

READING POLICE STATION

ENERGY STRATEGY

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MEP Building Services



Energy & Sustainability



BIM



Vertical Transport



Acoustics

DOCUMENT CONTROL

ISSUE	DATE	STATUS	PSH PREPARED	PSH CHECKED	PSH AUTHORISED
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2	09.04.26	FOR PLANNING	RT	MB	AH
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1. EXECUTIVE SUMMARY

This Energy Statement has been prepared by PSH Consulting Ltd on behalf of S2 Estates ('the Applicant') in support of the planning application for Reading Police Station ("the Site") located in Central Reading.

The application site sits within the administrative boundary of Reading Borough Council. The site currently comprises a police station. The existing station has been vacant since December 2025.

The site is bounded by Castle Street and the A329. It is adjacent to Reading Magistrate's Court and The Hexagon performing space. The proposed development is the demolition and redevelopment of the existing building to provide 205 residential units (Class C3) with residential amenity space, a total of 7 retail units (Class E(a)) at ground level, including a food store, and a Thames Valley Police office (Class E(g)(i)) at Lower Ground level. Both car and cycle parking will be provided.

Proposals seek to provide a development capable of year-round comfort with minimal energy consumption and resultant carbon emissions. The design has been developed in line with the energy hierarchy, i.e. being 'lean, clean, and green', and relevant National and local policies. Stand-out targets include:

- Target net zero regulated carbon emissions (100% savings beyond Building Regulations) with a minimum overall on-site reduction of at least 35% (Reading Local Plan 2019).

The proposed development has been assessed using Building Regulations Part L 2021 methodology.

1.1 ENERGY STRATEGY SUMMARY

'Be Lean' – Reduce energy demand

The design approach targets demand reduction measures first, giving priority to the optimisation of building fabric to reduce the need for energy use in the first instance. The objective is to have a building that is as energy- efficient (i.e. 'lean') as possible without relying on overly complicated systems or technologies to deliver low carbon performance. This passive approach is pursued in a fabric design that against a notional building delivers a considerable overall improvement in building element U-values compared to the notional building specification. Similarly, airtightness in both residential and non-residential parts of the building also exceed regulatory requirements.

The proposal's optimised façade also maximises daylight and useful solar gain, helps mitigate overheating risk and minimises heat loss. Key design intentions include:

- External solar shading from recessed windows to help reduce unwanted solar gains.
- Solar control glass to limit solar gain, whilst also enabling good light transmittance which contributes to good internal daylight, therefore reduces artificial lighting load.
- Double glazing to all areas to limit heat loss.
- Secure openable windows to enable effective natural ventilation and a passive cooling strategy where possible.
- High levels of thermal insulation for opaque elements, reducing heat loss.
- Thermal bridging mitigated in design detailing wherever possible to limit heat loss.
- High levels of airtightness, reducing heat loss and mitigating drafts.

In addition to the passive approach outlined above, the following energy-efficient plant is proposed:

- High-efficiency mechanical ventilation systems with heat recovery and occupancy control throughout, and peak lopping of supply air in domestic areas to mitigate overheating.
- Low energy lighting throughout with occupant detection and daylight controls, where appropriate.
- Water-saving showerheads to minimise hot water consumption
- System controls and diagnostics systems to operate the building effectively.
- Metering and sub-metering to monitor energy use and by dwelling, enabling energy use and occupant behavioural learnings and subsequent adjustments to improve building energy demand post occupancy.
- High efficiency Variable Refrigerant Flow (VRF) space heating and cooling powered by the ambient loop via water source heat pumps (WSHP's) in the amenity areas and retail units

Detailed dynamic modelling has demonstrated the optimised design can mitigate overheating in line with Approved Document Part O via an openable window strategy in the first instance and without the use of blinds. Testing has confirmed that the strategy could mitigate overheating risk sufficiently during a 1 in 3-year heatwave that might occur in the 2020-2040 period (DSY1). This strategy therefore limits the need for cooling and provides a resilient design for the future that doesn't rely on occupant control of blinds to be successful.

Blinds could be included to offer additional benefits and reassurance that dwellings are protected from overheating throughout the year. Guidance will be provided in Home User Guides to inform occupants of the benefits of blind use during the day to limit unwanted solar gains.

'Be Clean' – Supply energy efficiently

The feasibility of connecting to district energy networks has been considered. There are currently no existing heat networks in the vicinity.

'Be Green' – Maximise renewable energy

A feasibility study for various LZC technologies established air source heat pumps as suitable solutions for the Site. Air source heat pumps shall power a fully electrified, operationally cost effective and low-carbon thermal solution via a 5th generation ambient loop network serving the entire development.

The loop comprises of a network of water-to-water heat pumps (Daikin Altherma 3 WS) serving the apartments which are connected to an "ambient loop", i.e. a communal heat network maintained between 20-25°C powered by air source heat pumps. Low-grade heat is taken from the ambient loop by the water-to-water heat pump units to provide heating and hot water where required.

The ambient loop system shall also provide hot water to the non-domestic areas and power water source heat pump-driven VRF systems which will provide space heating and cooling to the non-residential areas.

1.2 PREDICTED CARBON EMISSIONS SUMMARY

In summary, the proposed development seeks to deliver savings in line with the energy hierarchy, limiting energy use in the first instance and selecting energy efficient plant and building services thereafter.

Overall, the development could be expected to achieve a 60% reduction in regulated carbon emissions over Part L 2021. This overall figure breaks down into regulated carbon emissions reductions of 12% at 'Be Lean' stage and 48% at 'Be Green' stage.

The breakdown in on-site savings exceeding Reading Local Plan policy is shown in Table 1.1 and 1.2.

In addition to the minimum 35% reduction in regulated emissions, Reading Borough Council planning policy requires a cash in-lieu contribution towards offsetting the residual emissions of the development in order to target net zero emissions. This is detailed in Paragraph 3.11 of the Sustainable Design and Construction Supplementary Planning Document (SPD), Adopted December 2019. The relevant text is included in Subsection 3.2.2 of this report. The cash-in-lieu contribution totals £143,526, calculated as £60 per tonne CO₂ over thirty years.

1.3 ENERGY HIERARCHY

Both the regulated and unregulated energy emissions for the development have been reported. Regulated emissions are emissions incurred over the running of the development as a result of its controlled, fixed building services. This includes space heating and cooling, ventilation, lighting and domestic hot water. Regulated emissions can be reduced via intelligent building design, high-efficiency fabric and building services. Unregulated emissions are emissions resulting from energy consumption on which the Building Regulations do not impose a requirement and cannot be reduced via selecting efficient services or high-performance building fabric. Such unregulated energy uses can include cooking, IT equipment, refrigeration or other appliances.

	Site-Wide Carbon Dioxide Emissions (Tonnes CO ₂ per annum)		
	Regulated	Unregulated	Total
Part L 2021 compliant building	199.5	168.8	368.3
Be Lean	176.2	168.8	345.0
Be Clean	176.2	168.8	345.0
Be Green	79.8	168.8	248.6

Table 1.1 – Site-wide CO₂ emissions after each stage of the energy hierarchy for the development

	Regulated carbon dioxide savings	
	(Tonnes CO2 per annum)	(%)
Be Lean Savings from demand reduction	23.3	12%
Be Clean Savings from heat network	0.0	0%
Be Green Savings from renewable energy	96.4	48%
Total Cumulative on-site savings	119.7	60%
Cumulative carbon to be off-set by payment	2,393 tonnes of CO2	
Cash in-lieu contribution (£)	£143,562	

Table 1.2 - Regulated site-wide CO₂ savings from each stage of the energy hierarchy.

