ENERGIST

BEYOND BUILDING

Energy Strategy

Land South of Barrow Green Road, Oxted

On behalf of Croudace Homes

CR.S.RH8

R03

26th February 2025

Revision History

Revision	Issue Date	Description	Issued by	Checked by
00	20/11/2024	Draft Report	DS	MK
01	17/12/2024	Update to site Plan	DS	MK
02	04/02/2025	Minor update to policy text	DS	-
03	26/02/2025	Update to site plan	DS	-

All advice provided by Energist regarding the performance of materials is limited solely to the purposes of demonstrating compliance with the services Energist has been appointed to deliver. The performance of materials under other criteria, including but not limited to fire, structural or acoustics, are not considered in our advice and it is the responsibility of the Client to ensure the wider suitability of materials specified in our assessments.

Calculations contained within this report have been produced based on information supplied to Energist by the Client and the Design Team. Any alterations to the technical specification on which this report is based will invalidate its findings.

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Contents

EXECUTIVE SUMMARY

This Energy Strategy has been produced by Energist UK on behalf of Croudace Homes ('the Applicant').

The Applicant seeks to make this a sustainable development that complements the character of the surrounding area and sets a high benchmark for future development. The Applicant will seek to go above and beyond many of the standards expected, including aligning with the Future Homes Standard (FHS), expected to be introduced in 2025. This standard is part of the UK government's broader strategy to improve the energy efficiency of new homes. It will set out requirements for new homes to produce 75-80% less carbon emissions compared to those built to the Approved Document L (AD L) 2013. The aim is for all new homes to be "zero carbon ready," meaning they will not require retrofitting to become zero carbon as the electricity grid decarbonises.

This statement will set out the measures planned by the Applicant to achieve significant CO_2 emission reductions at the proposed development site: Land South of Barrow Green Road, Oxted ('the Development') demonstrating compliance with:

i) The Climate Change Act (2008).
ii) National Planning Policy Framework (NPPF, 2024).
iii) Approved Document L Volume 1: Dwellings (2021).
iv) *Policy CSP 14: Sustainable Construction* highlighted in Tandridge District Core Strategy (2008).
v) *Policy CSP 15: Environmental Quality* highlighted in Tandridge District Core Strategy (2008).
vi) *Point 29 of Tandridge District Council Planning Local Validation Requirements 2024.*

The development has optimised every opportunity to reduce on-site emissions by integrating efficient building fabric, innovative design, and advanced heating systems, resulting in substantial CO_2 emission reductions compared to the baseline. The applicant decided to commit to a design approach that aligns with the principles of the energy hierarchy. The development is anticipated to achieve a total reduction in regulated CO_2 emissions of **77.9%** over the Target Emission Rate (TER) Approved Document Part L (AD L) 2021 through the following measures: 'Be Lean' and 'Be Green'.

Table 1 - Measures incorporated to deliver the energy standard at Land South of Barrow Road, Oxted

Fabric First: demand-reduction measures	▪ Energy-efficient building fabric and insulation to all heat loss floors, walls and roofs. ▪ High-efficiency triple-glazed windows throughout. ▪ Quality of build will be confirmed by achieving good air-tightness results throughout. ▪ Efficient-building services including high-efficiency heating systems. ▪ Efficient MVHR system throughout. ▪ Low-energy lighting throughout the building.
Renewable and low-carbon energy technologies	▪ Individual air-source heat pumps (ASHPs) to provide space heating and hot water across the development. ▪ 352 kWp of solar photovoltaic (PV) panels installed throughout the development. Currently assumed on a worst-case scenario of East or West facing.

In line with the strategy outlined above, the effectiveness of the design measures, along with the low-carbon and renewable energy solutions, in fulfilling the Applicant's commitment to the energy standard, is demonstrated in Table 2 and Figure 1 below.

Table 2 – CO_2 emissions at each stage of the energy hierarchy for the residential element

	CO_2 emissions	
	$kgCO_2$ per annum	*% reduction*
Target Emission Rate: compliant with AD L 2021	190,730.8	-
Fabric First: demand-reduction measures	134,497.4	29.5%
Renewable and low-carbon energy technologies	42,091.3	48.4%
Total cumulative savings	**148,639.4**	**77.9%**

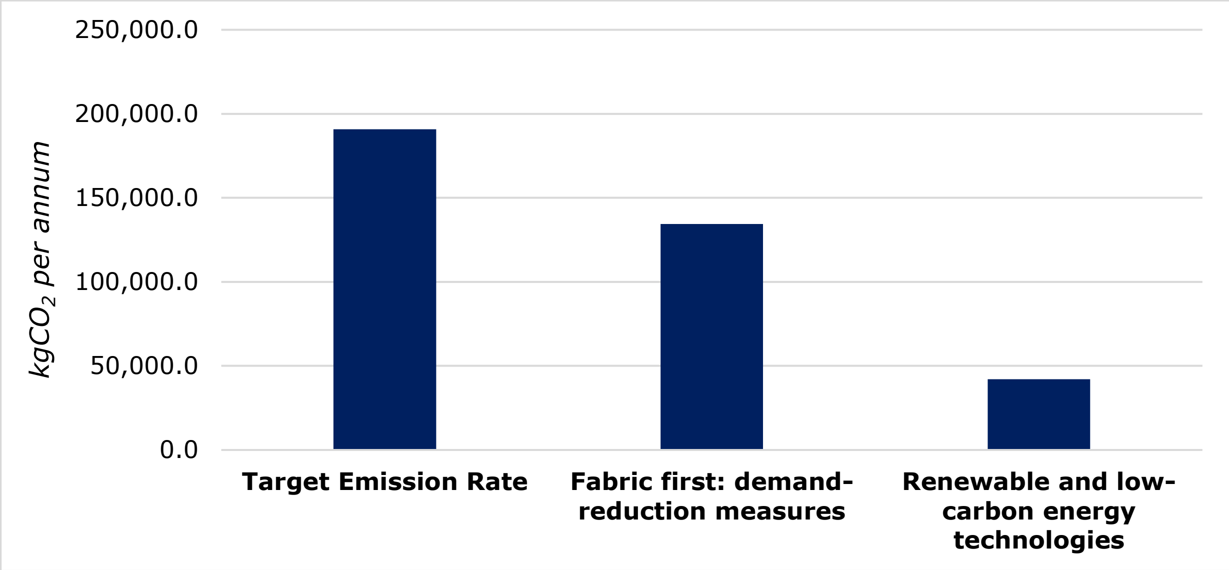

Figure 1 - How the Development delivers the energy standard

1. INTRODUCTION

1.1 Site Description

This Energy Strategy has been prepared for the proposed residential development at Land South of Barrow Green Road, Oxted, within the jurisdiction of Tandridge District Council. The current assessment excludes the future care home, which will be addressed at a later stage.

