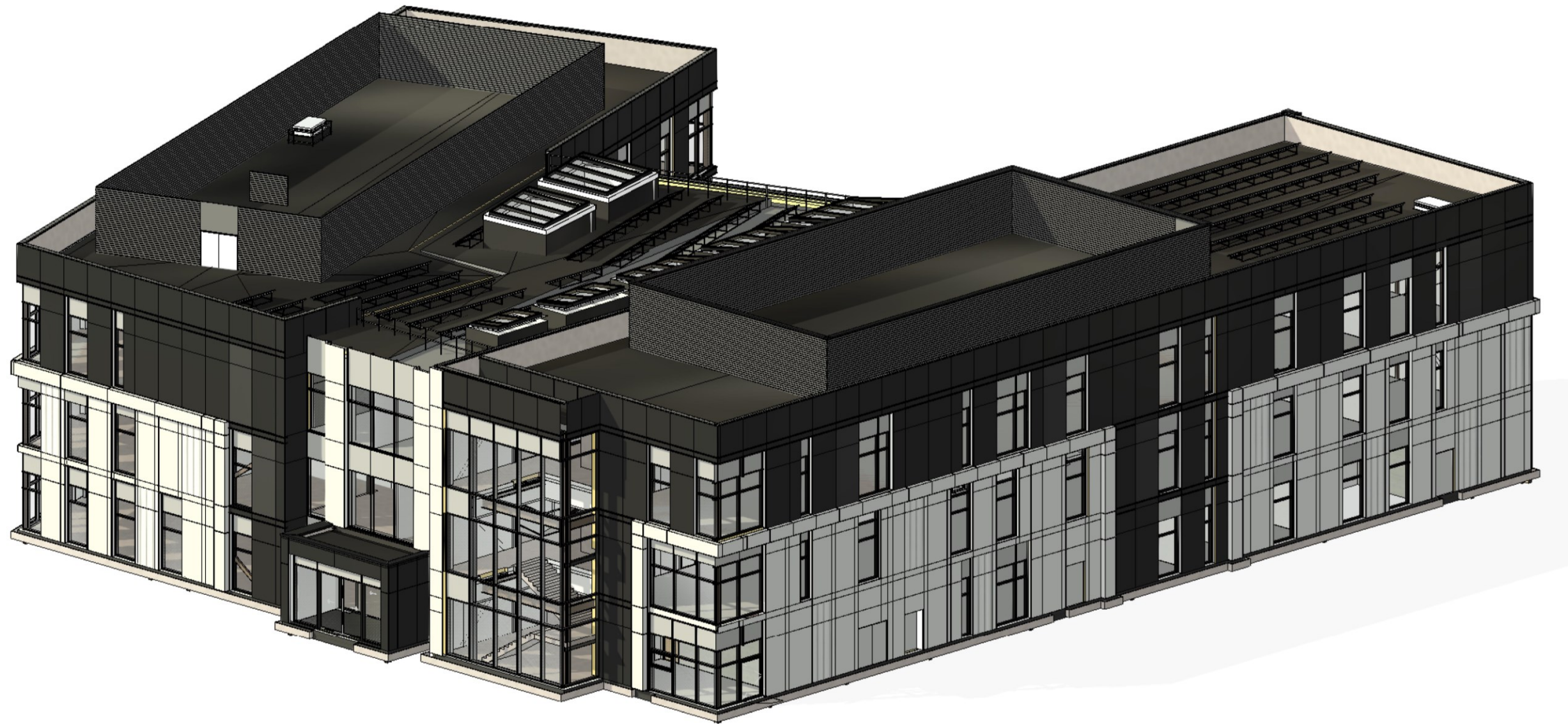




Project:

JD Sports Campus – Hub Building

Report Title:

Energy Strategy Report

Client: JD Sports PLC

Revision Date: 11/9/2024

Doc Ref: 220906-KRD-HB-XX-RP-Y-0002

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1 Document History and Validation

1.1 Revision History

Revision	Issue Date	Reason for Issue
Rev-	11 September 2024	Reserved Matters Planning Submission

1.2 Document Validation (Latest Issue)


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DILON HILTON

2 Introduction

JD Sports fashion PLC (herein referred to as JD) is set to enhance and expand its headquarters at the Pilsworth site in Bury, Greater Manchester. The planned developments include new commercial offices, a gym, a restaurant, and cutting-edge outdoor facilities.

The project is focused on delivering a sustainable design that is:

- **Commercially sustainable**
- **Based on fabric-first principles**, emphasizing low energy usage and locally sourced materials where possible
- **Incorporating energy-efficient systems**
- **Achieving a 30% improvement** over the Building Regulations Part L 2013 Target Emission Rate (TER), in compliance with the Bury Unitary Development Plan. The proposed scheme has also been assessed against Part L, 2021, demonstrating a 7% improvement over the TER and a 9% improvement over the target primary energy rate.
- **Utilising robust material selections**
- **Aligning with JD's ESG approach**, aiming to exceed current policies and standards while meeting JD's needs
- **Not relying on third-party certification** unless it specifically benefits JD and enhances its commitment to sustainability and corporate climate action.

This document aims to outline the energy strategy for the project and demonstrate how it aligns with local and regional planning policies. It is part of the reserved matters planning application and will inform the Bury Council planning department about the energy and sustainability strategy for the site.

