Low Carbon and Renewable Energy Assessment

RIBA Stage 2

Land South of Bryn Lane

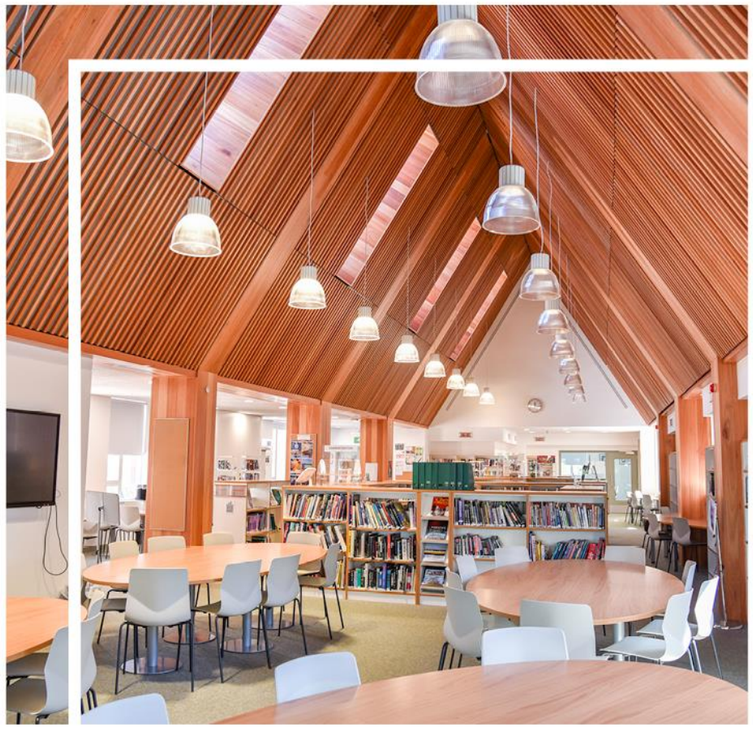
Mauna Kea Limited

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Issue P06























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Report Name: Low Carbon and Renewable Energy Assessment

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1. Executive summary

Hilson Moran has been appointed by Mauna Kea Limited (The Applicant) to provide Sustainability and Energy Consultancy services for the Proposed Development of Land South of Bryn Lane. The Site falls within the Wrexham Industrial Estate and is bounded by Bryn Lane to the north and a range of employment uses to the east, west, and south. The Proposed Development will deliver high quality employment floorspace, housed within a single building alongside an improved access off Bryn Lane and landscaping. This Low Carbon and Renewable Energy Assessment demonstrates how The Applicant shows commitment to principles of sustainability and the wider carbon emission reduction agenda. The Proposed Development achieves a 73% carbon emissions reduction on the Part L: 2010 (2022 edition) baseline and aligns with energy targets which are requisite to the awarding of a BREEAM 'Excellent' rating.

This Low Carbon and Renewable Energy Assessment has been prepared in accordance with the guidance stipulated in the Planning Policy Wales ED12 (2024) and Wrexham Local Development Plan documents. It sets out the key energy efficiency measures identified from the Proposed Development as part of the application for each stage of the energy hierarchy, addresses all national, regional, and local authority requirements, and demonstrates compliance with certification targets.

The methodology of this Low Carbon and Renewable Energy Assessment robustly follows the Welsh Government's Energy Hierarchy:

- **Reduce Energy Demand -** A wide range of passive and energy efficiency measures are incorporated in the design, including good levels of thermal insulation, high levels of building air tightness, good levels of internal daylight reducing reliance on artificial lighting, optimised solar control glazing to reduce cooling demand and improve thermal comfort.
- **Use Energy Efficiently -** The building is designed to be fully fossil-fuel free, with all-electric systems benefitting from the on-going grid decarbonisation. Mechanical and electrical systems are selected for maximum efficiency and heat recovery capacity. Smart systems and lighting controls are implemented to ensure optimal operation.
- **Renewable Generation -** A detailed assessment of renewable energy opportunities and viability has been undertaken. Accounting for the building's location, orientation, occupancy schedule and energy consumption it has been determined that roof mounted photovoltaic (PV) arrays, providing renewable electricity, is the most viable technology for integration into the scheme. An array of 350m^2 is proposed to be mounted on the pitched, east/west facing roof face of the Proposed Development.

Energy and CO_2 emission performance has been calculated using the current Building regulation methodology against Part L: 2010 (2022 edition) requirements. Following the guidance of Paragraph 2.13 of the Approved Document Part L Volume 2 – the unheated warehouse has been excluded from the assessment for the purposes of compliance modelling; all results presented in this report relate to the conditioned Office Block only.

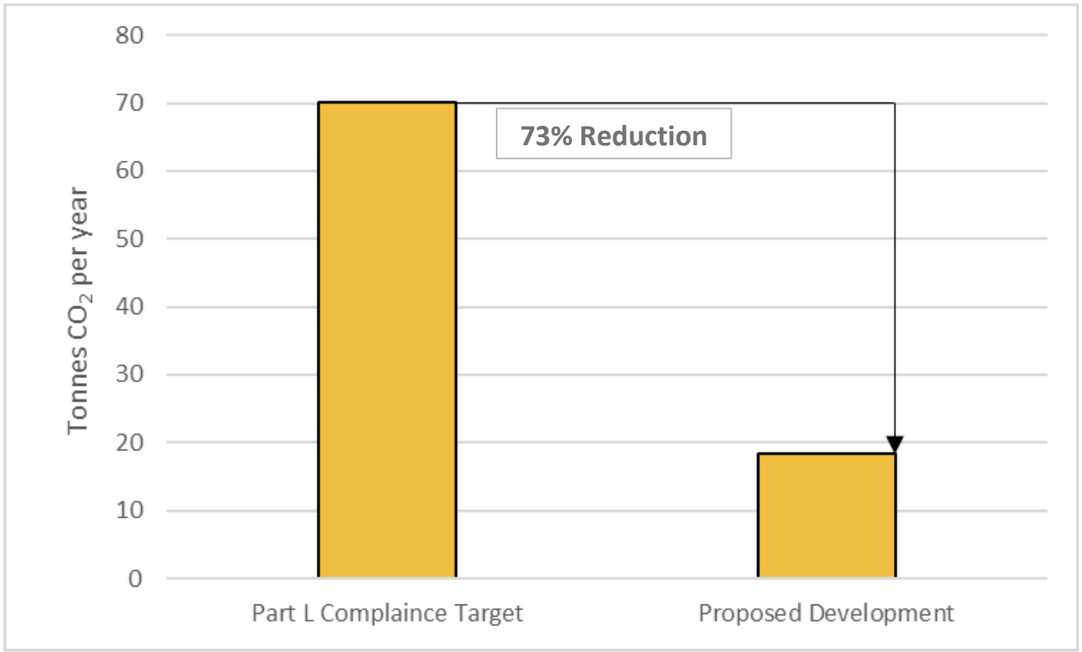


Figure 1 – Carbon emission performance of the Proposed Development

The analysis demonstrates that the Proposed Development meets and exceeds Part L regulation emission targets and achieves at least 4 credits under BREEAM V6.0 Ene01, meeting the requisite condition for awarding of a BREEAM 'Excellent' rating.