The project involves an Outline application for a residential development of up to 190 dwellings (including affordable homes) (Use Class C3), an extra care facility with up to up 80 beds (Use Class C2), together with the formation of vehicular access, landscaping, parking, open space, green and blue infrastructure, and all other associated development works. All matters reserved except access.

The development seeks to address local housing demand while adhering to sustainability and energy efficiency standards, alongside environmentally responsible construction practices.

Figure 2 – The illustrative layout of Land South of Barrow Green Road, Oxted.

[Source: Omega Architects, Drawing No.1005, Rev E.]

1.2 Purpose of the Energy Strategy

This Energy Strategy has been produced by Energist UK on behalf of Croudace Homes ('the Applicant'). It outlines climate change mitigation measures for the development at Land South of Barrow Green Road, Oxted. This report supports an outline planning application for residential development at Land South of Barrow Green Road, Oxted, this report does not include the proposed Care Home.

The Applicant will seek to go above and beyond many of the standards expected, including aligning with the FHS. It will set out requirements for new homes to produce 75-80% less carbon emissions compared to those built to the Approved Document L (AD L) 2013.

This Energy Strategy will demonstrate the approach adopted by the applicant to comply with:

i) The Climate Change Act (2008).

ii) National Planning Policy Framework (NPPF, 2024).

iii) Approved Document L Volume 1: Dwellings (2021).

iv) *Policy CSP 14: Sustainable Construction* highlighted in Tandridge District Core Strategy (2008), that requires, which requires new residential developments (10 or more dwellings) to achieve at least a 20% reduction in CO_2 emissions through on-site renewable energy

v) *Policy CSP 15: Environmental Quality* highlighted in Tandridge District Core Strategy (2008).

vi) *Point 29 of Tandridge District Council Planning Local Validation Requirements 2024.*

The way in which the Applicant meets the energy standard and CO_2 reduction target at Land South of Barrow Green Road, Oxted will be explained in further sections of this report.

1.3 Methodology

ENERGY HIERARCHY

This Energy Strategy is assessed against, and presented, to align with the following steps (please refer to the figure below):

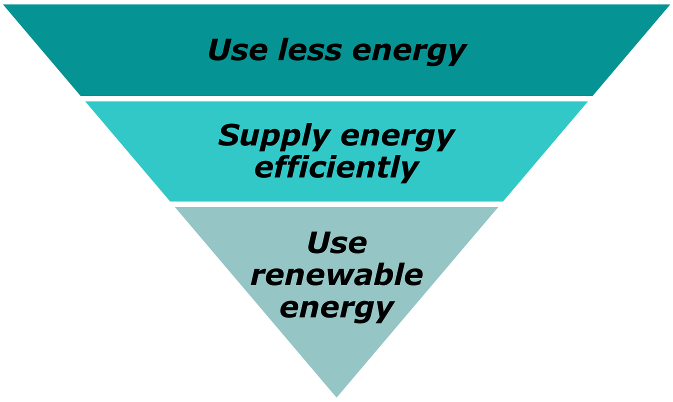

Figure 3 - Three-tier energy hierarchy

This three-tier energy hierarchy is based on widely recognised sustainable energy planning principles, consistent with UK national policy frameworks such as the NPPF and the guidance from the Department for Energy Security and Net Zero (DESNZ). This approach prioritises energy demand reduction ('use less energy'), followed by efficient energy supply ('supply energy efficiently'), and the integration of renewable energy technologies ('use renewable energy').

SAP

Energist UK employed the SAP 10.2 methodology to calculate the energy demand for ten representative units within the development. This sample data was carefully modelled and subsequently extrapolated to estimate the overall CO_2 emissions and energy demand for all the proposed homes included in the development application. The assessment was conducted using standard Croudace House types, ensuring that the energy performance predictions are tailored to the specific design characteristics of the development. This approach allows for a comprehensive analysis of the development's energy efficiency, ensuring compliance with current regulatory standards and providing a robust foundation for future energy strategy decisions.

2. BASELINE ENERGY DEMAND

2.1 Introduction

At each stage of the energy hierarchy, the estimated energy performance of the development has been calculated using the SAP 10.2 methodology to calculate representative dwellings consisting of each unit type configuration for one and two bed apartments. This sample size is considered appropriate for the purposes of extrapolation.

SAP calculates the regulated energy demands associated with hot water, space heating and fixed electrical items. Part L is used for the purposes of the new build energy assessment.

The design specifications for the Baseline (compliant with AD L 2021) are listed in the table below.