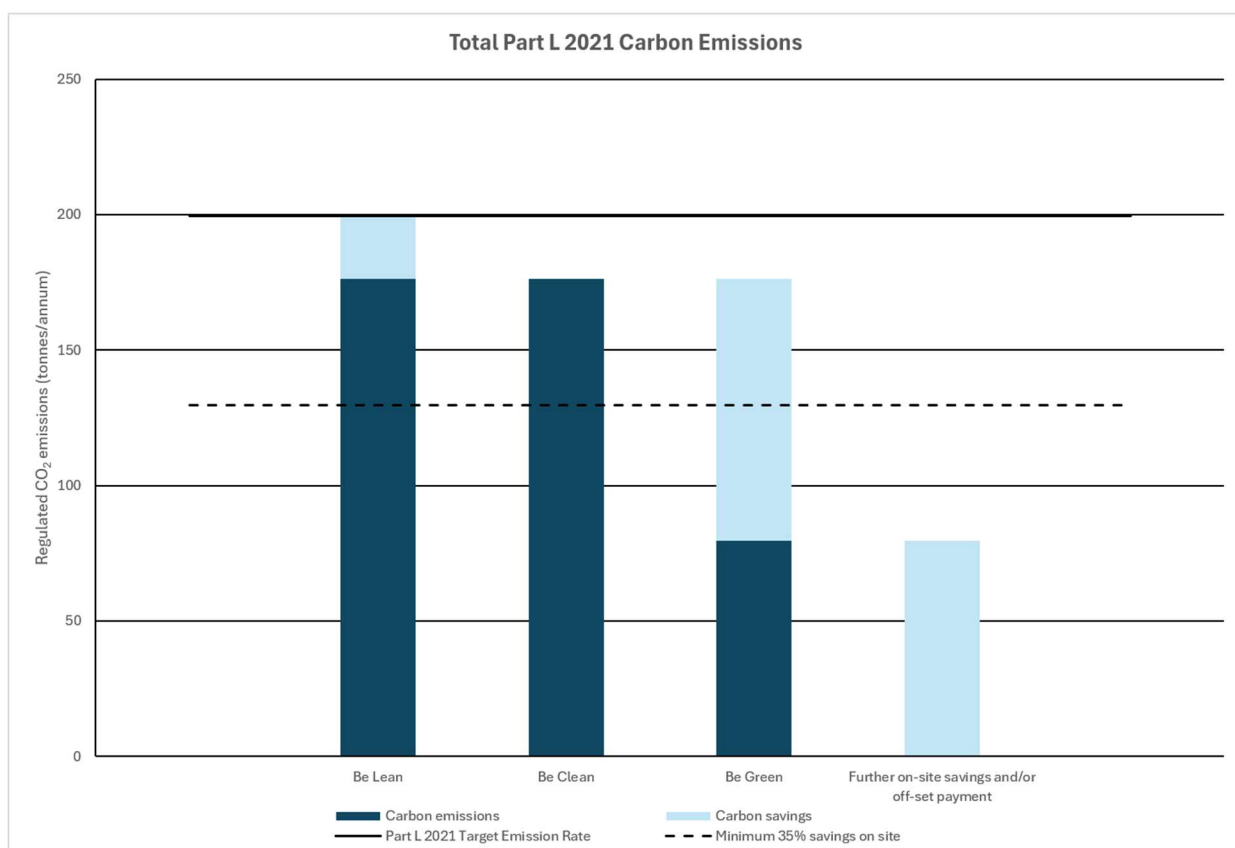


Figure 1-1: Regulated CO₂ emissions after each stage of the energy hierarchy

1.4 SUMMARY

In conclusion, though a combination of passive design measures, low carbon systems design, onsite generation and off-set payment, the proposed development seeks to achieve operational carbon neutrality over a span of 30 years with respect to its regulated energy consumption.

2. INTRODUCTION

This Energy Statement has been prepared by PSH Consulting Ltd on behalf of S2 Estates ('the Applicant') in support of the planning application for Reading Police Station ("the Site") located in Central Reading.

The application site sits within the administrative boundary of Reading Borough Council. The site currently comprises a police station. The existing station has been vacant since December 2025.

The site is bounded by Castle Street and the A329. It is adjacent to Reading Magistrate's Court and The Hexagon performing space. The proposed development is the demolition and redevelopment of the existing building to provide 205 residential units (Class C3) with residential amenity space, a total of 7 retail units at ground level, including a food store, and a Thames Valley Police office at Lower Ground level.

The following pages summarise the outcome of a collaborative design exercise carried out through RIBA stages 1-3 to meet and exceed the requirements of national, regional, and local planning guidelines in relation to the conservation of fuel and power but also enable a holistic design that provides comfort and resilience to climate change throughout the life of the proposed development.

2.1 SITE LOCATION AND PROPOSED DEVELOPMENT

The site is bounded by Castle Street and the A329. It is adjacent to Reading Magistrate's Court and The Hexagon performing space. The surrounding area is comprised by mainly residential uses, with an established allotments directly to the north of the Site. The surrounding character of the area is characterised predominantly by 18-19th Century 3 storey terraced townhouses, some of which has since been converted for commercial use.

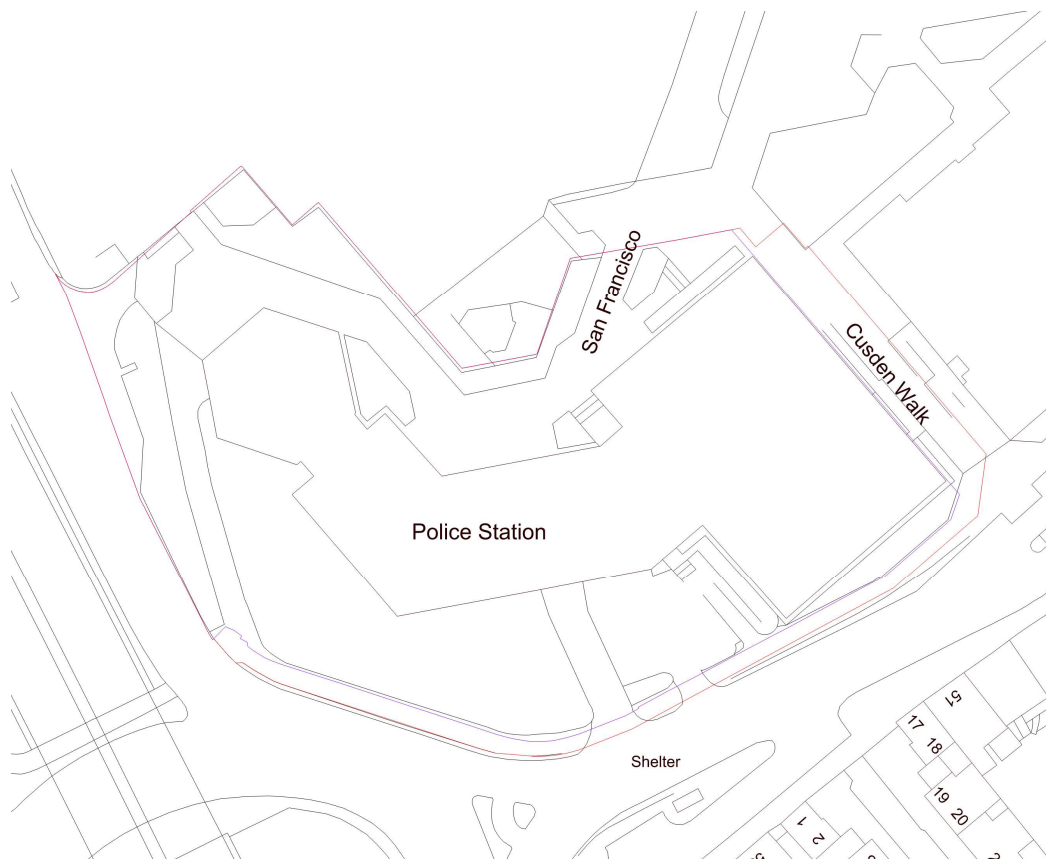


Figure 2-1: The Site and surrounding context

The proposed development is the demolition and redevelopment of the existing building to provide 205 residential units (Class C3) with residential amenity space, a total of 7 retail units (Class E(a)) at ground level and a Thames Valley Police office (Class E (g)(i)) at Lower Ground level. Both car and cycle parking will be provided.

The proposed site layout at roof level is shown below.

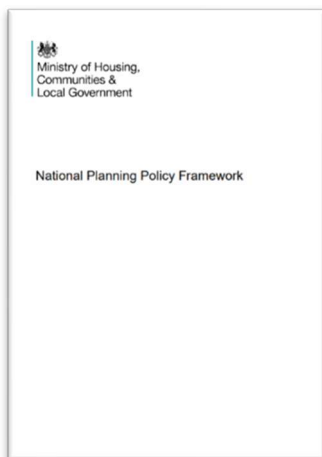


Figure 2.2 - The proposed site

3. SUSTAINABILITY DRIVERS

3.1 NATIONAL POLICY

3.1.1 NATIONAL PLANNING POLICY FRAMEWORK (NPPF) (2024 WITH 2025 AMENDMENTS)



The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally-prepared plans for housing and other development can be produced. Planning law requires that applications for planning permission be determined in accordance with the development plan unless material considerations indicate otherwise. The NPPF must be taken into account in preparing the development plan and is a material consideration in planning decisions. Planning policies and decisions must also reflect relevant international obligations and statutory requirements.

