

400 Longwater Avenue, Reading
Green Park Reading No.1 LLP

Energy Strategy
Rev. 01
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Audit Sheet

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1.0 Executive Summary

This Energy Strategy has been prepared on behalf of Green Park Reading No.1 LLP, hereafter referred to as the Applicant, in support of a full planning application for the office use development at 400 Longwater Avenue, Green Park, Reading, hereafter referred to as the Proposed Development.

Policy & Drivers

This strategy summarises the pertinent policies and requirements applicable to the Proposed Development. Of these, the principle target is to achieve a reduction in regulations CO₂ emissions reduction beyond Building Regulations Part L 2013 compliance, with at least a 20% CO₂ emissions reduction through the use of low and zero carbon technologies, as set out in Policy CS1 of the Core Strategy of Reading Borough Council (RBC).

However an update to the Sustainable Design and Construction SPD confirms that 'recent changes to the Building Regulations mean that the requirement in policy CS1 to 'off-set at least 20% of predicted carbon dioxide emissions' has now been superseded for both residential and non-residential developments. All other parts of policy CS1 are still relevant. For this reason, the requirement to off-set at least 20% of predicted carbon dioxide emissions from the estimated energy usage of the completed and occupied development in adopted policy CS1 is not mentioned further in this SPD'.

Appraisals

The Proposed Development has been assessed to determine the regulated energy requirements, associated CO₂ emissions and the likelihood of high internal temperature in summertime. The Proposed Development has been modelled using benchmark data from similar buildings compliant with Building Regulations Part L2A (2013).

Passive Design & Energy Efficiency Measures

A number of passive design and energy efficiency measures are targeted at the Proposed Development:

- Suitable glazing ratio and glass g-value to balance heat losses, heat gains and daylight ingress. This is particularly important to limit reliance on artificial lighting.
- Fabric insulation and air permeability levels achieving improvements of 70% over the Building Regulations Part L (2013) requirements.
- Efficient low-energy lighting throughout all areas. Passive infrared occupancy sensors and daylight dimming provision where appropriate.
- Highly efficient space heating, cooling and mechanical ventilation systems.
- Insulated pipework and ductwork (and air sealing to ductwork) to minimise losses and gains.
- Variable speed pumps and fans to minimise energy consumption for distribution of services.

Implementation of these measures throughout the Proposed Development is anticipated to exceed compliance with the requirements of the Building Regulations Part L (2013) with an 18% CO₂ emissions reduction, through passive design and energy efficiency measures, i.e. before the inclusion of any Low or Zero Carbon (LZC) technologies.

Infrastructure and Low Carbon Energy Supply

Due to the relatively low thermal demand of the Proposed Development (~30% of the total energy demand) inclusion of a Combined Heat and Power engine is not considered to be feasible for the site.

On-Site Renewable Energy Generation

The viability of installing renewable technologies in the Proposed Development has been assessed, given the roof space available. A 43kWp PV array installed on-site would achieve an approximate further 2% CO₂ emissions reduction beyond the Building Regulations Part L (2013) 'baseline'. This will be reviewed following a thorough assessment of the roof layouts during detailed design.

Overall CO₂ Emissions Reduction

A summary of the anticipated CO₂ emissions and reduction at each step of the energy hierarchy is given in Figure 1.1.

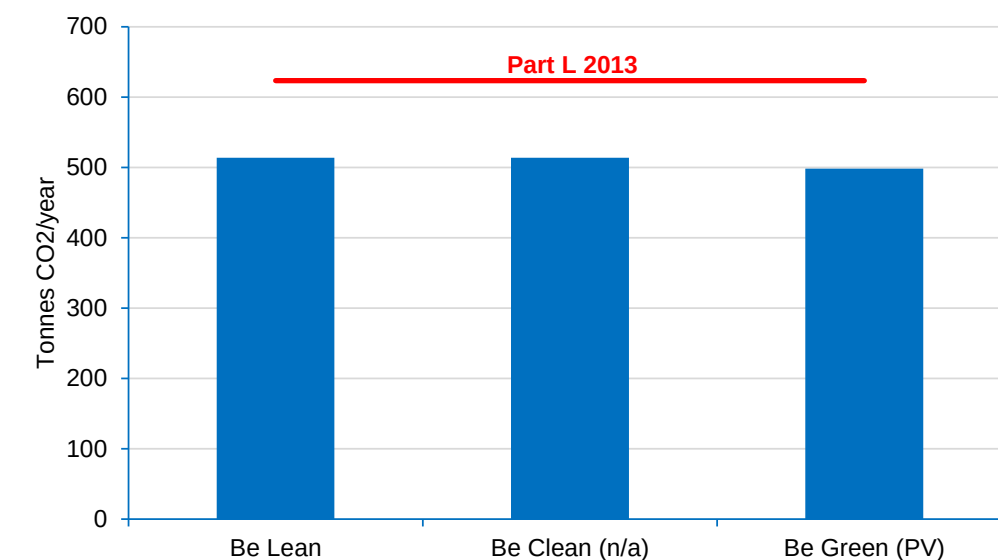


Figure 1.1: Summary of Regulated CO₂ Emissions Reductions.

An overall reduction in regulated CO₂ emissions of **20%** would be achieved when accounting for the benefits achieved through passive design and energy efficiency and PV array.

The CO₂ emissions reduction at the Proposed Development, as outlined in this energy strategy, will contribute to the credit requirements of the targeting BREEAM 'Excellent' rating and meet the mandatory minimum levels detailed to achieve this rating.

2.0 Introduction

2.1 The Application

This energy strategy has been prepared on behalf of Green Park Reading No.1 LLP, hereafter referred to as the Applicant, in support of a full planning application for the office development at 400 Longwater Avenue, Reading, hereafter referred to as the Proposed Development.

Development Description

The Proposed Development will be two five storey office buildings (B1) with floor plate sizes in the order of 2,000 – 3,000m² with a glass to glass dimension of circa 18m plus edge zone, totalling circa 27,000m² and associated car parking structures creating approximately 722 spaces in total (including 20 disabled parking bays).

The Proposed Development sits within the boundary of Green Park and is bound by Longwater Lake to the South and East, Longwater Avenue to the West and 350 Longwater Avenue to the North.

Aim

This strategy summarises the pertinent regulatory and planning policies applicable to the Proposed Development, and sets targets commensurate with these policies, which the Proposed Development will seek to achieve. This strategy summarises the sustainability measures that will be implemented for the detailed application areas of the development.

Approach

This strategy follows the energy hierarchy: 'Be Lean - Be Clean - Be Green'.

Calculations demonstrating the energy requirements and associated CO₂ emissions for the Proposed Development are based on outputs from Dynamic Simulation Modelling (DSM) undertaken using IES VE Software (compliant with CIBSE AM11) in accordance with National Calculation Methodologies as required by Part L2A of the Building Regulations (2013).