2. Introduction

The Site falls within the Wrexham Industrial Estate and is bounded by Bryn Lane to the north and a range of employment uses to the east, west, and south. Adjacent uses include warehouses used for leisure, distribution, manufacturing, and storage alongside the Kellogg's Factory which occupies a substantial footprint to the south-east of the Site.

The Site was historically used for manufacturing purposes and has since become grassland, which was previously grazed, alongside vegetation and trees. Other features on site include an area of slopping masonry forming a drain in the south-western corner, a disused concrete bunker in the north-eastern corner, and redundant fencing.

The Proposed Development will include:

- 14,564 sq.m (GIA) of employment floorspace (Use Classes B2 and B8) alongside ancillary office floorspace (Use Class B1A).
- 146 car parking spaces (including 15 disabled car parking spaces).
- 35 cycle parking spaces within an external cycle store.
- New landscaping.
- Retention of a Strategic Ecological Network around the southern and eastern perimeter of the Site.
- Improved access off Bryn Lane and new internal circulation roads.

This assessment has been based on floor plans received as part of the "Design freeze" package issued by PACE Architects on 14.10.24. The elevations have been based on a drawing by PACE architects titled "2061 - Post PAC Amends_grid rotation_05.02.25" received on 05.02.25.



Figure 2 – Proposed 3D render

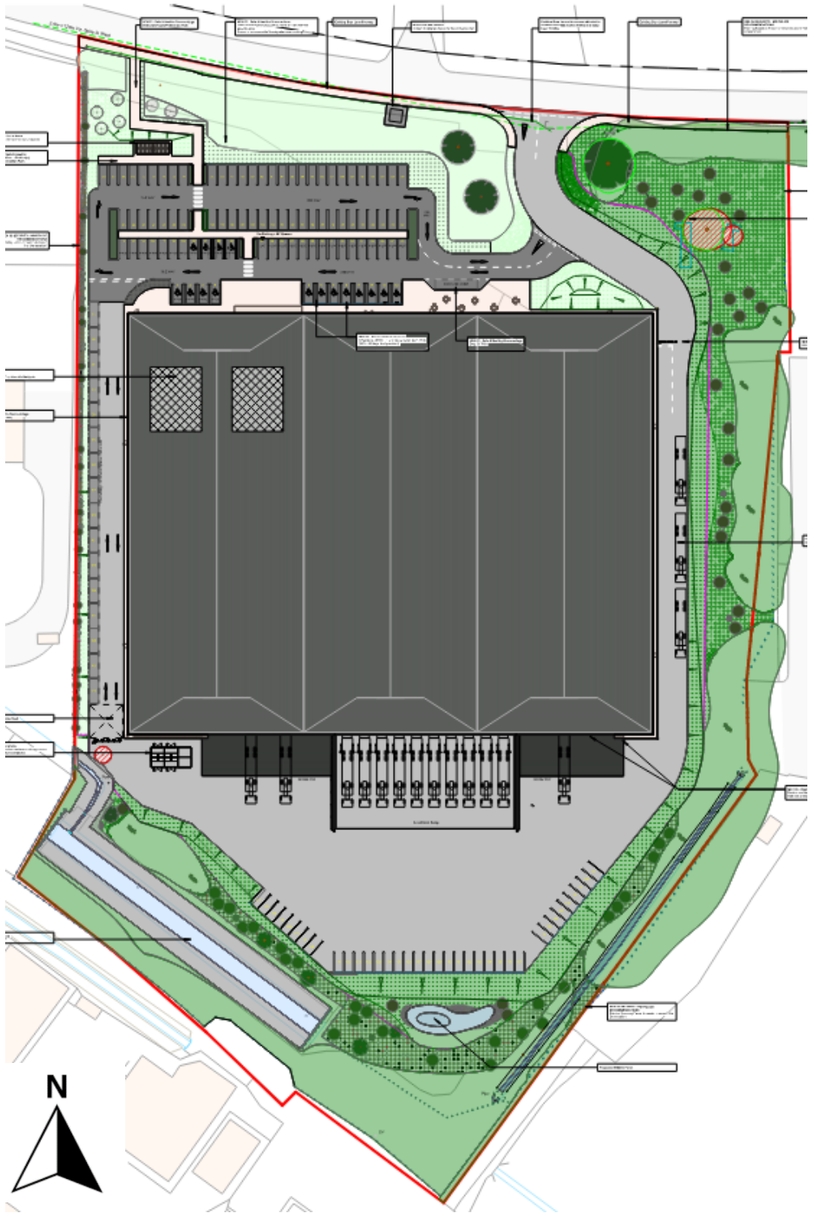


Figure 3 – Proposed Site Plan

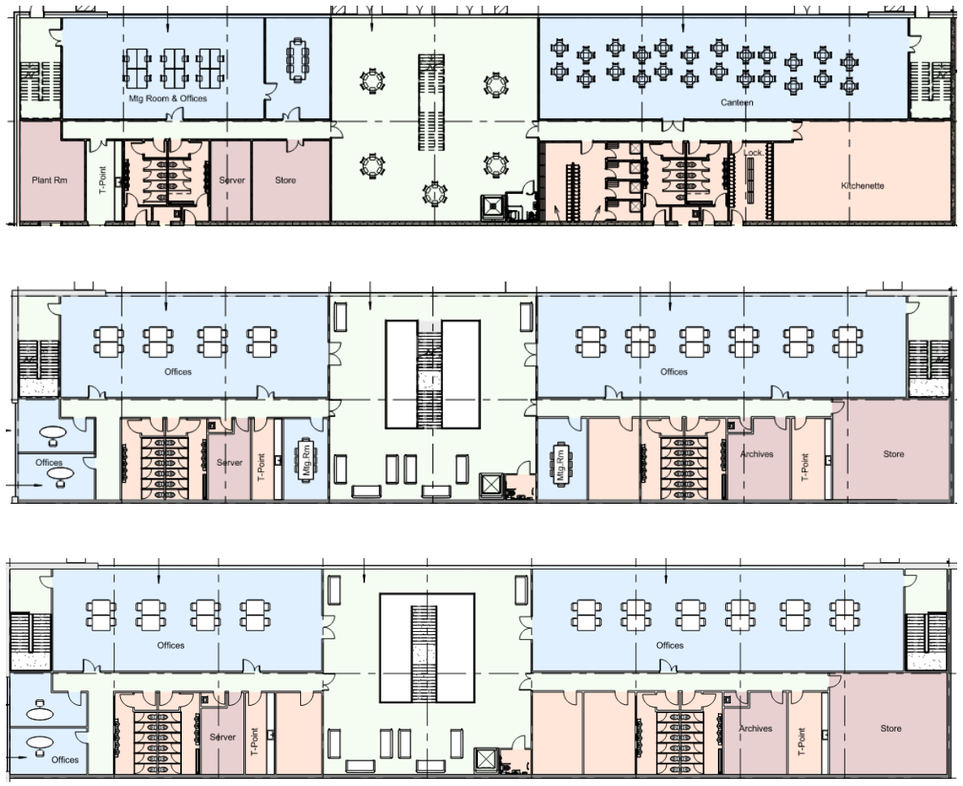


Figure 4 – Proposed Office Block Plans- GF, FF, SF

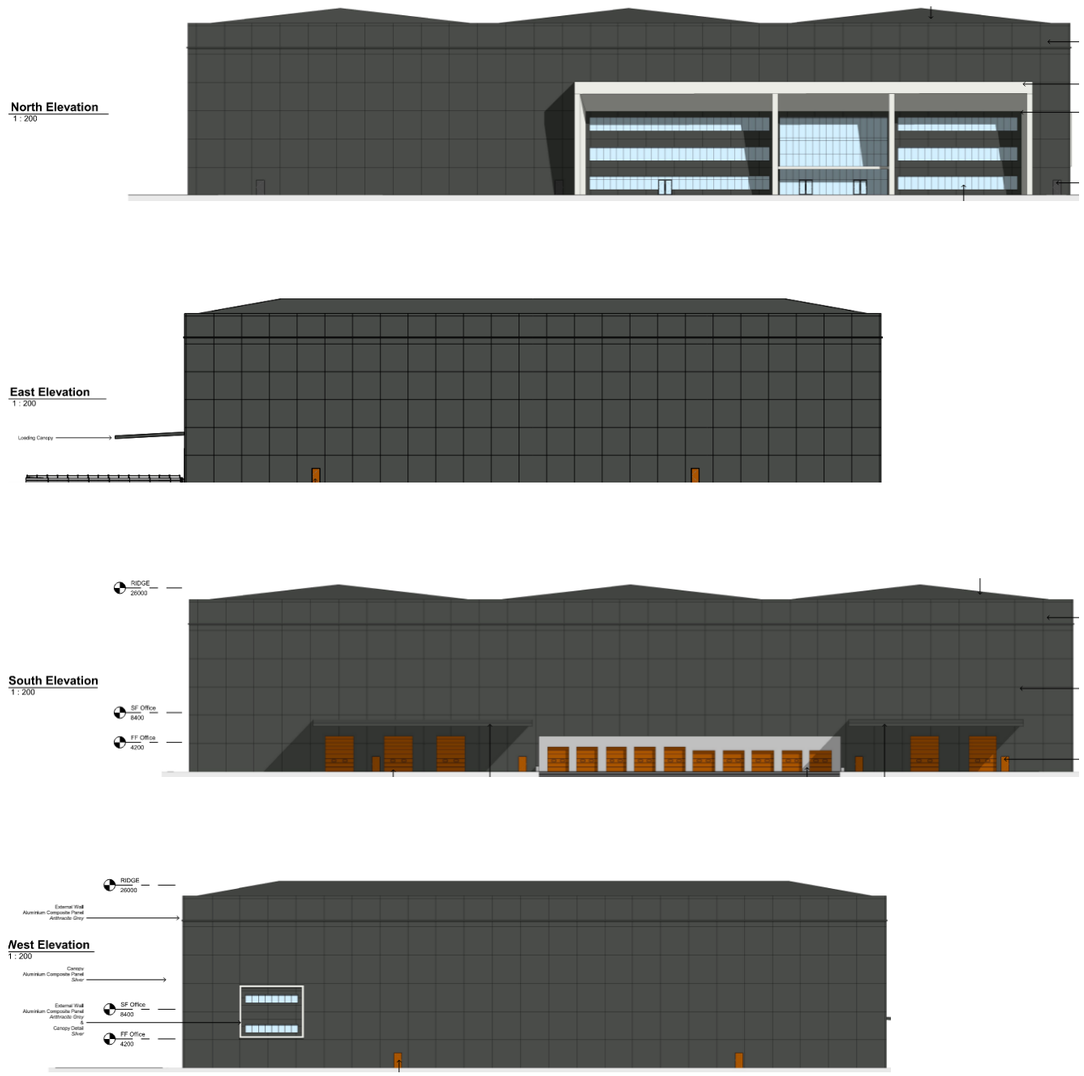


Figure 5 – Proposed Elevations – North, East, South, West

3. Policy context

The following tables summarise applicable national and local environmental sustainability policy and the status of the Proposed Development relative to each.

3.1. National Policy		Addressed
Approved Document L, Conservation of fuel and power, Volume 2: Buildings other than dwellings The Building Regulations 2010, 2022 edition	Sets out elemental minimum energy and CO_2 emissions performance standards for all elements of the built environment along with assessment methodologies necessary to confirm compliance. Sets out amendments to the current Part L documents, with regards to the requirements of the provision of a Low Carbon and Renewable Energy Assessment document, to include the viability assessment of all Low and Zero Carbon technologies. The 2022 edition of the Welsh Building Regulations Approved Document Part L came into effect on **29th of March 2023** for use in Wales.	Yes

3.2. Regional and Local Policy		Addressed
Planning Policy Wales ED12 Paragraph 5.7.13 Energy Hierarchy for Planning Welsh Government, 2024	Welsh Government Planning Policy recognises an energy hierarchy. The Welsh Government expects all new development to mitigate the causes of climate change in accordance with the energy hierarchy for planning, as set out in the following energy policies. Reducing energy demand and increasing energy efficiency, through the location and design of new development, will assist in meeting energy demand with renewable and low carbon sources. This is particularly important in supporting the electrification of energy use, such as the growing use of electric vehicles and heat pumps.	Yes
