HARLEY
HADDOW

WOSFC Training Centre

Energy Statement

January 2024

ENGINEERING POWERED BY THE PAST
BUILDING THE FUTURE

Document Revision Control

Revisions	Date	Reason for Issue	By	Approved
Rev 00	29/01/2024	Draft For Information	KA	AZA
Rev 01	30/01/2024	Removed reference to Roof level ASHP	KA	AZA

Contents

Executive Summary

Harley Haddow have produced an Energy Statement for the proposed WOSFC Training Centre which summarises the proposed route to compliance approach adopted for the project.

A digital model of the proposed building has been produced using the “Virtual Environment” by IES Ltd which has been populated with space conditioning set points, operational profiles, internal gains, building fabric performance and air infiltration, mechanical and electrical systems to demonstrate compliance with Building Regulations and any local planning policies.

The preference is to achieve all compliance requirements through the use of a mix of VRF, Split systems and electric panel heaters for the space heating requirements and Air Source Heat Pumps (ASHPs) for the hot water, with Photovoltaic Panels on the roof. This strategy can be used to meet Section 6 requirements and meet the requirements of the East Dunbartonshire Council Local Development Plan 2 which requires a minimum of 20% low and zero carbon technology contributions.

A total reduction in CO_2 emissions of **75.95%** can be met using the proposed LZCGT’s.

Section 6 compliance modelling for the development shows a Building Standards Target Delivered Energy Rate of **115.9 kWh/m^2** with a Building Delivered Energy Rate of **99.3 kWh/m^2**, which meets the requirements of the building standards with an improvement of the BDER on the TDER of **14.3%**.

Section 7 Aspect 1 Silver level would also be achieved for the building as the Building Emission Rate has been found to be better than the Target Emission Rate.

1.0 Introduction

1.1 General

This energy strategy report has been produced by Harley Haddow to support the Planning Application for the WOSFC Training Centre, in East Dunbartonshire. The energy strategy will provide proposed parameters to allow the proposed development to meet the carbon reduction targets as set out in the Scottish Building Standards, and the requirements of the local development plan.

The purpose of this report is to summarise the approach to energy conservation and the adoption of the low and zero carbon energy sources (LZC) for the project in response to the planning objectives of East Dunbartonshire Council and the carbon reduction requirements of Section 6 of the Scottish Building Standards.

The proposed scheme layout, engineering systems and the provision of energy services have been designed for the development with a low carbon approach being adopted.

The assessments have been undertaken based on the preliminary scheme design information for the proposed development. As this information has not been finalised it will be subject to further design development during the scheme's progression through to the construction stage.

A range of energy technologies have been appraised as potential on-site energy regeneration in relation to the development. These comprise:

- Solar Hot Water
- Solar Photovoltaics
- Combined Heat and Power
- Biomass heating
- Ground Source Heat Pumps
- Air Source Heat Pumps
- Fuel cells
- Wind turbines

1.2 Compliance Targets

The proposed development will be required to meet the following objectives:

- Scottish Building Standards (Non-Domestic), Section 6 requires the Building Emission Rate (DER) to meet or better the Target Emission Rate (TER).

- The Scottish Building Standards (Non-Domestic), Section 6 requires the Building Delivered Energy Rate (BDER) to meet or better the Target Delivered Energy Rate (TDER).

Where there is no heat or cooling supplied to a new building from 'direct emission heating systems' and all such sources are fuelled by electricity or thermal energy from a heat network, the Target and Building Emissions Rate calculation need not be undertaken.

The operation of the building is deemed to produce 'zero direct emissions'. Compliance with Standard 6.1 will therefore be demonstrated by the building meeting the Target Delivered Energy Rate (TDER).

The East Dunbartonshire Local Development Plan 2 2022, Policy 9 Climate Change, Sustainability and Energy Infrastructure states the following:

- Planning permission will only be granted for all new developments where it has been demonstrated that they are designed in such a way that it minimises carbon emissions in accordance with the energy hierarchy through reduced energy demand, a maximum building energy efficiency, energy generation from renewable or low carbon sources and incorporate conventional energy sources. They also should be resilient to potential effects of climate change and promote the use of sustainable materials.

- All qualifying new buildings must therefore demonstrate that, proposals must meet at least 20% of the carbon dioxide emissions reduction standard through the installation and operation of LZCGT.

We note that compliance with Section 7 Silver Standard is not currently a specific requirement for the project. However, the report will comment on the following Section 7 Aspects:

- Section 7 (Sustainability) Aspect 1: Project to meet Section 7 Silver Level (Building Emission Rate to meet or better the Target Emission Rate).

1.3 The Energy Strategy Approach

Harley Haddow have adopted a comprehensive strategy to address the energy and renewable technologies used on the scheme and how they will be adopted on the proposed development. The energy strategy will incorporate the following energy hierarchy:

- **"Lean"** Measures through Energy Efficiency & Passive measures including building fabric performance improvements.