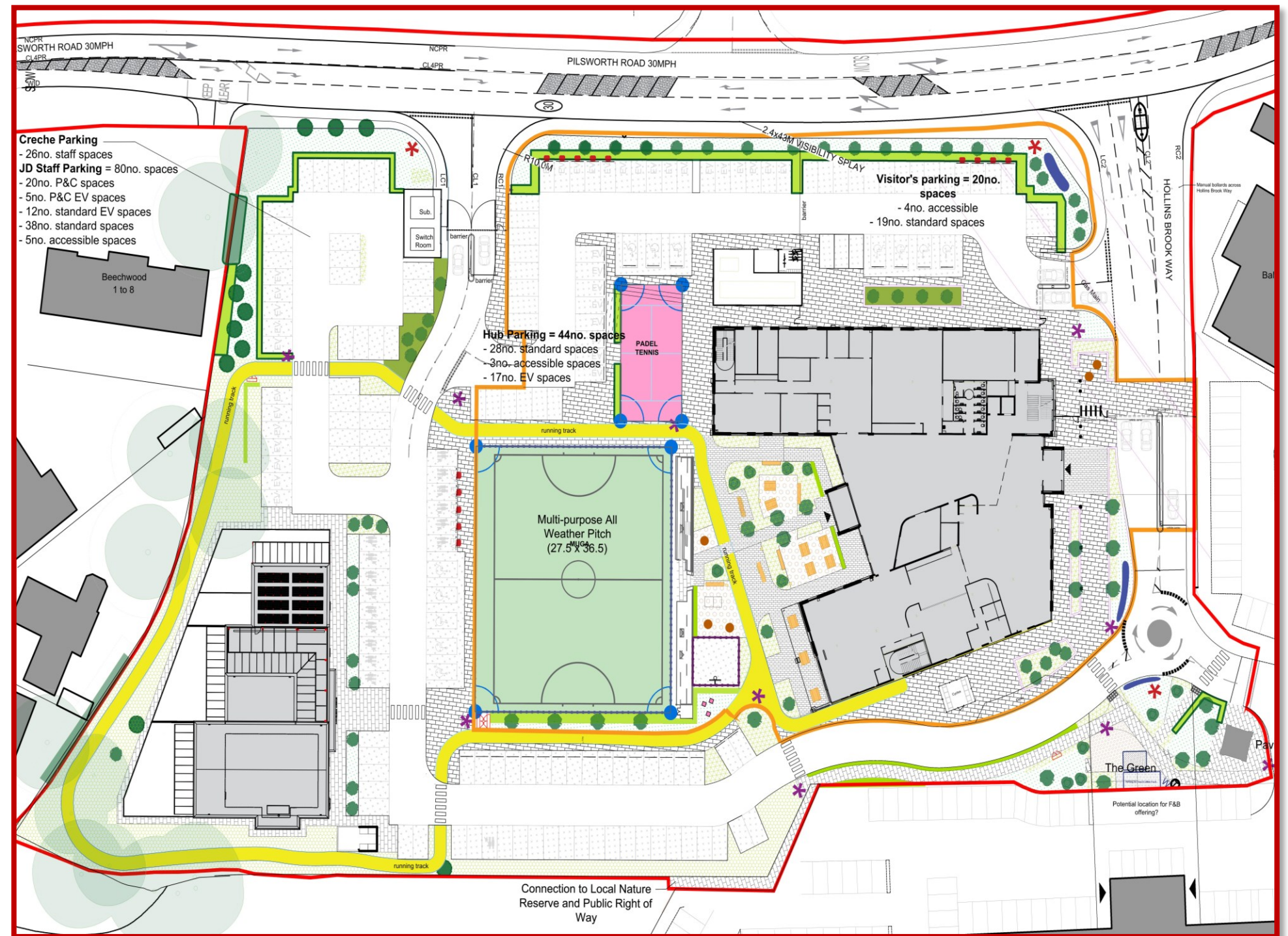


Figure 1-Proposed site plan.

3 Policy and Guidance

3.1 Policy and Guidance

This section sets out the National and Local planning policy and regulations that the site will comply with.

3.1.1 Planning Policy

The project will be designed and constructed in accordance with both national and local planning policies. It will take into account the National Planning Policy Framework (2021) (NPPF), the supporting National Planning Practice Guidance (PPG), the Local Plan Core Strategy (2016), and the saved policies of the Unitary Development Plan (1996-2016).

For this development, several aspects of the National Planning Policy Framework (NPPF) are particularly relevant:

- **Achieving Sustainable Development:** The NPPF emphasizes the importance of sustainable development, which includes economic, social, and environmental objectives. This project aligns with these goals by promoting energy efficiency, using locally sourced materials, and enhancing the local environment
- **Plan-Making:** The NPPF outlines the need for local plans to guide development. This project will need to comply with the Local Plan Core Strategy and the saved policies of the Unitary Development Plan
- **Decision-Making:** The NPPF encourages a presumption in favour of sustainable development, meaning that planning applications that comply with local and national policies should be approved without delay
- **Promoting Sustainable Transport:** Ensuring that the development supports sustainable transport options, such as cycling and public transport, is a key aspect of the NPPF.
- **Meeting the Challenge of Climate Change:** The NPPF requires developments to mitigate and adapt to climate change, which includes improving energy efficiency and reducing carbon emissions
- **Achieving Well-Designed Places:** The NPPF stresses the importance of high-quality design that reflects local character and history, while also promoting innovation

These aspects ensure that the development not only meets regulatory requirements but also contributes positively to the community and environment.

3.1.2 Local Planning Policy

The Bury Council Planning Guidance (SDP16) criteria is highlighted below:

Clause 5a. Development should ensure the highest environmental performance.

- All new non-residential developments should aim to achieve at least a BREEAM rating of 'Very Good' with at least 25% reduction in CO2 emissions beyond the requirements of the 2006 Building Regulations Approved Document L (2006);
- Within these requirements, in new non-residential developments of 1,000 sqm2 or more and new residential developments of 10 units or more, developers should provide 10% of their predicted energy requirements on site/near site or through connections to a low carbon decentralised energy supply, unless it can be demonstrated, having regard to the type of development and its design, that this is not feasible or viable.