Planning Policy Wales ED12 Paragraph 5.9.1 Renewable and Low Carbon Energy Welsh Government, 2024	Local authorities should facilitate all forms of renewable and low carbon energy development and should seek cross-department co-operation to achieve this. In doing so, planning authorities should seek to ensure their area's full potential for renewable and low carbon energy generation is maximised and renewable energy targets are achieved. Planning authorities should seek to maximise the potential of renewable energy by linking the development plan with other local authority strategies.	Yes
Planning Policy Wales ED12 Paragraph 5.8.5 Strategic Sites Welsh Government, 2024	Planning authorities should assess strategic sites to identify opportunities to require higher sustainable building standards, including zero carbon, in their development plan. In bringing forward standards higher than the national minimum, which is set out in Building Regulations, planning authorities should ensure the proposed approach is based on robust evidence and has taken into account the economic viability of the scheme.	Yes

3.2. Regional and Local Policy		Addressed
Wrexham LDP Policy SP19 Climate Change Wrexham Council, 2018	The Local Development Plan (LDP) requires proposals to explain how: • The Proposed Development will reduce carbon emissions through energy demand reduction, maximising energy efficiency and reducing the need for travel. • Renewable energy and low carbon systems have been incorporated to reduce reliance on fossil fuels. • The Proposed Development adapts to the implications of climate change - likely increased temperatures, more frequent and severe flooding and extreme weather events.	Yes
Wrexham LDP Policy RE1 Development and Renewable Energy/Low Carbon Technology Wrexham Council, 2018	The council will encourage developers of the Key Strategic Sites (100 dwellings or more or development exceeding 1000m^2) to incorporate schemes which generate energy from renewable and low carbon technology. An independent energy assessment investigating the financial viability and technical feasibility of incorporating such schemes will be required to support applications.	Yes
Wrexham UDP Policy GDP1 (c) Development Objectives Wrexham Council, 2005	The Unitary Development Plan (UDP) states that all new developments should make the best use of design techniques, siting, and orientation in order to conserve energy resources.	Yes
Wrexham UDP Policy PS12 Renewable Energy Wrexham Council, 2005	Proposals for the generation of energy from renewable sources will be supported provided that the wider environmental benefits are not outweighed by any detrimental impacts of the proposed development (including any electricity transmission facilities needed) on the landscape, public safety, and the local environment.	Yes

