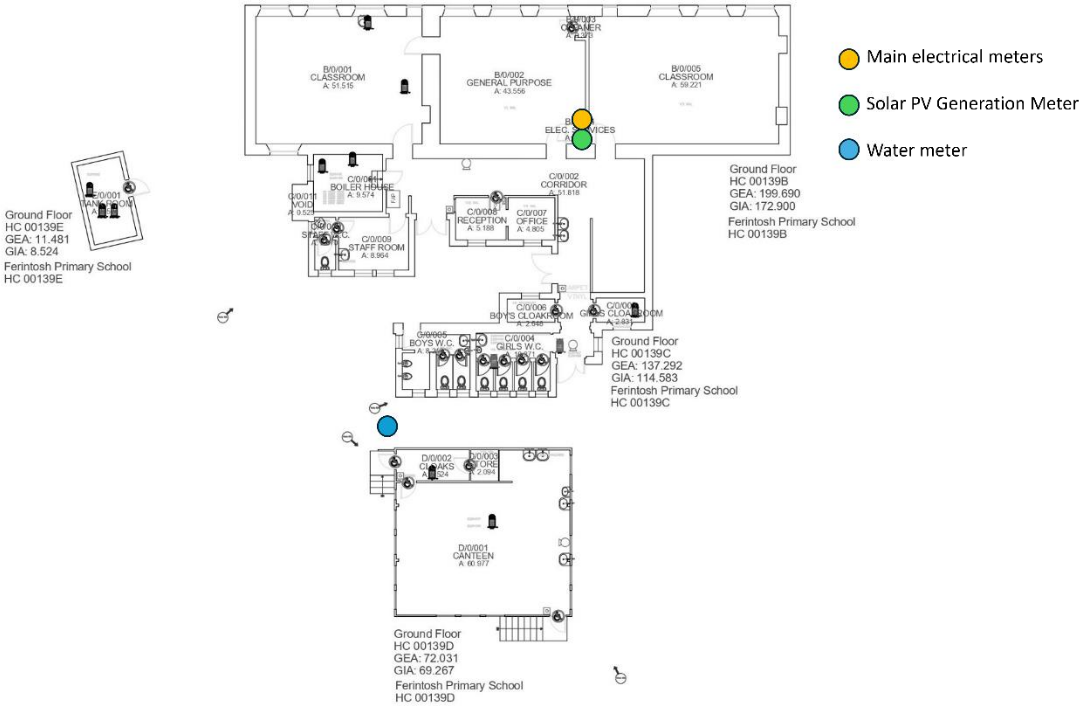


Figure 5: Electrical and water meter locations

3.3.3 Solar PV

A 4kW solar PV system, consisting of 20 panels is installed on the South-East facing roof (Figure 6). Based on historical data, the estimated annual generation is 1,300kWh, however at the time of the survey, the system was non-operational. The financial benefit of this system including Feed-in Tariff (FiTs) payments would be approximately £1,800/year. Inspections are planned during the financial year 24/25 for all PV assets, with the intention of bringing all systems back into operation where deemed practical and cost-effective.

Figure 6: Existing 4kW solar PV system

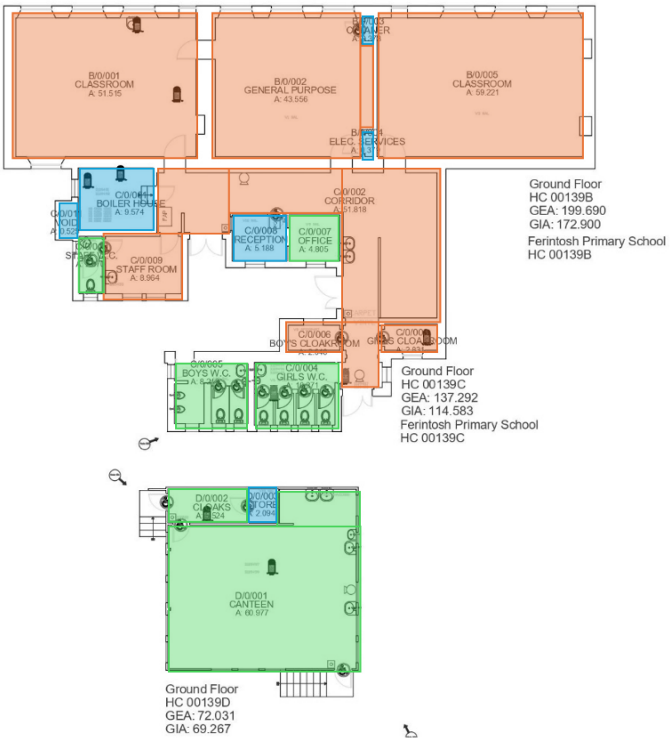
Onsite Observations

Condition of existing system:
• Fixings and panels look in fair condition. • PV inverter and kit in secure cupboard located relatively close to PV locations.
Overshading:
• Trees on the site boundary are potential source of shading (see Section 3.5.1).

3.3.4 Heating

The building uses both electric and oil-based heating. Figure 7 highlights the areas heated by oil and electric. The total area heated by oil is 221m^2 (70% of total heated floor area) and the total area electrically heated is 95m^2 (30% of total heated floor area). A further breakdown of the heating strategy is presented in Table 5.

The primary oil heating system in the school is a central wet system with flow and return pipework and radiators (Figure 8). The system served by two temporary 58-70kW oil boilers with two 60kW burners installed in a shipping container on site. There is a 2,500litre oil tank on site and supply detector in the reception area.



- Oil heated areas
- Electric heated areas
- Unheated areas

<u>Notes:-</u>
- No heat emitters in Boy's and Girl's Cloakrooms, open to and assumed heated from adjacent corridor/library space

Figure 7: Heated and unheated areas in school

Figure 8: Two temporary oil boilers (left); 2,500l oil tank (right)

Space	Fuel	Heat Emitters	Controls
Classrooms, Library & Circulation Space, Staffroom (Figure 9)	Oil	Cast iron and metal radiators	Central programmer, room thermostats in Classrooms and TRVs on radiators
Canteen (Figure 10)	Electric	Panel heaters	Timeclock and room thermostat and individual heater on/off switch

Canteen Cloakroom (Figure 10)	Electric	Wall mounted radiant panel heater	Timeclock - *assumed*
WCs (Figure 11)	Electric	Tube heaters (frost protection)	Room thermostats
Office (Figure 12)	Electric	Wall mounted element fan heater and convection heater	Manual on/off switch; Output/Timer

Table 5: Heating Strategy

Figure 9: Typical heat emitters in Classroom (left) and Library & Circulation Space (centre left); Typical controls on radiators in Classrooms, Library and Circulation Space (centre right); room thermostat in Classroom (right)

Figure 10: Canteen panel heater (left); Canteen thermostat (centre left); Heating timeclock control (centre right); Canteen Cloakroom wall radiant panel heater (right)

Figure 11: Electric tube heaters in WCs (left); thermostat controls in WCs (right)

Figure 12: Office wall mounted element fan heater (left); convection heater (centre); convection heater controls (right)

In terms of controls, there are two programmers; one for the wet system and one for the panel heaters within the Canteen building. Programmed times are as outlined in Table 6.