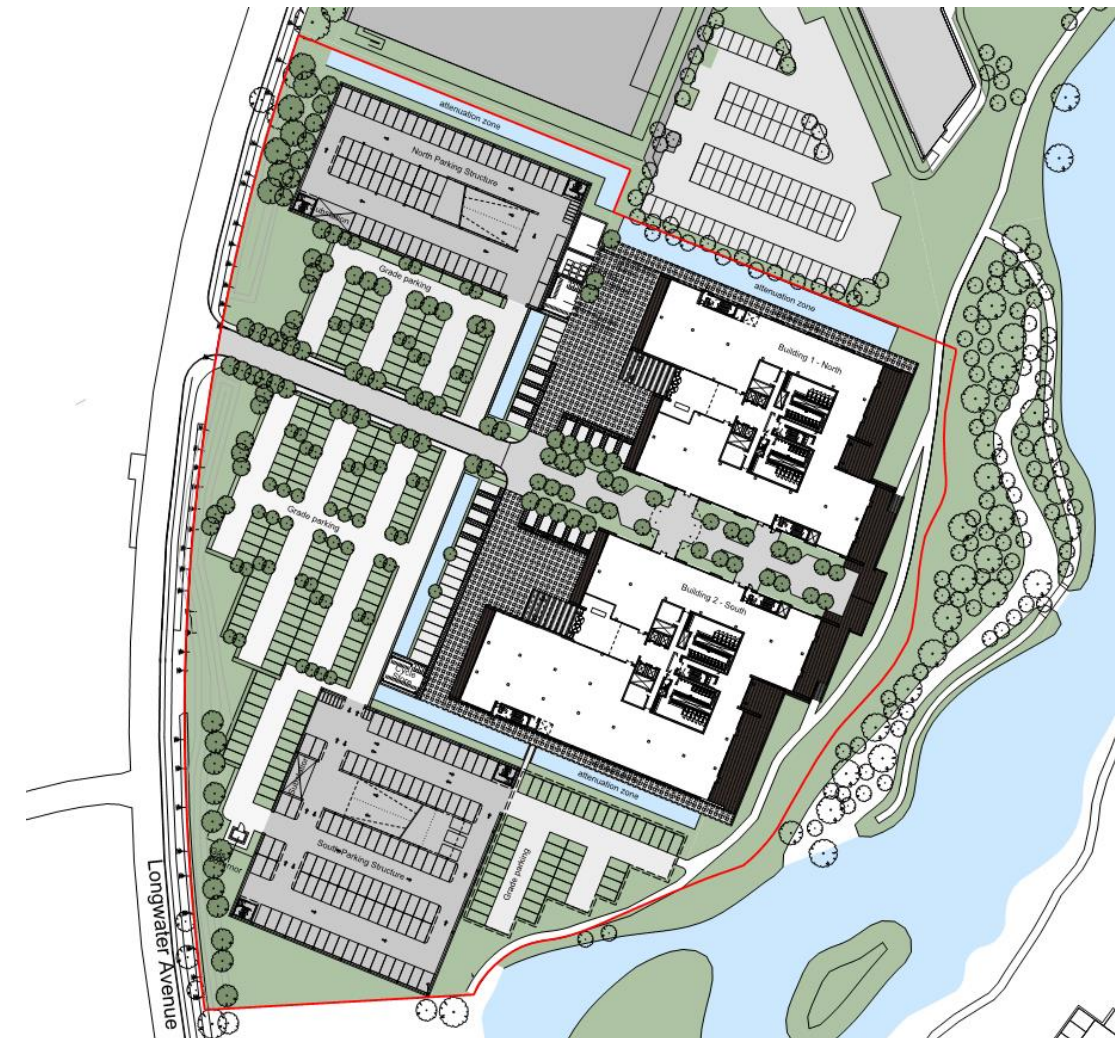


Figure 2.1: 400 Longwater Avenue Proposed Development Layout.

2.2 Policies and Drivers

This section provides a summary of the relevant national and local sustainability planning policies (energy and sustainability) – including, the national planning policy framework and the local policies of the Reading Borough Council (RBC).

This strategy has endeavoured to respond positively to the targets set and achieve the requirements where feasible. The policy documents summarised below are applicable to this development and have been reviewed in this report – see Appendix C for details.



Figure 2.2: Key Policy Documents.

The National Planning Policy Framework (March 2012)

The National Planning Policy Framework (NPPF) was published on 27th March 2012 and superseded all Planning Policy Statements (PPS) and Planning Policy Guidance (PPG) documents.

The National Planning Policy Framework sets out the Government's economic, environmental and social planning policies for England. In combination, these policies articulate the Government's vision of sustainable development, which should be interpreted and applied locally to meet local aspirations.

It provides a framework within which local people and their accountable councils can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities. The NPPF states that: "Proposed redevelopment that accords with an up-to-date Local Plan should be approved and proposed redevelopment that conflicts should be refused unless other material considerations indicate otherwise."

Building Regulations Part L (October 2013)

The assessment of the Proposed Development against policy targets has been carried out using the Building Regulations Part L 2013 methodology.

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

Current Requirements: Part L 2013

Part L has five key criteria which must be satisfied as follows:

- Criterion 1 - Achieving the Target Emission Rate (TER)
- Criterion 2 - Limits on design flexibility
- Criterion 3 - Limiting the effects of solar gains in summer
- Criterion 4 - Building performance consistent with the Building Emission Rate (BER)
- Criterion 5 - Provision for energy efficient operation of the building

Criteria one, two and three are addressed within this strategy.

Criterion one requires that the building as designed is not predicted to generate CO₂ emissions in excess of that set by the Target Emission Rate (TER) calculated in accordance with the Part L (2013).

Criterion two places upper limits on the efficiency of controlled fittings and services for example, an upper limit to an external wall U-value of 0.35W/m².K (non-dwellings).

Criterion three requires that commercial buildings are not subject to excessive solar gains. This is demonstrated by Dynamic Simulation Modelling (DSM) for non-residential buildings.

Current Policy Framework

The policies of Reading Borough Council (RBC) are contained within the Local Plan documents:

Those applicable to the Development are:

- Reading Borough Council Core Strategy (Alteration adopted January 2015)
- The Supplementary Planning Documents (SPD):
 - Reading Station Area Framework (December 2010)
 - Sustainable Design and Construction (July 2011)
 - The Sites and Detailed Policies Document (October 2012)
- An updated version of the Sustainable Design and Construction SPD (July 2011) states the following:
 - 'Recent changes to the Building Regulations mean that the requirement in policy CS1 to 'off-set at least 20% of predicted carbon dioxide emissions' has now been superseded for both residential and non-residential developments. All other parts of policy CS1 are still relevant. For this reason, the requirement to off-set at least 20% of predicted carbon dioxide emissions from the estimated energy usage of the completed and occupied development in adopted policy CS1 is not mentioned further in this SPD'.

3.0 Approach and Methodology

3.1 Definitions

The following definitions should be understood throughout this strategy:

- **Energy demand** – the ‘room-side’ amount of energy which must be input to a space to achieve comfortable conditions. In the context of space heating, this is the amount of heat which is emitted by a radiator, or other heat delivery mechanism.
- **Energy requirement** – the ‘system-side’ requirement for energy (fuel). In the context of a space heating system using a gas boiler, this is the amount of energy combusted (e.g. gas) to generate useful heat (i.e. the energy demand).
- **Regulated CO₂ emissions** – the CO₂ emissions emitted as a result of the combustion of fuel, or ‘consumption’ of electricity from the grid, associated with regulated sources (those controlled by Part L of the Building Regulations).

3.2 Limitations

Calculations demonstrating the energy requirements and associated CO₂ emissions for the Proposed Development and associated uses have been benchmarked using data from similar buildings compliant with Building Regulations Part L2A (2013).

The appraisals within this strategy should not be understood as a predictive assessment of likely future energy requirements or otherwise.

Occupants may operate their systems differently, and / or the weather may be different from the assumptions made by Part L approved calculation methods, leading to differing energy requirements.

3.3 Energy Hierarchy

This strategy outlines how the Proposed Development would have a reduced impact on climate change by reducing CO₂ emissions associated with energy use in buildings.

The Energy and CO₂ appraisal is based on the following approach:

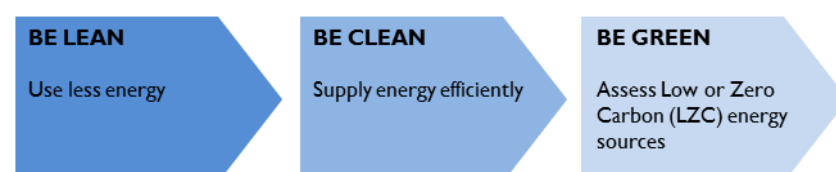


Figure 3.1: Energy Hierarchy.