Certification		Status
BREEAM New Construction V6.0 BRE, 2022	The Building Research Establishment Environmental Assessment Method (BREEAM) is a widely used environmental assessment methodology for non-domestic buildings, covering a broad range of sustainability categories. This includes Management, Health and Wellbeing, Energy, Transport, Water, Materials, Waste, Land Use & Ecology and Pollution. The methodology is used to quantify and reduce the environmental impacts of the built environment by rewarding designs that take positive steps to minimise their environmental effects. Undertaking a BREEAM assessment and integrating the associated design requirements into the scheme helps to set Best Practice sustainability standards across a broad range of building design, construction and operational targets, summarised by a single rating, from 'Pass' to 'Outstanding'.	'Very Good' rating targeted for the Office Block. The proposed development currently achieving 'Very Good'

4. Methodology

A comprehensive energy and carbon dioxide (CO_2) emissions assessment has been carried out for the development to incorporate a higher level of energy efficiency and reduce CO_2 emissions performance than that required by the 2010 Building Regulations 2022 edition. This analysis has included:

- Assessment of the non-domestic components of the scheme under the Building Regulations 2010 Approved Document L, Conservation of fuel and power, Volume 2: Buildings other than dwellings, 2022 edition calculation of the Building CO2 Emissions Rate (BER) through EDSL TAS v9.5.6 accredited software.
- A hierarchal design approach to develop an Low Carbon and Renewable Energy Assessment in line with industry best practice and the Welsh Government Energy Hierarchy.
- A review of how through passive design measures energy demand is reduced.
- A summary of building system performance targets that ensure efficient operations and reduced carbon emissions.
- A feasibility review of all potential low and zero carbon technologies in relation to the site and building. These sections are structured to respond to the BREEAM NC V6.0 credit Ene04 'Zero Carbon Design'.

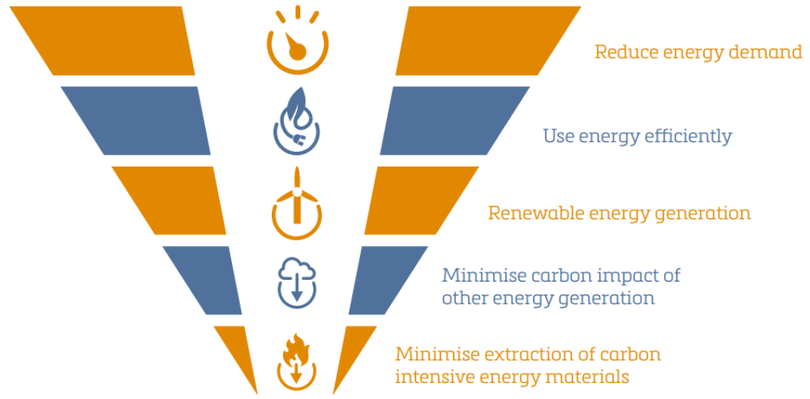


Figure 6 The Energy Hierarchy Design Approach (Planning Policy Wales)

4.1. Energy Modelling

Dynamic Thermal Modelling (DTM) methodology has been used to demonstrate compliance with Part L 2010 (2022 edition) of the Welsh Building Regulations. This advanced simulation method provides a detailed, time-based analysis of a building's thermal performance, accounting for variables such as weather conditions, occupancy patterns, and internal heat gains.

Unlike static calculations, dynamic modelling enables a more nuanced understanding of energy demand by evaluating how temperature, ventilation, and solar gains interact across the modelled spaces of the Proposed Development.

This approach ensures that designs can meet or exceed the stringent energy efficiency requirements of Part L while optimizing occupant comfort.

Considering that he proposed warehouse space is unheated, the Proposed Development is classed as a "Building with low energy demand". Following the guidance of Approved Document L2, Paragraph 2.13, the thermally partitioned Office Block is treated as a separate building and is assessed against Part L of the Welsh Building Regulations following normal procedures. A wireframe view of the model, highlighting the assessed office block can be seen below.

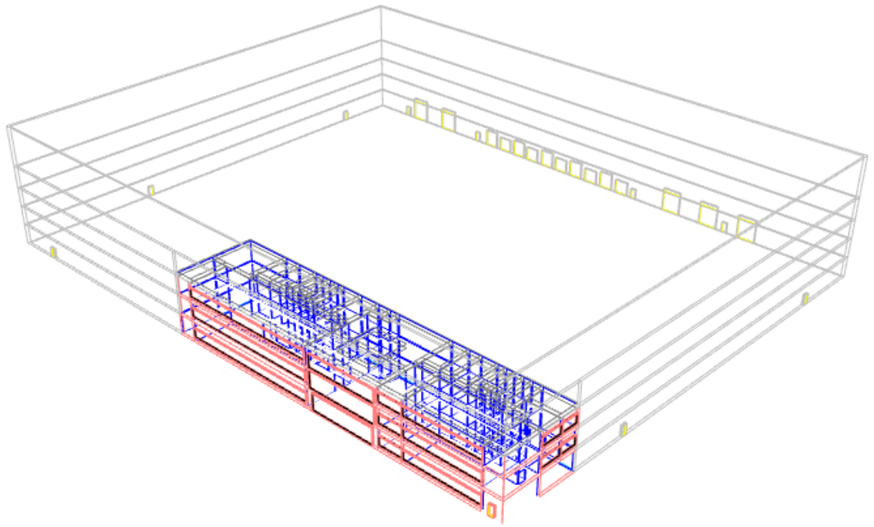


Figure 7 Wireframe view of the Part L model of the Proposed Development

4.1.1. Weather Data

In accordance with the NCM Modelling Guide (2021 Edition) CIBSE 2016 TRY Cardiff (as the only approved weather file for the proposed site) has been used in the calculation.

4.1.2. Internal Conditions

The internal conditions used within the DTM model for the purposes of Building Regulation compliance are specified in the Simplified Building Energy Model (SBEM) database. The v6.1b NCM Conditions have been used for Part L compliance.

4.1.3. System and Fabric Parameters

The building model has been setup with performance parameters for passive, active and renewable systems as described in the following sections.

4.2. Report Author

This report has been prepared by Dmitri Korolenko who is an energy specialist with over 10 years of experience in preparing energy strategies. The author has substantial experience in providing building sustainability and energy efficiency advice to clients and project teams and achieving challenging low carbon targets. He is an accredited Low Carbon Consultant and Low Carbon Energy Assessor and is not professionally connected to any building system or technology manufacturers.

5. Reduce Energy Demand

Within the first stage of the energy hierarchy, it was proposed to incorporate high levels of passive and energy efficient design measures in order to reduce the Proposed Development's energy demand.

Design recommendations were provided to the project architect and preliminary tests carried out enabling the development of a strategy from an early stage.

The table below summarises some of the viable energy demand reduction measures identified forming part of the design approach.

Table 1 – Energy Demand Reduction Measures Summary.