System	Days	Times
Wet system (main building)	Mon-Fri	7am-12pm; 12:30pm-4pm
	Sat-Sun	Off
Electric panel heaters (Canteen)	Mon-Fri	7am-9:30am; 12pm-1:45pm
	Sat-Sun	7am-9:30am; 12pm-1:45pm

Table 6: Programme settings of heating systems in school

Onsite Observations

Heat Emitters

- **Radiators:** Majority obscured by items (can reduce effectiveness of heat emission); radiators in one Classroom caged with no access to TRVs.
- **Tube heaters:** Aged condition with dust and detritus present. Ones in WCs were found to be on and emitting heat during the visit (summer).
- **Storage heater in office:** Set to 'on' during visit (summer).

Heating Controls

- **Programmers/Timeclock:** Correctly aligned to real time. Programmer times matched occupancy hours. Timeclock model allows day omitting device (ie Sat-Sun off) but this did not appear to be fitted on this unit.
- **Thermostatic Radiator Valves:** Present on all radiators. Settings varied but generally were in the off or low position (the boiler itself was switched off so no heat was being emitted). TRV settings were difficult to read and not labelled – this may result in inappropriate settings, both for thermal comfort and energy saving.
- **Room thermostats:** In the WCs, these were set to 21°C and 24°C. There did not appear to be any other control to the electric tube heaters.

Thermal comfort

- **Girl's WC:** Thermostat for tube heaters was set to 24°C; felt overly warm when entering.
- **Portable electric heaters:** Three stored in the old Boiler Room and one in the Staffroom (Figure 13).

Figure 13: Portable heaters stored in Boiler Room

3.3.5 Domestic Hot Water (DHW)

The overall DHW storage provision on site is 325litres. The main building and the extension's DHW requirements are provided by a 6kW 200litre calorifier with two electric immersion coils installed in the old Boiler Room (Figure 14). This supplies nine sinks/basins. A separate 3kW 125litre hot water calorifier with electric immersion coil (Figure 14) in the Canteen building supplies hot water to the four sinks within this area.

The main DHW system is controlled by a wall mounted programmer, whilst the Canteen system is via on/off switch in Kitchen area and temperature setting on the tank itself.

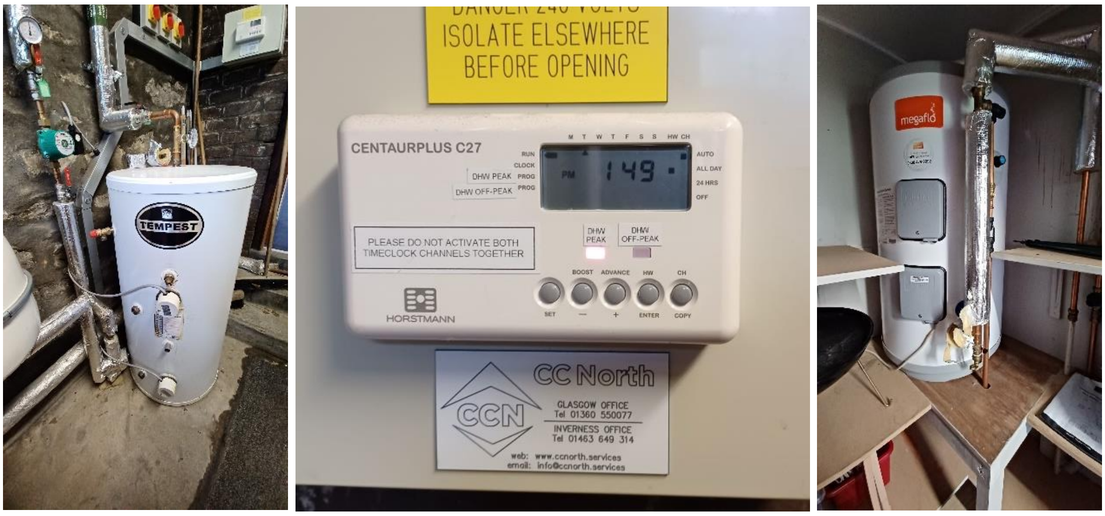


Figure 14: Main building hot water calorifier (left) and programmer control (centre); Canteen hot water calorifier (right)

Onsite Observations

Pipework:

- Generally well insulated except areas of ripped/broken insulation in old Boiler Room.
- Pipework from DHW tank in Canteen Store is uninsulated in parts.

Controls:

- Programmer appeared to be on 24/7 setting but auto time settings also set.

- DHW tank in Canteen flow meter **indicating temperature 50°C at time of visit compared to a desired 55-60°C**. Survey was undertaken during summer holiday period when DHW systems are expected to be shutdown.

3.3.6 Cold Water

Cold water is believed to be supplied directly from the mains. There are 22 outlets for cold water in the building: 13 sinks/basins, seven WCs, one urinal trough and one outdoor tap to front of building.

Onsite Observations

Urinals:

- A five-minute auto-flush is in operation, effectively providing constant operation (Figure 15).

Taps:

- Appear in acceptable condition, except one cold water tap in the Girls WC (Figure 15) which had a constant drip during the survey.

Figure 15: Urinal (left) and controls (centre); Dripping tap in Girls WC (right)

3.3.7 Ventilation

The school utilises a mix of natural and mechanical ventilation systems, as detailed in Table 7.

Space	Ventilation Strategy
Classrooms / Nursery/ Offices	Naturally ventilated. Tricklevents within double-glazed units (Figure 17). One extract fan in Classroom (Figure 16).
WCs	Localised extract units wall mounted. Controlled via PIR and control panel (Figure 16).

Table 7: Ventilation Strategy

Onsite Observations

Extract units in WCs:

- In working order when switched on.

Extract unit in Classroom:

- In working order when switched on but excessive noise.

Tricklevents:

- Noted in the majority of the double-glazed units. These were open in the Canteen building.

Natural cross-ventilation in Classrooms:

- High-level windows in the classrooms, if openable, combined with large south-facing windows could provide good cross-ventilation. However, it did not appear possible to open them.

Figure 16: Wall mounted extract fans in WCs (centre left); Extract fan controls in boys WC (centre right); Extract in Classroom (right)

Figure 17: Tricklevents in double-glazed units

3.3.8 Lighting

Table 8 outlines the lighting strategy for the school. All internal lighting within the school is LEDs (Figure 18) except for two ceiling mounted T8 fluorescent tubes with manual control in the old Boiler Room (Figure 19). External lighting is assumed fluorescent wall mounted security lights controlled by solar dial time switch in Reception (Figure 20).

Space	Lighting Strategy
Classrooms, Canteen, Staffroom	Ceiling mounted LED strip lighting with manual control (on/off only)
Office & Reception	Ceiling mounted LED strip lighting with manual control (dimmer switch)

WCs, Cloakrooms	Ceiling mounted LED circle lighting with manual control (on/off only)
Library & Circulation Space	Wall mounted LED circle lighting with ceiling mounted LED strip lighting with manual control (on/off only)
Boiler Room	Ceiling mounted T8 fluorescent tubes with manual control (on/off only)
External	Wall mounted fluorescent lights controlled by solar dial time switch

Table 8: Lighting Strategy

Figure 18: Typical LED lighting in school

Figure 19: Ceiling mounted T8 fluorescent tubes with manual control in old Boiler Room

Figure 20: External security lighting (left); solar dial time switch control (right)

Onsite Observations

Internal light fittings:

	• All new fittings appear in good condition. • Ceiling mounted fluorescent tubes in Boiler Room (Figure 19).
External light fittings:	
	• In fair condition but replacement with LED equivalents would reduce energy consumption in a cost-effective manner and also reduce associated maintenance requirements.
Controls:	
	• Solar dial time switch for external lights out by one hour and month reading Jan/Feb.