The strategic approach to the design of the proposed development has been to reduce demand for energy prior to the consideration of integrating Low or Zero Carbon (LZC) technologies, since controlling demand is the most effective way of reducing energy requirements and CO₂ emissions.

Further reductions are ensured through the specification of high-efficiency building services to limit losses in energy supply, storage and distribution.

After the inclusion of passive design and energy efficiency measures, various options have been investigated to reduce CO₂ emissions associated with energy supply.

The feasibility of LZC technologies have been investigated in line with the policy aspirations.

3.4 Methodology

The area outlined in table 3.1 have been used to undertake the appraisals described within this strategy. Please note that these numbers may be different from those provided within the planning application, as the energy appraisal refers to regulated (heated and/or cooled) spaces of the Proposed Development only.

Use	Area (m ²)
Office (B1)	25,154
Total	25,154

Table 3.1: Area Schedule.

The following Part L (2013) compliant CO₂ emission factors in table 3.2 were used to convert the energy requirement figures into CO₂ emissions for the proposed development.

Fuel	Emission Factor (kgCO ₂ /kWh)
Gas	0.216
Electricity	0.519

Table 3.2: Building Regulations Part L 2013 CO₂ Emission Factors.

4.0 Appraisal

4.1 Be Lean

The following sections detail the passive design and energy efficiency measures that are targeted at the Proposed Development.

Passive Design Measures

Passive design measures are those which reduce the energy demand within buildings, without causing an energy requirement in the process.

These measures form an effective method to reduce CO₂ emissions as the performance of the solutions (e.g. wall insulation), is unlikely to deteriorate significantly with time or be subject to change by future property owners. In this sense, we can be confident that the benefits of these measures would continue at a similar level for the duration of their installation.

Glazing Ratio

The Proposed Development has taken a 'fabric first' approach to reducing energy demand and CO₂ emissions.

With the glass technology currently available on the market, glazing ratio is an important metric to drive efficiency, whilst carefully balancing design and daylight / sunlight requirements.

Whilst office buildings are generally less sensitive to the extent of glazing, as generally the demand for energy is driven by lighting as opposed to heating, given the anticipated high cooling load, the architectural team has been mindful of these targets with the aim of reducing the need for cooling during summer months.

Additionally offices will benefit from increased glazing ratios to promote good daylight ingress.

Glazing Energy and Light Transmittance

The design team has also been mindful to balance the solar energy transmittance and light transmittance values of the glass façade, to control solar gains and to maximise daylight respectively.

Solar gains are beneficial in winter months as a means of avoiding the need for active heating to maintain comfortable internal temperatures. However, in summer months excessive solar gains can lead to high internal temperatures.

In tandem with the glazing ratio targets, the solar energy transmittance (g-value) of the glass has been targeted to allow solar gains in winter, but control solar gains in summer, whilst not having a detrimental effect on daylight ingress, allowing natural light to penetrate into the office in order to limit the demand for electric lighting.

Thermal Insulation

The Proposed Development would benefit from an efficient thermal envelope. Heat losses and gains would be controlled by the optimisation of the fabric of the building. Reducing the thermal transmittance of the building envelope where appropriate would assist in reducing both heating and cooling requirement and result in lower CO₂ emissions. The target U-values for the office uses would aim to be in accordance with the 'notional values' of Part L, an improvement beyond the baseline 'limiting values', as demonstrated in table 4.1.

The design will aim to improve the Part L2A targets for the Proposed Development where feasible as outlined in table 4.2.

Element	U-Value (W/m ² .K)		Betterment
	Part L2A (2013) Requirement	Proposed Development Target	
Roof	0.25	0.16	36%
External Wall	0.35	0.25	30%
Floor	0.25	0.21	16%
Windows ²	2.20	1.50	32%

Table 4.1: U-Value Targets.

² The Part L2A target excludes windows classed as 'display windows' for the purposes of displaying goods or services. Whereas there is no limit on the design flexibility for 'display windows', the CO₂ emissions must be calculated using the U-value as specified.

Thermal Mass

Thermal mass is the term given to describe the ability of a structure to absorb and emit heat. It is a product of the physical properties of materials. A low thermal mass would mean that internal heat gains and solar gains could not be absorbed by the fabric. Where these gains are not exhausted through ventilation, these could lead to the likelihood of high internal temperatures in summer months. A medium or a high thermal mass can assist in mitigating this risk.

The use of exposed thermal mass, where appropriate, will be considered during detailed design stages as a means of assisting the passive design of the Proposed Development.

Fabric Air Permeability

Fabric air permeability is a measure of the volume of air that can penetrate through the fabric of a building, leading to ventilation heat loss and gain.

High air permeability can lead to uncomfortable draughts and dramatically increase the demand for space heating in winter, and space cooling in summer, when the air-flow works in reverse i.e. cool air escaping from the building.

The building would be designed to reduce air infiltration rates through the incorporation of robust building detailing and high quality construction techniques. It is anticipated that the building would target an air permeability rate of 3m³/(m².h) at 50Pa. This is a 70% reduction beyond that required by Building Regulations Part L 2013.

Energy Efficiency Measures

Energy efficiency measures are those which seek to service the demand for energy (i.e. the demand remaining after implementation of passive design measures) in the most efficient way.

Lighting

For the Proposed Development the demand for lighting dominates over other uses (e.g. heating). As such, the implementation of energy efficient lighting design is paramount to reducing CO₂ emissions. It is anticipated that the Proposed Development would be supplied with energy efficient lighting that could

include 'Compact Fluorescent Lamps' (CFL), 'Light Emitting Diodes' (LED) or similar low energy lamps with efficacies of >60lm/W.

The market for LED lighting has developed significantly in recent years, resulting in a general reduction in the cost of LED lighting solutions. The quality and variety of lighting available that utilises efficient LED sources has also expanded.

Typically, LED lights exceed the 60lm/W target and achieve up to ~90lm/W. In addition, the use of lighting controls such as occupancy detection and daylight linking would be encouraged to further reduce the use of lighting systems, where appropriate.

A key consideration for the design was to optimise natural daylighting to reduce the artificial lighting demand requirement.

Cooling

Highly efficient chillers will be used for cooling at the Proposed Development with a cooling seasonal efficiency of at least 3.85.

Heating and Hot Water

The office will be coupled to high efficiency gas boilers delivering heating using efficient Fan Coil Units (FCU) with a low Specific Fan Power (SFP) and hot water. The boilers will target an efficiency of over 95% and will utilise insulated pipework and variable speed pumps to circulate heat.

Characteristically, the thermal demand for office uses is low. As such, a CHP engine is unlikely to be suitable for the Proposed Development.

Ventilation

A natural ventilation strategy would be preferable as it has zero energy consumption, is low cost and requires few controls. Given the close proximity to the motorway a natural ventilation strategy is not proposed.

Furthermore, the Proposed Development would be provided with high-efficiency centralised mechanical ventilation with heat recovery. The target specific fan power is 1.6W/l/s and a heat recovery efficiency of approximately 71%.

Building Energy Management System & Metering

A Building Energy Management System ('BMS') would be installed to monitor and report on the overall heating and cooling energy consumption of the Proposed Development. The system would highlight any out of range consumption figures and readings, allowing a preventative approach through interrogation and resolution of potential problems. The heating and cooling plant and distribution systems would include continuous monitoring and reporting of the operating parameters to ensure that the systems operation is optimised.

Metering & Controls

Metering will be provided in accordance with the requirements of the Building Regulations and other pertinent guidance. Large items of plant such as chillers and any renewable technology contribution will be separately metered.

The meters may be linked via a network to provide automatic meter readings. This could form the basis for the charging mechanism by the management company.