- In non-residential schemes developers will be required to provide evidence of on-site energy provision within their BREEAM assessment (design and post construction review). In residential schemes, developers will be required to achieve 1.2 points or higher under the Code for Sustainable Homes energy requirements.

Key Sustainability Points

- Developments should aim to achieve at least Level 3/Very Good rating against the Code for Sustainable Homes/BREEAM Standards;
- Developers should aim to provide 10% of their predicted energy requirements on site or through connections to low carbon decentralised energy supply;
- Sustainable design techniques which improve energy efficiency will be encouraged in all developments.

This section outlines the development's approach to achieve the Bury Council's planning requirements.

- The development will aim to comply with the existing Bury Council policy document, The Bury Unitary Development (UDP) adopted in 1997, and the Development Control Policy Guidance Note 16 (SDP16) adopted in October 2008.
- SDP16 item 5a states the requirement to improve on the 2006 Building Regulations Approved Document L by a minimum of 25% reduction in CO2.
- To calculate carbon emissions and reductions, the design was assessed under 'Part L 2013: Conservation of Fuel and Power' of the UK Building Regulations (which supersedes Part L 2006), using the National Calculation Methodology (NCM). A detailed energy model was created using Government approved software Integrated Environmental Solutions: Virtual Environment (IES: VE) 2019, in line with CIBSE AM11. The model was revised for each of the steps of the Energy Hierarchy to establish expected performance and satisfaction of the policy requirements.
- As part of the Energy Strategy an energy assessment has been carried out to benchmark the proposed energy strategy and evaluate its performance against the relevant Policies. The energy strategy will cover passive design elements, energy efficiency measures and low and zero carbon energy delivery systems and how they have been incorporated into the project.

3.2 Building Regulations Part L Compliance

The project will be designed to meet the standards set by Building Regulations Approved Document Part L2A, Conservation of Fuel and Power in New Buildings other than Dwellings. An energy assessment for the proposed development has been conducted by the MEP consultant, based on the requirements of Part L2A (2013) and calculated using the National Calculation Methodology (NCM) with approved software.

The project will comply with the existing Bury Council policy document, the Bury Unitary Development Plan (UDP) adopted in 1997, and the Development Control Policy Guidance Note 16 (SDP16) adopted in October 2008. According to SDP16 item 5a, there is a requirement to improve on the 2006 Building Regulations Approved Document L by achieving a minimum 25% reduction in CO2 emissions.

Additionally, both local and regional policies are currently being updated with the Bury Council's Bury Local Plan and the Greater Manchester Combined Authority's (GMCA) Places for Everyone (PfE). The emerging policies' direction will be taken into consideration.

The design has also accounted for future guidance or policies under consultation that might impact the development before the 2038 target noted in the Greater Manchester Places for Everyone development plan. This includes considering the whole life carbon of the development, focusing on reducing embodied carbon where possible and minimising operational carbon emissions upon completion.

The primary goals are to:

- Detail the development’s strategy for reducing the site’s impact on climate change by minimizing energy needs and CO2 emissions, utilizing renewable and sustainable resources, reducing waste generation, and conserving finite resources.

- Ensure that the proposed development adheres to the highest standards of sustainable design and construction at every stage of the project, including demolition, construction, and long-term management.
- No gas supply or gas boilers are proposed, reducing reliance on fossil fuels.

Throughout this report carbon emissions are split into two categories:

- Regulated - Emissions associated with heating, cooling, hot water, lighting and any other fixed building services equipment (those covered under Building Regulations Part L2A and L2B).
- Unregulated - Emissions that are associated with small power and plug-in items and any other process of plant equipment (these are not covered by Building Regulations Part L).

4 Energy Strategy

This section details the project's energy strategy and its approach to meeting the local Council's planning requirements. An energy assessment has been conducted as part of the Energy Strategy to benchmark and evaluate its performance against relevant policies. The strategy encompasses passive design elements, energy efficiency measures, and low and zero carbon energy delivery systems, illustrating how these have been integrated into the project.