Table 3 – Design specification for the Baseline

Element	**Design specification for the Baseline**
Ground Floor (W/m^2.K)	0.13
External Wall U-Value (W/m^2.K)	0.18
Party Wall U-Value (W/m^2.K)	0 *(fully filled and sealed)*
Roof U-Value (W/m^2.K)	0.11
External Door U-Value (W/m^2.K)	1.00
Glazing U-Value (W/m^2.K)	1.20 (double-glazed units)
Glazing G-Value	0.50
Design Air Permeability (m^3/m^{2}hr @50 Pa)	4.0
Thermal Bridging	SAP 10 Appendix R values
Lighting (W/m^2)	100% of 80 lm/W
Ventilation	Natural ventilation with intermittent extract fans

Space Heating	92.3% efficient gas boiler
Space Heating Controls	Standard controls *(time and temperature zone control, thermostatic radiator valves)*
Domestic Hot Water Heating	From main heating system
PV system	For houses: kWp = 40% of ground floor area, including unheated spaces / 6.5 For flats: kWp = 40% of dwelling floor area / (6.5 ´ number of storeys in block)

The cumulative floor areas for representative, sample dwellings have been used to estimate the Target Emission Rate (TER) and Dwelling Emission Rate (DER) for new dwellings, within the development proposals.

2.2 Development's Baseline

The resulting TER, representing the total maximum CO_2 emissions permitted for the development has been calculated as **190,738.8 kgCO_2 per annum**. To ensure compliance with AD L 2021, CO_2 emissions should not exceed this figure.

Table 4 - Development's Target Emission Rate for Residential Element

	CO_2 emissions	
	kgCO_2 per annum	*% reduction*
Target Emission Rate: Compliant with AD L 2021	190,730.8	-

3. FABRIC FIRST – DEMAND -REDUCTION MEASURES

3.1 Introduction

The development achieves a high quality, sustainable design by integrating the following passive and active design measures to reduce energy demand:

- Energy-efficient building fabric and insulation to all heat loss floors, walls and roofs
- High-efficiency triple-glazed windows throughout, lower G-values.
- Quality of build will be confirmed by achieving good air-tightness results throughout
- Efficient-building services including high-efficiency heating systems
- Low-energy lighting throughout the building with a high lm/W efficacy.

Designing an efficient thermal envelope significantly reduces the need for space heating by minimising heat transmittance through the building's thermal elements. Additionally, achieving low air permeability further lowers heating demand by limiting the amount of air that can infiltrate the building, effectively reducing heat loss during winter and minimising heat gain in summer.

Energist UK has considered a fabric-first approach as the priority solution for this Development with exemplary passive design features to align with the FHS.

Table 5 – 'Fabric first' design specification for Land South of Barrow Green Road, Oxted.

Element	**Proposed 'Be Lean' Design Specification**
Ground Floor ($W/m^2.K$)	0.12
External Wall U-Value ($W/m^2.K$)	0.15
Party Wall U-Value ($W/m^2.K$)	0 *(fully filled and sealed)*
Roof (Flat) U-Value ($W/m^2.K$)	0.11
External Door U-Value ($W/m^2.K$)	1.00
Glazing U-Value ($W/m^2.K$)	0.80 (triple-glazed units)

Glazing G-Value	0.50
Design Air Permeability (m^3/m^2hr @50 Pa)	4.0
Thermal Bridging	SAP 10 Appendix R values
Lighting (W/m^2)	100% of 80 lm/W
Ventilation	Highly efficient MVHR *(model used for SAP calculations: Nuaire MRXBOX ECO3)*
Space Heating	92.3% efficient gas boiler*
Space Heating Controls	Zone controls, delayed start thermostat
Domestic Hot Water Heating	From main heating system
PV system	For houses: kWp = 40% of ground floor area, including unheated spaces

* *Note: By using a standard system like gas boilers in the 'Fabric first' stage, a consistent baseline is established to measure the energy savings achieved solely through improvements in the building's fabric. This approach ensures that any reductions in energy demand are due to the efficiency of the building design itself, rather than the heating system. This standardisation allows for a like-for-like comparison of energy performance across different buildings or design options. Additionally, ventilation and lighting are assessed in this stage as they significantly impact the building's overall energy efficiency. The actual heating system, along with renewable technologies, is introduced in later stages to enhance these foundational efficiencies.*

3.2 Development's 'Fabric First' stage results

The total calculated CO_2 emissions at the 'fabric first' for the residential aspect of Land South of Barrow Green Road, Oxted is **134,497.4 kgCO_2 per annum**, which is a reduction of 56,233.4 kgCO_2 per annum, or 29.5% over the Baseline. Please refer to Appendix 3 for SAP results.

Table 6 - Development's 'fabric first' for Residential Element

	CO_2 emissions	
	$kgCO_2$ per annum	*% reduction*
Target Emission Rate: Compliant with AD L 2021	190,730.8	-
Fabric First: demand-reduction measures	134,497.4	29.5%