- **"Mean"** Measures through energy efficient plant, low energy lighting and heat recovery systems. Viability of CHP and connection to district heating.

- **"Green"** Measures including the inclusion of renewable technology.

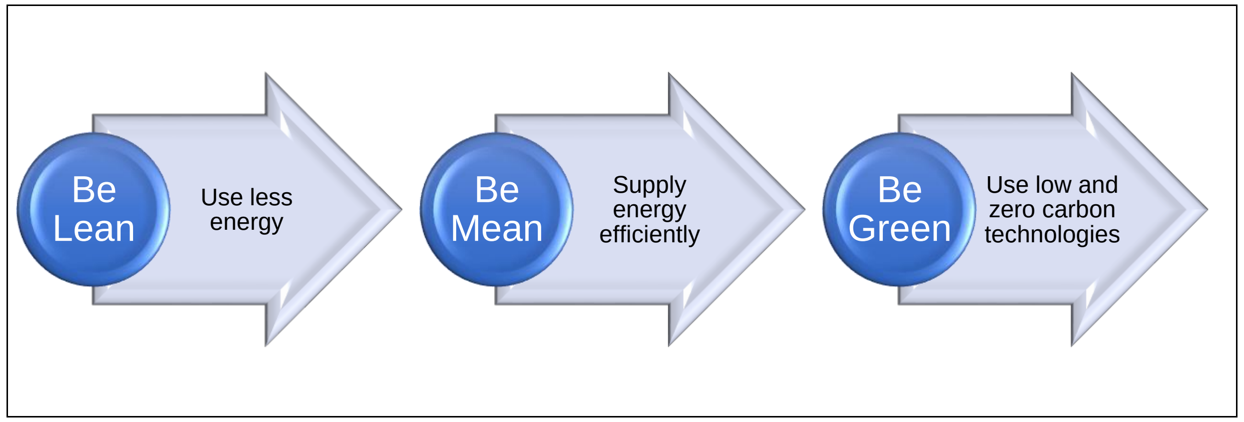

Figure 1. Energy Strategy compliance methodology

1.4 Non-domestic Assessment

Dynamic thermal simulation is a sophisticated form of building energy modelling used for non-domestic buildings. IES Version 2023 software has been used, which is approved National Calculation Method (NCM) simulation software.

The software is able to base its performance calculations upon incremental time steps as low as two minutes. This allows realistic variations in fabric thermal storage (thermal mass effects), weather conditions, occupancy, internal and solar gains to be considered and their implications upon building/plant operation to be modelled effectively.

Dynamic thermal simulation uses zone specific operational profiles (occupancy, lighting, ventilation, and domestic hot water demand) and plant performance data to effectively model and predict the energy performance of a building. This comprehensive approach is considered best practice for assessing building energy performance.

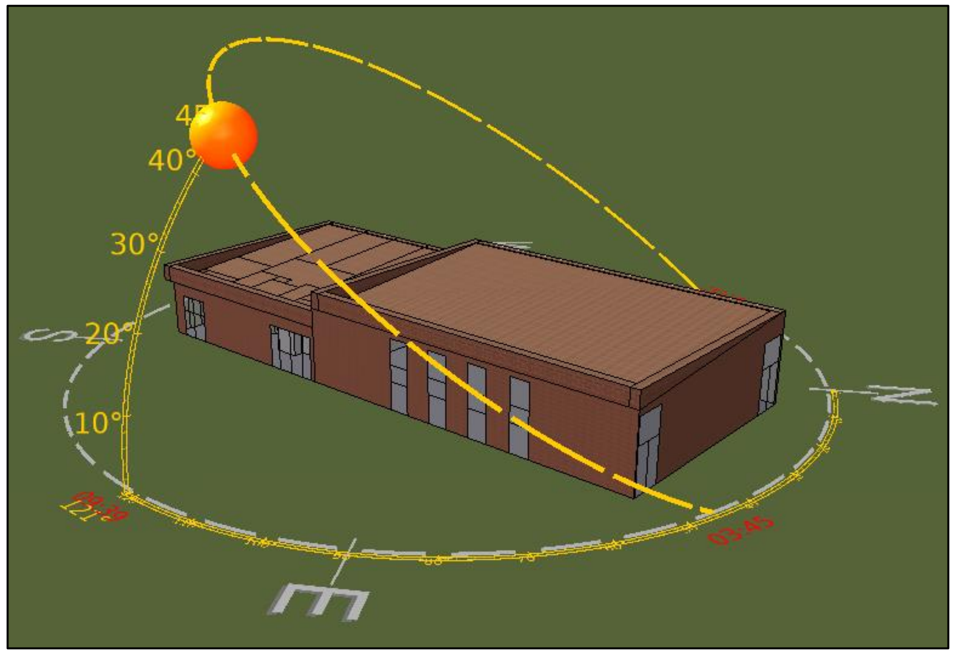

Figure 2. IES Dynamic Simulation Model

1.5 Weather Data

To accurately model the dynamic nature of the buildings' thermal response, hourly recorded weather data is used in dynamic thermal simulations. Such weather data contains records of radiation, temperature, humidity, sunshine duration and additionally wind speed and direction.