3.3.9 Electrical Equipment

The electrical equipment noted was found to be typical of a primary school.

Onsite Observations

General
• All equipment including fridges were switched off except for ICT server rack (including wifi hubs). • Evidence of PAT testing (Feb 2023).
Portable heaters
• Portable heaters found in Staffroom and old Boiler Room (Figure 13).

3.4 Building Performance

3.4.1 Utility Consumption

The annual oil, electricity and water consumption figures for Apr-23 to Mar-24 are shown in Table 9 along with the associated annual emissions. The total energy consumption was 121,415kWh and total annual emissions were 29.7tCO_2e.

Utility	Annual Consumption	Cost	Annual Emissions (tCO_2e)
Oil	97,824kWh	£5,892	24.1
Electricity	23,591kWh	£7,687	5.3
Water	967m^3	£901	0.3

Table 9: Utility Consumption and Emissions

3.4.2 Energy Breakdown

Due to the absence of electrical sub-metering and variability of oil deliveries, a precise breakdown of the school's energy consumption was not possible. Figure 21 offers an estimated breakdown of the school's total energy consumption; indicating space heating contributes to the majority of the school's energy consumption (85%).

This suggests that efforts to improve the efficiencies of heating systems, alongside reducing heat loss and improving heating control will likely have the most significant impact on improving overall energy efficiency.

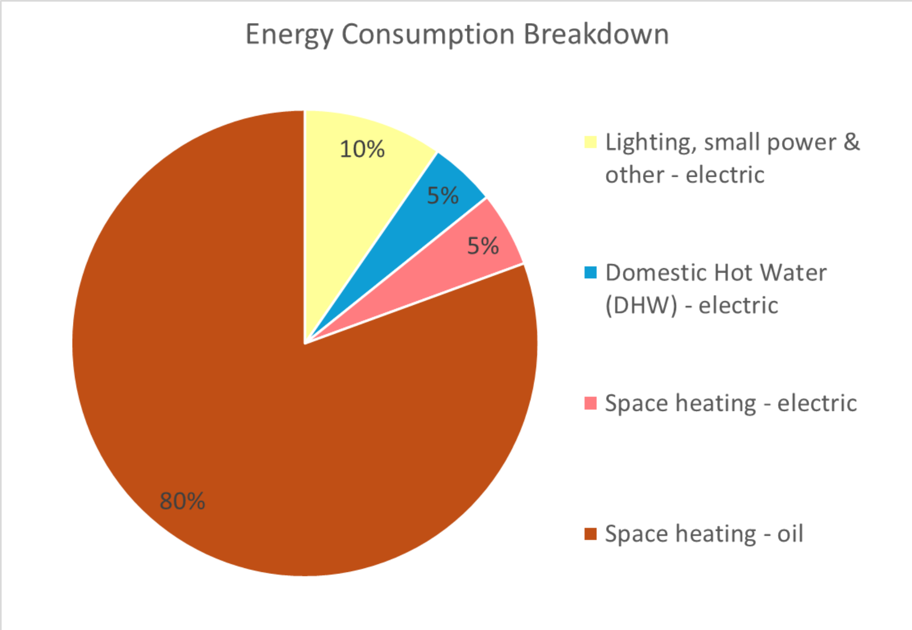


Figure 21: Energy Consumption Breakdown (Apr23-Mar24)

3.4.3 Carbon Emissions

Figure 22 outlines the estimated carbon emissions of different energy end-uses in the school. Note, this does not include travel or waste related emissions. The main area of carbon emissions is space heating (oil).

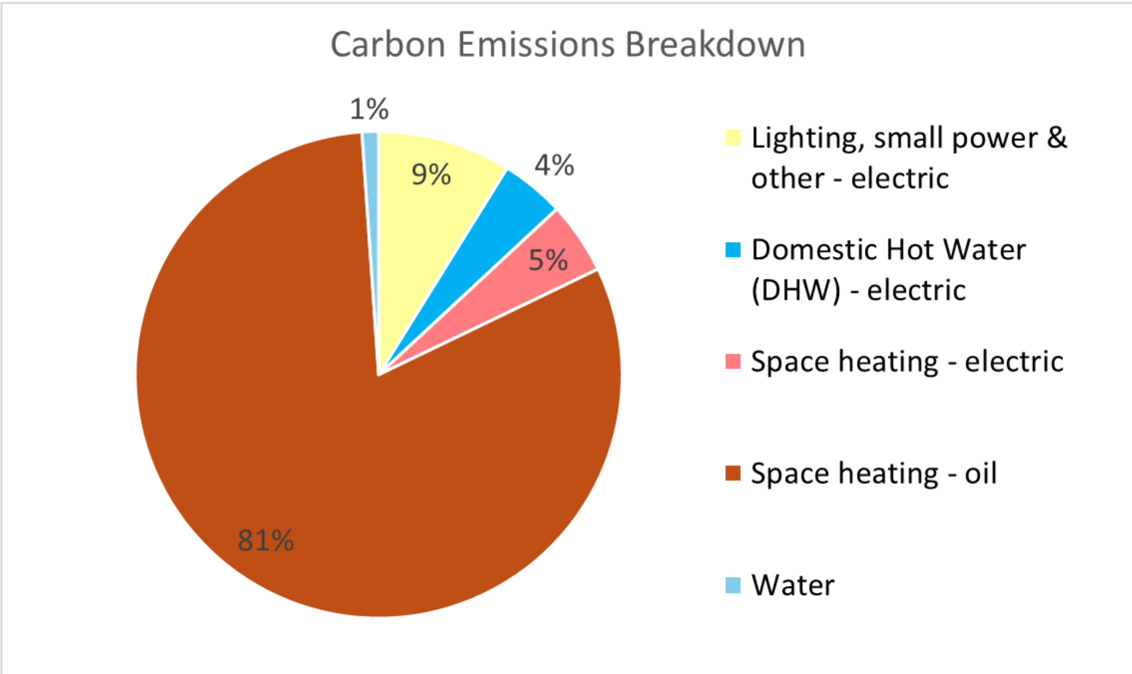


Figure 22: Carbon Emissions Breakdown

3.4.4 Benchmarking

Benchmarking energy performance is a process that either compares the energy use of a building with other similar structures or how energy use varies from a baseline. It informs organisations about how and where they use energy and what factors drive their energy use. Benchmarking enables energy, building, and asset managers to determine the key metrics for assessing performance, to establish baselines, and to set performance goals.

The school's energy performance can be compared to a typical primary school in Scotland and other primary schools in the Highland area on the Highland Council's Energy Benchmarking Tool.

More detailed benchmark analysis has been undertaken (Table 10) due to the complexity of the mixed-fuel heating system.