Efficiency measures	Commentary	Scope
		Office Block
Site orientation	The site orientation was fixed.	×
Site layout optimization	The layout and location of the office block have been optimised to guarantee enough level of daylight while reducing cooling requirements and a risk of overheating.	✓
Enhanced U-value	Enhanced U-values for both opaque and transparent elements.	✓
High performance glass	Solar control glazing within the West façade, balancing passive solar control versus overheating on the commercial floors.	✓
Glazing percentage of the facade	The glazing percentage of the exposed facade seeks to achieve a balance between overheating/thermal comfort, ingress of daylight and heat gains from the façade.	✓
Air-tightness improvement	Improved levels of air tightness exceeding regulation requirements.	✓
Thermal bridging	Low thermal bridging applying DCLG Approved Construction Details and use of Ψ values calculated using the guidance set out in BR 497.	✓
Thermal mass	A lightweight structure is proposed due to building type.	×
Natural ventilation	The building will be fully mechanically ventilated.	×
Lighting	Energy efficient lighting systems.	✓
Lighting control	Presence detection on lighting controls in common areas.	✓
Mechanical ventilation	Heat recovery integrated into ventilation systems.	✓
SFP	Low energy, variable volume fans in ventilated areas.	×
Heating	High efficiency Variable Refrigerant Flow plant for heating.	✓
Cooling	High efficiency Variable Refrigerant Flow plant for cooling.	✓

5.1. Passive Design

The fabric's thermal and air permeability performance level exceeds the Part L: 2010 (2022 edition) minimum standards and the following tables outline the U-values of the external envelope for the opaque and transparent elements. Additionally, for the glazing, the light transmission has been maximised in order to increase the availability of natural light and reduce the use of artificial lighting. The glazing percentage of the buildings is 30% and seeks to achieve a balance between overheating/thermal comfort, ingress of daylight and heat losses/gains from the façade. The values in the following table highlight the performance against Part L limiting values.

*Table 2 - **Proposed Building Envelope Thermal Properties.***

Opaque Fabric Performance	Part L Limiting Values W/m²K	Office Block W/m²K	Warehouse W/m²K
External wall	0.26	0.15	0.26
Roof (flat)	0.18	0.15	-
Roof (pitched)	0.16	-	0.16
Ground Contact Floor	0.18	0.15	0.18
Air Permeability	8 m³/(h.m²) @50Pa	3m³/(h.m²) @50Pa	8 m³/(h.m²) @50Pa

External wall refers to any exposed walls and walls between the office block and warehouse.

Roof refers to the top roof of the building and any terrace/exposed ceiling.

Table 3 - Proposed Glazed Façade Performance Properties.

Glass Performance	Part L Limiting Values (W/m²K)	Proposed performance W/m²K
Assembly U-value, (W/m²K)	1.6	1.5
Light transmission (%)	-	0.76
North Façade Solar transmittance (g-value)	-	0.56
West Façade Solar transmittance (g-value)	-	0.35

5.2. Overheating Risk Analysis

To ensure the proposed design provides high levels of internal thermal comfort, an overheating risk analysis has been undertaken aligned with the proposed layouts, design assumptions and fabric properties. The analysis has revealed that all occupied spaces within the development achieve compliance with CIBCE Guide A criteria for air-conditioned spaces under current and future climate scenarios. The full report describing the calculation methodology, findings and results of the overheating study is provided as part of the BREEAM evidence issue pack. Overheating risk analysis results demonstrate that the Proposed Development will provide comfortable environment for occupants and is resilient to changes in external temperatures due to climate change. The Proposed Development demonstrates achievement of BREEAM Hea04 Thermal Comfort credits.

6. Use Energy Efficiently

High efficiency targets for plant and equipment are specified to limit energy consumption and carbon emissions, while ensuring the achievement of best practice indoor environment, system performance and controls.

6.1. Lighting

The proposed design includes a highly glazed façade for maximising daylight provision with artificial lighting provided by high efficacy luminaires. All luminaires shall be controlled automatically by presence or absence detection (based on space type and requirement). All luminaires in perimeter spaces with access to windows shall be equipped with photoelectric daylight dimming controls. The following table details the proposed light power densities and controls:

Table 4 Proposed Lighting Performance.

Use	Power density (W/m²)	Illuminance (lux)	Occupancy Sensing	Daylight control
Offices (Perimeter)	5	400	*Man ON/Auto OFF*	*Daylight Dimming*
Offices (Internal)	5	400	*Man ON/Auto OFF*	*None*
Atrium	6	200	*None*	*None*
Warehouse	6	200	*Auto ON/Auto OFF*	*None*
Toilet	7	200	*Auto ON/Auto OFF*	*None*
Changing rooms	7	200	*Auto ON/Auto OFF*	*None*
Stores	7	100	*Auto ON/Auto OFF*	*None*
Corridors	7	200	*Auto ON/Auto OFF*	*None*
Stairs	6	100	*Auto ON/Auto OFF*	*None*
Comms Room	5	200	*Auto ON/Auto OFF*	*None*

6.2. Mechanical Systems

The efficiency performance of mechanical systems has been carefully assessed and selected to exceed Part L: 2010 (2022 edition) minimum compliance requirements. A Variable Refrigerant Flow (VRF) system has been selected to serve the building's heating and cooling demand. VRF is a type of Air Source Heat Pump which uses refrigerant to deliver heating and cooling at very high efficiencies. Ceiling mounted cassette units respond to local demand and allow for exchanging heat between parts of the building. further reducing system energy consumption.

In order to ensure the occupied areas achieve highest standards of air quality and acoustic performance, the building shall be fully mechanically ventilated by local Mechanical Ventilation with Heat Recovery (MVHR) units. MVHR units use plate heat exchangers to recover energy from exhaust air, significantly reducing space heating and cooling requirement. Operated based on CO_2 sensors, the units modulate fan speeds to optimise internal air quality and energy consumption.

As the Proposed Development is in early stages of design, the proposed system efficiencies are to be taken as targets and are to be reviewed as design develops.

Table 5 Proposed Mechanical System Efficiencies

Use	System	Heating Source Seasonal Efficiency	Cooling Source Seasonal Efficiency	Heat Recovery efficiency	Ventilation Plant SFP (W/(l/s))		
					SP	EX	TR
Offices	VRF with Mechanical Ventilation	350%	550%	80%	0.6	0.6	-
Kitchenette	VRF with Mechanical Ventilation	350%	550%	80%	0.6	0.6	-
Atrium	VRF with Natural Ventilation	350%	550%	-	-	-	-
Stairwells	Local heaters with Natural Ventilation	100%	-	-	-	-	-
Toilets and changing	Local heaters with Extract	100%	-	-	-	0.5	-
Storerooms	Extract Only	-	-	-	-	-	-
Plant rooms	Unheated	-	-	-	-	-	-
Corridors	Unheated	-	-	-	-	-	-

Further to the above specifications:

- A power factor correction (> 0.95) will be included to improve the electric stability and efficiency of the transmission network.
- Mechanical ventilation systems are controlled via local CO_2 sensors and time switching as appropriate.

The Proposed Development includes relatively large shower facilities to accommodate active travel and provide amenity to warehouse workers. An energy efficient heat pump unit shall generate the building's hot water requirement, complimented by a highly insulated hot water storage cylinder. This system design ensures the building's energy demand is met efficiently.

Table 6 Hot Water System Efficiency

Use	System	Heating Source Gross Seasonal Efficiency	Total Storage volume (litres)
Domestic Hot water	Air Source Heat Pump	250%	500

7. Renewable Energy Generation

All commercially available Low and Zero Carbon options have been reviewed with respect to the Proposed Development. These technologies have been considered within the constraints of the prevailing environmental conditions, building operation, loads, building services integration, financial viability, architectural design, capital and maintenance costs with associated payback and overall effective carbon dioxide reduction.