A CIBSE Test Reference Year (TRY) for Glasgow has been used for this analysis as per the National Calculation Methodology (NCM) requirements.

1.6 Limitations

The project is currently at concept design stage. This report is based on preliminary information only and is therefore only valid based on this information as presented within this report. The energy strategy will be developed and refined as the design progresses.

1.7 Future Proofing

The Scottish Government currently aims to achieve the following carbon emissions reduction targets:

- 70% CO_2 reduction by 2030;
- 90% CO_2 reduction by 2040;
- Net-zero carbon by 2045.

As part of this process, there will be policies and targets put in place which will push new developments and existing buildings to move away from fossil-fuel based heating systems such as gas. Potential alternatives will include electric solutions which will be supplied by a largely decarbonised electricity grid due to the significant contribution from renewable technologies onto the network.

From April 2024 the Scottish Government's new building regulations will mean that gas heating solutions will no longer be accepted for any new developments, with non-direct emission heating systems the only option allowed.

Figure 3. Net Zero Timeline

1.8 Grid Decarbonisation

The following fuel emission factors used within the 2023 Section 6 Compliance modelling are detailed in Table 1.

Fuel	CO_2 Emission Factor ($kgCO_2/kWh$)
Natural gas	0.210
Electricity	0.139 *(average)*

Table 1 Carbon Dioxide Emissions Factors

As the electrical grid is now being produced more and more by renewable power sources rather than gas or coal fired power stations the grid is decarbonising and as such the carbon emission factor for electricity as a fuel has been revised.

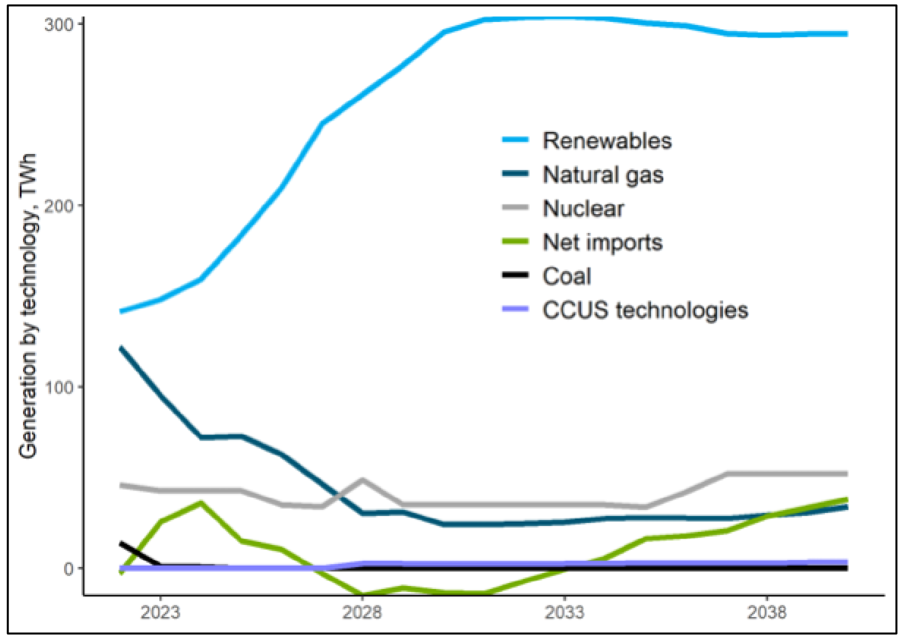

Figure 4 Grid generation breakdown

2.0 “Be Lean” Energy Efficiency Measures

The ‘Be Lean’ measures proposed will reduce the energy consumption and CO_2 emissions for the proposed development so that a substantial reduction beyond Section 6 can be achieved without the reliance on ‘Be Green’ measures. The proposed development shall focus on ‘lean’ design measures first maximising the opportunities available in energy efficient design.

The ‘Be Lean’ measures shall include:

- Improved levels of fabric insulation with U-values exceeding compliance with Section 6 2023.
- Optimised glazing areas, orientations and performance levels (both thermal and solar) which aim to maximise the benefits of passive solar gain where appropriate and limit unwanted solar gain where necessary.
- Reduced levels of air permeability in order to minimise uncontrolled heat gains or losses.

2.1 U-values

The proposed development will feature thermal fabric performance such that compliance with Section 6.2 of the 2023 Building Regulations would be bettered.