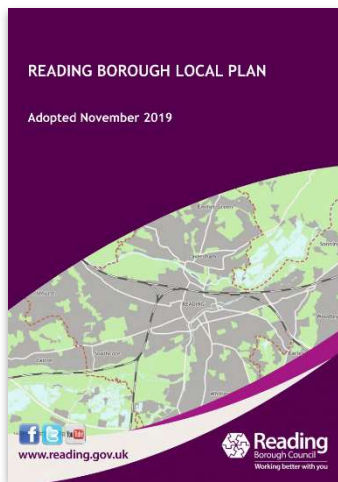
The purpose of the NPPF is to contribute to the achievement of sustainable development. At a very high level, the objective of sustainable development can be summarised as meeting the needs of the present without compromising the ability of future generations to meet their own needs. Achieving sustainable development means that the planning system has three overarching objectives, which are interdependent and need to be pursued in mutually supportive ways:

- a) An economic objective – to help build a strong, responsive and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation and improved productivity; and by identifying and coordinating the provision of infrastructure.
- b) A social objective – to support strong, vibrant and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering well-designed, beautiful and safe places, with accessible services and open spaces that reflect current and future needs and support communities' health, social and cultural well-being.
- c) An environmental objective – to protect and enhance our natural, built and historic environment; including making effective use of land, improving biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.

This statement has been developed in line with the NPPF and alongside the suite of documents submitted as part of this application fulfils the requirements of the NPPF.

3.2 LOCAL POLICY

3.2.1 READING BOROUGH LOCAL PLAN 2019



The Reading Local Plan 2019 sets out Reading Borough Council's strategy for the future of its area and includes the policies that will be used to direct development and determine applications for planning permission.

This Local Plan combines and updates the Borough's previous Core Strategy (2015), the Reading Central Area Action Plan (2009) and Sites & Detailed Policies Document (2015). The Local Plan provides a series of policies to ensure development is well designed, accessible, safe and respects and enhances the environment.

Notable policies that are relevant to this Energy Statement include:

Policy CC1: Presumption in Favour of Sustainable Development

A positive approach to considering development proposals will be taken that reflects the presumption in favour of sustainable development contained in the National Planning Policy Framework (NPPF). Where appropriate, the Council will work proactively with applicants jointly to find solutions which mean that proposals can be approved wherever possible.

Planning law requires that applications for planning permission must be determined in accordance with the development plan unless material considerations indicate otherwise. Planning applications that accord with the policies in the development plan (including, where relevant, with policies in neighbourhood plans) will be approved without delay, unless material considerations indicate otherwise. Proposed development that conflicts with the development plan will be refused, unless other material considerations indicate otherwise.

Where there are no policies relevant to the application or the policies which are most important to determining the application are out of date at the time of making the decision then permission will be granted unless material considerations indicate otherwise – taking into account whether:

The application of policies in the NPPF that protect areas or assets of particular importance provides a clear reason for refusing the development proposed; or

Any adverse impacts of doing so would significantly and demonstrably outweigh the benefits, when assessed against the policies in the NPPF taken as a whole.

Policy CC2: Sustainable Design and Construction

Proposals for new development, including the construction of new buildings and the redevelopment and refurbishment of existing building stock, will be acceptable where the design of buildings and site layouts use energy, water, minerals, materials and other natural resources appropriately, efficiently and with care and take account of the effects of climate change.

To meet these requirements:

- All major non-residential developments or conversions to residential are required to meet the most up-to-date BREEAM 'Excellent' standards, where possible;
- All minor non-residential developments or conversions to residential are required to meet the most up-to-date BREEAM 'Very Good' standard as a minimum;
- All non-residential development or conversions to residential should incorporate water conservation measures so that predicted per capita consumption does not exceed the appropriate levels set out in the applicable BREEAM standard. Both residential and non-residential development should include recycling greywater and rainwater harvesting where systems are energy and cost effective.

Policy CC3: Adaptation to Climate Change

All developments will demonstrate how they have been designed to incorporate measures to adapt to climate change. The following measures shall be incorporated into development:

Wherever possible, new buildings shall be orientated to maximise the opportunities for both natural heating and ventilation and reducing exposure to wind and other elements;

Proposals involving both new and existing buildings shall demonstrate how they have been designed to maximise resistance and resilience to climate change for example by including measures such as solar shading, thermal mass, heating and ventilation of the building and appropriately coloured materials in areas exposed to direct sunlight, green and brown roofs, green walls, etc;

Use of trees and other planting, where appropriate as part of a landscape scheme, to provide shading of amenity areas, buildings and streets and to help to connect habitat, designed with native plants that are carefully selected, managed and adaptable to meet the predicted changed climatic conditions; and

All development shall minimise the impact of surface water runoff from the development in the design of the drainage system, and where possible incorporate mitigation and resilience measures for any increases in river flooding levels as a result of climate change

Policy CC4: Decentralised Energy

In meeting the sustainability requirements of this plan, developments of the sizes set out below shall demonstrate how consideration has been given to securing energy for the development from a decentralised energy source.

Any development of more than 20 dwellings and/ or non-residential development of over 1,000 sq m shall consider the inclusion of decentralised energy provision, within the site, unless it can be demonstrated that the scheme is not suitable, feasible or viable for this form of energy provision.

Where there is existing decentralised energy provision present within the vicinity of an application site, further developments of 10 dwellings or more or non-residential development of 1,000 sq m or more will be expected to link into the existing decentralised energy network or demonstrate why this is not feasible.

Policy H5: Standards for New Housing

New build housing should be built to the following standards, unless it can be clearly demonstrated that this would render a development unviable:

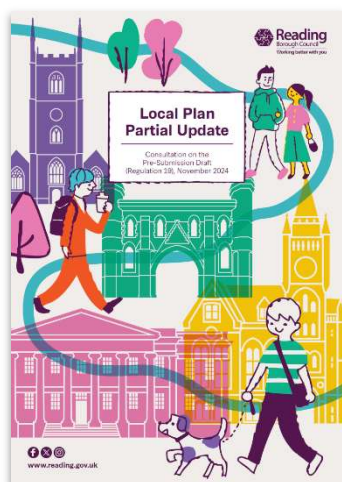
- a) All new build housing outside the Central Area as defined on the Proposals Map will comply with the nationally-described space standard.
- b) All new build housing will be built to the higher water efficiency standard under Regulation 36(3) of the Building Regulations 79.
- c) All major new-build residential development should be designed to achieve zero carbon homes.
- d) All other new build housing will achieve at a minimum a 19% improvement in the dwelling emission rate over the target emission rate, as defined in the 2013 Building Regulations.
- e) All new build housing will be accessible and adaptable in line with M4(2) of the Building Regulations, unless it is built in line with M4(3) (see below).
- f) On developments of 20 or more new build dwellings, at least 5% of dwellings will be wheelchair user dwellings in line with M4(3) of the Building Regulations. Any market homes provided to meet this requirement will be 'wheelchair adaptable' as defined in part M, whilst homes where the Council is responsible for allocating or nominating an individual may be 'wheelchair accessible'.

3.2.2 SUSTAINABLE DESIGN AND CONSTRUCTION SPD 2019

For residential development of ten dwellings or more, the Local Plan requires 'Zero Carbon' development, unless it can be clearly demonstrated that this would render a development unviable. Zero carbon homes is an achievable standard that, until recently, was intended to be a national requirement in the Building Regulations. It is required through planning policy for major residential new build development, and the viability of this approach was tested through the Local Plan and was not found to place an unreasonable burden on development. The paragraphs below describe the requirements in more detail.

In achieving Zero Carbon Homes for major residential developments, the preference is that new build residential of ten or more dwellings will achieve true carbon neutral development on-site. If this is not achievable, it must achieve a minimum of 35% improvement in regulated emissions over the Target Emissions Rate in the 2013 Building Regulations, plus a Section 106 contribution of £1,800 per remaining tonne towards carbon offsetting within the Borough (calculated as £60/tonne over a 30 year period).

3.2.3 READING LOCAL PLAN PARTIAL UPDATE DRAFT 2024



The Reading Local Plan is currently under review to update local planning policy in line with national targets. It was submitted to the Secretary of State in May 2025 and is currently undergoing a process of public examination. Although the policies of the Draft Local Plan do not currently apply, they have been considered in preparing this energy statement and the wider submission documents.

Notable policies that are relevant to this Energy Statement include:

Policy CC2: Sustainable Design and Construction (Strategic Policy)

Proposals for new development, including the construction of new building(s) and the redevelopment and refurbishment of existing building stock, will be acceptable where the design of building(s) and site layouts use energy, water, minerals, materials and other natural resources appropriately, efficiently and with care and take account of the effects of climate change.