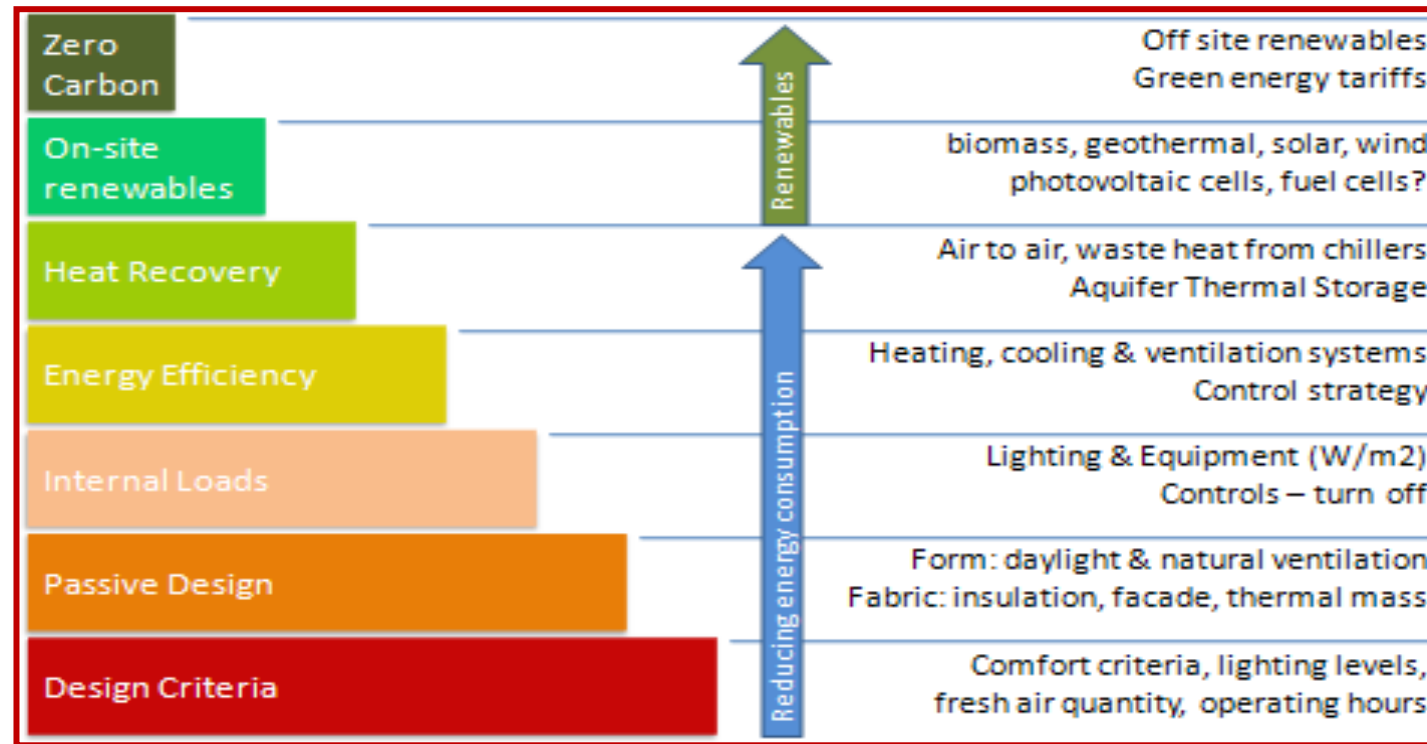


Figure 2 - "Steps to low carbon" methodology.

4.1 The Energy Hierarchy

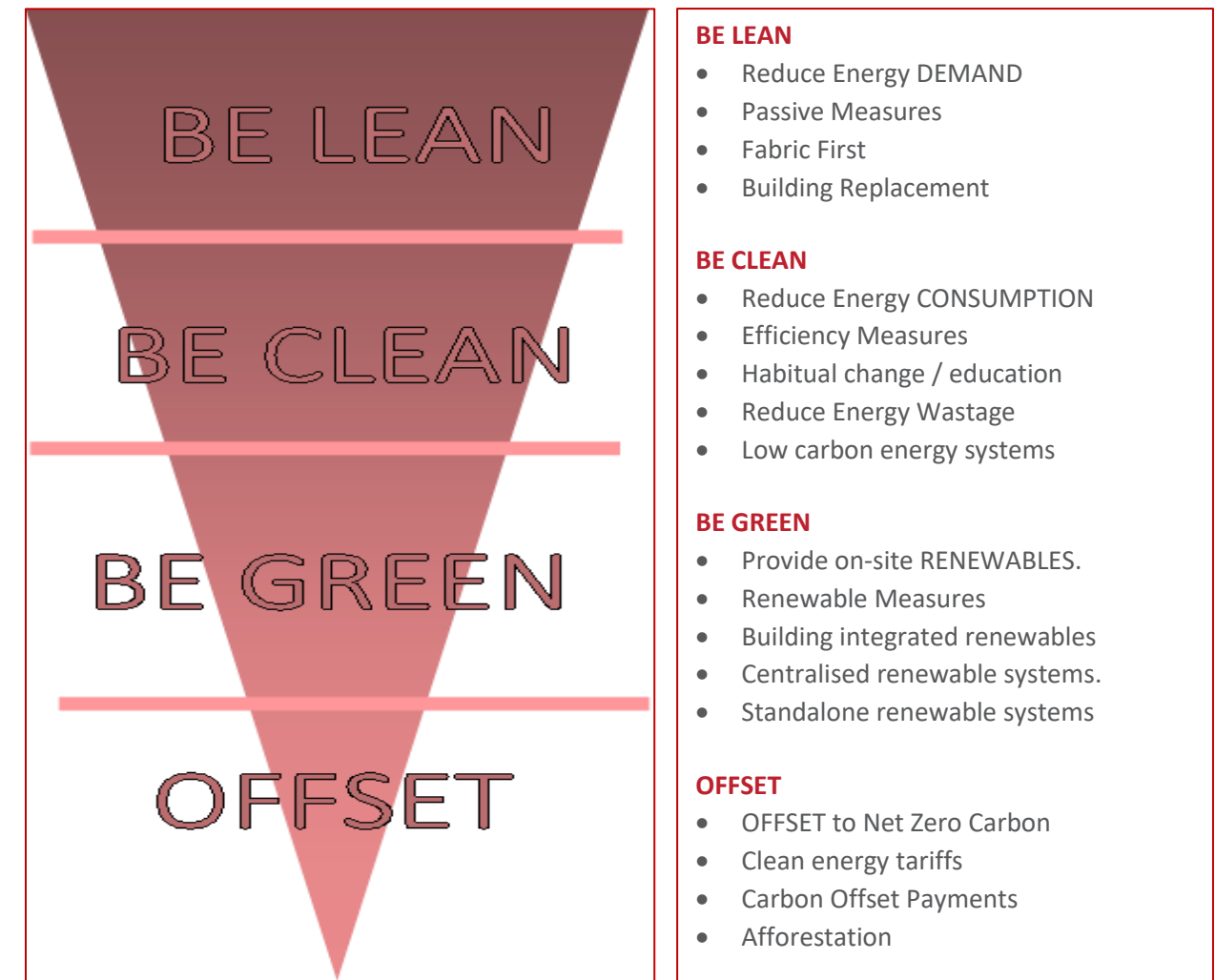
To achieve this, a "Steps to Low Carbon" methodology will be followed throughout the design process, which includes the following steps in order of consideration:

1. Evaluating and incorporating passive design solutions where feasible.
2. Integrating energy efficiency measures through service design and enhanced fabric performance.
3. Calculating the predicted design energy consumption rates and the associated annual CO₂ emissions for the development, compared to Building Regulations.
4. Assessing the feasibility of incorporating low and zero carbon energy sources.