The proposed U-values as outlined below have been used in the initial energy calculations, which exceed the minimum requirements of Section 6 2023:

Type of Element	(a) Area-weighted average U-value (W/m^2K) for all elements of the same type
Wall	0.14
Floor	0.10
Roof	0.10
Glazing (Includes glazed doors)	1.00
Pedestrian Doors	1.10

Table 2. Proposed U-Value Levels

2.2 Air Permeability

It has been assumed for calculatioAn purposes that the air pressure testing will produce test certificates of no greater than the following:

- 3 $m^3/h.m^2$@50Pa

2.3 Solar Control Glazing & Overheating

Glazing areas shall be optimised with solar controlled glazing with low g-values to limit the amount of solar gain transmittance into areas with a high solar gain. Passive solar gain shall be included where possible to limit heating loads.

The following outline specification has been determined to allow compliance against the solar gain check contained within the Section 6 calculation methodology;

Type of Element	G - value
Glazing G-value	0.45
Frame factor	70% (typical)

Table 3. Proposed Glazing G-values

3.0 “Be Mean” Energy Efficiency Measures

Be “Mean” measures shall be incorporated throughout the scheme in order to reduce energy consumption and the associated carbon emissions, these will include but are not limited to the following:

- Comprehensive incorporation of heat recovery on ventilation systems.
- Utilisation of high efficiency heating plant.
- The use of low energy variable speed drives and motors.
- The installation of automated controls to limit plant and lighting operation where practical.
- Installation of low energy lighting schemes throughout.

3.1 Ventilation

It is proposed that the building will utilise Mechanical ventilation with heat recovery (MVHR) within the Changing rooms, training studio and WCs. This type of system results in a more comfortable indoor environment maintaining good air quality whilst also minimising energy losses through the retention of energy recovered through the heat exchanging process. The MVHR is assumed to incorporate heat recovery in the region of 80% for the training studio and 82.5% elsewhere, with reduced specific fan powers.

3.2 Cooling

Cooling will be provided via Variable Refrigerant Flow (VRF) and split systems to the changing rooms and training studio.

3.3 Lighting

It is recommended that all light fittings are specified as dedicated energy efficient LED lights only. The lighting shall be complete with the appropriate lighting controls where required. For the purposes of demonstrating compliance against Section 6 presence detection has been included throughout with daylight dimming capabilities in the training studio.

3.4 Heating Generation and Distribution

It is proposed that the buildings heat demands will be met by a mix of electric panel heaters, VRF and split systems.

3.5 Daylighting

Daylighting levels should be optimised to ensure good levels of natural daylight while not increasing solar gains which may increase the overheating risk.

4.0 District Heating and CHP

4.1 District Heating

East Dunbartonshire Council planning requirements require the viability of the installation of new or connection to existing district heating networks and the viability of local generation technologies, such as Combined Heat and Power (CHP).

These type of heating systems are favoured because they offer:

- Potential economies of scale in respect of efficiency and therefore reduced carbon emissions.
- Better economic life cycle costs through efficiencies associated with planning and maintenance requirements.
- Increased opportunities for future proofing the development to react to energy supply market factors.
- Greater potential for further replacement with LZC technologies.

District heating works by the supply of hot water distributed from a central source, typically a CHP / Boiler.

A desktop study has been undertaken considering the viability of utilising district heating for the site.

The Councils Local Heat and Energy Efficiency Strategy (LHEES) will indicate the zones within East Dunbartonshire with the greatest potential for heat networks based upon existing energy demand, proximity of energy resources and prevailing fuel sources, however this document is not currently available with a draft expected the beginning of 2024. In light of this, the Scotland Heat Map has been consulted.

Through the use of this tool, it has been determined that there are no existing or proposed district heating centres within the local area of the site, therefore connection to an existing district heating energy centre is not deemed to be a viable solution in this instance. However, it is recommended that as the project progresses that the Councils LHEES is consulted as it becomes available to ensure that no opportunities for district heating are missed.

4.2 Combined Heat and Power (CHP)

The feasibility of Combined Heat and Power (CHP) as a 'clean' measure shall be carefully assessed and requires taking consideration of a wide range of factors and influences.

CHP is considered a 'clean' technology because it is a cogeneration of heat and electricity which increases the overall utilisation efficiency of primary energy.

CHP generates electricity and captures heat that is produced in this process. The captured heat can be used to pre-heat Domestic Hot Water used for a centralised heating network.

To be economical a CHP unit generally needs to operate for a minimum of 4,000 hours per year, around 14 hours per day. Furthermore, CHP units cannot be easily switched off and on to reflect loading variations and doing so dramatically affects its operation and efficiency.

To overcome these limitations CHP units are sized on the base heat load, for this development it would be therefore proposed that it will be sized on the domestic hot water (DHW) load, which has a constant annual profile.

With the de-carbonisation of the electrical grid the fuel carbon emission factors for the production of electricity via gas does not provide the same level of carbon saving.

Due to the above, it has been determined that CHP is not feasible for the proposed development.

5.0 "Be Green" Energy Efficiency Measures

5.1 General

East Dunbartonshire Council planning guidance encourages the incorporation of on-site renewable energy supplies and requires a **20%** reduction through the incorporation of LZC technologies where possible in all new developments.