All non-residential developments or conversions to achieve net-zero development defined as “a scenario in which the quantity of anthropogenic greenhouse gas emissions arising from the development’s operational energy use on an annual basis is zero or negative, and where whole-life emissions are reduced through sustainable design measures.” Net zero building status must be achieved through the application of the following energy hierarchy:

- Minimise and manage operational energy demand through building design, fabric performance and servicing measures;
- Use local low carbon energy resources (such as secondary heat) wherever possible to meet residual demands;
- Meet remaining residual energy demands by producing, storing and using renewable energy on-site; and
- Monitor and report on energy performance

Policy H5: Standards for New Housing (Strategic Policy)

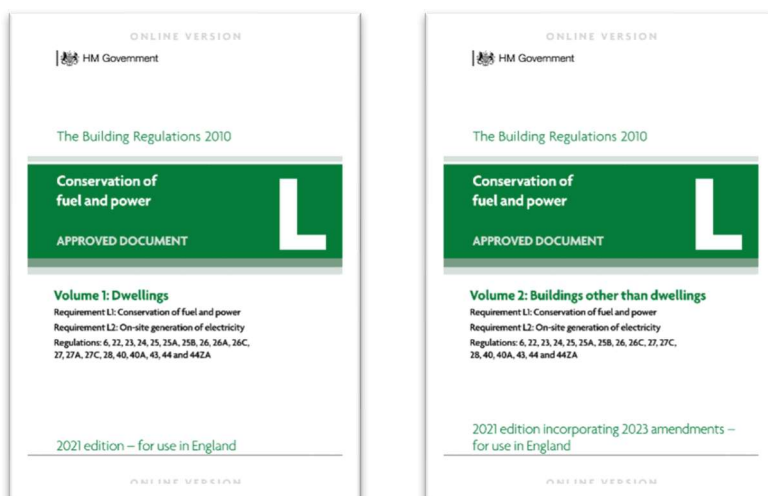
New build housing should be built to the following standards, unless it can be clearly demonstrated that this would render a development unviable:

- a) All new build housing outside the Central Area as defined on the Proposals Map will comply with the nationally-described space standard.
- b) All new build housing will be built to achieve water neutrality, where possible. As a minimum, all water fittings and appliances within new-build housing should be compliant with the ‘optional’ standard outlined in Table 2.2 Part G of the Building Regulations which requires a fittings approach
- c) All other new-build housing will be required to achieve net-zero development as defined in Policy CC2 and to achieve the following (calculated using a methodology proven to accurately predict a building’s actual energy performance):
 - Site average space heating demand of 15-20kWh/m²/annum;
 - Site average of total energy demand less than 35kWh/m²/annum;
 - No single dwelling unit to have a total energy demand in excess of 60kWh/m²/annum, irrespective of the amount of on-site renewable energy production; and
 - On-site renewable energy generation to match total energy use over the course of the year, with a preference for roof-mounted solar PV.

In cases where the points cannot be met for reasons of viability, an Energy Statement must set out in full the degree to which the requirements can be met in order to enable the development to become viable.

3.3 BUILDING REGULATIONS

3.3.1 THE BUILDING REGULATIONS APPROVED DOCUMENT PART L 2021



Part L of the Building Regulations is the mechanism by which the Government is driving reductions in the regulated CO₂ emissions from new buildings.

In June 2022, Building Regulations Part L 2021 came into effect. As such, this Energy Statement have been prepared using Part L 2021 methodology.

Part L 2021 covers two requirements of the Building Regulations, and multiple regulations for new buildings which must be satisfied as follows:

- Requirement L1: Conservation of fuel and power
- Requirement L2: On-site generation of electricity
- Regulation 24: Methodology of calculation of the energy performance
- Regulation 25: Minimum energy performance requirements for new buildings
- Regulation 25A: Consideration of high-efficiency alternative systems for new buildings
- Regulation 26: CO₂ emission rates for new buildings
- Regulation 26A: Fabric efficiency rates for new buildings
- Regulation 26C: Target primary energy rates for new buildings
- Regulation 27: CO₂ emission rate calculations
- Regulation 27A: Fabric energy efficiency rates calculations
- Regulation 27C: Target primary energy rate calculations for new buildings
- Regulations 40 & 40A: Providing information
- Regulation 43: Pressure testing
- Regulations 44 & 44ZA: Commissioning

Requirement L1 sets minimum standards on the thermal performance of building elements and efficiency of building services.

Requirement L2 ensures any on-site renewable energy, i.e. solar PV or wind turbines, are appropriate for the site and have effective controls.

Regulations 24, 25, 27, 27A and 27C define the standards for building energy performance and the calculation methodology.

Regulation 25A requires that the feasibility of potentially emissions-reducing technologies such as community heating must be investigated

Regulation 26 requires that a building does not generate CO₂ emissions in excess of the Target Emission Rate (TER) as calculated in accordance with the approved methodologies for dwellings and non-domestic buildings.

Regulation 26A requires that a dwelling's fabric performs well enough to minimise heating and cooling demands. This is defined by the Target Fabric Energy Efficiency (TFEE).

Regulation 26C establishes a new criterion for building performance. Due to the ongoing decarbonisation of the National Grid, there was a concern that carbon emission rates alone did not provide an accurate picture of building energy efficiency. Low carbon intensity electricity, combined with efficient heating plant such as a heat pump, could theoretically allow a dwelling with higher than average heat losses to achieve emissions equal to or below the TER. Therefore, Regulation 26C requires that the building's primary energy rate, a measure of the energy used to generate the useful energy consumed by the building services, does not exceed the Target Primary Energy Rate (TPER).

Regulations 40 & 40A, 43, 44 & 44ZA are dealt with during the as-built phase of the development energy assessment and are therefore not covered in this report.

3.3.2 THE BUILDING REGULATIONS APPROVED DOCUMENT PART O 2021



Part O of the Building Regulations is the mechanism by which the Government is mitigating the effects of overheating within new domestic buildings. Part O 2021 took effect on 15th June 2022 and has been applied to this project assessment.

Part O 2021 covers two requirements of the Building Regulations, and one regulation for new buildings which must be satisfied as follows:

- Requirement O1: Overheating mitigation
- Requirement O1(2)(a)
- Regulation 40B: Providing information

Requirement O1 mandates that all new dwellings demonstrate that reasonable provision has been made to limit unwanted solar gains in summer and remove heat from the indoor environment. This must be demonstrated via either a simplified calculation method or dynamic simulation calculation.

Requirement O1(2)(a) mandates that any environmental conditions such as noise, pollution and occupant safety be taken into account in the overheating mitigation strategy.

Regulation 40B is dealt with upon completion of the works and is therefore not covered in this report.

4. ESTABLISHING BASELINE CO₂ EMISSIONS

The following section presents the baseline CO₂ emissions or Target Emissions Rate (TER). This establishes the Building Regulations baseline from which performance against the Building Regulations Part L 2021 targets can be measured.

To establish this baseline energy modelling has been completed using approved software as follows:

- Elmhurst SAP 10.2 for the dwellings.
- IES VE Compliance Part L 2021 ApacheSim for the non-domestic areas

A representative sample of dwellings have been modelled, providing an accurate representation of the Site. Design drawings issued by JTP Studios were used to model the proposed development. All retail units and other non-domestic/amenity zones were modelled. The actual use of the retail units is yet to be determined. For the purposes of modelling, it was assumed that 1/3 of the food store floor area would be a chilled sales area. The remaining floor area and other units were modelled as general sales areas.

The sample apartments were selected to account for variations in apartment layout and orientation. A markup of the site plans showing the selected dwellings can be found in the Appendices.

A spreadsheet calculating overall combined emissions for the development is in the Appendices.

Baseline carbon emissions for the development are summarised below.

The SAP worksheets and BRUKL reports can be found in the Appendices.

4.1 DOMESTIC

	Carbon Dioxide Emissions for domestic buildings (Tonnes CO ₂ per annum)		
	Regulated	Unregulated	Total
Part L 2021 compliant building	184.1	118.0	302.1
Be Lean	-	-	-
Be Clean	-	-	-
Be Green	-	-	-

Table 4.1 – Baseline domestic CO₂ emissions of the energy hierarchy

4.1.1 NON-DOMESTIC

	Carbon Dioxide Emissions for non-domestic buildings (Tonnes CO ₂ per annum)		
	Regulated	Unregulated	Total
Part L 2021 compliant building	15.4	50.8	66.2
Be Lean	-	-	-
Be Clean	-	-	-
Be Green	-	-	-

Table 4.2 – Baseline domestic CO₂ emissions of the energy hierarchy

5. DEMAND REDUCTION (BE LEAN)

In line with the Energy Hierarchy, the design approach for the Site has prioritised passive design and energy efficiency measures to limit energy use, as not using energy in the first instance is the best way to reduce energy consumption.