The energy strategy been developed to minimise the energy consumed by following the energy hierarchy process by focusing on a lean, clean and green approach as defined below: -

- Lean - Use advanced building modelling and passive construction techniques to develop cost effective measures that will minimise energy demand.
- Clean - Incorporate high efficiency MEP systems and effective controls within the design to reduce energy consumption.

- Green - Incorporate renewable energy sources/technology where necessary and are economically viable to achieve the carbon emissions and energy targets.



4.2 Be Lean

4.2.1 Passive Design

Passive design options focus on enhancing various elements of a project, particularly buildings, to improve aspects such as form, massing, glazing, and the natural surroundings, thereby reducing energy demand.

These passive design options, considered alongside environmental systems, aim to reduce energy loads and consumption. Collectively, these measures significantly lower energy consumption and carbon emissions, aligning with local and national sustainability goals.

- Thermal insulation: Enhance insulation levels for all building elements beyond minimum Building Regulation standards to substantially reduce heat loss through conduction. Targeting or approaching NZC level U-values and air tightness, subject to buildability.
- Air tightness: Prioritize low permeability to prevent heat loss via uncontrolled infiltration.
- Solar control: Select glazing/shading to avoid overheating in summer and increase passive gains in winter.
- Natural daylighting: Improve occupant comfort and reduce the need for artificial lighting, saving energy.

The project has considered and/or included the following:

- Controlled thermal fluctuation from solar gains by optimizing the building’s orientation and limiting overshadowing.
- Simplified building form to reduce the overall surface area.
- High levels of insulation.
- Development of efficient and effective building materials, including high-performing building fabric with an airtight envelope.
- High-performance glazing systems with window proportions optimized for the project’s site location and building orientation.
- Window system design to facilitate natural ventilation, assisted by low-energy, efficient ventilation units with heat recovery.

To reduce overall energy demand, the building will be specified to meet or exceed the Part L notional building standards for construction and air tightness.

Reducing energy demand offers the greatest potential to minimize a project’s carbon emissions. The design strategies considered include both passive design elements, such as building form and fabric, and active design elements, such as energy-efficient building services. Focusing on passive design measures during the early stages of new build projects is often the most efficient and cost-effective way to reduce energy consumption and carbon emissions.

4.2.2 Building Fabric

The design adheres to the principles of the Fabric First approach, which enhances energy efficiency, reduces energy consumption, and lowers carbon emissions and energy costs, while aligning with regulatory design standards.

The design includes the following elements:

- Building Layout Optimization: Every space is appropriately planned and located.
- Exceeding Part L Standards: All building components aim to surpass Part L requirements where possible, to achieve post-occupancy carbon budget targets.
- High-Quality Build and Airtight Construction:
 - A significant portion of a building’s operational energy is used for heating and cooling. This can be greatly reduced by adopting a Fabric First approach, which aims to:
 - Control solar shading and solar gain.
 - Optimize the thermal performance of building components, such as walls, windows, and roofs.
 - Minimize thermal bridging.
 - Provide an airtight envelope.
 - Ensure appropriate, controlled ventilation.

Table 1 - Building Fabric Targets

Detail	Part L2A minimum values	Target Values
Exposed floor average area weighted U-value (W/m2K) *	0.25	0.10 – 0.14
Roof average area weighted U-value (W/m2K)	0.25	0.10 – 0.14
Wall average area weighted U-value (W/m2K)	0.25	0.15 – 0.18

External Window - average area weighted U-value (including glass, frame and solid panels) (W/m2K)	2.20	1.20 – 1.40
Façade total solar transmission g-value	0.68	0.32 – 0.4
Glazing visible light transmission (VLT)	0.71	0.70
Glazing frame factor (%) – typical value	-	10%
Glazed pedestrian doors U-value (W/m2K)	2.20	1.20 – 1.40
Air permeability @ 50 Pascals (m3/hr/m2)	10.00	2.00 – 3.00

Table 2: Designed building fabric

Building Element	Design values
Floor average area weighted U-value (W/m2K)	0.14
Roof U-value (W/m2K)	0.14
External wall average area weighted U-value (including curtain walling) (W/m2K)	0.18
Internal Ceiling/Floor U-Value [W/m2K]	1.00
Internal Wall U-Value [W/m2K]	1.80
Vehicle door u-value (W/m2K)	N/A
External personnel door u-value [W/m2K]	1.40
External window (including frame) average area weighted U-value (W/m2K)	1.40
Façade total solar transmission g-value	0.4
Glazing visible light transmission (VLT)	0.70
Glazing frame factor (%) - typical value	10%
Opaque Window Panels U-Value (W/m2K)	1.40
Glazed pedestrian door U-value (W/m2K)	1.40
Glazed pedestrian door total solar transmission g-value	0.35
Glazed pedestrian door visible light transmission (VLT)	0.70
Glazed pedestrian door frame factor (%) - typical value	10%
Air permeability @ 50 Pascals (m3/(hr.m2))	3

4.3 Be Clean

4.3.1 Optimising Energy Use

The project’s strategy aims to minimise energy usage through passive design measures, following the energy hierarchy. This includes high building thermal performance, low air permeability, and optimizing external glazing to maximize natural daylight without causing excessive heat gains. The building will be designed to maximize occupant comfort while minimizing energy use for systems such as lighting, heating, and cooling.