Table below sets out the complete list of potential low and zero and renewable technologies along with their concluding viability for this development. Further details of each technology and associated assessment in relation to the development are provided in Appendix A.

Table 7 Summary of Renewables Sources Appraisal

Technology	Feasible	Notes	Included within the proposals?
Solar Photovoltaics	**Yes**	Photovoltaic (PV) panels convert the suns energy into electricity. As the Proposed Development is solely electricity serviced, offsetting imported energy from the grid will benefit the scheme. The minimal overshading of the site, and an extensive roof area of the Proposed Development allows a large array to be deployed and effectively utilised.	**Yes**
Combined Heat and Power	**No**	A Combined Heat and Power (CHP) plant integrates the production of heat and power into a single, highly efficient process. CHP is considered feasible where the heating requirement of a scheme brings together many small intermittent loads to form a substantial base load demand for heat. As the development consists of office and warehouse space, and therefore has low base load demand and intermittent heat demand, CHP was not considered a technically feasible and cost effective option.	**No**
Solar Thermal	**No**	Solar thermal panels convert the suns energy into hot water and are typically used to pre heat domestic hot water systems. Unless the system is significantly oversized, solar thermal cannot sustain the demands through the months where the solar resource is at its weakest, and when the DHW demand is at its highest. For this reason, it ismore favourable to utilise roof space to install photovoltaic panels (PV) in lieu of solar thermal.	**No**
Bio-fuel Heating	**No**	There are currently a number of environmental concerns regarding the use of biofuel in buildings. These include, fuel transportation / storage issues, potential air quality impact and resulting flue structure, plant space / storage requirements & maintenance requirements.	**No**

Technology	Feasible	Notes	Included within the proposals?
Ground Source Heat Pump	**No**	Ground source heat pumps make use of the relatively stable ground temperatures to improve the efficiencies of the heat pumps compared to an air source option. A high -level feasibility study of GSHP has concluded that the heat pump is a feasible technology for this specific site. However, It would require extensive excavation works that would make this technology unfeasible.	**No**
Air Source Heat Pump	**Yes**	Air source heat pumps (ASHP) are like ground source heat pumps but extract heat from the ambient air rather the ground. The efficiency of air source heat pumps are generally lower than ground source heat pumps. Alternative technology such as CO_2 air source heat pumps may also be considered for domestic hot water systems to maximise energy efficiency.	**Yes**
Wind power	**No**	There is considerable evidence of urban wind turbines failing to perform to manufacturer's output estimates. Significant planning and integration issues also exist and consequently wind turbines are not viable.	**No**

7.1. Solar Photovoltaics Assessment

Following the analysis of all viable Low and Zero carbon technologies and the assessment of project targets it has been proposed to integrate a solar photovoltaic array on the building's roof. The following table summarises the performance parameters of the proposed array.

Table 8 – PV Performance Summary

Performance Summary	Value	Unit
Approximate total net area of active PV	350	m^2
System size	77	kWp
Estimated electricity generation	60,127	kWh/annum
Total CO_2 emissions reduction	7.55	Tonnes CO_2/annum
Total CO_2 emissions reduction	30%	% CO_2 of regulated scheme emissions
CAPEX (approximate)	138,600	£
Feed in Tariff rate	Unknown	p/kWh
Export tariff	Unknown	p/kWh
Electricity cost saved	18,904	£/annum
Simple payback	7.3	Years
Expected lifetime	20	Years

8. Summary

This Low Carbon and Renewable Energy Assessment outlined for the Proposed Development demonstrates full compliance with Part L 2010 (2022 edition) of the Building Regulations, exceeding compliance target by 73%. In accordance with Planning Policy Wales energy hierarchy the Proposed Development incorporates the following design measures:

Reduce Energy Demand

- Optimised façade to provide high levels of insulation and access to daylight.
- Highly insulated building elements.
- High levels of air tightness.

Use Energy Efficiently

- High efficacy lighting systems.
- Lighting occupancy and daylight controls.
- Space conditioning though a high efficiency VRF system with simultaneous heating & cooling and heat recovery.
- Mechanical Ventilation with Heat Recovery operated with local CO_2 sensors.
- High efficiency Air Source Heat Pump hot water system with highly insulated storage cylinder.

Generate Renewable Energy

- A solar photovoltaic array of 350m^2 will offset around 30% of the office block's carbon emissions.

This comprehensive approach ensures that the Proposed Development not only meets but exceeds the energy performance standards required by Part L and complies with all local planning policies aimed at addressing climate change.

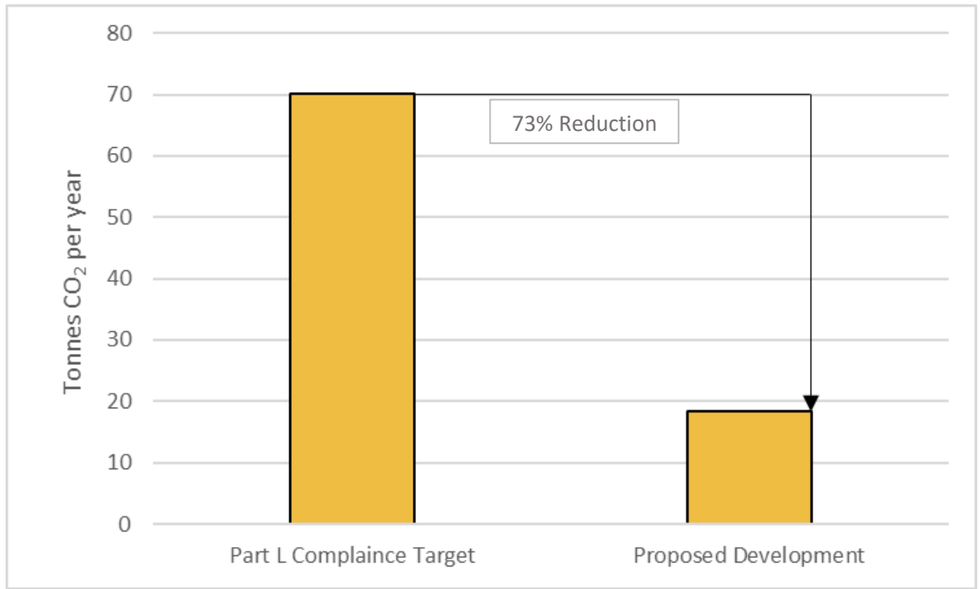


Figure 8 – Carbon Emission Performance of the Proposed Development

9. Appendix A

9.1. LZC Technology Appraisal

A preliminary low zero carbon technology feasibility study has been produced to compare available technologies.

9.1.1. Photovoltaics (PV)

Photovoltaic cells directly convert sunlight into electrical current using semi-conductors. The output of a cell is directly proportional to the intensity of the light received by the active surface of the cell. Exposure to sunlight causes electricity to flow through the cells. Direct sunlight produces the greatest output, but power is produced even when overcast.

Table 9 Viability of PV

Discussion	Commentary
Local planning criteria	Policy RE1
Feasibility	The building's location and orientation perfectly lend itself for PV integration. No local overshading have been identified. As this is an all-electric development, it is likely that a large fraction of electricity generated from a PV array would be used on-site. Excess energy will be exported to the grid to generate income.
Available grants and subsidies	Could be eligible for Smart Export Guarantee (SEG) that replaced Feed in Tariffs. Alternative tariff options and incentives will be sought during the procurement stage. However, SEG includes only an export tariff and the Proposed Development is likely to use all of the produced electricity on-site.
Microgeneration certification Scheme (MCS)	Will require certification to apply for the SEG.
Reasons for excluding this technology	None
Is integrated PV recommended?	**YES**

9.1.2. Combined Heat and Power (CHP)

The potential integration of conventional gas-fired CHP plant to provide heat and power on site has been evaluated for the development, in compliance with industry best practice and appropriate planning policies.