Performance Area	Typical School	Ferintosh PS	Comparison[1]
Heating (oil) – kWh/m^2	149	444	198%
Heating (electric) – kWh/m^2	143	128	-10%
Non-heating (electric) – kWh/m^2	52	47	-9%
Water – m^3/m^2	0.95	3	179%
Carbon – $kgCO_2e/m^2$	45	82	81%

Note:-
[1] Percentage difference compared to typical school benchmark; positive % indicates worse performance / negative % indicates better performance

Table 10: Benchmarking energy performance

It is assessed that the school performs poorly for heating, water and carbon.

The water performance is particularly poor. The annual water consumption per pupil is $74m^3$/pupil/year. In comparison, data from Northern Ireland indicates that on average, primary schools use $7m^3$ of water per pupil per year. If attained at the school, it would potentially result in a >90% reduction in associated emissions.

3.5 Renewable Potential

The site was assessed for the potential installation of a variety of renewable technologies. The results of each are indicated in Table 11.

Renewable Technology	Commentary	Further Analysis (Y/N)
Solar PV	South facing roof space available for further PVs. When viewed in conjunction with the electrical load of the school and Highland Council policy regarding renewable generation, PVs are a very suitable technology for the school.	Y
Battery Storage	The possible onsite generation will be consumed by the building under normal operating conditions therefore limiting the requirement for battery storage.	N
Air Source Heat Pumps (ASHP)	Sufficient space is available for ASHP units externally and for associated storage tanks and equipment internally (old Boiler Room). Flooring appears to be suspended timber floor and pipework routes already in existence.	Y
Ground Source Heat Pump (GSHP)	Grass pitch could be utilised for GSHP bore holes but is quite far from school building and up a hill.	N

Table 11: Assessed Renewable Energy Options

3.5.1 PV

The school presents an ideal opportunity for solar panel installation. A south-east facing roof with PV already installed offers ample space (approximately 33m^2) for further panels (Figure 23).

This area would potentially provide a PV system of 5kW, with an estimated annual generation of 3,500kWh. Combined with the existing solar PV system, this could meet approximately 20% of the school's annual electricity consumption (Figure 24).

Site constraints include:

- Shading due to adjacent trees and a small hill directly in front of the roof.
- Little space in the current electrical services cupboard; cabling and metering requirements may result in additional cupboard space being required (current cleaner's cupboard in appropriate position but was inaccessible during site visit to assess suitability).
- Network constraints require further assessment

To ensure a safe and efficient installation, any solar PV system should adhere to the Council's Solar PV specification including a full assessment by a competent designer/contractor, encompassing structural appraisals as required.