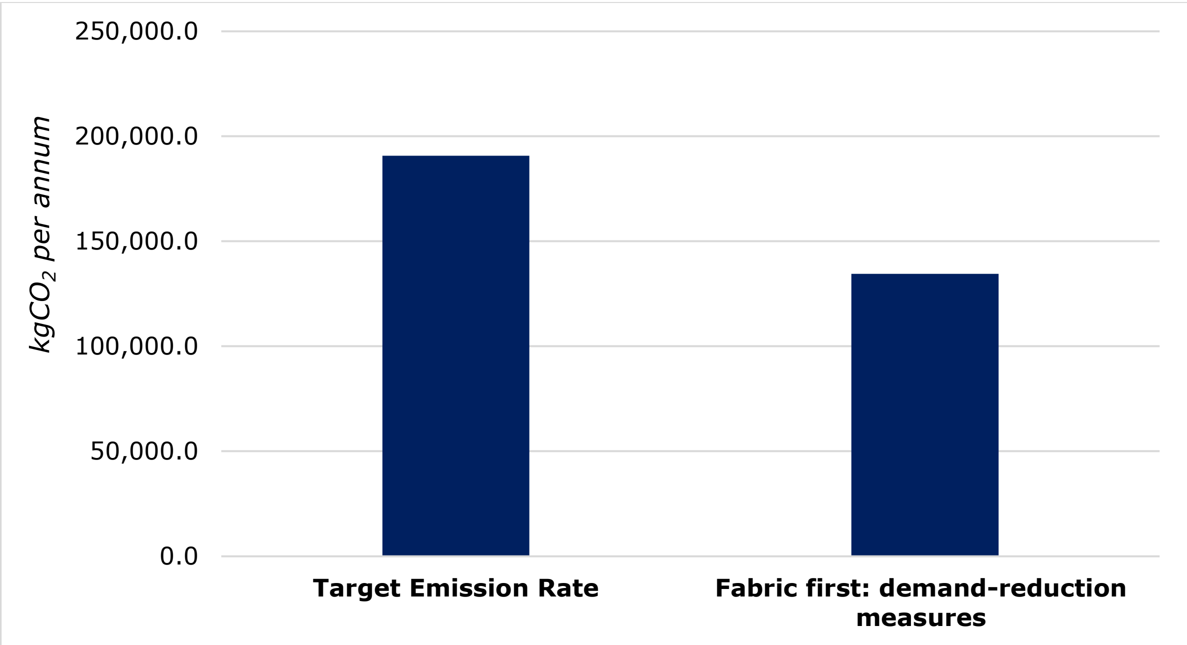

Figure 4 - TER and 'fabric first' CO_2 emissions summary

4. LOW-CARBON AND RENEWABLE ENERGY

4.1 Introduction

The applicant has also committed to maximising the integration of Low and Zero-Carbon (LZC) technologies within their energy strategy for the development.

Viability of the following low-carbon and renewable energy technologies have been considered:

- Wind
- Solar
- Aerothermal
- Geothermal
- Biomass

The above LZC technologies have been assessed for their viability as a component of a complementary heating strategy for the development. A detailed review of the LZC technologies is provided in Appendix 4, including wind, solar thermal, biomass, and other heat pump technologies. The Applicant's adopted strategy for LZC technologies is compatible with the 'Fabric First' design specification.

The following low-carbon and renewable energy technologies, summarised here in Table 7, are considered potentially viable options for the mixed-use development scheme at Land South of Barrow Green Road, Oxted

Table 7 - Summary of feasibility for Land South of Barrow Green Road, Oxted

✓	*Solar Thermal* *Solar PV* *Air Source Heat Pumps*
✗	*Wind Turbines* *Biomass Boilers* *Ground Source Heat Pumps*

AIR SOURCE HEAT PUMPS

Following the implementation of 'fabric first' design measures to reduce energy demand, the strategy proposes the use of individual air-source heat pumps (ASHPs). Ensuring efficient, low-carbon space heating and hot water across the residential properties.

SOLAR PV

The renewable energy contribution will be maximised through the installation of PV panels, each rated at an assumed 400 W. For this assessment, 352 KWp of solar PV panels have been assumed, based on the modelled samples, which equates to 880 panels. As this is an Outline application, Energist have currently assumed an east or west orientation, to take into account worst case scenario. At detailed design the panels will be positioned on suitable roof spaces and more favourable roof orientations, where applicable.

Both proposed technologies meet the 'Be Green' criteria and are designed to bring the development in line with the anticipated FHS benchmarks.

4.2 Development's 'low carbon and renewable energy' stage results

The estimated site-wide CO_2 emissions after implementation of the suitable LZC technologies for the residential spaces at Land South of Barrow Green Road, Oxted are 42,091.3 **kgCO_2 per annum**, which is a reduction of further 92,406 kgCO_2 per annum, or 48.4% over the Baseline. Please refer to Appendix 3 for SAP results.

Table 8 – Development's 'low carbon and renewable energy' for Land South of Barrow Green Road, Oxted.

	CO_2 emissions	
	kgCO_2 per annum	*% reduction*
Target Emission Rate: Compliant with AD L 2021	190,730.8	-
Fabric First: demand-reduction measures	134,497.4	29.5%
Renewable and low-carbon energy technologies	42,091.3	48.4%

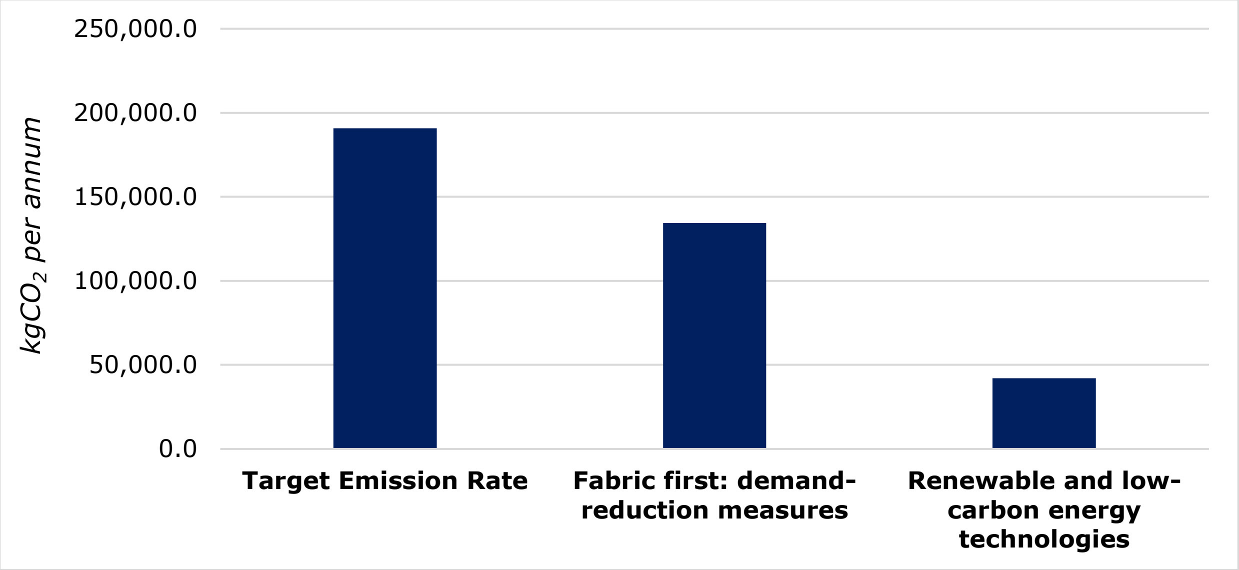

Figure 5 – TER, 'Fabric First' and 'low carbon and renewable energy' k CO_2 emissions summary