Decentralised CHP recovers the waste heat from a site-based power generation prime mover (e.g. engine) via the engine water jacket, exhaust gases and oil cooler (dependent on model).

While CHP is still conventionally considered a low-carbon technology, electricity produced by the CHP from combusting fuel will now be more carbon intensive than grid electricity, which is undergoing rapid decarbonisation. CHP can only prove beneficial financially when serving a constantly high heating or hot water baseload.

Table 10 Viability of CHP

Discussion	Commentary
Local planning criteria	Policy RE1 Air quality considerations to be considered with respect to NOx levels from combustion process.
Feasibility	CHP plant would normally be sized on the minimum base load for optimum operation, with back-up boilers and thermal storage to address demand-led higher and peak loads.
Available grants and subsidies	CHP (1-2kW) eligible for FIT Only CHP that generates heat from geothermal, biogas, solid biomass contained in waste, or solid biomass, and meet the specific operational criteria are eligible for the Non-Residential RHI.
Microgeneration certification Scheme (MCS)	MSC certificate would be required through the procurement process, where CHP is specified.
CHPQA standard certification	A CHPQA standard certificate would be required through the procurement process, where CHP is specified.
Reasons for excluding this technology	The Proposed Development will be served by all electric systems in line with the net zero carbon aspirations of the UK. Heating and hot water baseload is not high enough for this system to be financially viable. This technology is therefore discounted.
Is integrated CHP recommended?	NO

9.1.3. Solar Thermal Systems

A solar thermal array converts sunlight into heat, typically to integrate into a building's hot water service. The system can be further supported by traditional 'top up' boilers when the solar resource is insufficient, or the relative hot water demand is too great for the solar thermal system alone to support.

A solar water heating system usually consists of solar collector(s) that absorbs solar energy, a hot water storage tank, a back-up energy source, pump and controls. Performance of solar thermal systems can vary depending on the technology and the location, with a typical installation being an angled array that is roof mounted.

Table 11Viability of Solar Thermal Systems

Discussion	Commentary
Local planning criteria	Policy RE1 Roof-mounted solar thermal panels must not exceed the height restrictions imposed on the development. Safe access around the panels and to other roof plant should be maintained.
Feasibility	The combination of a small and intermittent domestic hot water load, and high maintenance requirements make this system unviable.
Available grants and subsidies	There are currently no commercial grants available for Soar Hot Water.
Microgeneration certification Scheme (MCS)	MSC certificate would be required through the procurement process, where solar thermal is specified.
Reasons for excluding this technology	High maintenance requirements and low demand for hot water.
Is Solar Thermal recommended?	NO

9.1.4. Biofuel

Biofuels have the potential to contribute to the reduction of CO_2 emissions of various developments by using this fuel within a boiler or CHP plant, in place of fossil fuels. Biofuels are considered to have low or zero CO_2 intensities, as theoretically the CO_2 released when these fuels are combusted is no greater than the CO_2 that has been absorbed from the atmosphere when the plants grow. CO_2 emissions attributed to biofuels are those associated with the collection, processing, and distribution of the biofuels, and are available as liquid or solid fuels.

Liquid fuels are generally named biodiesel and are available in various blends with traditional fossil fuel oil, up to 100% biofuel (B100). Biodiesels can be produced from virgin crops or by recycling waste oils. Solid biofuel or biomass is typically wood chips or wood pellets. Wood pellets have a greater density and subsequent heat to volume ratio, with benefits regarding on site storage requirements. They also 'flow' better, improving the delivery process, but carry a cost premium over wood chips. Other biofuels broadly include biogases from waste, sewage or landfill gas processes. However, this is not usually available or compatible with the urban built environment.

The following considerations would be required of biofuel technologies:

- The impact on local air quality.
- The maintenance regime of boiler because of biofuel use.
- The sustainability and carbon intensity of the biofuel in line with the Government's Renewable Transport Fuel Obligation (RTFO).
- Fuel storage on site.

Table 12 Viability of Biofuels

Discussion	Commentary
Local planning criteria	Policy RE1 Biofuel combustion needs to be accounted for in an Air Quality Assessment.
Feasibility	A biofuel combustion system, will be sized on the baseload of a development backed by an energy storage system. It is unlikely that energy will be available for export and due to the high efficiency fabric, the base load will be small making a bio-fuel system inefficient and troublesome in operation.
Available grants and subsidies	There are currently no commercial grants available for Biofuel technologies.
Microgeneration certification Scheme (MCS)	Plants using solid biomass that are less than or equal to 45kWth must have Microgeneration Certification Scheme (MCS) or its equivalent.
Reasons for excluding this technology	The Proposed Development will be served by all electric systems in line with the net zero carbon aspirations of the UK. This technology is therefore discounted.
Is biofuel recommended?	NO

9.1.5. Wind Power

Wind turbines have the potential to generate renewable electricity, using turbine blades to capture the wind in order to turn a generator. Wind turbines have been designed and sized to suit the urban and rural environment, as well as the more traditional larger machines serving the electricity grid.

Table 13 Viability of Wind Power

Discussion	Commentary
Local planning Criteria	Policy RE1 Significant planning issues may to exist for wind turbine masts proposed within this location, with respect to heritage, height and townscape impact issues.
Feasibility of exporting energy from the system	Wind turbines in urban contexts are likely to generate a very small proportion of the electrical demand of a commercial building.
Available grants and subsidies	There are currently no commercial grants available for Wind Power.
Microgeneration certification Scheme (MCS)	MCS required for small installations.
Reasons for excluding this technology	Wind turbines in an urban environment are unlikely to have a yield that makes them a feasible option.
Is Wind Power recommended?	NO

9.1.6. Battery Storage

Energy storage can be used in various ways to enhance the reliability, resilience, and efficiency of building operations. Based on the type of energy which needs to be stored, energy storage type varies. Batteries are one of the most popular forms of electricity storage. Large scale manufacturing and production of batteries have given it a significant portion of the commercially viable energy storage market. Batteries consist of a range of technologies varying in size, shape, and chemistry. Batteries are usually used for short term storage (1 to 6 hours).

Table 14 Viability of Battery Storage

Discussion	Commentary
Local planning Criteria	Policy RE1 For small scale units there is no need for planning permission. However, considering that are highly sensitive to temperature, the building or container is typically provided with an active cooling system to maintain the batteries within an optimal temperature range and availability of such space should be considered at early design stage.
Available grants and subsidies	There are currently no commercial grants available for Battery Storage.
Microgeneration certification Scheme (MCS)	N/A
Reasons for excluding this technology	Proposed renewable electricity generation is not large enough to significantly benefit from battery storage. This system, therefore, is not financially feasible.
Is battery storage recommended?	NO

9.1.7. Ground Source Heat Pump

Ground Source Heat Pumps recover heat from the ground by circulating water within pipes (closed loop) or by extracting water from the ground (open loop) which can be used for heating and cooling cycles. Typically, they are a system which would be installed with multiple bore holes to a depth of up to 125 metres depending on the ground conditions.