Passive building design is focused on reducing both the duration and intensity of periods requiring active heating or cooling to provide year-round thermal comfort. Studies were undertaken throughout the pre-planning stage to optimise the building envelope in terms of its form and thermal performance.

Where systems do require energy to operate, selecting energy efficient plant and services reduces energy consumption as much as possible.

However, designing energy efficient buildings can lead to overheating risk if not properly considered. To avoid this, dynamic modelling of overheating risk was carried out in parallel to provide a holistic design solution in accordance with Approved Document O.

The following sections summarise the passive design and energy efficiency measures proposed to reduce operational carbon emissions and mitigate overheating risk.

5.1 PASSIVE DESIGN MEASURES

The current Site is relatively exposed. This has been factored in the design response when considering daylight and energy consumption, particularly on southern facades. Further passive design measures incorporated in the project include:

- Optimised glazing ratios, seeking to maximise daylight and useful solar gain, help mitigate overheating risk and minimise heat loss.
- External solar shading from recessed windows and balconies helping reduce unwanted solar gains.
- Solar control glass to limit solar gain, whilst also enabling good light transmittance which contributes to good internal daylight, therefore reducing artificial lighting.
- Double glazing to all dwellings and non-domestic areas; limiting heat loss and providing winter comfort by reducing internal cold surfaces which can result in a radiative cooling effect.
- Openable windows without permanent restrictors to enable effective natural ventilation and a passive cooling strategy, where possible.
- High levels of thermal insulation for opaque elements, reducing heat loss.
- Thermal bridging mitigated wherever possible to limit heat loss.
- High level of airtightness, reducing heat loss and mitigating drafts

5.1.1 BUILDING FABRIC

The target fabric performance for the Site is presented in the table below.

Parameters		Units	Domestic		Non-Domestic	
			Part L (2021)	Proposed building	Part L (2021)	Proposed building
External walls		W/m ² K	0.26	0.15	0.26	0.15
Wall to unheated spaces		W/m ² K	0.26	0.22	0.26	0.22
Party walls		W/m ² K	0.20	0.0	N/A	
Exposed & ground floors		W/m ² K	0.18	0.10	0.18	0.10
Exposed roof		W/m ² K	0.16	0.10	0.18	0.10
Glazing, inc. opaque panels	U-value	W/m ² K	1.60	1.20	1.60	1.20
	g-value	-	-	0.35	-	0.30 (Retail) 0.35 (Elsewhere)
Opaque door		W/m ² K	1.60	1.00	1.60	1.00
Air permeability rate		m ³ /m ² .hr @50Pa	8.0	3.0	8.0	3.0

Table 5.1 – Fabric performance parameters for the Site

Thermal bridging i.e. thermal losses at the junction between construction elements can account for up to 30% of the heat loss through the façade when calculated in compliance software and often more in practice.

To mitigate this, the design team intends to mitigate thermal bridging wherever possible through detailed modelling and calculations at the appropriate design stage. The proposed development is targeting the following enhancements to minimise this heat loss wherever possible:

Thermal bridges in SAP	SAP reference	Domestic (Psi value)		Commentary
		Default (W/m.K)	Proposed (W/m.K)	
Lintels	E1	1.00	0.05	Assumed value
Sill	E3	0.10	0.04	Assumed value
Jamb	E4	0.10	0.04	Assumed value
Party floor between dwellings	E7	0.28	0.10 (0.05)	Assumed value
Balcony between dwellings	E9	0.15	0.10 (0.05)	Assumed value
Flat roof	E14	0.16	0.05	Assumed value

Thermal bridges in SAP	SAP reference	Domestic (Psi value)		Commentary
		Default (W/m.K)	Proposed (W/m.K)	
Corner	E16	0.18	0.05	Assumed value
Party wall between dwellings	E18	0.24	0.10 (0.05)	Assumed value
Exposed Floor	E20	0.32	0.10	Assumed value
Party wall with intermediate floor between dwellings	P3	0	0	Assumed value
Party wall and roof	P4	0.48	0.10 (0.05)	Assumed value
Party wall and exposed floor	P7	0.48	0.16 (0.08)	Assumed value

Table 5.2 – Thermal bridging details

Psi values given are the “full” values, where a thermal bridge is shared between more than one dwelling it shall be divided by the number of dwellings. The effective psi value for thermal bridges typically split between 2No. dwellings are given in brackets.

ApacheSim accounts for the effect of non-repeating thermal bridging in the non-domestic development by adding a “Thermal Bridging Coefficient” to the U-value of each building element. The values for each building element have been set to 10% of the U-value to match the Notional building.

5.2 ACTIVE DESIGN MEASURES

Active design measures seek to limit energy use through efficient selection or utilise some energy to further reduce heat loss providing a net saving. The following is proposed:

Low energy lighting throughout including the use of LEDs.

Lighting control systems to detect occupants or adjust to daylighting levels in the non-domestic areas.

Mechanical Ventilation with Heat Recovery (MVHR) providing constant fresh air whilst preheating incoming air with outgoing warm air, reducing the need for space heating by up to 90%.

System controls and diagnostics systems to operate the building effectively.

Metering and sub-metering to monitor energy use by type and by dwelling, enabling energy management and occupant behavioural changes.

High efficiency Variable Refrigerant Flow (VRF) space heating and cooling powered by the ambient loop via water source heat pumps (WSHP's) in the amenity areas and retail units.

For the purpose of the Be Lean assessment the dwelling heating and domestic hot water systems are assumed to be a gas boiler with efficiency and controls as per the Notional Building. The non-domestic space heating and domestic hot water services were modelled as the same type and fuel as the Actual

building but using Notional efficiencies; a heat pump of COP 2.64 for space heating and direct electric heating with 100% efficiency for hot water.

The cooling efficiency in the non-domestic areas has been calculated in accordance with the latest guidance from the SEER of the WSHP's and the central ASHP as reported by the manufacturer. The manufacturer's stated SEER for the ASHP in cooling mode is 4.80; and for the WSHP condenser units the cooling SEER is 7.7. Using the overall efficiency equation from CIBSE AM16, an overall SEER of 3.21 has been calculated for the system. The procedure for calculating the overall efficiency of an ambient loop system is explained in greater detail in section 7.2.1.

The table below summarises the current performance targets for the active design measures for dwellings.

System	Inputs		Comments
Mechanical Ventilation with Heat Recovery	SFP range 0.61-0.63	Heat recovery efficiency 89-90%	Model Reference - MRXBOXAB-ECO5
Ventilation ducting	Rigid ducting only		Reducing air path resistance and fan power.
Lighting	Lamp efficacy 75lm/W		LED throughout
Hot water	180litre hot water store 1.2kWh/day standing losses Low flow showers- max. 8litre/minute		

Table 5.3 – Current domestic active design performance targets

The table below summarises the current performance targets for the active design measures for the non-domestic areas across the site.

System	Inputs	Comments
Heating and cooling	Retail units & Residential Amenity - Water Source Heat Pump VRF - Cooling SEER 3.21	
Ventilation	Retail units - MVHR - SFP 1.10W/l/s - Heat recovery efficiency 80% - Speed control based on occupancy Residential Amenity - MVHR - SFP 1.20W/l/s - Heat recovery efficiency 75% - Speed control based on occupancy	

System	Inputs	Comments
Hot Water	Instantaneous direct electric Efficiency 100%	
Lighting	Retail units - Efficacy 150lm/W 100lm/W display lighting - Display lighting time switching - Daylight control dimming Residential Amenity - Efficacy 125lm/W - Daylight control dimming Basement Police Room - Efficacy 150lm/W - No lighting controls Entrance lobbies - Efficacy 125lm/W - Daylight control dimming Corridors - Efficacy 125lm/W - Auto On/Off Stairwells - Efficacy 150lm/W - Auto On/Off Bike & Refuse Stores - Efficacy 125lm/W (Residential) - Efficacy 150lm/W (Commercial) - Man On/Auto Off Plant Areas - Efficacy 125lm/W - Auto On/Auto Off Car Park - Efficacy 120lm/W - No lighting controls	
Power Factor Correction	>0.95	
Metering	Lighting systems metered Alerts for out-of-range values	

Table 5.4 – Current non-domestic active design performance targets

5.3 OVERHEATING RISK ANALYSIS

In compliance with Building Regulations Part O, this section presents the overheating risk analysis and mitigation strategies.

Detailed overheating analysis, using TM59, has been undertaken to inform optimum strategies in response to the cooling hierarchy.

5.3.1 DETAILED OVERHEATING RISK ANALYSIS

Detailed overheating analysis was undertaken for the proposed Site. For the purpose of the study, the following assessment methods provide a robust and agreed methodology agreed by industry peers:

- Residential areas – Approved Document Part O (2021), and CIBSE TM59: Design methodology for the assessment of overheating risk in homes (2017).