5. CONCLUSIONS AND RECOMMENDATIONS

The applicant has committed to achieving significant CO_2 emission reductions at the proposed development site, Land South of Barrow Green Road , Oxted. The strategy follows the three-tier energy hierarchy of 'use less energy', 'supply energy efficiently', and 'use renewable energy', aligning with key policies such as the Climate Change Act (2008), NPPF (2024), AD L Volume 1: Dwellings (2021), the Tandridge District Core Strategy (2008), which requires new residential developments of 10 or more dwellings to achieve at least a 20% reduction in CO_2 emissions through on-site renewable energy. The applicant is also preparing to meet the FHS, expected in 2025, which will likely mandate a 75-80% improvement over the ADL 2013 standards. Preparing the Development to withstand the effects of climate change inline with CSP 15.

The development has prioritised reducing energy demand by incorporating a series of 'Fabric First' measures, focusing on enhancing the energy efficiency of the building's structure. Furthermore, the individual ASHPs play a crucial dual role in this energy strategy. Firstly, they are introduced to supply energy efficiently, with a high operational efficiency. Secondly, as a low-carbon technology, ASHPs are integral to achieving the FHS's goals by significantly reducing carbon emissions from new homes. This dual functionality positions ASHPs as key contributors within the energy hierarchy, reducing reliance on fossil fuels and lowering overall carbon emissions.

In addition to ASHPs meeting the heating and hot water demand for the Development, PV panels will be provided across the Development. The current Outline proposal assumed 352 kWp across the development, based on 400 W panels on a worse case scenario of an East West orientation this equates to 880 panels.

A summary of these measures is listed in the table below.

Table 9 - Measures incorporated to deliver the energy standard

Fabric First: demand-reduction measures	▪ Energy-efficient building fabric and insulation to all heat loss floors, walls and roofs. ▪ High-efficiency triple-glazed windows throughout. ▪ Quality of build will be confirmed by achieving good air-tightness results throughout. ▪ Efficient-building services including high-efficiency heating systems. ▪ Efficient MVHR system throughout.

	▪ Low-energy lighting throughout the building.
Renewable and low-carbon energy technologies	▪ Individual air-source heat pumps (ASHPs) to provide space heating and hot water across the development. ▪ 352 kWp of solar photovoltaic (PV) panels installed throughout the development. Currently assumed on a worst-case scenario of East or West facing.

This comprehensive approach ensures that the development at Land South of Barrow Green Road Oxted, will achieve an 77.9% reduction in regulated CO_2 emissions over AD L 2021 using SAP 10.2 methodology. It will also meet the Future Homes Standard, that will set out requirements for new homes to produce 75-80% less carbon emissions compared to those built to the 2013 standards.

Each stage of the energy hierarchy has been meticulously followed, ensuring that the development not only complies with but exceeds the requirements of the relevant policies. By reducing energy demand, supplying energy efficiently, and maximizing the use of renewable energy, the development delivers significant environmental benefits and supports the broader goals of sustainable development.

Details of the CO_2 emissions and percentage savings are provided in Table 10, with Figure 6 illustrating the impact of these design measures and low-carbon solutions in achieving compliance with the energy hierarchy.

Table 10 – CO_2 emissions at each stage of the energy hierarchy

	CO_2 emissions	
	$kgCO_2$ per annum	*% reduction*
Target Emission Rate: compliant with AD L 2021	190,730.8	-
Fabric First: demand-reduction measures	134,497.4	29.5%
Renewable and low-carbon energy technologies	42,091.3	48.4%
Total cumulative savings	**148,639.4**	**77.9%**