A range of technologies have been appraised in order to generate renewable energy in relation to the development. These include:

- Site mounted wind turbines
- Roof mounted wind turbines
- Solar Photovoltaics (PV)
- Solar Hot Water
- Ground Source Heat Pumps
- Biomass
- Biomass CHP
- Direct Air Source Heat Pumps
- Fuel cells

A renewable energy options assessment has been undertaken to evaluate which of these technologies would be most feasible in terms of economic, political, environmental and practical considerations.

5.2 Unfeasible Renewable Technologies

A desktop study has discounted the following technologies for this project:

5.2.1 Biomass

Biomass systems differ from other renewable sources because they emit carbon dioxide when they burn fuel. However, the amount is equal to the carbon absorbed when the biomass material was growing. For large scale projects there are three types of wood fuel that are generally used: logs, pellets and woodchip.

A biomass boiler is not considered appropriate for this scheme for the following reasons:

- High cost of heat generation and distribution system.
- Air quality / pollution issues.
- Fuel delivery and storage issues.

5.2.2 Biomass Combined Heat and Power (CHP)

Although CHP is not strictly a renewable source of energy, it produces both heat and electricity from a single heat source using a highly efficient process. CHP generates electricity and captures heat that is produced in this process. The captured heat can be used to pre-heat Domestic Hot Water used for a centralised heating network.

This system can be used in a centralised plant network serving multi-residential units. However, it is not considered feasible due to the fuel delivery, storage issues and air quality issues.

5.2.3 Fuel Cells

Fuel cells could potentially have a massive impact on the future UK energy market. Current research indicates that although the technology is developing commercially, viable equipment and reliable sources of non-fossil fuel hydrogen are not yet available, on a commercial scale.

5.2.4 Site mounted large wind turbines

Due to the scheme's location and poor associated wind speeds, the technology is deemed unsuitable in this instance.

The associated noise with large scale wind turbines could have a potential impact to any adjacent properties. A 300kW turbine could potentially reach a sound level of 100 dBa at 8 m/s wind speed.

5.2.5 Roof mounted wind turbines

The feasibility of roof mounted wind turbines has been studied in terms of:

- Size and visual impact on the building
- Power output
- Noise generation

Wind turbines extract energy from the wind using a rotor which usually comprises of two or three blades similar in profile to the wing of an aeroplane. Most small wind turbines generate direct current (DC) electricity. Systems that are not connected to the national grid require battery storage and an inverter to convert DC electricity to AC.

Wind systems can also be connected to the national grid. A special inverter and controller converts DC electricity to AC at a quality and standard acceptable to the grid, hence no expensive battery storage is required. Any unused or excess electricity may be able to be exported to the grid and sold to the local electricity supply company.

The average wind speed on site is 4.83 m/s at 10m. For a turbine to be feasible a wind speed of at least 6m/s is required to produce a satisfactory energy output.

Due to low wind speeds, aesthetic impact and potential detrimental impact on wildlife, roof mounted wind turbines are not considered suitable for this application.

5.2.6 Ground / Water Source Heat Pumps (GSHPs)

GSHP systems provide extracted heat from the ground during the winter months via a heat pump and circulate hot water into a building to provide space-heating and pre-heated domestic hot water. In the summer months the process can be reversed to provide cooling.

However, GSHPs are not considered an appropriate technology for this scheme for the following reasons:

- A substantial amount of land, either via slinky or bore holes would be required in order to serve the development, which may be available using the site, but would provide significant disruption.
- High cost of centralised heating / cooling generation and distribution systems for a building which will not be used constantly.

5.3 Feasible Renewable Technologies

An initial desktop study has appraised and has considered the following technologies as potentially suitable technologies.

5.3.1 Solar Hot Water

Solar hot water uses a heat collector, usually as panels on the roof, in which liquid is heated by the sun.

In a typical system, a heat transfer medium (generally a water/antifreeze mixture) travels through a series of heat conducting tubes known as a heat collector. During its circulation through the tubes, the fluid picks up heat from the sun which is then transferred to the domestic hot water supply as it passes through a coil in an appropriate storage cylinder.

These systems do not generally provide space heating and are often described as 'solar thermal' systems. They are among the most cost-effective renewable energy systems that can be installed to developments in urban environments. A basic solar thermal collector comprises of a translucent cover, an absorption plate, and the heat transfer system. In the UK, there are two main types of collector, known as evacuated tube and flat-plate.

The Training Centre will have a relatively high DHW demand therefore solar hot water is a potential solution for this development.

However, consideration must be given to the final plant solution for the development for example if PV is deemed an appropriate solution, the carbon benefit from PV may be more beneficial to the development compared to solar hot water.

5.3.2 Solar Photovoltaics (PV)

The incorporation of Solar Photovoltaic (PV) panels has been assessed as a possible renewable technology to reduce the carbon emissions for the proposed development.

PV uses energy from light to create electricity for the running of appliances and lighting. The PV cell consists of one of the two layers of a semi conducting material, usually silicon (normally Monocrystalline, Polycrystalline and Amorphous silicon).