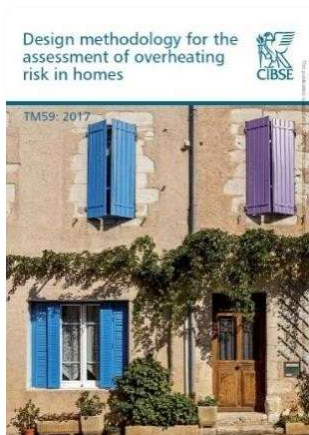
Overheating analysis has been carried out using dynamic simulation modelling software IES-VE 2024, which is fully compliant with the CIBSE Applications Manual 11: Building Energy and Environment Modelling.

The following assumptions have been accounted for in the detailed overheating analysis:

- Surrounding buildings have been modelled to take into account the overshadowing from the neighbouring buildings, implying a real case scenario with respect to solar exposure.
- The model has been built to reflect the proposed layouts of high risk zones.
- Bedroom windows would be shut at night due to acoustic issues
- Air quality has minimal impact on window openings.
- Occupancy patterns and internal gains for the domestic areas are prescribed by the CIBSE TM59 methodology.
- Thermal elements performance (U-values and glazing g-values), shading features and thermal mass details can be found in section 5.1.1.

Extracts from the modelling software are shown in the Appendices. A full summary of the overheating risk analysis is provided in report 3778-PSH-ZZ-ZZ-RP-SE-0002.

CIBSE TM59: Design Methodology for the Assessment of Overheating Risk in Homes



Residential areas of the proposed development are assessed against the CIBSE TM59: Design Methodology for the Assessment of Overheating Risk in Homes criteria. This uses an adaptive approach in which occupants' thermal comfort is affected by their experience over the previous days.

An additional criterion is assessed at night. This criterion assesses whether night- time temperatures will be greater than 26°C – the temperature above which sleep disruption is likely to occur.

Criteria allows for an amount of deviation from the criteria as shown in the following table.

	Assessment Criteria	Target / acceptable deviation
Criterion A	Living rooms, kitchens, bedrooms & studios Frequency of occupied hours when $\Delta T \geq 1^\circ\text{C}$ (Internal temperature vs external running mean)	3% of occupied hours during May - September, i.e. <i><110 hrs for bedrooms & studios</i> <i><59 hrs for living rooms</i>
Criterion B	Bedrooms & studios: Frequency of occupied hours when operative temperature $\geq 26^\circ\text{C}$	1% of annual hours from 10pm to 7am, i.e. <i><32 hrs for bedrooms & studios</i>

Table 5.5 - CIBSE TM59 assessment criterion

For Criterion A, ΔT is the difference in temperature, rounded to the nearest whole degree, between the operative temperature in a room and the limiting maximum acceptable temperature, $T_{\max}$. $T_{\max}$ is calculated from the formula below:

$$T_{\max} = 0.33T_{rm} + 21.8$$

There T_{rm} is the running mean outdoor temperature.

Approved Document O – Overheating (ADO)

Part O dynamic thermal modelling method employs CIBSE TM59 with modifications.

a) When a room is occupied during the day (8am to 11pm), openings should be modelled to do all of the following.

- I. Start to open when the internal temperature exceeds 22°C .
- II. Be fully open when the internal temperature exceeds 26°C .
- III. Start to close when the internal temperature falls below 26°C .
- IV. Be fully closed when the internal temperature falls below 22°C .

b) At night (11pm to 8am), openings should be modelled as fully open if both of the following apply.

- V. The opening is on the first floor or above and not easily accessible.
- VI. The internal temperature exceeds 23°C at 11pm.

Windows are likely to be closed during sleeping hours if noise within bedrooms exceeds the following limits.

- a) 40dB LAeq,T, averaged over 8 hours (between 11pm and 7am).
- b) 55dB LAFmax, more than 10 times a night (between 11pm and 7am).

Acoustic Criteria

The acoustics analysis essentially separates the proposed development into three zones described previously and shown below in Figure 5.1. This takes into account Building Regulation Part O acoustic criteria, setting the following opening limitations.

Red – bedroom windows closed 23:00-07:00

Yellow – bedroom windows could potentially open slightly 23:00-07:00

Green – bedroom windows can be fully opened day and night



Figure 5.1 – Part O Acoustic Zones

Future weather scenarios

Overheating risk analysis has considered future weather scenarios to ensure that the building is fit for the future. In accordance with TM59/Part O, the weather file Swindon-Brise-Norton DSY1 2020High50 was used. The weather files, despite named as '2020', represents a global high emissions scenario, 50% percentile, historical weather data adjusted to represent a projected 2011 – 2040 weather scenario. The more severe DSY2 weather data file was also used.

Measures to mitigate overheating risk and reduce cooling demand.

Red Acoustic Zone

As part of the drive to mitigate overheating and reduce cooling demand, the team prioritise passive measures first to develop a successful strategy, including:

- Fabric thermal performance
- Window thermal performance
- Window sizes
- External overshadowing
- MVHR boost with peak lopping.

Cooling Hierarchy	Proposed development
Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls.	Targeting Part L 2021 Notional building fabric thermal performance. - Window g-values reduced during the exercise - Window areas reduced during the exercise. - Window recesses provide shading. - Balconies provide shading.
Passive ventilation	Natural ventilation where permitted by Part O enabled via openable windows and balcony doors
Mechanical ventilation	Mechanical ventilation provided by a whole house mechanical ventilation system with option for peak boost mode. Peak lopping applied to ventilation air

Table 5.6 – The overheating mitigation strategy

Yellow Acoustic Zone

This acoustic zone represents bedroom window nighttime openings being limited. The windows have been modelled as fully closed at night and mitigation measures included are therefore identical to the red acoustic zone.

Green Acoustic Zone

This acoustic zone represents bedroom window openings without acoustic limit. The mitigation measures included are similar to the red acoustic zone. Some apartments in the green zone do not require peak lopping to achieve compliance with Part O.

5.3.2 DOMESTIC OVERHEATING RESULTS FOR DSY1

Detailed dynamic modelling has demonstrated the optimised design can mitigate overheating in line with ADO and CIBSE TM59. Testing has confirmed that the strategy could mitigate overheating risk sufficiently during a 1 in 3-year summer period that might occur in the 2020-2040 period (DSY1). This strategy therefore limits the need for cooling and provides a resilient design for the future. A full overheating assessment is detailed in PSH document 3778-PSH-ZZ-ZZ-RP-SE-0002, submitted as part of this planning application.

DSY1 results can be summarised as follows:

	No. Tested	Pass	Fail
Bedrooms	53	53	0
Living rooms/Kitchens	87	87	0

Table 5.7 - Overheating results for the dwellings during a moderately warm summer (DSY1 2020 50% percentile)

5.3.3 DOMESTIC OVERHEATING RESULTS FOR DSY2

DSY2 results can be summarised as follows:

	No. Tested	Pass	Fail
Bedrooms	53	53	0
Living rooms/Kitchens	87	87	0

Table 5.8 - Overheating results for the dwellings during a hot summer (DSY2 2020 50% percentile)

5.4 'BE LEAN' SUMMARY

5.4.1 DOMESTIC FABRIC ENERGY EFFICIENCY

The area weighted average Fabric Energy Efficiency (FEES) calculated in line with Part L 2021 Criterion 1 for the domestic areas is provided in the table below. Results exceed the Target Fabric Energy Efficiency.

	Target Fabric Energy Efficiency (kWh/m2)	Design Fabric Energy Efficiency (kWh/m2)	Improvement (%)
Development total	33.47	32.28	4%

Table 5.9 – Total FEES for the domestic areas of the proposed development

5.4.2 ESTIMATED CARBON EMISSIONS SAVINGS ('BE LEAN')

The passive design and energy efficiency measures described throughout Section 5 are calculated to exceed Reading Local Plan policy requirements and offer savings as outlined below.

Domestic

	Carbon Dioxide Emissions for domestic buildings (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Part L 2021 compliant building	184.1	118.0	302.1
Be Lean	161.5	118.0	279.5
Be Clean	-	-	-
Be Green	-	-	-

Table 5.10 – Domestic CO₂ emissions after the be lean stage of the energy hierarchy

Non-Domestic

	Carbon Dioxide Emissions for non-domestic buildings (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Part L 2021 compliant building	15.4	50.8	66.2
Be Lean	14.7	50.8	65.5
Be Clean	-	-	-
Be Green	-	-	-

Table 5.11 – Non-domestic CO₂ emissions after the be lean stage of the energy hierarchy

6. HEATING INFRASTRUCTURE (BE CLEAN)

Following the minimisation of energy demand via all technically and economically feasible demand reduction measures (“Be Lean”), the feasibility of exploiting local energy resources or efficiently supplying energy to the site has been investigated.