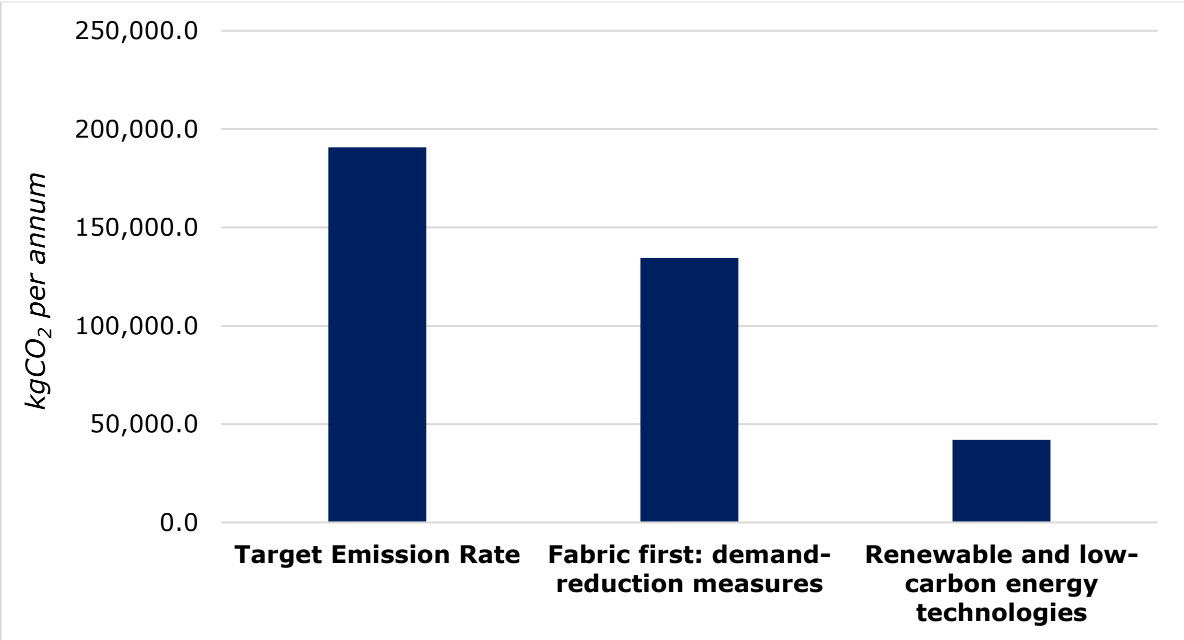

Figure 6 - How the Development delivers the energy standard

APPENDICES

APPENDIX 1: LIST OF ABBREVIATIONS

AD L 2021	*Approved Document Part L of Buildings Regulations 2021*
ASHP	*Air Source Heat Pump*
BER	*Building Emission Rate*
BRE	*Building Research Establishment*
CIBSE	*Chartered Institution of Building Services Engineers*
COP	*Coefficient of Performance*
DER	*Dwelling Emission Rate*
DHN	*District Heat Network*
DHW	*Domestic Hot Water*
EAHP	*Exhaust Air Heat Pump*
EVC	*Electric Vehicle Charging*
FEES	*Fabric Energy Efficiency Standard*
FHS	*Future Homes Standard*
GLA	*Greater London Authority*
LZC	*Low and Zero-Carbon technologies*
NCM	*National Calculation Methodology*
PV	*Photovoltaics*
SAP	*Standard Assessment Procedure*
SBEM	*Simplified Building Energy Model*
TER	*Target Emission Rate*
TFEE	*Target Fabric Energy Efficiency*
VRF	*Variable Refrigerant Flow*

APPENDIX 2: PLANNING POLICY AND DESIGN GUIDANCE

The Climate Change Act (2008)

Passed in November 2008, the Climate Change Act mandated that the UK would reduce emissions of six key greenhouse gases, including Carbon Dioxide, by 80% by 2050.

As a consequence, the reduction of carbon dioxide emissions is at the forefront of National, Regional and Local Planning Policy, along with continuing step changes in performance introduced by the Building Regulations Approved Document L (2021).

Approved Document L (2021)

This development is subject to the requirements of Approved Document L (2021). ADL 2013 represented an approximate reduction of 6% in the Target Emission Rate (kgCO_2/sqm per annum) over the requirements of Approved Document L (2010) for residential development and an aggregate 9% reduction for non-residential development. ADL (2021) has seen a further 31% improvement over these targets. It also sees the introduction of a Primary Energy Target, a measure of heating demand (kW hrs/sqm per annum) to ensure new-build dwellings with low-carbon heating systems still meet satisfactory energy-efficiency standards.

National Planning Policy Framework (Dec 2024)

The National Planning Policy Framework (NPPF) encourages Local Planning Authorities to 'support the transition to net zero by 2050 and take full account of all climate impacts including overheating, water scarcity, storm and flood risks and coastal change. I ' (NPPF paragraph 161), 'Plans should take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes, and the risk of overheating and drought from rising temperatures '. (NPFF Paragraph 162).

Paragraph 165, upholds the requirement for Local Plans to: 'To help increase the use and supply of renewable and low carbon energy and heat, plans should:
a)provide a positive strategy for energy from these sources, that maximises the potential for suitable development, and their future re-powering and life extension, while ensuring that adverse impacts are addressed appropriately (including cumulative landscape and visual impacts);
b) consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and

c) identify opportunities for development to draw its energy supply from decentralised, renewable or low carbon energy supply systems and for locating potential heat customers and suppliers.

In paragraph 166, NPPF stipulates that local planning authorities should take account of the benefits of decentralised energy and passive design measures as a means of energy efficiency in new development: 'In determining planning applications, local planning authorities should expect new development to:
a) comply with any development plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and
b) take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.'

Tandridge District Core Strategy (2008)

Policy CSP 14

Sustainable Construction

The Council will encourage all residential development (either new build or conversion) to meet Code level 3 as set out in the published Code for Sustainable Homes. Commercial development with a floor area of 500m² or greater will be encouraged to meet the BREEAM "Very Good" standard.*

All new residential development (either new build or conversion) and commercial development with a floor area of 500m² or greater will be required to reach a minimum percentage saving in CO_2 emissions through the incorporation of on-site renewable energy (as set out in the table below). The requirement varies according to the type of development and in the case of dwellings, the size of development.*

Development Type	Percentage savings in Carbon Dioxide emissions through the provision of renewable energy technologies
Dwellings (1-9 units)	10%
Dwellings (10 + units)	20%**
Commercial* (500m²+)	10%

Development over 5000m² will be expected to incorporate combined heat and power or similar technology.

Small scale renewable energy projects will be permitted except where there are overriding environmental, heritage, landscape, amenity or other constraints.

** Commercial includes all forms of non-residential development, for example social and leisure related development.*

***Only where a developer can satisfy the Council why the higher target of 20% cannot be achieved will the lower target of 10% be applied.*

APPENDIX 3: SAP RESULTS

SAP 10.2 Compliance Sheets provided separately.

APPENDIX 4: LZCT ASSESSMENT

Wind	*The ability to generate electricity via a turbine or similar device which harnesses natural wind energy. This could be considered as an onsite solution to reducing carbon emissions (turbines included within the development), or offsite (investing financially into a nearby wind farm).*
Installation considerations	▪ Wind turbines come in a variety of sizes and shapes. Turbines of 1 Kw can be installed to single house and large-scale turbines of 1-2 MW can be installed on a development to generate electricity to multiple dwellings and other buildings. In both instances the electricity generated can be used on site or exported to the grid. Vertical- or horizontal-axis turbines are available. ▪ A roof-mounted 1 kW micro wind system costs up to £3,000. A 2.5 kW pole-mounted system costs between £9,900 and £19,000. A 6 kW pole-mounted system costs between £21,000 and £30,000 (taken from the Energy Saving Trust, TBC by supplier) ▪ Local average wind speed is a determining factor. A minimum average wind speed of 6 m/s is required. ▪ Noise considerations can be an issue dependent on density and build-up of the surrounding area. ▪ Buildings in the immediate area can disrupt wind speed and reduce performance of the system. ▪ Planning permission will be required along with suitable space to site the turbine, whether ground installed, or roof mounted.
Advantages	▪ Generation of clean electricity which can be exported to the grid or used onsite. ▪ Can benefit from the Feed in Tariff, reducing payback costs.