The development will also reduce its energy demand based on five key principles:

1. Continuous thermal insulation
2. Airtightness
3. Thermal bridge-free construction
4. High-performance windows
5. Ventilation systems with heat recovery

These principles focus on creating a continuous, well-insulated envelope that is both airtight and free of thermal bridges. High-performance glazing provides a positive energy balance and improves thermal comfort. A centralized AHU with heat recovery ensures a continuous supply of fresh air with minimal heat loss.

The project targets an air leakage rate of 3m³/hm². Achieving good airtightness involves prefabricating key building components under factory conditions, robust detailing of junctions, and good building practices on site.

Where mechanical ventilation is required for functionality or regulatory compliance, the project is designed to be energy-efficient and easy to operate, incorporating heat recovery to reduce energy consumption. Natural cooling through openable windows is proposed for regularly occupied spaces, such as general teaching areas, reducing the need for energy-intensive cooling systems during warmer weather.

The design ensures effective and efficient environmental systems that are simple to operate and control, while also giving end users full control over their environment.

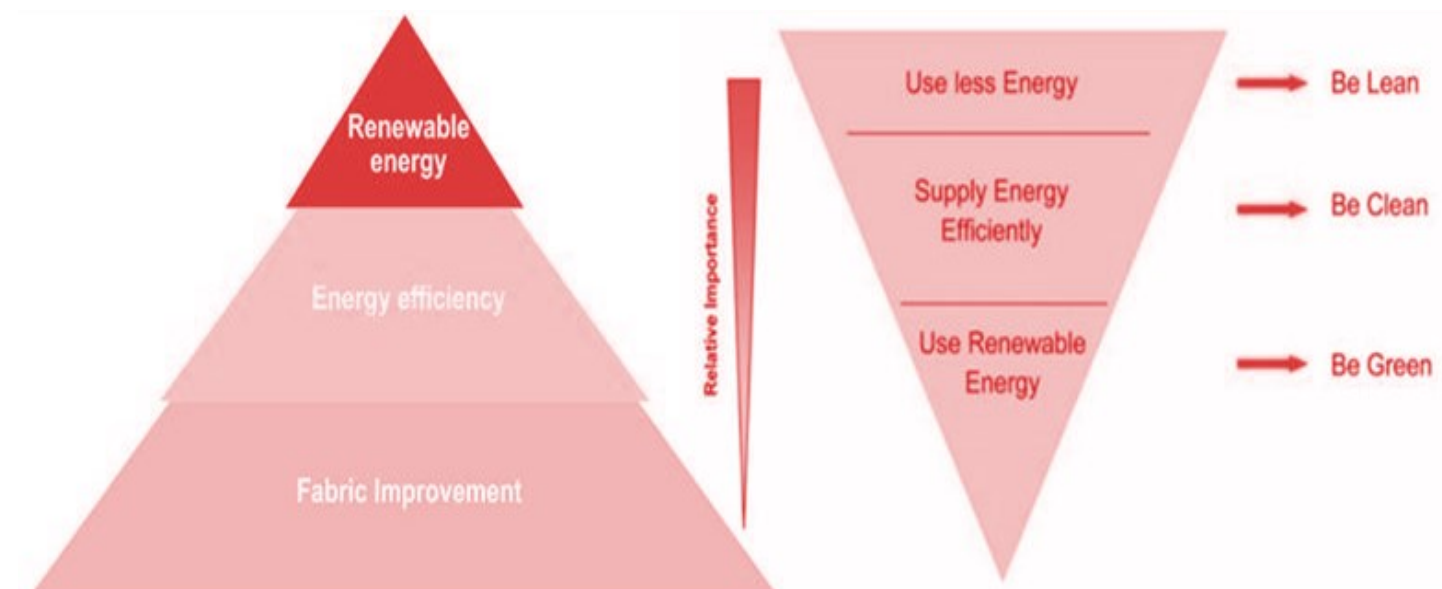


Figure 3 - Energy Hierarchy

4.3.2 Energy Efficient Measures

Active design involves incorporating energy efficiency measures within the building and its environmental systems to reduce energy consumption. All services will be designed to meet or exceed the minimum recommended performance standards outlined in the UK Government's Non-Domestic Building Services Compliance Guide (2021), where applicable.

To achieve energy efficiency, the project incorporates several specific measures:

- **Fabric-First Approach:** Prioritizing high-performance building materials to reduce energy demand. This includes enhanced insulation, high-quality windows, and airtight construction to minimize heat loss.
- **Energy-Efficient Systems:** Installing advanced heating, ventilation, and air conditioning (HVAC) systems that use less energy, such as high-efficiency boilers, heat pumps, and energy recovery systems.
- **Renewable Energy Sources:** Integrating renewable energy technologies like solar panels and possibly wind turbines to generate on-site electricity and reduce reliance on non-renewable energy sources.
- **Low-Energy Lighting:** Using LED lighting and other low-energy solutions throughout the development to reduce electricity consumption.
- **Smart Building Technologies:** Implementing smart meters and building management systems to monitor and optimize energy use in real-time, ensuring efficient energy usage.
- **Water Efficiency:** Installing water-saving fixtures and fittings to reduce water consumption, which in turn lowers the energy required for water heating.
- **Sustainable Transport:** Providing facilities for cycling and electric vehicle charging to encourage the use of low-emission transport options.
- **Landscaping and Green Spaces:** Designing outdoor areas with green roofs, walls, and other landscaping features to help regulate building temperatures and reduce the urban heat island effect.