Heating systems will be provided with zonal, programmable thermostatic controls linked to a master control panel. This will allow zones within the Proposed Development to be controlled independently for maximum flexibility. Hot water will be separately programmable.

Cooling will be controlled by zonal, programmable thermostatic controls linked to the fan coil units in each zone. It is anticipated that an interlock will be provided such that cooling is not permitted to operate in tandem with heating.

Consideration will be given to providing 'demand controlled ventilation' whereby the system controls are linked to internal temperature, relative humidity and carbon dioxide sensors which would trigger increased rates of ventilation if indoor air quality falls below a set point, whilst the zone is occupied.

Lighting in circulation areas will be linked to daylight (where suitable) and presence detection to minimise unnecessary use.

Pipework & Ductwork Insulation

Heating, hot water and cooling distribution pipework will be insulated in accordance with the requirements of the Building Regulations and guidance in the Heat Networks: Code of Practice for the UK (2015).

This will serve to minimise heat gains and losses to / from distribution pipework, and maximise system efficiency.

Variable Speed Pumping

Variable speed pumps allow the distribution systems to modulate during periods of low demand. Using variable speed pumps therefore uses less energy than traditional pumps, which run at a constant speed. The use of variable speed pumps throughout the building services systems would be considered.

Operation & Maintenance Manuals

In accordance with the requirements of the Building Regulations detailed Operation and Maintenance (O&M) manuals would be provided to the tenants of the Proposed Development.

The guides will be written in plain and clear English, and guidance will be provided to indicate where tenants may procure a version of the guide in other languages, large type text or braille.

The guides will provide both an overview of the systems and their intended operation, and relevant engineering details of the installations.

Commercial tenants will be responsible for provision of O&M manuals in accordance with the relevant Building Regulations.

4.2 Summary of Passive Design & Energy Efficiency Measures

Table 4.2 summarises the passive design and energy efficiency targets for the Proposed Development.

Parameters	Target	Part L2A 2013
Air permeability (m ³ /m ² .h) at 50Pa	3.00	10.00
External Wall U-value (W/m ² .K)	0.25	0.35
Ground Floor U-value (W/m ² .K)	0.21	0.25
Roof U-value (W/m ² .K)	0.16	0.25
Glazing U-value (including frame) (W/m ² .K)	1.50	2.20
g-value	0.4	-
LIGHTING		
General Lighting Lamp Efficacy (lm/W)	>60	60
Display Lighting Lamp Efficacy (lm/W)	>22	22
HEATING, COOLING AND VENTILATION		
Heating Boiler Efficiency	98%	91%
Cooling Efficiency (CoP)	3.85 (seasonal)	2.55
Ventilation specific fan power (SFP)	1.6 W/l/s	1.6 W/l/s
Heat recovery effectiveness	71%	65%
HOT WATER		
Hot Water Boiler Efficiency	98%	86.45%

Table 4.2: Summary of Passive Design Energy Efficiency Measures.

Note that the values shown above have been taken from the preliminary modeling results and are subject to change following subsequent modelling that will be carried out based on the final design at later stages.

4.3 Energy Requirements and CO₂ Emissions Appraisal

The following is an appraisal of the anticipated energy requirements and resultant CO₂ emissions that are likely to arise as a result of the proposed development, after the inclusion of the passive design and energy efficiency measures as described in the previous section.

The appraisal is based on approved calculation methodology of Part L (2013) and should not be understood as a predictive assessment as occupants may operate their systems differently, and / or the weather may be different from the assumptions made within the calculations.

Regulated Sources

Regulated energy sources are those controlled by the Building Regulations, as follows:

- Space Heating
- Hot Water
- Space Cooling
- Lighting
- Auxiliary (pumps, fans and controls)

Unregulated Sources

Unregulated energy includes small power electricity use (computers, plug in devices) and energy consumption associated with cooking. Currently, unregulated energy is not included within the Building Regulations Part L assessment requirements. It is anticipated that the proportion of unregulated energy would gain in significance when compared to regulated energy as each revision of Building Regulations Part L comes into force and regulated energy is reduced.

It is therefore foreseeable that energy efficiency and the rising cost of energy would play an increasing role when future building users are deciding which appliances to purchase and the frequency of their use. However, it is not possible at present to quantify the extent of this potential reduction.

Given the uncertainty, measures to educate the future building users on how they can reduce their equipment energy use would be encouraged. This can be provided in the form of building user guides and tenant fit-out guides. The guidance measures detailed within these types of documents would consider:

- Use of A / A+ rated white goods and
- Energy star rated computers and flat screen monitors.
- Energy efficient lifts
- Voltage optimization and power factor correction

The appropriate design of lifts including counter weights and appropriate sizing along with dimmable lighting when not in use would be considered for the Proposed Development.

Results

The results presented below demonstrate that prior to the implementation of any LZC technologies, it is anticipated that the annual regulated energy requirement of the proposed development is calculated to be approximately **~1,432 MWh**, equivalent to **514 tonnes** of regulated CO₂ emissions.

Of the total regulated energy requirement of the Proposed Development, heating (28%) and lighting (26%) are the largest contributors. As a result of the higher carbon factor of electricity, lighting is the highest contributor to regulated CO₂ emissions.

Overall, it is predicted that the Proposed Development will achieve compliance with the requirements of Building Regulations Part L (2013) via passive design and energy efficiency measures alone, prior to the implementation of any LZC technologies.

Summary Tables and Charts

Table 4.3 compares the energy requirements and associated CO₂ emissions of the proposed development for the Building Regulations Part L 2013 'baseline' and the energy requirements and CO₂ emissions after the inclusion of 'be lean' measures.

Parameters	Energy Requirements		CO ₂ Emissions	
	kWh/yr	% Reduction	kgCO ₂ /yr	% Reduction
Part L 2013 'Baseline'	~1,705,400	-	~623,300	-
'Be Lean'	~1,431,800	~16%	~513,900	~18%

Table 4.3: Summary of Be Lean Energy Requirements and Associated CO₂ Emissions.

Table 4.4 and 4.5 and figures 4.1 and 4.2 outline the anticipated annual regulated energy requirement and associated CO₂ emissions by service and space use for the Proposed Development.

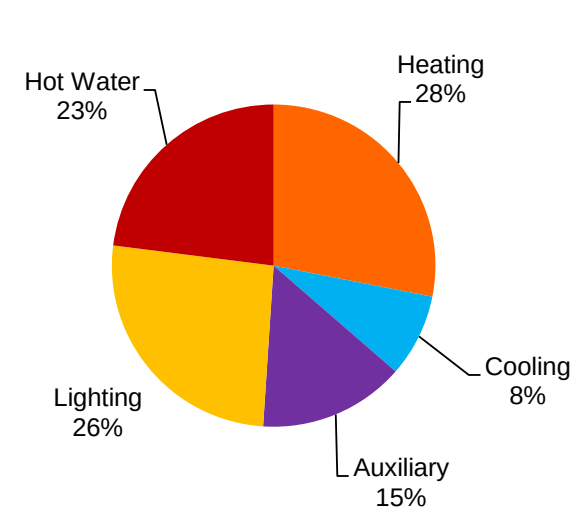


Figure 4.1: Anticipated Regulated Energy Requirement.

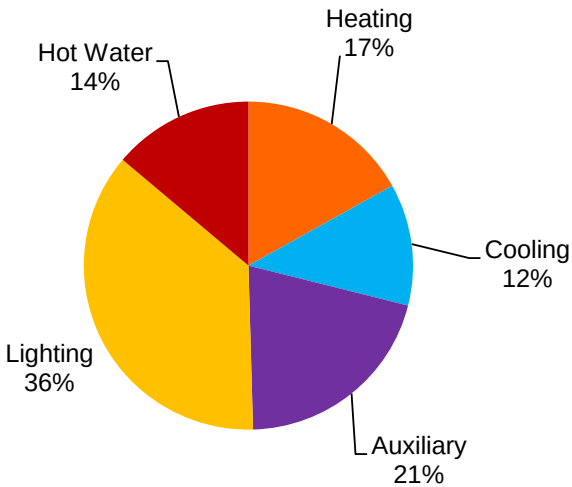


Figure 4.2: Anticipated Regulated CO₂ Emissions.