A communal heat network to provide space and water heating to the site was determined to be feasible based on the size and density of the development. An appropriate heat source for the communal system was selected following the heating hierarchy detailed below:

- a. Connection to existing or planned heat networks
- b. Zero-emission or local secondary heat sources (in conjunction with a heat pump, if required)
- c. Low-emission CHP (combined heating and power)
- d. Ultra-low NOx gas boilers

6.1 LOCAL DISTRICT HEATING NETWORKS

There are no existing or proposed heat networks in the vicinity of the development.

6.2 A CENTRALISED HEAT PUMP SOLUTION

It has been proposed to serve the development via a standalone 5G ambient loop community heating network. This has been accounted for at the “Be Green” stage.

6.3 FUTURE PROVISION FOR DISTRICT HEATING CONNECTION

A 5G network allows the benefits of connection from zero carbon energy sources e.g., ground water & air source heat pumps.

If the development were connected to a future network, this would involve the use of plate heat exchangers to provide a hydraulic break. The plate heat exchangers can be selected to provide lower grade heat to serve an ambient loop, i.e., at 25/30°C flow temperatures.

6.4 ‘BE CLEAN’ RESULTS

Domestic

	Carbon Dioxide Emissions for domestic buildings (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Part L 2021 compliant building	184.1	118.0	302.1
Be Lean	161.5	118.0	279.5
Be Clean	161.5	118.0	279.5
Be Green	-	-	-

Table 6.2 – Domestic CO₂ emissions after the be clean stage of the energy hierarchy

Non-Domestic

	Carbon Dioxide Emissions for non-domestic buildings (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Part L 2021 compliant building	15.4	50.8	66.2
Be Lean	14.6	50.8	65.4
Be Clean	14.7	50.8	65.5
Be Green	-	-	-

Table 6.2 – Non-domestic CO₂ emissions after the be clean stage of the energy hierarchy

7. RENEWABLE ENERGY (BE GREEN)

The final step in the Energy Hierarchy, 'Be Green' promotes the generation of energy from low and zero carbon technologies.

At an early stage, a holistic review of low and zero carbon technologies has been undertaken factoring in a wide range of factors that influence their successful design and operation which considers the following:

- Current and future planning policies/aspirations
- Opportunities of the site and energy demand/profile of the development
- Practical implementation considerations
- Installation and maintenance issues
- Implications for internal arrangement and space allocation, infrastructure and site layout
- Public acceptability
- Environmental and visual impact
- Deliverability
- Security and availability of fuel supply
- Capital and life cycle costs, payback and grants
- Carbon contribution and cost per CO2 saving
- Interactions of the technologies with one another.

7.1 RENEWABLE FEASIBILITY STUDY

A feasibility study of renewable energy technologies has been carried out for the Proposed Development. Overall, multiple renewable technologies have been determined to be sufficient for the development.

The following table presents a summary of the technologies considered unsuitable for the site. The technologies have been considered as:

H – High feasibility: Technology is technically and economically feasible with few barriers to implementation;

M – Medium feasibility: Technology is technically and economically feasible, but there are barriers to implementation; and

L – Low feasibility: Technology is technically or economically unfeasible and has been discounted.

Technology	Feasibility			Comments
	H	M	L	
Water Source Heat Pump (WSHP)				Whilst reducing energy consumption, heat pumps replace gas as the heating fuel with electricity. The electricity grid is expected to decarbonise and therefore the emissions associated with this technology are likely to drop. The WSHP's used on site will utilize the ambient loop system as a heat source. Advantages: High efficiency; Flexible operation and ease of installation (i.e. no requirement for gas supply, ventilation and flue arrangements and therefore the installation is straightforward); Lower associated carbon

Technology	Feasibility			Comments
	H	M	L	
				emissions due to the decarbonisation of the Grid; and Low maintenance requirements. Disadvantages: Capital cost for the system tends to be high; and potential for refrigerant leaks, however advancing technology has reduced this risk. Considerations: The system can generate increased noise levels. An acoustic assessment may be necessary, particularly in dense urban areas. This technology is considered to be feasible and will be investigated further
Air Source Heat Pumps (ASHP)				Whilst reducing energy consumption, heat pumps replace gas as the heating fuel with electricity. The electricity grid is expected to decarbonise and therefore the emissions associated with this technology are likely to drop. Advantages: High efficiency; Flexible operation and ease of installation (i.e. no requirement for gas supply, ventilation and flue arrangements and therefore the installation is straightforward); Lower associated carbon emissions due to the decarbonisation of the Grid; and Low maintenance requirements. Disadvantages: Capital cost for the system tends to be high; and potential for refrigerant leaks, however advancing technology has reduced this risk. Considerations: The system can generate increased noise levels. An acoustic assessment may be necessary, particularly in dense urban areas. This technology is considered to be feasible and will be investigated further
Solar Hot Water (SHW) Systems				Active solar hot water technology uses the Sun's energy to heat fluid passing through a collector in an active process. All available roof space is allocated for PV panel and plant. Alternative renewable solution in a form of plate heat exchanger served by high efficiency heat pump is proposed instead.
Photovoltaics				PV panels generate electricity from solar radiation. The generating potential of PV panels is not dependent on development demand, but

Technology	Feasibility			Comments
	H	M	L	
				on available roof space for installation and ensuring that they are not overshadowed. The generated energy can be used on site, in the locality or sold back to the national grid or used for Demand Side Response / flexibility. This means that the technology will directly offset the energy that would otherwise be drawn from the national grid.
Wind Power				Micro wind turbines can be fitted to the roof of any selected building (given appropriate structural measures). Mast-mounted wind turbines can be located in an open area away from obstructions such as buildings and tall trees. A report by BRE1 highlighted inherent problems and the poor performance to date of urban micro wind installations. Both technologies are considered marginally viable in-built environments by the majority of small wind turbine manufacturers due to the relatively low (and turbulent) wind speed prevailing in an urban environment. Hence, due to the configuration of the site, the character of the location, the lack of space and the relatively low wind speed in this built environment, the use of these technologies is not considered feasible.
Biomass Heating				Biomass boilers work on the principle that the combustion of wood chip or pellets can create heat for space heating and hot water loads. There are several factors that strongly disadvantage this technology, namely: ▪ On-site fuel storage space requirements; ▪ The impact on local air quality (concerns exist over the level of NO₂ and particulate matter PM10 from biomass boiler installations); ▪ Fuel sourcing and the cost of fuel; ▪ Traffic movement and access arrangements for regular fuel deliveries; and ▪ Regular ash removal and maintenance requirements. Biomass boilers are therefore not further considered for the Proposed Development.

Table 6.1 - Renewable "Be Green" Feasibility Study

The study concludes that the following technologies were suitable, and further in-depth analysis of those systems is summarised below.

- Air Source Heat Pump
- Water Source Heat Pump
- Photovoltaics

7.2 AIR SOURCE HEAT PUMP - AMBIENT LOOP SYSTEM

The National Grid is, over time, seeing an increase in contribution in renewable energy technology and as a result, a reduced contribution from fossil fuels. The net result is that the National Grid is becoming cleaner and the 'carbon intensity' is reducing. The reduction in carbon intensity is now so significant that in the latest consultation to revise the Building Regulations it is proposed that a unit of electricity now has a lower carbon intensity than a unit of gas.

The impact of this is that traditional technologies such as boilers or combined heat and power (CHP), which were preferable due to their ability to offset high carbon intensity mains electricity, sees its benefit diminish to, in the majority of cases, zero. Alongside this, electrically run technologies such as heat pumps which previously resulted high carbon emissions, are no longer as carbon intensive and become more preferable.

Given the impact of National Grid decarbonisation, the proposed development seeks to achieve compliance with Building Regulations and Reading local carbon emissions targets via an Air Source Heat Pump system (ASHP) connected to a 5th generation (5G / ambient loop) district heating network.

4th generation networks typically offer heating only solutions to provide building heating and hot water demand. 5th generation networks can additionally offer cooling solutions when coupled with heat pump installations, using the network as a heat sink for heat rejection from the cooling process due to the lower system operating temperatures which the 5G systems employ.

The loop comprises of a network of water-to-water heat pumps (Hydro-boxes) with integrated DHW cylinders which are connected to a common landlord ambient water loop. Heat is taken from the ambient loop by the water-to-water heat pump units to provide heating and hot water where required.