4.4 Be Clean

The building services systems will be based on the following:

- **Heating and Hot Water:** Provided by air source heat pumps (ASHPs).
- **Mechanical Ventilation with Heat Recovery (MVHR):** Proposed to enhance ventilation and heating efficiency.
- **Low Specific Fan Power (SFP):** All ventilation equipment will have low SFP to reduce energy consumption.
- **High Efficiency and Low Distribution Losses:** All equipment will be specified to achieve high efficiency and low distribution losses, including low fan and pump power, and insulation in accordance with relevant standards.
- **Compliance with Building Services Guides:** All equipment and plant will exceed the minimum requirements of the Building Services Compliance Guides, which provide guidance on complying with Approved Document Part L2 of the Building Regulations for space heating/cooling systems, hot water systems, and ventilation systems.
- **Variable-Speed Drives:** All fans and pumps will be specified with variable-speed drives to reduce energy consumption by more than two-thirds compared to constant speed alternatives, by supplying only the required flow rate to meet demand.
- **Zoned Heating and Cooling Systems:** Appropriately zoned with local, fast-responding controls.
- **Maximized Natural Light:** Where practicable, natural light will be maximized through appropriate glazing design, reducing electric lighting energy consumption during daylight hours, and lowering running costs and CO₂ emissions.
- **Efficient Low Energy Light Fittings:** Installing efficient low-energy light fittings internally and externally to significantly reduce the building's overall lighting load and annual CO₂ emissions. Low energy, high efficacy LEDs will be specified for all areas, with appropriate lighting and occupancy controls to reduce energy use where applicable.
- **Hybrid Ventilation Systems:** A combination of natural ventilation and mechanical ventilation with heat recovery is proposed. Natural ventilation will be relied upon whenever possible (subject to external conditions) via passive design, while mechanical ventilation will be used during the heating season when natural ventilation openings are closed.

- The buildings facades have undergone design review to control the amount of solar gain entering internal spaces. The façade elements have been specified with a low solar transmission (g-value) in all facades.
- Where white goods are specified, these will be chosen to be A/A+ rated under the EU Energy Labelling Scheme.
- Unregulated energy is those uses that fall outside the typical scope of building regulations. This includes energy used through cooking, computers, external lighting and other ‘plug loads’ which are typically under the control of the occupant.
- Addressing these loads, which often form a significant portion of a building’s overall energy consumption, is key to reducing energy consumption to levels required for Net Zero Carbon. This will be achieved through the specification of energy efficient white goods, lifts, and other appliances.
- The building has been designed to minimise its use of energy intensive cooling systems through passive and energy efficient measures.
- Minimising internal heat generation -Plug-in loads and occupant densities associated with the building’s activities cannot be altered beyond the client’s brief. Therefore, the only area that can be targeted is the lighting. Low energy, high efficacy, LED lighting will be used through- out the building to minimise internal heat gains and energy consumption.
- Reducing the amount of heat entering the building
- Active Cooling-The Part L assessment also provides a quantification of the energy demand likely to be expected of the cooling system. This is compared to the notional building benchmark demand to demonstrate compliance.

This approach ensures effective and efficient environmental systems that are simple to operate and control, while also giving end users full control over their environment.

4.5 Low & Zero Carbon Technologies – Be Green

The following renewable technologies were considered for inclusion within the project:

- Solar Photovoltaics
- Wind Power
- Gas or Biomass CHP
- Micro Hydro Power
- Solar Hot Water
- Heat Pumps (Ground and Air Source)
- Biomass

The development will incorporate renewable energy technologies, such as Air Source Heat Pumps (ASHPs) and Solar PVs, to reduce overall demand on the national grid. This will decrease the energy required from the grid for heating, cooling, ventilation, lighting, and powering the dwellings.

The project will utilize passive energy techniques available in the construction industry to minimize ongoing energy consumption for heating, ventilation, and lighting. This will be achieved through efficient fabric design that exceeds the thermal properties outlined in the Building Regulations.

Energy efficiency measures will be integrated into the Building Services to further reduce the site’s carbon footprint beyond passive improvements. This includes using highly efficient plant, heat recovery systems, and energy-efficient, highly controllable lighting.

Renewable energy sources will provide low-carbon electricity to the development, and any excess generation will be exported back to the grid where possible. This strategy enhances the fundamental principles of the Building Regulations and will significantly contribute to reducing the development’s annual CO2 emissions.

However, if low and zero carbon (LZC) equipment and design are not properly integrated, there is a risk of increased capital costs, operational and maintenance issues, higher whole-life costs, and failure to deliver financial returns on assets, along with associated economic and commercial risks.

4.5.1 Solar Photovoltaics (PV)

Solar PV panels could be installed on the building’s roof, which has ample space to accommodate them. These panels would help reduce the overall electricity demand for the development by converting solar energy directly into electricity. One of the key advantages of photovoltaic cells is that, once installed, they require minimal maintenance and have no primary fuel requirements.

The building’s open flat roof is ideal for PV panel installation, which could significantly lower the site’s electrical load. While feed-in tariffs alone used to make this technology commercially viable, achieving significant energy and carbon reductions may require large areas for PV panels. Fortunately, there is sufficient space on the proposed roof to accommodate this. The design includes spatial allowances for PV panels on the buildings’ roof spaces, with inverters proposed to be located within the roof plant rooms.

4.5.2 Heat Pumps

Ground Source Heat Pumps

Ground source heat pumps (GSHPs) require either boreholes or ground loops to extract heat from the stable ground temperature, necessitating substantial groundworks and often resulting in higher costs compared to traditional heating systems. Additionally, connecting GSHPs to conventional wet heating systems, such as radiators, may require these systems to be oversized.