When light shines on the cell it creates an electric field across the layers causing electricity to flow. The greater the light intensity, the greater the flow of electricity.

Individually PV cells only provide a small amount of electricity, they are generally grouped together into a module for convenience and higher output.

PV is most suitable where electricity is generated at the point of use and the energy loss and costs with transmission and distribution are avoided.

A key advantage of PV in the urban environment is their potential to be integrated into the fabric of the building. No extra land space is required, and the visible aesthetics of a building can be altered – either to be unobtrusive, or to give a clear indication of 'green' credentials.

5.3.3 Air Source Heat Pumps (ASHP)

An Air Source Heat Pump (ASHP) could be installed to meet the building's space heating or hot water demands. The technology works by extracting available heat from the air and boosting this to a higher temperature which can be used in the building for heating using compressor technology. ASHPs are more cost effective to install than ground source systems as they do not involve expensive ground works.

ASHPs require evaporator units to be exposed to ambient air. This is most effectively achieved by mounting the units external to the building. Any planning implications would have to be assessed prior to installing external units. The ASHP Coefficient of Performance (CoP) is 3 therefore assuming that each 1 kW of electricity used to drive the ASHP, generates 3 kW of heat energy from the outside air to heat the building.

An ASHP installation would be appropriately sized and designed to meet the heating requirements of the building. The domestic hot water load of the buildings may also be met by the ASHP but the CoP of the system may reduce due to the higher temperatures required for DHW. However, newer technologies with high temperature heat pumps can help to reduce the impact on performance with seasonal efficiencies between 3 and 4 now possible.

Colder climates will result in a reduction in efficiency and the achievable seasonal coefficient of performance (SCoP) of Air Source Heat Pump technology. However, ASHP technology has advanced in recent years and through consideration of the specification of a system with key design features so that the negative impact on their performance when the outside air is cold can be reduced.

The seasonal efficiency of the heat pump is greatly affected by the building/heating system it serves, thus efficient levels of fabric insulation and the specification of a heating system which can operate effectively at lower temperatures will improve the performance of the unit throughout the year. Good quality heat pumps are capable of providing hot water above 52°C when the outside air is as cold as -16°C.

A key consideration for an ASHP system is the acoustic performance of the external unit. The typical noise rating of a domestic external unit is up to 60dBA at 1m which equates to a similar noise level of a conversation or background music. Depending on the location of the heat pump, acoustic measures such as an acoustic enclosure will be required to minimise noise pollution to nearby occupied spaces or dwellings. However, the current market also offers ultra-quiet ASHPs for the domestic market and the noise rating is around 50dBA at 1m.

The proposed option is to utilise Air Source Heat Pumps for the hot water demands of the building, with the outdoor units located at ground level.

5.3.4 VRF and Split Systems

Variable Refrigerant Flow (VRF) systems are a type of HVAC technology that efficiently heats and cools spaces by controlling the flow of refrigerant between multiple indoor units and a single outdoor unit. They offer zonal control, allowing different areas or zones within a building to have individualised heating requirements.

During heating mode, the VRF system operates by absorbing heat from the outdoor air and transferring it indoors. The refrigerant absorbs heat energy from the outdoor air and then releases it inside through the indoor units. This process is facilitated by the systems reversible heat pump functionality, allowing it to operate in both heating and cooling modes.

VRF systems offer high energy efficiency due to their ability to modulate the flow of refrigerant to match the specific heating demands of different zones. By adjusting the amount of refrigerant sent to each indoor unit, the system can precisely regulate temperatures in various areas, maximising comfort and minimising energy consumption and waste.

Split systems work in a similar fashion to VRFs, consisting of both external and internal units, however, they are typically chosen for smaller spaces. Unlike VRFs, split systems do not modulate the flow of refrigerant to each indoor evaporator, and thus are unable to provide both simultaneous heating and cooling.

The proposed option for the building is to utilise two individual Split systems for the changing rooms, and a VRF system within the Training Centre to provide the heating and cooling requirements for the building.

5.4 Preferred Renewable Energy Options

This assessment has identified that the technically viable technologies recommended for further study that can provide some of the development's energy from a renewable source are:

- Air Source Heat Pumps (ASHPs)
- VRF and Split system

The preference is for the proposed hot water system is to incorporate Air Source Heat Pump (ASHP) technology, likely located at ground level. The heating and cooling requirements would be met by VRF and split systems to the changing rooms and training studio. This proposed renewable system will allow the development to meet the requirements of Section 6 of the Scottish Building Standards and the subsequent requirements of the East Dunbartonshire Council local planning policy.

6.0 Results Summary

6.1 Non-Domestic Proposed Parameters

The below performance parameters summarised in Table 4 were used to review the minimum requirements to enable the development to both comply with the requirements of Section 6 and the subsequent requirements of the local planning policy.