Disadvantages	▪ Planning restrictions and local climate often limit installation opportunities. ▪ Annual maintenance required. ▪ High initial capital cost. It is usual for an investor to consider a series of turbines to make the investment financially sound.
Development feasibility ×	▪ Installing a large turbine in an area such as this is not considered to be appropriate due to its appearance and physical impact on the built-up environment. Residents' and neighbours' concerns may include the look of the turbine, the hum of the generator and the possibility of stroboscopic shadowing from the blades on homes. ▪ Wind speed has been checked for the development scheme using the NOABL wind map: ▪ http://www.rensmart.com/Weather/BERR. The wind speed at ten metres for the development scheme is 4.2 metres per second (m/s) which is below the minimum of 5 m/s and threshold for technical viability. ▪ Typical payback times for a single turbine are expected to be greater than 15 years which means that the cost of installing and maintaining a single wind turbine is not considered a commercially-viable option.

Solar PV **Solar Thermal**	*The ability to generate energy (either electricity, hot water or a combination of the two) through harnessing natural solar energy. This could include the use of solar thermal panels, photovoltaic (PV) panels, or a combined solution. PV panels, similarly, to turbines, can be considered both on and offsite.* Solar Photovoltaics convert solar radiation into electricity which can be used on site or exported to the national grid. Solar Thermal generates domestic hot water from the sun's radiation. Glycol circulates within either flat plate or

	evacuated tube panels, absorbing heat from the sun, and transferring this energy to a water cylinder. A well-designed solar thermal system will account for 50-60% of a dwelling's annual hot water demand. Sizing the system to meet a higher demand will lead to excess heat generation in the summer months and overheating of the system.
Installation considerations	▪ Operate most efficiently on a south-facing sloping roof (between 30- and 45-degree pitch.) ▪ Shading must be minimal (one shaded panel can impact the output of the rest of the array.) ▪ Panels must not be laid horizontally on a flat roof as they will not self-clean. Panels will therefore need to be installed at an angle and with appropriate space between them, to avoid over-shading. ▪ Large arrays may require upgrades to substations if exporting electricity to the grid. ▪ Local planning requirements may restrict installation of panels on certain elevations. ▪ Installation must take into account pitch and fall of the roof, along with any additional plant on the roof to ensure there is sufficient room. ▪ The average domestic solar PV system is 4kWp and costs £5,000 - £8,000 (including VAT at 5 per cent) - (taken from the Energy Saving Trust).
Advantages	▪ Relatively straightforward installation, connection to landlord's supply and metering. ▪ Linear improvement in performance as more panels are installed. ▪ Installation costs are continually reducing. ▪ Can benefit from the Feed in Tariff to improve financial payback.

Disadvantages	▪ Less appropriate for high-rise developments, due to lack of roof space in relation to total floor area. ▪ With Solar Thermal, performance is limited by the hot water demand of the building – system oversizing will lead to overheating.
Development feasibility ✓	▪ The suitability of Solar panels has been considered for this Development and are concluded as a technically-viable option. ▪ There are potential areas of roof space suitable for the positioning of unshaded Solar PV arrays. ▪ The Development is not on land, which is protected or listed, so it is considered that Solar panels would not have a negative impact on the local historical environment or the aesthetics of the area.

Aerothermal	*The transfer of latent heat in the atmosphere to a compressed refrigerant gas to warm the water in a heating system. This includes air to water heat pumps and air conditioning systems.* Air Source Heat Pumps (ASHPs) extract heat from the external air and condense this energy to heat a smaller space within a dwelling or non-domestic building. A pump circulates a refrigerant through a coil to absorb energy from the air. This refrigerant is then compressed to raise its temperature which can then be used for space heating and domestic hot water. They can feed either low-temperature radiators or underfloor heating and often have electric immersion heater back-up for the winter months.
Installation	▪ ASHPs operate effectively in buildings with a low energy demand, as they emit low levels of energy suitable for maintaining rather than dramatically increasing internal

considerations	temperatures. It is therefore vital that the dwelling has a low heating demand to ensure the system can provide appropriate space-heating capability. ▪ Underfloor heating will give the best performance, but oversized radiators can also be used. ▪ Immersion heater back-up required to ensure appropriate Domestic Hot Water (DHW) temperature in winter months. ▪ Noise from the external unit can limit areas for installation. ▪ £7,000-£11,000 per dwelling (taken from the Energy Saving Trust).
Advantages	▪ Air source systems are a good alternative solution to providing heating and hot water to well-insulated, low heat loss dwellings. ▪ Heat pumps are generally quiet to run, however if a collection of pumps were used, this could generate a noticeable hum while in operation. ▪ Running costs between heat pumps and modern gas boilers are comparable.
Disadvantages	▪ Residents need to be made aware of the most efficient way of using a heat pump as the low flow rates used by such a system means that room temperature cannot be changed as reactively as a conventional gas or oil boiler system. ▪ Will not perform well in homes that are left unoccupied and unheated for a long period of time. ▪ Back-up immersion heating can drastically increase running costs. ▪ Noise and aesthetic considerations limit installation opportunities. ▪ They require additional space when compared to a gas boiler. Space for an external unit is needed, as is space for the hot water cylinder and internal pump.

Development feasibility

✓

- ASHPs are considered a viable option for this development scheme and shall be utilised as part of an individual heat pump strategy for dwellings. This works well with the reduced energy demand, as achieved through passive design principles.
- This presents a zero carbon ready energy strategy for the development, as the national grid continues to decarbonise.
- ASHPs are aligned with the FHS which seeks to move towards high efficiency all electric systems and away from on-site combustion associated with fossil fuels.