Achieving a low payback period is only feasible with a high cooling load. Although there is technically enough external space on site due to the amount of car parking, there was no existing information at the time of the original assessment regarding the type and extent of underground infrastructure (drainage, power, utilities) or the likely condition of the ground. Without this information, installing coils for GSHPs around the site was deemed unfeasible. Given the high capital costs and extensive groundworks required, GSHPs are economically unfeasible for the development site.

Air Source Heat Pumps

Air source heat pumps (ASHPs) are a feasible option and may be suitable if further carbon savings are desired beyond current achievements. However, the increased cost compared to traditional gas boilers must be acceptable. While ASHPs are less expensive than ground source heat pumps (GSHPs), careful design with low-temperature heat emitters, such as underfloor heating or larger radiators, is necessary to improve overall system efficiency.

ASHPs exchange heat between the outside air and the building, providing space heating in winter and cooling in summer. The efficiency of these systems is closely linked to ambient air temperatures. Heat pumps supply more energy

than they consume by extracting heat from their surroundings, with systems capable of delivering up to 4kW of heat output for just 1kW of electrical energy input.

Domestic hot water will be provided to all areas via ASHPs, utilizing high-temperature refrigerants like CO₂, which operate efficiently at the temperatures required for domestic hot water generation. These heat pump systems will enable significant emissions savings compared to conventional gas boiler systems, especially considering the decarbonization of the electrical grid.

ASHPs are viable and can be utilized as the primary heat source for both buildings. The plant space will be acoustically shielded to meet noise criteria. Achieving a lower payback period is feasible with a high cooling load.

Space Heating:

- A low-temperature hot water (LTHW) system is proposed, generated via externally mounted, modular ASHPs.
- ASHPs will be located at roof level within a screened plant deck area or at ground level within an external compound.

Domestic Hot Water:

- Central domestic hot water storage cylinders served by high-temperature ASHPs are proposed.
- High-temperature CO₂ ASHPs will be located either at roof level within a screened plant deck area or at ground level within an external compound.
- Storage cylinders will be located in a rooftop internal plant room or an external packaged plant room at ground level.

4.5.3 Other Technologies Considered

Other technologies were considered but deemed inappropriate for the development. These include:

Wind Turbines:

- Free-standing wind turbines would likely be rejected by planners due to the proximity to surrounding commercial and residential buildings, as they can cause shadowing and flicker. The wind speeds at the site are unlikely to support a substantial wind-powered installation. Floor-mounted free-standing turbines would also affect existing space.
- Roof-mounted micro wind turbines are a potential option, but they would be commercially unsustainable compared to the energy saved. The output from wind turbines is highly sensitive to wind speed, requiring clear exposure to the prevailing wind, which is not feasible in the urban nature of the site.
- An average wind speed of 5 m/s is required for wind turbines to be viable. Even if this wind speed is achieved, wind turbines are still unlikely to be feasible for the site due to potential shadow flicker, noise, and vibration disruptions.

Biomass:

- There is inadequate space in the building for the boiler or fuel storage, and while there is external space, the use of biomass is not practical, or a suitable investment based on the current building services systems.
- Biomass fuel can be hard to obtain, and fuel delivery would increase operational carbon. The site layout requires dedicated fuel delivery routes and storage, making this technology unfeasible.
- Biomass, in the form of logs, wood chips, and wood pellets, is classified as a renewable energy source. However, biomass boilers and their associated NO_x emissions would impact local air quality, making them unsuitable for this development.

- For a biomass boiler to be feasible, sufficient space for a fuel store and delivery is required. The Carbon Trust recommends storing two weeks of fuel on-site, but the necessary space is not available. Additionally, for biomass to be considered low carbon, the fuel must be delivered from a supplier within 60 km of the site.

Solar Thermal:

- Solar thermal collectors use solar radiation to heat water for buildings, typically designed to meet a development's base heat load for domestic hot water requirements. However, the complexities of integrating pipework and limited roof space make solar thermal collectors unfeasible for this development.
- While technically feasible, incorporating solar hot water (SHW) with traditional gas boilers and thermal storage would require careful design. SHW offsets gas boiler use at a rate of 0.216 kgCO₂/kWh, compared to PV panels, which offset electricity use at 0.517 kgCO₂/kWh.
- Due to the greater carbon reduction achievable with PV panels, SHW will not be considered moving forward.

Micro Hydro Power:

- There is no capacity for micro-hydro power on this site as there are no local water courses available.

Combined Heat and Power (CHP):

- While a CHP system could utilize the domestic hot water (DHW) load as the base load and generate electricity, the site does not have an appropriate load profile to justify its use. The run time and efficiency would not be suitable for the building.
- A CHP system would require significant noise treatment to meet requirements. The heating and electrical loads of the building are not suitable to support this technology.
- For CHP to be feasible, there needs to be a high, constant heat demand, such as a swimming pool. Gas-fired CHP systems also produce large amounts of NO_x emissions compared to gas boilers, negatively impacting local air quality, making it an unsuitable option for this scheme.

Solar Hot Water Panels:

- The building has an open flat roof suitable for installing solar hot water panels. However, given the building's high electrical load compared to its domestic hot water (DHW) load, it would be more appropriate to install PV panels on the roof. The building's hot water load profile does not justify a separate solar thermal installation, although the technology is viable for the scheme.

Rainwater Harvesting:

- Economically unfeasible. The building's WC/grey water load profile for the Hub is unlikely to result in a worthwhile investment. However, there is an opportunity to consider the Hub in terms of payback within the building's lifespan.

Waste Water Heat Recovery:

- Integrated within the typical spatial allocation for services. Wastewater from showers carries thermal energy that is traditionally drained away. To save energy, the heat from the shower wastewater can be recovered via a pipe-mounted heat exchanger, transferring the recovered heat to the incoming water supply. This reduces the hot water load, as there is no need to heat water from cold to the desired temperature.