The advantages of such a system are as follows:

- Combustion free, no local emissions
- Provides a route to zero carbon as Grid electricity de-carbonises further.
- Most energy efficient generated by excellent SCOPs due to ambient temperature requirements, lower distribution losses & benefits from sharing heat recovery.
- Lowest lifetime operational carbon emissions.
- Lowest operational costs compared to alternative electric systems.
- Can easily be connected to all types of future 4G or 5G district heating networks in the future.
- Reduces communal corridor overheating risk.
- Future flexibility in being able to provide cooling if required.
- Cooled spaces can be served by water-cooled-VRF fed from the ambient loop, rejecting heat to the network and reducing heating energy required from the ASHPs.
- Potential to secure RHU support.
- Potential to recover heat from low grade heat sources in future

Based on the advantages above the all-electric 5G ambient loop district heating was chosen as the preferred district heating system for this development.

It is proposed that the ambient loop system provides a source of energy to generate heating, hot water as required to all residential apartments. All other areas are unheated, as documented within the SAP worksheets provided in the appendices.

In accordance with industry standard best practice, the air source heat pumps will be sized in accordance with the Danish District Heating Design Guide DS 439:2009, CIBSE Heat Networks Code of Practice for the UK CP 01 2020 & Design Guide for Stored Hot Water Solutions in Heat Networks 2018.

7.2.1 PROPOSED SYSTEMS EFFICIENCIES

The table below shows the proposed MEP system efficiencies for the domestic areas of the proposed development.

The overall efficiency of the ambient loop network was calculated in accordance with CIBSE Applications Manual 16: Heat pump installations for multi-unit residential buildings (2021) and the most recent guidance from Elmhurst Energy. As shown in Figure 7.1 below, the total COP, i.e. the overall efficiency of the system, for a combination of a centralised air source heat pump and individual water source heat pump is calculated as the ratio of the total heat output divided by the sum total of electrical input to both heat pumps.

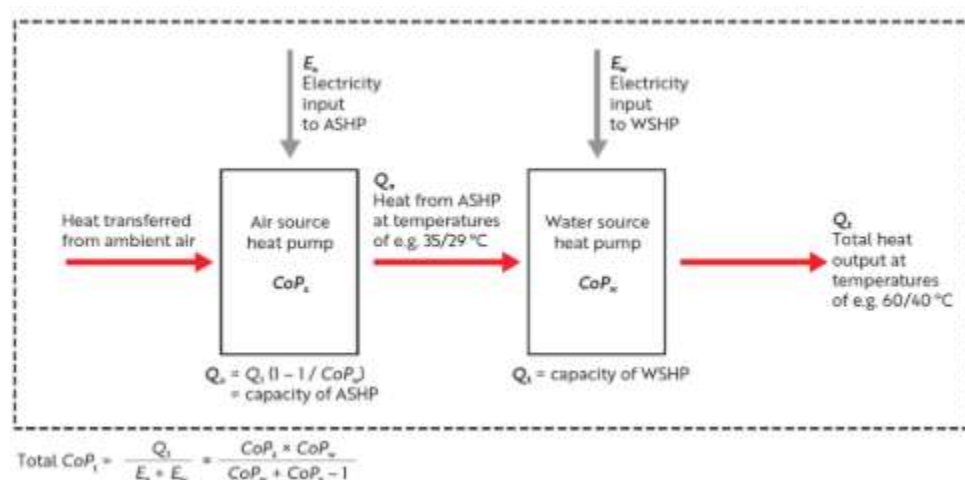


Figure 6.1 – Calculation of total COP for combination of heat pumps, CIBSE AM16 (2021)

This ratio can be calculated using the following equation from the individual COPs of the apartment heat pumps and the centralised air source heat pump.

$$\text{COP}_T = \frac{\text{COP}_a \times \text{COP}_w}{\text{COP}_w + \text{COP}_a - 1}$$

The manufacturer's stated COP of the centralised ASHP at the proposed 20/25°C flow temperatures is 4.01. The manufacturer's stated COP for the apartment water-to-water heat pumps (Daikin Altherma 3 WS) at an output temperature of 55°C is 4.15. The total COP is therefore calculated as $(4.01 \times 4.15) / (4.01 + 4.15 - 1) = 16.64 / 7.16 = 2.32$.

Efficiency/SCOP	Comments
232%	Calculated from efficiency values provided by manufacturer

Table 6.2 – Systems performance for the domestic buildings

7.3 WATER SOURCE HEAT PUMP - VRF

High efficiency VRF systems powered by Water Source Heat Pumps will provide space heating to the retail units and residential amenity areas. The heating SCOP of all the heat pumps exceed the Notional

value. The effect of this increased efficiency and the consequent reduction in carbon emissions is accounted for at the “Be Green” stage.

The total efficiency of the WSHP VRV systems have been calculated using the formula in section 7.2. The manufacturer’s stated SCOP for the WSHP’s powering the VRV systems is 11.9. The total COP is therefore calculated as $(4.01 \times 11.9) / (4.01 + 11.9 - 1) = 47.72 / 14.91 = 3.20$.

Efficiency/SCOP	Comments
3.20	Calculated from efficiency values provided by manufacturer

Table 6.3 – Systems performance for the non-domestic buildings

7.4 PHOTOVOLTAICS

Photovoltaics (PV) are anticipated to become standard in all new build dwellings. Under SAP 10.2, all notional buildings are assumed to be provided with PV in proportion to their floor area, incentivising either the use of PV or further energy efficiency measures to reduce the BER below the TER. Locally generated electricity by PV shall reduce the electricity which must be drawn from the National Grid, further reducing the building emissions.

7.4.1 PROPOSED PV ARRAY

The table below shows the proposed PV array design. In accordance with current guidance, PV generated electricity and associated carbon offsets are apportioned between apartments proportionally based on floor area.

	Orientation	Elevation	No. panels	Approx. kWp
Block A	Various	10°	177	62

Table 6.4 – PV specification for the domestic buildings

Although the PV array is installed only on the Block A roof, the electricity generated by it will be routed to the common mains electrical connection shared by both blocks. Therefore, the PV has been apportioned between the apartments in both blocks.



Figure 6.2 – Roof Level PV Arrangement

7.5 'BE GREEN' RESULTS

The 'Be Green' stage carbon dioxide emissions and savings for the proposed development are presented in the table below.

Domestic

	Carbon Dioxide Emissions for domestic buildings (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Part L 2021 compliant building	184.1	118.0	302.1
Be Lean	161.5	118.0	279.5
Be Clean	161.5	118.0	279.5
Be Green	65.2	118.0	183.2

Table 6.5 – Domestic CO₂ emissions after the be green stage of the energy hierarchy

Non-Domestic

	Carbon Dioxide Emissions for non-domestic buildings (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Part L 2021 compliant building	15.4	50.8	66.2
Be Lean	14.7	50.8	65.5
Be Clean	14.7	50.8	65.5
Be Green	14.6	50.8	65.4

Table 6.6 – Non-domestic CO₂ emissions after the be green stage of the energy hierarchy

8. SUMMARY OF SAVINGS

In summary, the Site proposals seek to deliver savings in line with the Energy Hierarchy, limiting energy demand in the first instance, selecting energy efficient plant and building services, before maximising the use of any renewable energy.

Overall, the Site could be expected to achieve a 60% reduction in regulated carbon emissions over Part L 2021 when calculated using SAP 10 carbon factors. This saving includes a 12% reduction in regulated carbon emissions for the 'Be Lean' scenario.

In accordance with Paragraph 3.11 of Reading Borough Council Sustainable Design and Construction SPD, 2019; a cash in-lieu contribution has been sought to offset residual emissions, totalling £143,526. Cash in-lieu contribution has been calculated as £60 per tonne CO₂ over thirty years.

The breakdown in savings which meet and exceed Reading Local Plan requirements is shown in Table 7.1 and Table 7.2.

8.1 DEVELOPMENT ENERGY HIERARCHY

	Site-wide Carbon Dioxide Emissions (Tonnes CO ₂ per annum)		
	Regulated	Unregulated	Total
Part L 2021 compliant building	199.5	168.8	368.3
Be Lean	176.2	168.8	345.0
Be Clean	176.2	168.8	345.0
Be Green	79.8	168.8	248.6

Table 7.1 – Site-wide CO₂ emissions after each stage of the energy hierarchy

	Site-wide carbon dioxide savings	
	(Tonnes CO ₂ per annum)	(%)
Be Lean Savings from demand reduction	23.3	12%
Be Clean Savings from heat network	0.0	0%
Be Green Savings from renewable energy	96.4	48%
Total Cumulative on-site savings	119.7	60%
Cumulative carbon to be off-set by payment	2,393 tonnes of CO ₂	
Cash in-lieu contribution (£)	£143,562	

Table 7.2 - Regulated & unregulated CO₂ savings from each stage of the energy hierarchy

9. APPENDICES



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