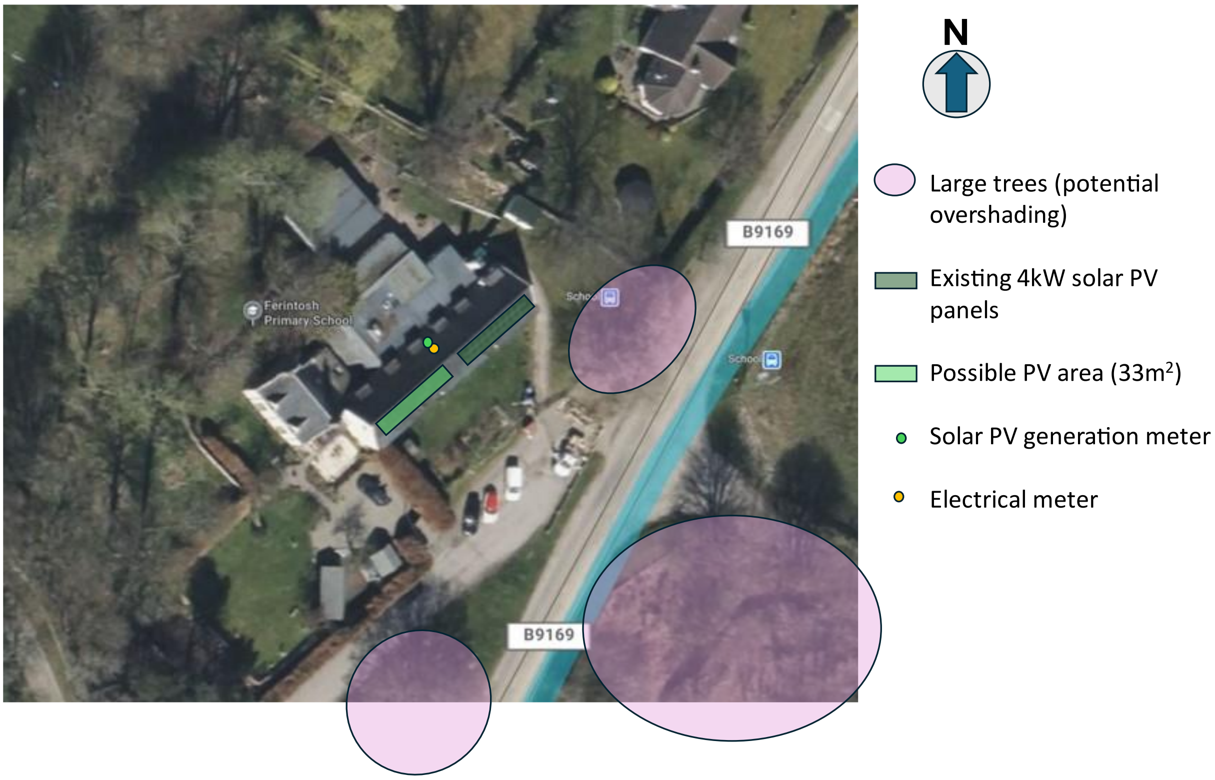


Figure 23: Possible PV Location and Constraints

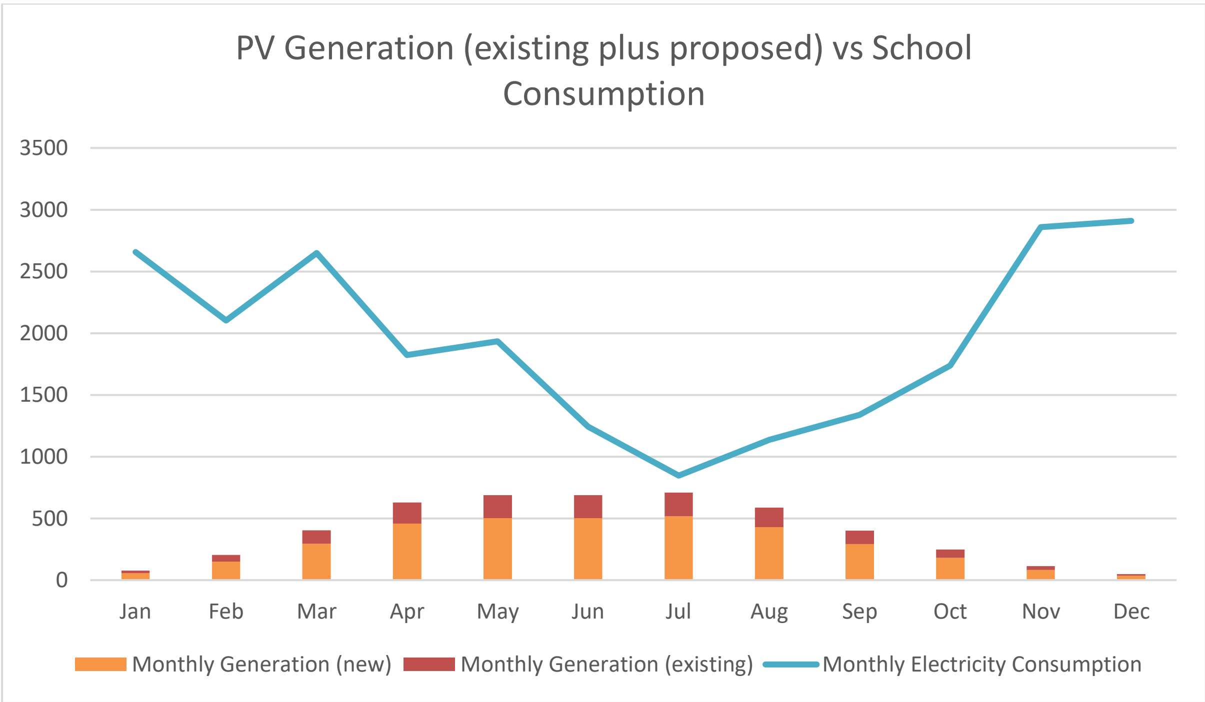


Figure 24: Monthly PV Generation (estimated existing 4kW plus proposed 5kW) vs School Consumption (2023)

4 Energy Change Measures

To support a sustainable transition to Net Zero, the Energy Hierarchy in Figure 25 has been followed when assessing suitable Energy Change Measures (ECMs).

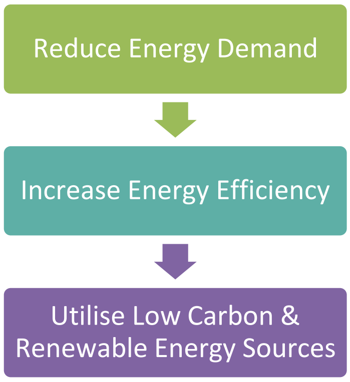


Figure 25: Energy Hierarchy principles followed when selecting ECMs

Table 12 lists the ECMs that were evaluated for their applicability with the school.

Building Fabric	Glazing Upgrade/Replacement, Wall Insulation, Roof Insulation, Floor Insulation, Draughtproofing.
Heating	Heating Infrastructure, Heating Controls, Hybrid / Bivalent Heating, Heat Pump + Back up, HW Ancillaries, HW Controls, HW Plant Replacement (Heat Storage)
Ventilation	Heat Recovery
Lighting	Lighting (LED Upgrade), Lighting Control
Cooling	Cooling Replacement, Cooling Control
Renewables	Solar PV, Solar Thermal

Table 12: Potential Energy Change Measures

Appendix A provides commentary on all ECM's, the ECM's highlighted in Table 13 were selected for further analysis.

ECM	Commentary
Glazing Replacement	Windows are generally single glazing and in poor condition with full replacement recommended.
Draughtproofing	During a window replacement draughtproofing measures should be put in place.
Roof Insulation (assumed)	Although roof void was inaccessible at the time of site visit it is assumed based on other local schools that the insulation could be improved upon.
Air Source Heat Pump and heat system upgrade	Replacement of oil system with ASHP, pipework and heat emitter upgrades recommended. Electric heating in Canteen and WCs to be retained but upgraded to improve efficiency.
LED Lighting	LED replacement should be prioritised throughout the school.
Solar PV (5kW)	Installing 5kW of PV is recommended as this would further reduce the electrical consumption on top of the existing 4kW installation.

Table 13: Selected Energy Change Measure Results

4.1 Behavioural Change Measures

Introducing behavioural changes and awareness programmes presents another avenue in reducing energy consumption within the school. Such initiatives create a collective commitment to sustainability within the school community. By encouraging students, teachers, and staff to adopt simple yet impactful behaviours, it can have a significant impact on energy consumption, and generally have little to no costs attached. Presented below (Table 14) are several effective strategies for implementing behavioural changes in school, along with potential savings opportunities.

Behavioural Change	Commentary	Potential saving opportunity
Water efficiency	As outlined previously within report	
Switch off lighting in daylight and when room is unoccupied	Switch off lighting when not required and maximise use of natural daylight. Also check that lights are switched off at breaks etc.	Savings are dependent on existing practices and size of windows (up to 10% saving).
IT equipment labelling and switch off	The active labelling of all equipment (switches and plugs) can help reduce energy consumption as all school users know what they can switch off.	Up to 5% saving.
Reducing out of hours electrical load	School opening hours can be less than 2,000 hours per year meaning they're unoccupied for 5,000 – 6,000 hours a year. If electrical items such as computers are left on, out of hours, this causes a major waste of energy. Energy Champions and Monitors can help ensure equipment is off at the end of the day/holidays.	Up to 20% saving.
Checking that heating times fit with school usage	Heating accounts for the majority of energy consumption in a school. Reductions can be made by making sure occupants are aware of this and reduce thermostats and set local heating controls to only be on when spaces are in use. Recommended temperatures and settings are listed in THC heating policy.	Reducing heating by 1 hour a day can reduce heating costs by 10%.
Dressing appropriately for the weather	Encourage staff and pupils to wear more clothes if they're cold rather than turning the heating up.	Turning the thermostat up by 1°C can increase the heating costs by up to 8-10%.

Note, the percentage figures stated above relate to the consumption of the application or system, not the overall school consumption.

Table 14: Behavioural Change Measures

There are a number of online resources that can help schools, pupils and staff become more aware of their energy consumption including Energy Sparks, Eco Schools, National Energy Action and the Energy Saving Trust. They advocate simple no-cost activities such as 'Energy Monitors' and 'Energy Champions' within the school to ensure IT equipment and lighting are turned off out-of-school hours.

5 Travel

5.1 Transport

Transport and active travel aspects were not included within the scope of this study, however comment has been provided below with respect to Electric Vehicle charging.

5.2 Electrical Vehicle Charge Points

The school has no parking within the site boundary. However, there is an informal space for 5-6 cars which is used by staff and visitors. There are no formal parking bays outlined. Scottish Government guidance suggests 10% of car parking spaces should be designated for electric vehicle charge points (EVCPs).

Ideally therefore, one EVCP would be situated close to the school, with the proposed approximate cable routing outlined in Figure 26. Further investigation is necessary to determine whether the EVCPs could be directly connected from the local substation (red line) or utilise the school's spare electricity capacity (purple line). Currently, the substation adjacent to the school has a capacity allowance of 100kVA (Figure 27), with a maximum demand of 29.62kVA, leaving 70.38kVA potentially available for EVCPs. The recommended EVCP setup would consist of a 7kW (14kVA) fast charging point, which could be currently accommodated. Please note, the impact on available capacity of the school and substation due to the proposed change from oil to electric heating (heat pump) must be considered prior to any EVCP proposals.