Space Use	Regulated Energy Requirement						Unregulated
	Heating	Cooling	Auxiliary	Lighting	Hot Water	Total	
	kWh/yr	kWh/yr	kWh/yr	kWh/yr	kWh/yr	kWh/yr	
B1 Office	402,200	119,000	209,500	371,800	329,300	1,431,800	937,000
Total	402,200	119,000	209,500	371,800	329,300	1,431,800	937,000

Table 4.4: Anticipated Regulated Energy Requirements.

Space Use	Regulated CO ₂ Emissions						Unregulated
	Heating	Cooling	Auxiliary	Lighting	Hot Water	Total	
	kgCO ₂ /yr	kgCO ₂ /yr	kgCO ₂ /yr	kgCO ₂ /yr	kgCO ₂ /yr	kgCO ₂ /yr	
B1 Office	86,900	61,700	106,000	188,100	71,100	513,900	486,300
Total	86,900	61,700	106,000	188,100	71,100	513,900	486,300

Table 4.5: Anticipated Regulated CO₂ Emissions.

4.4 Be Clean

The following sections discuss the infrastructure and clean energy supply measures that have been considered and the technologies that would be implemented at the Proposed Development.

Infrastructure

Infrastructure at the proposed development would be the key to achieving the target reduction in regulated CO₂ emissions beyond the requirements of the Building Regulations Part L (2013).

Combined Heat and Power (CHP)

Consideration has been given to the relative merits of providing either Combined Heat Power (CHP) versus a traditional high efficiency systems.

Figure 4.3 and 4.4 demonstrate that these systems can work more efficiently in primary energy terms than their traditional counterparts, i.e. grid electricity and gas boilers, by simultaneously producing electricity and heat. It is estimated that where thermal demand is adequate, CHP can achieve reductions in primary energy demand relative to traditional sources of approximately 30%.

Such plant is more efficient than deriving electricity from the grid as the heat generated in the process of creating the electricity can be used on-site, and the electricity does not have to travel great distances over the national grid before use, thus minimising transmission losses.

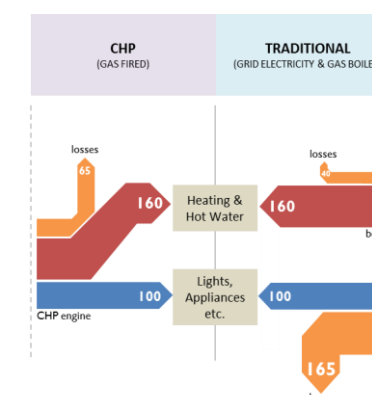


Figure 4.3: CHP Efficiency.

The benefit of a CHP engine is based on the heat carbon factor which is derived from CHP efficiency, gas carbon factor and electricity carbon factor of the national grid. It is worth noting that with a gradually decarbonising electricity grid, CHP becomes less able to reduce CO₂ emissions.

Therefore where analysis indicates that the 'day-one' CO₂ emissions reduction of a CHP engine is marginal, it should be considered that over the lifetime of the system, CO₂ emissions would likely be above the traditional counterpart.

For efficient operation, a CHP engine requires a high thermal base-load as it is not well suited to highly variable loads. On this basis high efficiency gas fired boilers are required in addition to the CHP system to meet the peak heating demand.

Figure 4.5 demonstrates that site-wide, thermal sources account for 31% of the overall CO₂ emissions, which is a relatively low thermal demand.

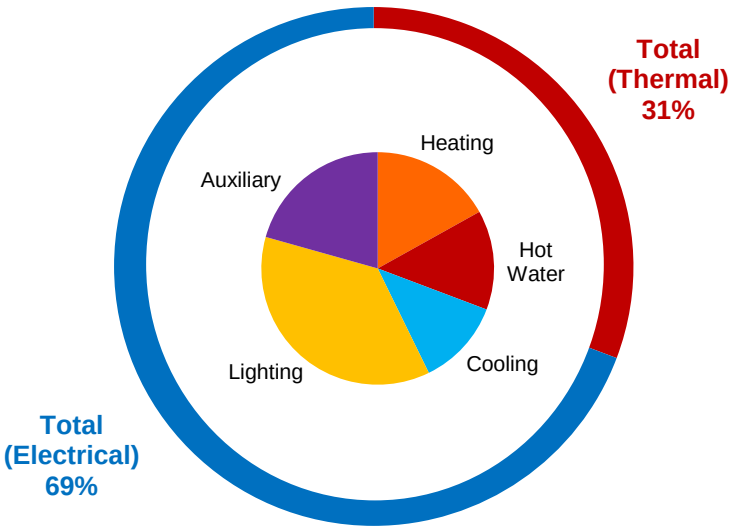


Figure 4.5 Site-Wide Anticipated Regulated CO₂ Emissions Summary

This technology has been appraised against the anticipated thermal demand profile to determine suitability and potential CO₂ emission reductions. A CHP analysis has been carried out using the energy appraisal calculations assuming a 30% contribution to space heating and a 100% contribution to hot water demand. This would require approximately a 50kW_e CHP engine.

Figure 4.6 displays the anticipated thermal profile for the Proposed Development.

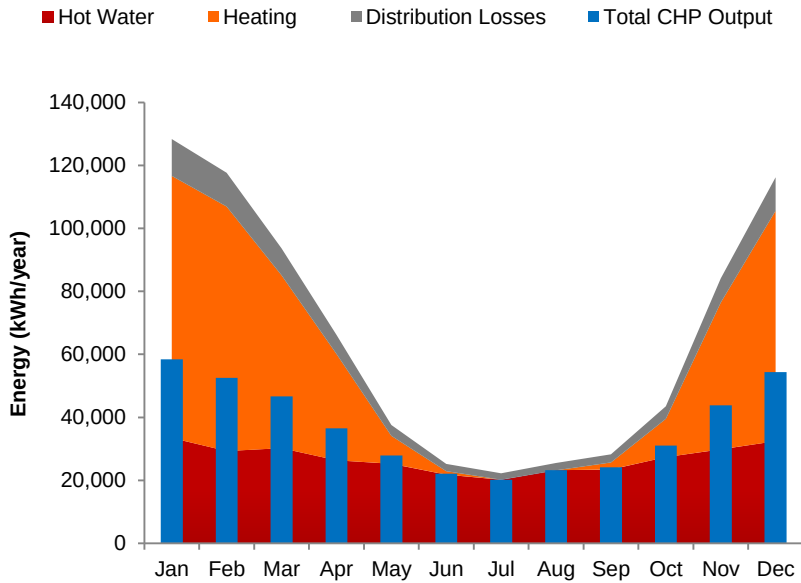


Figure 4.6: Annual Thermal Load Profile and Potential CHP Contribution.

It is estimated that a CHP engine of this size, allowing for losses and pumping associated with delivering the energy to the Proposed Development could reduce regulated CO₂ emissions by approximately **24.2 tonnes** per annum. This is equivalent to a CO₂ emissions reduction of **3.9%** beyond the Building Regulations Part L baseline.

Therefore the relatively low thermal demand would lead to increased modulation of the CHP engine which can be detrimental to the system and could lead the system to be turned off entirely for long periods for repair. This would lead to a reduced efficiency of the CHP engine.

Summary of Be Clean Measures

Given the relatively low heating and hot water demand inclusion of a CHP engine is not considered suitable for the Proposed Development.