The efficiency of ground source heat pumps is measured by Co-efficient of Performance (CoP), this is the ratio of units of heat output for each unit of electricity used to drive the compressor and pump for the ground loop. An average CoP is around 4- 7 although some systems may produce a greater rate of efficiency. This means that for every unit of electricity used to pump the heat, 2-4 units of heat are produced, making it an efficient way of heating a building.

Table 15 Viability of Ground Source Heat Pump

Discussion	Commentary
Local planning criteria	Policy RE1
Feasibility	GSHPs are feasible for the most building types, subject to a detailed ground condition analysis and detailed design. However, due to the existing site having many compact and impaired features from underground services, this technology would be extremely difficult to integrate for any real benefit.
Available grants and subsidies	There are currently no commercial grants available for Ground Source Heat Pumps.
Microgeneration certification Scheme (MCS)	MSC certificate would be required through the procurement process.
Reasons for excluding this technology	Potential areas required for bore holes. Subject to ground condition assessment. Significant numbers of under ground services. Restricted plot sizes. Water extraction quality.
Is Ground Source Heat Pump recommended?	NO

9.1.8. Air Source Heat Pump

Air Source Heat Pumps (ASHP) recover heat from the air which can be used for heating and cooling requirements. Typically, they are a system which would be installed at roof top or ground level and require relatively large areas of external plant space allocation.

The efficiency of air source heat pumps is measured by Co-efficient of Performance (CoP), this is the ratio of units of heat output for each unit of electricity used to drive the compressor and pump. An average CoP is around 2- 4 although some systems may produce a greater rate of efficiency. This means that for every unit of electricity used to pump the heat, 2-4 units of heat are produced, making it an efficient way of heating a building.

Considering the internal conditions requirements for offices, a system that can provide both heating and cooling would be beneficial. ASHPs are a perfect low carbon system candidate for this scenario and can be integrated with either water-based or refrigerant-based configurations. An ASHP system is proposed as the primary means of space conditioning in the Proposed Development.

Table 16 Viability of Air Source Heat Pump

Discussion	Commentary
Local planning criteria	Policy RE1
Feasibility	ASHPs are feasible for the site, subject to allocating adequate plant space.
Available grants and subsidies	There are currently no commercial grants available for Air Source Heat Pumps.
Microgeneration certification Scheme (MCS)	MSC certificate would be required through the procurement process.
Reasons for excluding this technology	None
Is Air Source Heat Pump recommended?	YES

9.1.9. Water Source Heat Pump

Water Source Heat Pumps recover heat from water which can be used for heating and cooling requirements. Typically, they are a system which would be installed at ground level and require a body of water to draw energy from.

The efficiency of water source heat pumps is measured by Co-efficient of Performance (CoP), this is the ratio of units of heat output for each unit of electricity used to drive the compressor and pump. An average CoP is around 4-7 although some systems may produce a greater rate of efficiency. This means that for every unit of electricity used to pump the heat, 4-7 units of heat are produced, making it an efficient way of heating a building.

Table 17 Viability of Air Source Heat Pump

Discussion	Commentary
Local planning criteria	Policy RE1
Feasibility	WSHPs are feasible for the site, subject to detailed ground/water condition analysis and detailed design. However, due to the existing site having many compact and impaired features from underground services, this technology would be extremely difficult to integrate for any real benefit.
Available grants and subsidies	There are currently no commercial grants available for Water Source Heat Pumps.
Microgeneration certification Scheme (MCS)	MSC certificate would be required through the procurement process.
Reasons for excluding this technology	No body of water locally available for heat exchange.
Is Water Source Heat Pump recommended?	NO

10. Appendix B

10.1. BRUKL Document Extract

BRUKL Output Document

Compliance with Wales Building Regulations Part L 2022

Llywodraeth Cymru Welsh Government

Project name

Land South of Bryn Lane — As designed

Date: Mon Feb 10 16:17:09 2025

Administrative information

Building Details

Address: Wrexham Industrial Estate, Wrexham, LL13 9XW

Certifier details

Name: Dmitrijs
Telephone number: +447827308424
Address: Neo, 9 Charlotte Street, Manchester, M1 4ET

Certification tool

Calculation engine: TAS
Calculation engine version: "v9.5.6"
Interface to calculation engine: TAS
Interface to calculation engine version: v9.5.6
BRUKL compliance module version: v6.1.e.0

The CO_2 emission and primary energy rates of the building must not exceed the targets

Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	19.65	
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	5.27	
Target primary energy rate (TPER), $kWh_{PE}/m^2.annum$	108.11	
Building primary energy rate (BPER), $kWh_{PE}/m^2.annum$	55.98	
Do the building's emission and primary energy rates exceed the targets?	BER =< TER	BPER =< TPER

The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Fabric element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	First surface with maximum value
Walls*	0.26	0.18	0.18	EW 0.47 (Heavyweight)
Floors	0.22	0.15	0.15	GF (office)
Pitched roofs	0.2	-	-	No pitched roofs in project
Flat roofs	0.2	0.15	0.15	R (Office)
Windows**	1.6	1.48	1.48	W_02_N
Roof windows	1.8	-	-	No roof windows in project
Rooflights***	2.2	-	-	No rooflights in project
Personnel doors	1.8	-	-	No personnel doors in project
Vehicle access & similar large doors	1.3	1.2	1.2	PD_01
High usage entrance doors	3	-	-	No high usage entrance doors in project

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)] — $U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for roof windows.
** Automatic U-value check by the tool does not apply to glazed doors whose limiting standard is similar to that for personnel doors. Display windows and similar glazing are excluded from the U-value check.
*** Values for rooflights refer to the horizontal position.
NB: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air permeability	Limiting standard	This building
$m^3/(h.m^2)$ at 50 Pa	8	3

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m^2]	3564	3564
External area [m^2]	2298	2298
Weather	CAR	CAR
Infiltration [m^3/hm^2@ 50Pa]	3	5
Average conductance [W/K]	982	1038
Average U-value [W/m^2K]	0.43	0.45
Alpha value* [%]	27.04	12.04

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
	Offices and Workshop Businesses
	General Industrial and Special Industrial Groups
98	**Storage or Distribution**
	Hotels
	Residential Institutions: Hospitals and Care Homes
	Residential Institutions: Residential Schools
	Residential Institutions: Universities and Colleges
	Secure Residential Institutions
	Residential Spaces
	Non-residential Institutions: Community/Day Centre
	Non-residential Institutions: Libraries, Museums, and Galleries
	Non-residential Institutions: Education
	Non-residential Institutions: Primary Health Care Building
	Non-residential Institutions: Crown and County Courts
	General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger Terminals
	Others: Emergency Services
2	**Others: Miscellaneous 24hr Activities**
	Others: Car Parks 24 hrs
	Others: Stand Alone Utility Block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	1.63	11.33
Cooling	4.32	4.46
Auxiliary	3.24	4.82
Lighting	12.5	10.77
Hot water	33.01	81.2
Equipment*	42.13	42.13
TOTAL**	**54.7**	**112.58**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	16.87	17.75
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*16.87*	*17.75*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	102.85	111.24
Primary energy [kWh_{PE}/m^2]	55.98	108.11
Total emissions [kg/m^2]	5.27	19.65

Hilson Moran

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