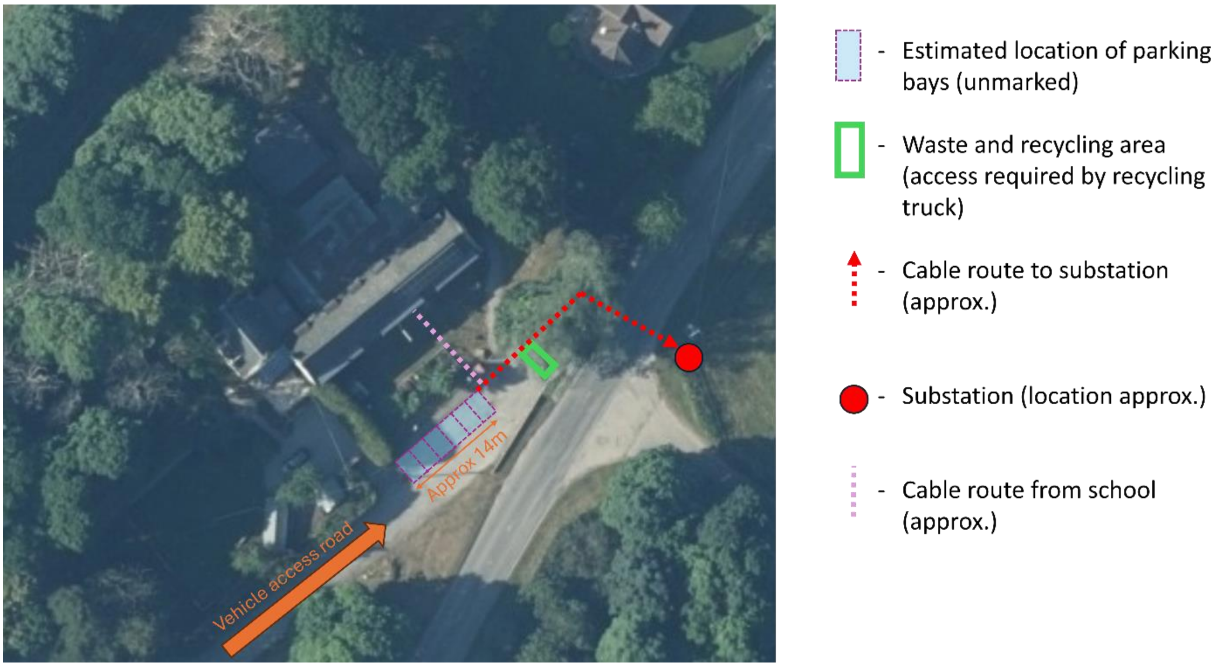


Figure 26: Proposed EV charger location

The nearest secondary substation appears to be pole mounted, directly opposite the school.. If EV chargers are under consideration for future installation, a connection request to SSEN would need to be submitted to confirm the availability of this capacity.

The implementation of EVCPs would positively impact emissions by encouraging EV travel to and from the site.

Figure 27: Substation Location and Capacity (via SSEN LENZA Tool)

6 Waste

Waste management, recycling and food waste aspects were not included in the scope of the study.

However it was noted that the school has secure waste and recycling storage, that included a large commercial waste bin and a large commercial recycling bin.

School has a septic tank for waste disposal. Condition and regularity of removal unknown.

7 Recommendations

7.1 ECM Recommendations

Table 15 summarises the recommended ECMs to be adopted by the school. The calculations assume that the building fabric energy efficiency measures (glazing/ draughtproofing/ insulation) are applied before considering the Air Source Heat Pump (ASHP) as per the Energy Hierarchy principles noted previously.

ECM	Estimated Annual Savings (£)	Estimated Cost of Works (£)	£/LTt. CO_2e	Annual Carbon Savings (tCO_2e)	Simple Payback (years)
Glazing Replacement	£1,201	£74,825	£757	3.7	62.3
Draughtproofing	£323	£1,208	£43	1.0	3.7
Roof Insulation*	£610	£11,500	£214	1.9	18.9
ASHP	-£2,560	£222,643	£911	13.6	N/A
External LED Lighting	£393	£759	£232	0.3	1.9
Solar PV	£1,373	£7,128	£789	1.2	5.2

*Assumed roof insulation is required based on similar schools in the area and lack of access during visit.

Table 15: Recommended ECM's

Glazing Replacement

- Although this measure has a longer payback period it provides improved thermal comfort, soundproofing and security and will reduce the building's overall energy demand.

Draughtproofing

- To be included as part of any glazing replacement providing a four-year simple payback and the lowest £/LTt.CO_2e.

Roof Insulation

- Insulation in main building provides a 19 year payback and a low £/LTt.CO_2e.

Air Source Heat Pump

- Despite modelled high costs for installation and payback, ASHP remains a recommended measure due to its impact on reducing carbon emissions (annual savings of 13.6tCO_2e). The modelled costings do not take into consideration the long-term expected reduction in electricity prices relative to oil prices.
- Heat pump installation and associated works should be considered as part of scheduled refurbishment costs of the overall heating system (in comparison to installation of new oil boiler) rather than a standalone premium costed item.

External LED Lighting

- Low-cost installation with a quick payback period (less than two years).

Solar PV (5kW)

- 5kW of PV installed adjacent to the existing 4kW could reduce annual bills by £1,373 and improve annual site emissions by 1.2tCO_2e.
- Simple payback is only 5.2years indicating a quick return of investment.

7.2 Forecasting

7.2.1 Annual Energy Costs and Consumption

Figure 28 and Figure 29 highlight the changes in annual energy consumption and energy costs when implementing the ECM's, with doing nothing (red) vs doing something (green). By introducing the ECMs indicated in 2025,2026 & 2027 the annual energy consumption and costs are reduced. Between 2024 and 2045 the estimated cost savings and energy reduction would be £85,321 and 1,403,341kWh.