Geothermal

The transfer of latent heat from the ground to a compressed refrigerant gas to warm the water in a heating system. This includes ground source heat pumps. Heat can be collected through the use of either horizontally laid or vertically installed coils.

Ground Source Heat Pumps (GSHPs) operate on the same principle as an Air Source Heat Pump (ASHP) in that they extract heat from a source (in this instance the ground) and compress this energy to increase temperature for space heating and hot water. Pipework is installed into the ground, either through coils or in bore holes and piles, circulating a mix of water and antifreeze to extract energy from the ground, where the year-round temperature is relatively consistent (approx. 10 ℃ at 4 metres depth). This leads to a reliable source of heat for the building.

Again, an electrically powered pump circulates the liquid and powers the compressor, however annual efficiencies for GSHPs tend to be higher than those of ASHPs.

Installation considerations	▪ Require appropriate ground conditions to sink piles/bore holes or excavate for coils (which also require a large area of land.) ▪ Decision between coils or piles can lead to significant extra cost. ▪ Need to consider whether low temperature output is fed through underfloor heating (most efficient) or oversized radiators. ▪ Similar to ASHPs, perform best in well-insulated buildings with a low heating demand. ▪ Electric immersion heater required for winter use. ▪ £11,000-£15,000 per dwelling dependent on the size of the system (taken from the Energy Saving Trust).
Advantages	▪ Perform well in well-insulated buildings, with limited heating demand. ▪ More efficient than ASHPs.
Disadvantages	▪ The coils can be damaged by natural earthworks and by intensive gardening practices – occupants would need to be aware of the location of the coils for this system, and how to operate the system efficiently. Coils may also be damaged within the dwelling where the circuit is connected to the internal unit. ▪ Will not perform well in buildings that are left unoccupied and unheated for a long period of time. ▪ Back up immersion heating can drastically increase running costs. ▪ Large area of ground needed for coil installation.
Development feasibility ×	▪ GSHPs are not considered a viable option for this development scheme as they conflict with the preferred option of ASHP electric heating which works well with the reduced energy demand, as achieved through passive design principles.

Water Source Heat Pumps	*The transfer of latent heat from a local water source to a compressed refrigerant gas to warm the water in a heating system. This includes water source heat pumps. Heat can be collected through the use of either horizontally laid or vertically installed coils.* Water Source Heat Pumps (WSHPs) operate on the same principle as an Air Source Heat Pump (ASHP) in that they extract heat from a source (in this instance the water) and compress this energy to increase temperature for space heating and hot water. Pipework is installed into the water source, circulating a mix of water and antifreeze to extract energy from the water, where the year-round temperature is relatively consistent (approx. 10 ℃ below surface). This leads to a reliable source of heat for the building. Again, an electrically powered pump circulates the liquid and powers the compressor, however annual efficiencies for WSHPs tend to be higher than those of ASHPs.
Installation considerations	▪ Require a reliable water source near to the site. ▪ Need to consider affect on the water course. ▪ Need to consider whether low temperature output is fed through underfloor heating (most efficient) or oversized radiators. ▪ Similar to ASHPs, perform best in well-insulated buildings with a low heating demand. ▪ Electric immersion heater required for winter use. ▪ £11,000-£15,000 per dwelling dependent on the size of the system (taken from the Energy Saving Trust).
Advantages	▪ Perform well in well-insulated buildings, with limited heating demand. ▪ More efficient than ASHPs.

Disadvantages	▪ The coils can be damaged by high water flow or low water levels– occupants would need to be aware of the location of the coils for this system, and how to operate the system efficiently. Coils may also be damaged within the dwelling where the circuit is connected to the internal unit. ▪ Will not perform well in buildings that are left unoccupied and unheated for a long period of time. ▪ Back up immersion heating can drastically increase running costs. ▪ Large area of water needed for coil installation.
Development feasibility ×	▪ WSHPs are not considered a viable option for this development scheme as they conflict with the preferred option of ASHP electric heating which works well with the reduced energy demand, as achieved through passive design principles.

Biomass	*Providing a heating system fuelled by plant based materials such as wood, crops, or food waste.* Biomass boilers generate heat for space heating and domestic hot water through the combustion of biofuels, such as woodchip, wood pellets or potentially biofuel or bio diesel. Biomass is considered to be virtually zero carbon. They can be used on an individual scale or for multiple dwellings as part of a district-heating network. A back-up heat source should be provided as consistent delivery of fuel is necessary for continued operation.
Installation considerations	▪ Biomass boilers are larger than conventional gas-fired boilers and also require what can be significant storage space for the fuel source. This needs to be considered at planning stage to ensure an appropriate plant room can be provided.

	▪ Flue required to expel exhaust gases – design needs to be in line with the requirements of the Building Regulations. ▪ Need to consider whether fuel deliveries will be reliable and consistent to the location of the site (especially relevant in rural areas) and whether the plant room can be easily accessed by the delivery vehicle. ▪ £9,000-£21,000 per dwelling dependent on size (taken from Energy Saving Trust).
Advantages	▪ Considerable reduction in CO_2 emissions.
Disadvantages	▪ Limited reduction in running costs compared to A-rated gas boilers, but at a substantially higher up-front cost. ▪ Plant room space required for boiler and storage. ▪ Dependent on consistent delivery of fuel. ▪ Ongoing maintenance costs (need to be cleaned regularly to remove ash.)
Development feasibility ×	▪ Biomass is not considered a technically viable option for the development scheme. The primary reason for this is down to the development's location within the context of London and the negative environmental impact of high levels of NOx gases that are emitted from biomass boilers and the subsequent impact on local air quality. This is contrary to planning policies for air quality in London. ▪ There are also concerns regarding a sustainable supply of biomass to the site. ▪ The capital installation cost would be high which leads us to the conclusion that biomass would not be a commercially viable option for this development scheme. ▪ The on-site combustion associated with biomass is not aligned with the FHS and would contribute negatively to air quality issues.