	Peak Output (kW)		Annual Output (kWh)		CO ₂ Emission Reduction		Suitable?	Notes
	Electrical	Thermal	Electrical	Thermal	Total (Tonnes)	% Beyond Part L 2013 'Baseline'		
CHP	50	79	279,000	440,000	24	3.9%		100% - HW 30% - SH

Table 4.8: CHP Appraisal Summary.

Key:
(h) heating and hot water output
hw hot water
sw space heating

Off-site Network Connections

Using the National Heat Map the feasibility of connecting to an off-site network has been assessed.

As figure 4.8 shows, the Proposed Development is surrounded by relatively low heat density areas, where no existing schemes are in the area at the time of submission and connection to a local district energy scheme does not appear to be feasible.



Figure 4.8: National Heat Map – Focused on Proposed Development.

4.5 Be Green

The following sections discuss the renewable energy generation measures that have been considered, and those which are targeted for at the Proposed Development.

Renewable technologies harness energy from the environment and convert this to a useful form. Many renewable technologies are available. However, not all these are commercially viable, suitable for city-centre locations or appropriate for the Proposed Development.

Technologies considered for the Proposed Development include:

- Ground Source Heat Pumps
- Air source heat pumps
- Biomass boilers
- Solar Thermal Panels
- Micro-wind turbines
- Photovoltaic panels

Ground Source Heat Pumps

Ground Source Heat Pumps (GSHP) work to extract heat from the ground. The Ground Source Heat Pump system proposed for the Proposed Development is a closed loop heat pump. Impacts to ground conditions are valid considerations for all GSHP technologies, meaning a balanced heating and cooling strategy should be applied.

The cooling demand of the Proposed Development is approximately 8% of the overall regulated energy requirement). The amount of heat extracted from the ground for heating in winter, and rejected for cooling in summer would need to balance over a yearly cycle. If an imbalance were to occur this could lead to freezing of the ground heat exchange system, rendering the system unusable and potentially damaging nearby structures and local hydrology.

Therefore the GSHP needs to be sized to avoid an impact on ground conditions by the imbalance of heat extraction and rejection and limit the effect on the efficiency of the system. Assuming a GSHP with a SEER of 4 (i.e. four units of useful heat for every unit of electricity consumed), a GSHP could provide 65% of the space heating requirement and 50% of the cooling requirement. This could be met by a 90kW GSHP providing a reduction in CO₂ emissions of approximately 21 tonnes which is equivalent to a CO₂ emissions reduction of 3.4% beyond the Building Regulations Part L (2013).

Given the complexities of installing a GSHP and the low potential CO₂ emissions reduction, it is proposed that the use of GSHP would not be implemented at the proposed development.

Air Source Heat Pumps

ASHPs do not operate as efficiently as GSHPs. Moreover, during times of peak demand (i.e. during winter months) the ambient air temperatures are at their minimum, meaning the ASHPs needs to work harder to extract the desired amount of heat. Systems have been noted to perform poorly in operation, in particular those systems which are also providing hot water.

The implementation of ASHP was assessed at an early stage in the project. To accommodate the demands at the Proposed Development, large external condenser units would be required.

On a site-wide basis, when assuming an ASHP could operate at Seasonal Energy Efficiency Ratio (SEER) of 3.0 (i.e. three units of useful heat for every unit of electricity consumed), to deliver 100% of space heating but no cooling or hot water, it is anticipated that a reduction in CO₂ emissions of 19 tonnes per annum could be achieved. This is equivalent to a reduction in regulated CO₂ emissions of 3.0% beyond the Building Regulations Part L (2013) 'baseline'.

Therefore, considering the low efficiencies of an ASHP and the external space requirements along with the low potential CO₂ emissions reduction, it is proposed that the use of ASHPs would not be implemented at the proposed development.

Biomass Boilers

Biomass boilers burn wood fuel or other bio-fuel sources to generate heat. These boilers can operate at high efficiencies, comparable to condensing gas boilers. However, they require a large fuel store to maintain continuous operation during the winter months. As such, area taken for such a plant at ground level is high. Furthermore, fuel deliveries to the site may disturb employees and pose difficulties and security of fuel supply is an important consideration.

Biomass boilers also result in higher emissions of Nitrogen Oxides (NO_x) in comparison with gas boilers. This can have a negative impact on the local air quality.

If a biomass boiler was to be implemented to provide 100% of the hot water demand, and 30% of the space heating demand, a reduction in CO₂ emissions of 80 tonnes per annum could be achieved. This is equivalent to a reduction in regulated CO₂ emissions of 13% beyond the Building Regulations Part L (2013) 'baseline'.

The calculations indicate that the use of a biomass boiler could yield significant regulated CO₂ emissions savings however this would also likely result in increased levels of NO_x emissions from the Proposed Development. As such, the use of biomass boilers at the Proposed Development would not be implemented.

Solar Thermal Panels

Solar thermal panels operate by capturing solar energy and transferring this via glycol to a thermal store to generate hot water. These systems can operate at efficiencies up to ~75% thus a high yield of energy can be derived from small collector areas.

Based on a solar thermal installation of approximately 150kW_p to deliver 42% of the hot water demand, it is anticipated that 340 MWh of heat could be generated per annum. This level of thermal generation enables a reduction in overall regulated CO₂ emissions by approximately 30 tonnes.

This is equivalent to a reduction in regulated CO₂ emissions of **4.8%** beyond the Building Regulations Part L (2013) 'baseline'.

However given the low hot water demand of the Proposed Development and the implications on installation and maintenance, it is not proposed that solar thermal panels are implemented on site.

Micro Wind Turbines

For efficient operation and to yield high energy output, wind turbines require a smooth laminar flow of air. Whilst the Proposed Development is located on the outskirts of an urban environment, the wind flow profile is not conducive to high annual yields.

Moreover, mounting wind turbines on the roofs of the Proposed Development could result in unacceptable vibration and resonance being felt within the building. The turbines are also likely to generate noise which may be a nuisance to neighbouring properties. This scenario is likely to result in the turbines being switched off.

Nevertheless, an appraisal has been carried out based on providing four 6kW horizontal axis wind turbine, to generate electricity for Proposed Development. It is estimated that approximately 6,330 kWh of electricity could be generated annually, reducing CO₂ emissions by 3 tonnes per annum.

This is equivalent to a reduction in regulated CO₂ emissions of 0.5% beyond the Building Regulations Part L (2013) 'baseline'.

Therefore, given the small benefit in terms of CO₂ emission reduction the use of wind turbines would not be implemented at the Proposed Development.

Photovoltaic Panels

An appraisal of the contribution of implementing a solar photovoltaic (PV) array has been undertaken. Figure 4.8 outlines the potential location of a roof-mounted PV array at the Proposed Development. The PV output has been based on solar irradiance data for London.

To allow for spacing between panels and installation cables a 300m² PV array is proposed, equivalent to 43kW_p. It is anticipated that approximately 30,000 kWh of renewable electricity could be generated per annum. This would achieve an approximate further 2% CO₂ emissions reduction beyond the Building Regulations Part L (2013) 'baseline'.

Whilst the CO₂ emissions reductions are not significant, given the anticipated roof space available on-site it is proposed that a PV array would be feasible for the Proposed Development. This will be reviewed following a thorough assessment of the roof layouts during detailed design.