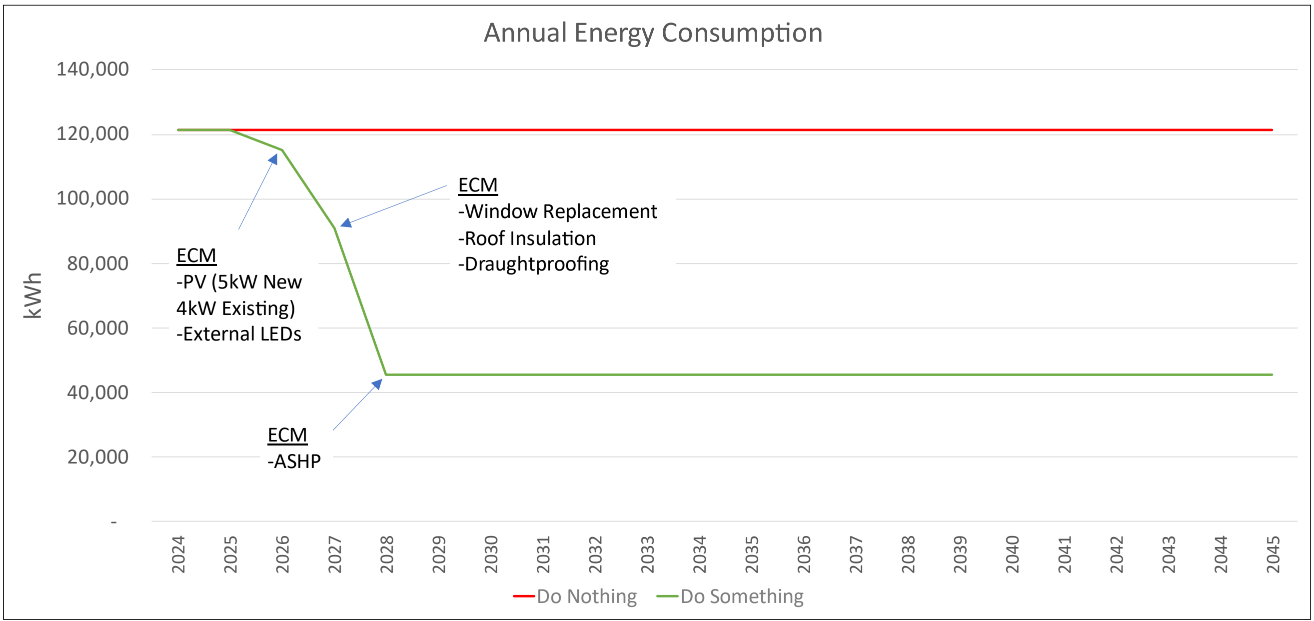


Figure 28: Annual Energy Consumption Forecast

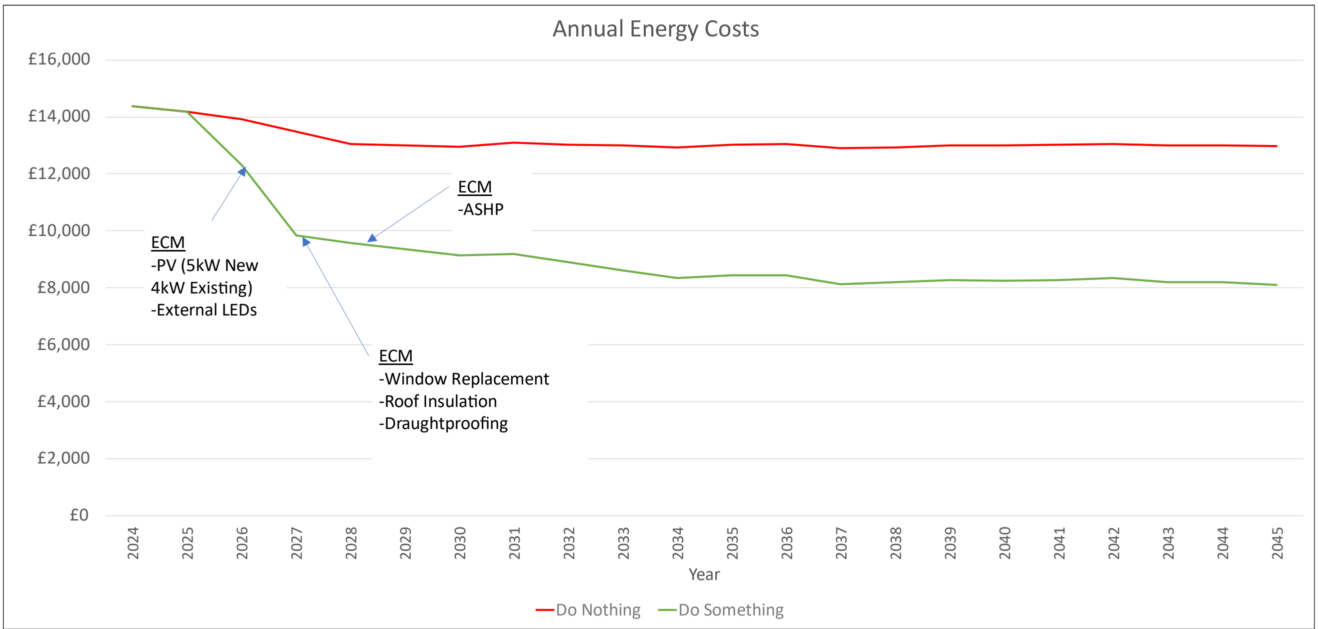


Figure 29: Annual Energy Cost Forecast

7.2.2 Net Zero Emissions Forecast

Figure 30 showcases the projected impact of taking action on the school's carbon footprint. The red line, labelled "Doing Nothing," depicts a business-as-usual scenario with CO_2 emissions reducing only in line with the decarbonisation of the grid. The green line, labelled "Doing Something," represents the positive change achieved by implementing the noted Energy Conservation Measures (ECMs) between 2026-2028.

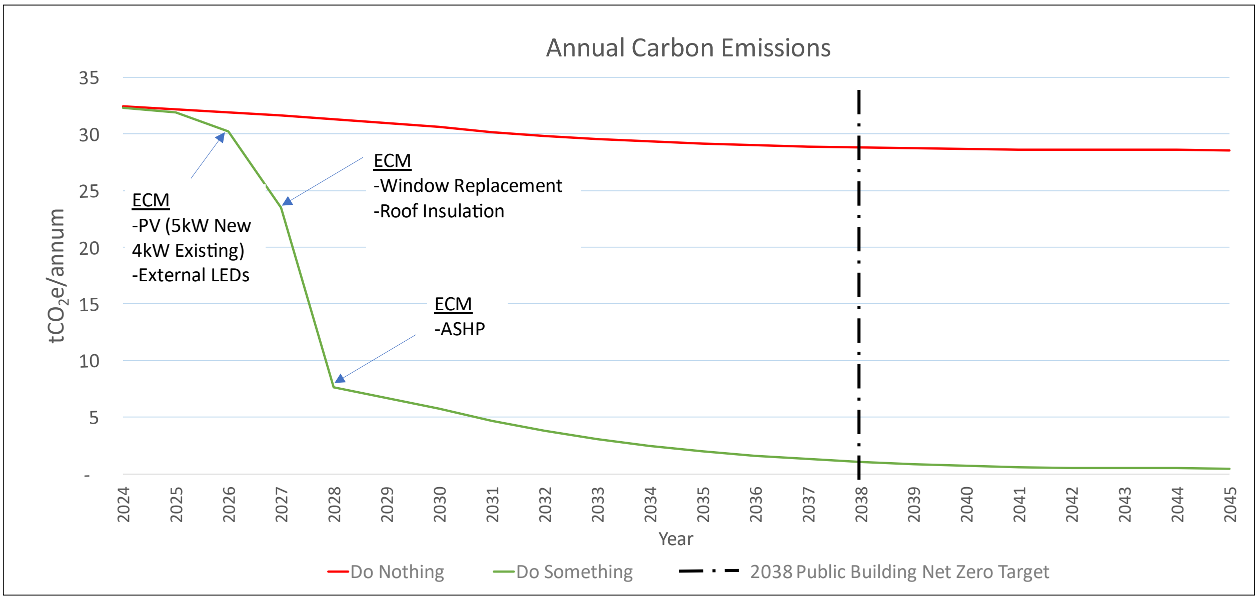


Figure 30: Annual Emissions Forecast

By taking a proactive ECM's approach, the estimated reduction in carbon emissions between 2024 and 2045 is 494tCO_2e. This reduction is equivalent to 3,359 cars driving the North Coast 500 route.

Each ECM shows a reduction in tCO_2e/annum, however the most significant emission reduction can be seen by going from Oil heating to Electrical (ASHP) heating as shown by the sharp decrease from 23tCO_2e/annum to 8tCO_2e/annum in 2028. The overall natural downward trend of both "Do Nothing" and "Do Something" is due to the decarbonisation of the electricity grid.