System	Performance Parameters
Glazing (includes glazed doors)	U-Value 1.0 W/m^{2}K
Fabric	External Wall: U-Value 0.14 W/m^{2}K Roof: U-Value 0.10 W/m^{2}K Ground/Exposed Floor: U-Value 0.10 W/m^{2}K Personnel Doors: U-Value 1.10 W/m^{2}K
Air Permeability	Maximum 3 m^{3}hr/m^2 @ 50Pa, tested and certified.
Artificial Lighting	Energy efficient lighting assumed generally – 95 Lm/W.
	Presence Switching: All spaces except stores and plant room Photoelectric Control Type - Dimming within the Training Studio
Power Factor Correction	Assumed - None (< 0.90)
Ventilation	Demand Control Ventilation for Training Studio (Gas sensors / speed control) Demand Control Ventilation changing rooms (Occupancy sensors / speed control)
	Supply and Extract ventilation to Changing rooms & WCs – 0.99 W/l/s, HR - 80% Supply and Extract ventilation to Training Studio – 1.5 W/l/s, HR – 82.5%
Heating & Cooling	VRF – Heating SCOP 4.7, Cooling SEER 7.5 Split Systems – Heating SCOP 4.53, Cooling SEER 4.37 Radiant Panel heaters – 100% efficient Optimum Start/Stop Control and Local Temperature Control
Domestic Hot Water	SCOP 2.25 1,000 L storage cylinder Storage losses assumed to be 0.0038 kWh/l.day
LZC Technology	Air Source Heat Pump (ASHP) DHW VRF and Split systems providing heating and cooling.
	Roof-mounted Solar PV (120 m^2) – South-east facing @ 5° incline, with rated power of 24.120 kWdc

Table 4. Non-Domestic Proposed Parameters

6.1.1 Non-Domestic Results Summary

The design parameters noted in Table 5 give the following results for the building.

BER	TER	BDER	TDER	Pass / Fail
Kg CO_2 / m^2	Kg CO_2 / m^2	kWh / m^2	kWh / m^2	%
14.5	-	99.3	115.9	14.32

Table 5. Standard 6.1 Results

It should be noted that as the proposed development is to have a non-direct emission heating system, then the compliance with the TER is no longer required, therefore it is only the TDER that must be met for this building.

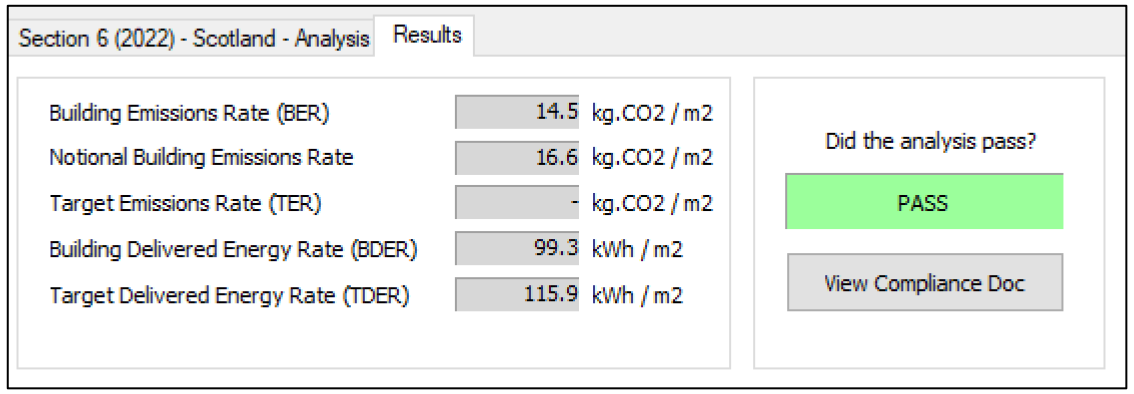

Figure 5. Non-Domestic Route to Compliance Result

Furthermore, this reduction can be directly attributed to the inclusion of the Air Source Heat Pumps (ASHP), VRF and Split systems along with the PV technology which meets East Dunbartonshire Council's planning policy requirements of at least a 20% contribution to the reduction in carbon emissions via Low and Zero Carbon Generating Technologies (LZCGTs).

7.0 Conclusions

The table below highlights the recommended strategy associated with the proposed Training Centre.

This preferred strategy utilises each of the 'Be Lean', 'Be Mean' and 'Be Green' measures to demonstrate compliance with the required sustainability standards.