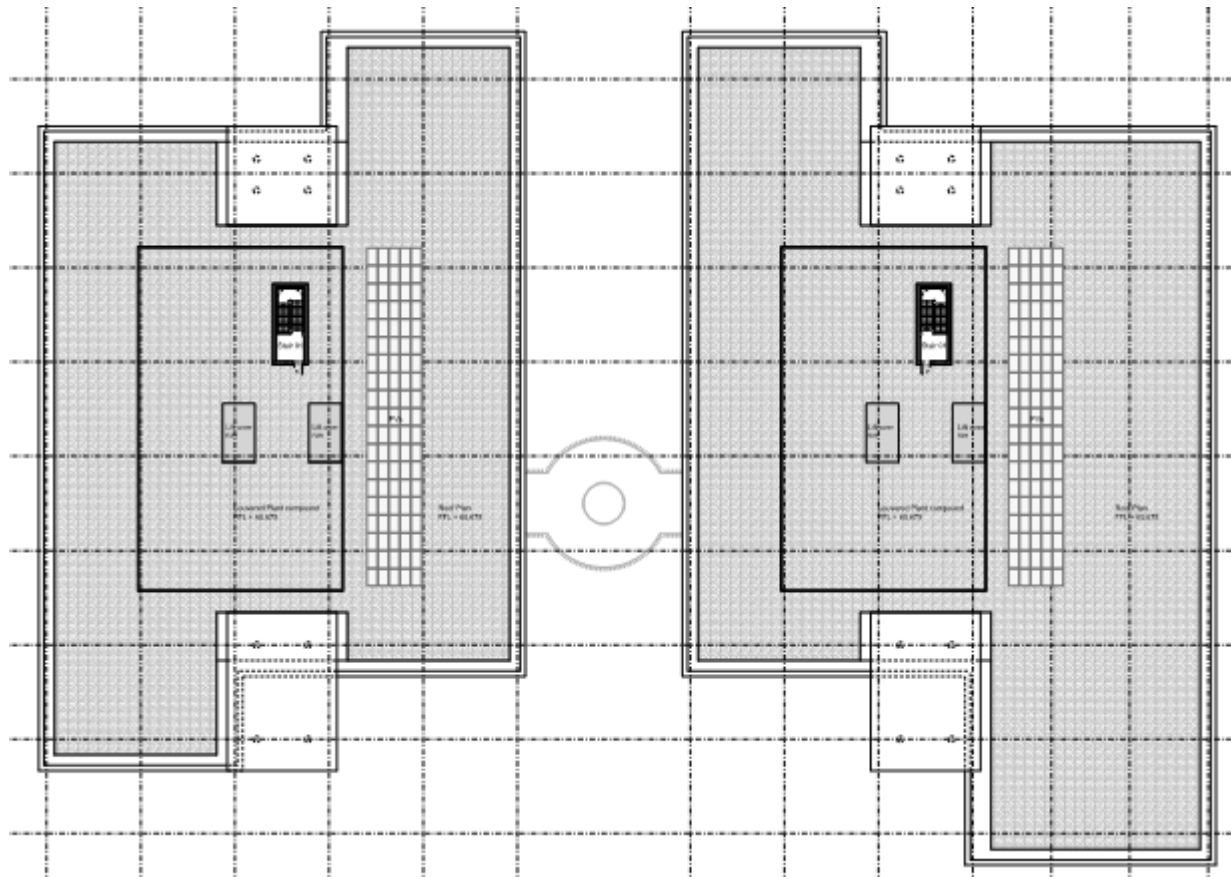


Figure 4.9: Indicative Locations of PV on Roof Plan.

Summary of Be Green Measures

Table 4.9 provides a summary of the technologies assessed previously.

	Annual Output		Annual Regulated CO ₂ Emission Reduction		Sizing Notes	Suitable?
	Thermal (kWh/year)	Electrical (kWh/year)	Tonnes per year	% Beyond Part L 'baseline'		
~43kWp (300sqm) Photovoltaic (PV) Panels	-	15.6	20	2.5%	Requires approximately 600sqm.	
~150kWp (300sqm) Solar Thermal Heating	137,000	-	30.2	4.8%	Requires approximately 600sqm.	
~240kW Wood Pellets Boilers	491,000	-	79.7	12.8%	30% space heating and 100% hot water.	
~90kW Ground Source Heat Pump	509,600	-63,400	21.2	3.4%	65% space heating and 50% space cooling	
~112kW Air Source Heat Pump	394,200	-	16.3	2.6%	100% space heating 0% hot water and cooling.	
4 No. 6kW Horizontal axis wind turbine	-	6,330	3.0	0.5%	-	

Table 4.9: Zero Carbon Technologies Appraisal.

4.6 Minimisation of Cooling Demand & Limiting the Effects of Heat Gains

In tandem with the energy and CO₂ emissions appraisal, an iterative approach has been undertaken to limit the effects of heat gains in summer (Part L Criterion 3) and to minimise the cooling demand.

Cooling Hierarchy

The Proposed Development would aim to follow the 'cooling hierarchy' to limit the effects of heat gains in summer as outlined below:

- a) Minimise internal heat generation through efficient design and efficient equipment selection
- b) Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration and insulation
- c) Natural ventilation
- d) Mechanical ventilation
- e) Active cooling systems

Summary of Mitigation Measures

The following mitigation measures would be considered for implementation at the Proposed Development.

Internal heat gains would be minimised by providing:

- a) Energy efficient lighting (such as LED or fluorescent) with low heat output
- b) Insulation to heating and hot water pipework and minimisation of dead-legs to avoid standing heat loss (from pipework)

External heat gains would be minimised by providing:

- a) Shading to windows by roof overhang and vertical brise-soleil
- b) Glazing with internal shading (blinds, to be provided by future tenants) and suitable g-value (0.4) to limit solar heat gains
- c) High levels of insulation and low fabric air permeability which will retain cool air within the building in summer months

Summary of Results

The cooling requirement at the Proposed Development has been reduced using the above measures (see energy demand and CO₂ emissions appraisal, p13), representing approximately **8%** of the overall energy requirement.

5.0 Conclusion

Energy & CO₂ Emissions

This Energy Strategy has demonstrated that through the implementation of passive design measures and a PV array, it is anticipated to achieve a **20%** reduction in regulated CO₂ emissions beyond the requirements of the Building Regulations Part L (2013) 'baseline'.

Passive design and energy efficiency measures which would be implemented at the Proposed Development include:

- Suitable glazing ratio and glass g-value to balance heat losses and gains and daylight ingress;
- Fabric insulation levels achieving improvements over Building Regulations Part L 2013 requirements;
- Fabric air permeability achieving improvements over Building Regulations Part L 2013 requirements;
- Efficient space heating systems with zonal, programmable and thermostatic controls, with separate controls for hot water;
- Efficient low-energy lighting (such as LED or fluorescents)
- Efficient mechanical ventilation with heat recovery which would limit the need for space heating in winter months, aid the mitigation of overheating risk in summer months (where openable windows cannot be used due to ambient acoustic conditions), and maintain good indoor air quality;
- Energy display devices to allow occupants to instantaneously view energy demand;
- Insulated pipework and ductwork (and air sealing to ductwork) to minimise losses and gains; and
- Variable speed pumps and fans to minimise energy consumption for distribution of services.

These measures are anticipated to exceed compliance with the requirements of the Building Regulations Part L (2013) by **18%**.

The viability of installing PV panels in the Proposed Development has been assessed and it is anticipated that a 43kWp PV array will be considered during detailed design stages. It is anticipated that a PV array of this size could achieve approximately a **2%** reduction in CO₂ emissions beyond Building Regulations Part L (2013) 'baseline'.

These reductions contribute to RBC CS 1 which states that low and zero carbon technologies off-set at least **20%** of the CO₂ emissions of the Proposed Development.

Implemented Option & Energy Hierarchy

In summary, the Proposed Development would be provided with efficient passive design and energy efficiency measures and a PV array.

Following the energy hierarchy, reductions in regulated energy requirements and associated CO₂ emissions have been made at each stage as demonstrated in table 5.1.