The outcome of applying these ECM's is a near net zero building by 2038 (1.1tCO_2) reducing further in 2045 to 0.4tCO_2.

7.3 Additional Recommendations

	Cost	Complexity
Water efficiency: Leaking tap in Girls WC to be replaced.		
Water efficiency: Auto flush settings on Boys urinal to be amended to increase time between flushes.		
Hot water usage: Review and amend DHW settings and controls to ensure water heating corresponds with occupancy usage.		
Out of Hours Heating Settings: Ensure all room thermostats are reduced when school is unoccupied. Turn off/reduce heating during school holidays.		
Behavioural Changes and Awareness Raising: Implement behaviour change and awareness raising initiatives such as active labelling of light switches and equipment.		
Behavioural Changes and Awareness Raising: Energy Champions and Energy Monitors to encourage switching off heating, lights, and electrical equipment when not in use/out of school hours.		
Hot water system: Insulate DHW pipework fully.		
New electrical equipment: Any new or replacement equipment to be energy efficient models.		
EVCP: The study suggest that spare capacity is available on site for EVCPs. Installing these would help reduce travel emissions for visitors and others travelling to site, however further investigation would be required to determine the most cost-effective solution for the electricity supply.		

Low-no cost / low-no complexity
Medium cost / medium complexity
High cost / high complexity

7.4 Additional Considerations

7.4.1 Delivering ECM Projects

The following should also be considered when undertaking any of the ECM projects recommended above:

- **Cost:** The modelled costs and savings outlined in this document are based on current figures and assumptions. A full survey, investigations and in-depth cost analysis should be undertaken as part of any future ECM works undertaken.
- **Disruption:** All projects will have a degree of disruption, some more than others, however the ECM's recommended should be planned and co-ordinated with the school to minimise impact on service provision.
- **Maintenance requirements:** Maintenance requirements for new equipment, heating systems and building fabric improvements should be identified and included into maintenance schedules and budgets accordingly.
- **Asbestos:** The site is known to have asbestos in various locations and as part of any project, a "Refurbishment and Demolition Asbestos Survey" would be required.

7.4.2 Climate Change Adaptation

Climate change is expected to result in the area being hotter, drier and more cloudy by 2050 (Table 16). Review of SEPA flood map modelling indicates the area is unlikely to be at risk of future coastal or river flooding. However, data is not available on future risk from surface water flooding. Table 17 outlines the key impacts and adaptation measures to be considered when undertaking any future building work due to such changes in climate.

	Temperature (°C)	Rainfall (mm/day)	Cloudiness (W/m2)	Windiness (m/sec)
Yearly	+2.8	-0.1	+12.6	-0.1
Summer	+3.2	-0.2	+27.1	-0.1
Winter	+2.4	+0.1	+2.1	No change

Table 16: Climate change impacts in 2050 from 1980 baseline figures for Black Isle North region under worst case scenario(equivalent to global warming level of 3.2-5.4C which is RCP 8.5). [Taken from: Local Climate Adaptation Tool (lcat.uk)]

	Impact on buildings	Potential damage	Adaptation measures
Warmer, wetter winters	Higher internal humidity	Increased prevalence of insect pests and fungal attack; warping of timber elements	Ensure adequate ventilation through inspection and improvement of existing natural ventilation strategies (eg. Ensuring cross ventilation in classrooms)
	Increased moss and algal growth	Dampness, mould, staining and discolouration of building fabric	Regular and scheduled maintenance of building fabric; Improved weathering details
	Rising ground water levels	Dampness in wall footings	Enhanced drainage adjacent to building; Regular inspection and maintenance of water vapour handling of walls
	Prolonged saturation of masonry	Algal growth, vegetation	Regular and scheduled repointing and maintenance of masonry; Improved weathering details when undergoing any renovation
Hotter, drier summers	Increased thermal stress on building fabric	Cracking of hard materials	Repair and maintenance schedules of cracks or missing plaster coatings to include flexible traditional materials
	High internal temperatures	Thermal discomfort; warping/splitting of timber elements	Maintenance schedules of windows and ventilation systems; Installation of blinds and/or canopies and soft flooring
	Ground shrinkage	Movement of foundations	Adaptation of surface draining and landscaping/planting
	Flash flooding from watercourses and roads	Physical damage; saturation of fabric; Sewage contamination	Regular maintenance of adjacent culverts & water causeways; Routes for surge waterflows around building installed
Cloudier days	Reduction in performance of solar PV and solar thermal systems	-	Ensure PV systems appropriately sized and situated to maximise performance

Table 17: Key building impacts and potential adaptation measures (adapted from Historic Environment Scotland Guidance on Climate Change Adaptation for Traditional Buildings)

Appendix A -Energy Change Measures

ECM		Comments	Y/N
Building Fabric	Glazing Upgrade/Replacement	Main windows are single glazing and wooden frames are in poor condition and recommended to be replaced	Y
	Wall Insulation	Unable to determine exact wall insulation during site visit; solid wall insulation possible but practical constraints likely to reduce its cost-effectiveness	N
	Roof Insulation	Unable to access roof void however assumed to be poorly insulated based on other local schools	Y
	Floor Insulation	Unable to determine exact floor insulation during site visit	N
	Draughtproofing	Draught improvements to windows	Y
Heating	Heating Infrastructure	Combined as part of the heat pump replacement considerations	N
	Heating Controls	Building currently uses domestic-sized heating programmer, room thermostats and simplistic time clock which are sufficient for a school of this size	N
	Hybrid / Bivalent Heating	See below	N
	Heat Pump + Back up	The site is 70% oil heating with existing pipework routes. Suggested recommendation would be to replace oil system with heat pump and retain electric heating in Canteen building and WCs. The site has suitable space for an ASHP and ancillary equipment. The pipework routing is already in place however asbestos management and removal would likely be required as part of this upgrade. It would only be recommended for the main school building and not the demountable canteen.	Y
	HW Ancillaries	Hot water is currently provided by good condition electrically heated cylinders. As part of any heating upgrade the integration of heating and hot water should be considered	N
	HW Controls	As above	N
	HW Plant Replacement (Heat Storage)	N/A due to age and condition of existing DHW plant	N
Ventilation	Heat Recovery	Building naturally ventilated throughout with local extract in toilets/kitchen	N
Lighting	Lighting (LED Upgrade)	Internal lighting has already been upgraded to energy efficient LEDs. Recommend replacement of external light fittings to energy efficient LED	Y
	Lighting Controls	Minimal benefits due to small size of the school and improvement of internal lighting already	N
Cooling	Cooling Replacement	No cooling equipment onsite	N
	Cooling Control	N/A	N
Renewables	Solar PV	School is suitable for Solar PV however shading from trees does need consideration	Y
	Solar Thermal	Solar PV deemed more suitable for remaining suitable roof space	N
	Air Source Heat Pump	Space is available for this technology and removal of oil from site a key aspect of reducing carbon emissions. See comment above against heating	Y
	Ground Source Heat Pump	A sports pitch may be suitable however the distance and uphill nature of this would add unnecessary complexity over an air source heat pump	N