Energy Hierarchy Stage	Proposed Measures:
"Be Lean" – Use Less Energy	Improved Building Fabric Performance over Section 6 and air tightness testing: External Wall: U-Value 0.14 W/m^2K Roof: U-Value 0.10 W/m^2K Exposed Floor: U-Value 0.10 W/m^2K Doors: U-Value 1.10 W/m^2K Glazing: U-Value 1.0 W/m^2K Air testing to 3 m^3hr/m^2 @ 50 Pa tested and certified.
'**Be Mean' – Supply Energy Efficiently**	▪ Heat recovery ventilation with efficiency of at least 80%. ▪ 100% Dedicated Energy Efficient lighting throughout. ▪ Energy metering. ▪ Efficient Air Source Heat Pump serving heating and DHW. ▪ Efficient VRF and Split systems serving heating and cooling. ▪ Roof-mounted Solar PV
'Be Green' – Use Renewable Energy	ASHP, VRF, Split system & Solar PV

Table 6. Final Recommended Energy Strategy

The energy strategy approach has focused initially on the reduction of energy through passive means.

This includes improvement of the building fabric levels in excess of the minimum requirements of the building standards.

As the Building Emission Rate has been found to be better than the Target Emission Rate then Section 7 Aspect 1 Silver level could be achieved for the building.

Once an optimum solution was found the strategy then focused on energy efficiency measures again to ensure the overall energy consumption and associated carbon emissions were as low and as efficient as possible.

Continuous supply and extract ventilation has been included to reduce heating energy costs with the inclusion of heat recovery and to maintain air quality with reduced U-values and air tightness testing.

Energy efficient lighting is proposed throughout along with heating controls.

In line with the East Dunbartonshire Council Local Development Plan 2 2022, Policy 9 which requires a minimum 20% carbon dioxide emissions abatement through the use of low and zero carbon green technologies, various technologies were appraised for feasibility.

The high-level appraisal which was carried out to demonstrate compliance with Section 6 and Section 7 shows that by utilising an Air Source Heat Pump, VRF and Split system and roof-mounted solar PV, a **75.95%** reduction of the total CO_2 emissions through the use of a Low or Zero Carbon Generating Technology (LZCGT) can be achieved. The calculations for the BER for both the building with and without LZC are located within Appendix B.

The proposed parameters detailed within this report demonstrate compliance with Section 6 and East Dunbartonshire Councils requirements.

Appendix A

Sample BRUKL Report

Apache Specification Information

Scottish Building Regulations 2022 Section 6 Guidance

Carbon Dioxide Emissions, Energy Consumption, U-Values, Air Permeability, and HVAC

Project name

Draft - WOSFC Training Centre

Date: Fri Jan 26 17:00:39 2024

Administrative information

Building Details

Address: 71 Glasgow Road, Milngavie, G62 6HX

Agent details

Name: Harley Haddow

Telephone number: 0131 226 3331

Address: 124-125 Princes Street, Edinburgh, EH2 4AD

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.23.0

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.23.0

Compliance module version: v6.1.e.1

Foundation area [m²]: 390.26

1- The predicted CO_2 emissions and energy consumption

Target CO_2 emission rate (TER), $kgCO_2/m^2$annum	16.6	
Building CO_2 emission rate (BER), $kgCO_2/m^2$annum	14.5	
Target delivered energy rate (TDER), kWh/m^2annum	115.93	
Building delivered energy rate (BDER), kWh/m^2annum	99.33	
Do the building's emission and delivered energy rates exceed the targets?	TER N/A	BDER =< TDER

2- The performance of the building fabric and the building services systems

Fabric element	$U_{a-Limit}$	U_{a-Calc}	$U_{i-Limit}$	U_{i-Calc}	First surface with maximum value
Walls	0.21	0.14	0.7	0.14	0T000001:Surf[7]
Floors	0.18	0.1	0.7	0.1	0T000001:Surf[0]
Roofs	0.16	0.1	0.35	0.1	0T000001:Surf[23]
Windows* and roof windows	1.6	1	3.3	1	0T000001:Surf[1]
Rooflights**	2.2	-	3.8	-	No roof lights in building
Personnel doors	1.4	-	3.3	-	No personnel doors in building
Vehicle access & similar large doors	1.5	-	3.3	-	No vehicle access doors in building
High usage entrance doors	3	-	N/A	-	No high usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]
$U_{i-Limit}$ = Limiting individual element U-values [W/(m²K)]
U_{i-Calc} = Calculated individual element U-values [W/(m²K)]

* Display windows and similar glazing are excluded from the U-value check.
** Values for rooflights refer to the horizontal position.

Air Permeability	This building's value
m3/(h.m2) at 50 Pa	3

Appendix B
LZCGT Carbon Reduction Calculations

No LZCGT

TER	BER
52.6	60.3

To demonstrate the CO_2 emissions without LZCGT's the proposed ASHP's & roof-mounted solar PV's have been omitted from the calculations.

- The DHW ASHP's have been replaced by conventional gas-fired boilers having a seasonal gross efficiency of 93%.
- The comfort cooling VRF and split systems have been replaced by a conventional 4-pipe FCU system served by conventional gas-fired boilers having a seasonal gross efficiency of 93% and an air-cooled chiller having the same SSEER as the VRF and Split systems. (4.37 and 7.5 respectively)

With LZCGT

TER	BER
16.6	14.5

- LZCGT's include ASHP's + PV

Reduction via LZC	**75.95%**