	Regulated Carbon Dioxide Emission Savings	
	(tonnes/yr)	(%)
Reduction from Be Lean	109	18%
Reduction from Be Clean	0	0%
Reduction from Be Green	16	2%
Total Reduction	125	20%

Table 5.1: Summary of Regulated CO₂ Emissions Reductions.

The CO₂ emissions savings are represented graphically in Figure 5.1.

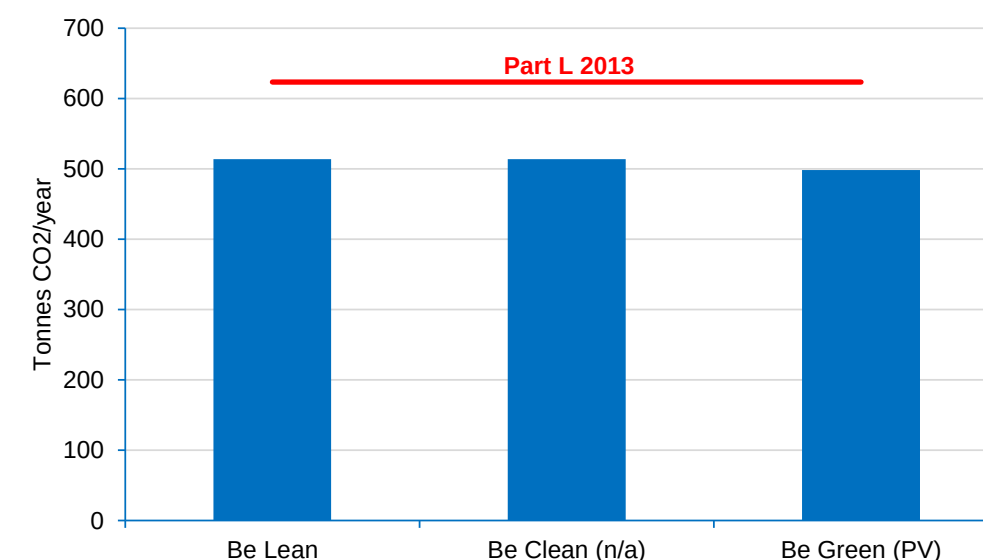


Figure 5.1: Summary of Regulated CO₂ Emissions Reductions.

6.0 Appendix A: Regulatory and Policy Context

The following outlines the regulatory and planning policy requirements applicable to the Proposed Development.

6.1 The Building Regulations

Approved Document Part L

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

Current Requirements: Part L 2013

Part L has five key criteria which must be satisfied as follows:

- f Criterion 1 - Achieving the Target Emission Rate (TER)
- g Criterion 2 - Limits on design flexibility
- h Criterion 3 - Limiting the effects of solar gains in summer
- i Criterion 4 - Building performance consistent with the Building Emission Rate (BER)
- j Criterion 5 - Provision for energy efficient operation of the building

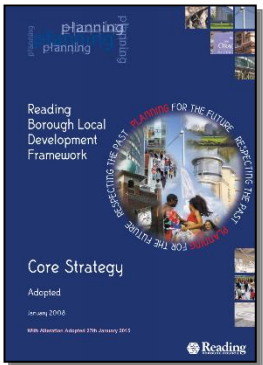
Criteria one, two and three are addressed within this strategy.

Criterion one requires that the building as designed is not predicted to generate CO₂ emissions in excess of that set by the Target Emission Rate (TER) calculated in accordance with the Part L (2013)

Criterion two places upper limits on the efficiency of controlled fittings and services for example, an upper limit to an external wall U-value of 0.35W/m².K (non-dwellings).

Criterion three requires that commercial buildings are not subject to excessive solar gains. This is demonstrated by Dynamic Simulation Method (DSM) for non-residential buildings.

1.2 Local Policies and Supplementary Planning Documents

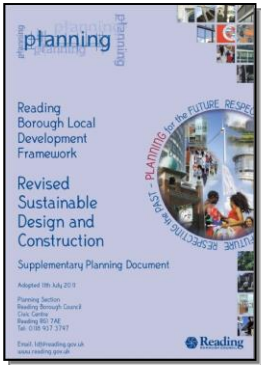


Reading Borough Council Core Strategy – Alteration adopted in January 2015

The Reading Borough Council Core Strategy (2008) sets out the key elements of the planning framework for the area of Reading. The Local Plan includes the following planning policies which relate to sustainable design and development:

- Policy CS 1 (Sustainable Construction and Design)
- Policy CS 2 (Waste Minimisation)
- Policy CS 18 (Residential Conversions)
- Policy CS 20 (Implementation of The Reading Transport Strategy)

- Policy CS 22 (Transport Assessments)
- Policy CS 24 (Car/ Cycle Parking)
- Policy CS 29 (Provision of Open Space)
- Policy CS 34 (Pollution and Water Resources)
- Policy CS 35 (Flooding)
- Policy CS 36 (Biodiversity and Geology)
- *Reading Borough Council Core Strategy*

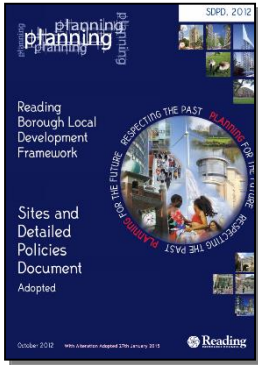


Reading Borough Council Supplementary Planning Document (SPD) on Sustainable Design and Construction – July 2011

- This SPD sets out material considerations on which planning applications are decided and provide more detailed guidance on how the Council's policies can be met during the planning process in relation to Sustainable Design and Construction. *An updated version of the Sustainable Design and Construction SPD (July 2011) states the following:*
 - *'Recent changes to the Building Regulations mean that the requirement in policy CS1 to 'off-set at least 20% of predicted carbon dioxide emissions' has now been superseded for both residential and non-residential developments. All other parts of policy CS1 are still relevant. For this reason, the requirement to off-set at least 20% of predicted carbon dioxide emissions from the estimated energy usage of the completed and occupied development in adopted policy CS1 is not mentioned further in this SPD'*

Key targets and requirements set out in the SPD are as follows:

- *Code for Sustainable Homes* - 50% of new residential units in a large development to achieve Code Level 4 with the remainder having to achieve Code Level 3.
- *BREEAM* - 50% of new commercial units in a large development to achieve BREEAM Excellent with the remainder having to achieve BREEAM Very Good.



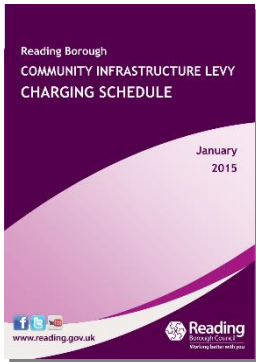
Reading Sites and Detailed Policies Document (SDPD) – October 2012

The Sites and Detailed Policies Document contains detailed policies to help guide decisions on planning applications and includes policies on matters, such as residents' amenity, house extensions, affordable housing, and adapting to the effects of climate change.

The Local Plan includes the following planning policies which relate to sustainable design and development:

- DM1: Adaptation To Climate Change
- DM2: Decentralised Energy
- DM3: Infrastructure Planning
- DM8: Residential Conversions
- DM10: Private And Communal Outdoor Space
- DM11: Development Of Private Residential Garden Land
- DM12: Access, Traffic And Highway-Related Matters
- DM15: Protection of Leisure Facilities and Public Houses
- DM16: Provision of Open Space
- DM17: Green Network
- DM18: Tree Planting
- DM19: Air Quality

1.3 Emerging Policy and Alterations to the Local Plan



Community Infrastructure Levy – Charging Schedule (January 2015)

In April 2010 the Government introduced the Community Infrastructure Levy (CIL) which comes into force in Reading on 1 April 2015. The levy allows local authorities to fund infrastructure to support growth and development in their area. It is chargeable on most new developments, at a pre-defined rate. There is no charge for offices outside the central core catchment.