PRICE & MYERS

149-151 Heath Road, Richmond

Energy Strategy Report

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Project ref: 25498

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Reviewed by: Deepika Singhal

STRUCTURES GEOMETRICS SUSTAINABILITY INFRASTRUCTURE

Contents

Executive Summary

This report details the proposed energy strategy for the 149-151 Heath Road scheme, which entails the demolition of an existing disused building. The new scheme comprises two ground floor commercial units totalling 110m^2. The first to third floors shall provide four 1-bed apartments and five 2-bed apartments. The scheme is located within the London Borough of Richmond Upon Thames.

The proposed development addresses national planning policies on energy; in particular, mitigation of climate change and energy security through energy efficiency enhancements and use of alternative energy technologies. In order to reduce the carbon footprint of the building beyond the requirements of current regulatory and market standards, the development will benefit from the following integrated systems:

- Passive design features (Be Lean)
- Energy efficiency measures (Be Clean)
- Low and zero carbon technologies (Be Green)

An energy assessment has been carried out based on design information to identify the most appropriate renewable strategy. The building fabric performance, of the development, has been specified to exceed the Building Regulations Part L 2013 requirements. High efficiency gas combination boilers have been specified for the residential units with a high efficiency communal boiler being specified for the commercial units. MVHR units will also be incorporated in both the residential and commercial units. Improved thermal detailing for the thermal bridges will be considered in the design of the residential unit and shall be calculated at a later stage. The project is required to follow the London Plan through the Energy Hierarchy and meet the London Borough of Richmond Upon Thames requirements to achieve an improvement of 35% over building regulations and 20% reduction in carbon emissions through the use of renewables. The proposed strategy has the potential to provide a 37% improvement over the Building Regulations 2013 minimum target; through passive design measures, energy efficient equipment and renewable technologies.

The proposed PV system will serve the residential units and have been specified to achieve an overall 20% saving in carbon emissions. The reductions meet the targets set out by the London Borough of Richmond Upon Thames and the London Plan.

1 Introduction

1.1 Site Analysis

The 149-151 Heath Road development is located within the London Borough of Richmond Upon Thames.

The proposal entails the demolition of an existing disused building. The new scheme comprises two ground floor commercial units totalling 110m^2. The first to third floors shall provide four 1-bed apartments and five 2-bed apartments. The roof shall be used for the installation of PV panels as well as a green roof. The development occupies the whole site but outdoor space has been made available in the form of communal terrace space on the first and second floors with private terraces for the penthouse apartments. Private car and bike parking shall be made at the rear of the development along with designated space for the storage of waste and recycling bins.

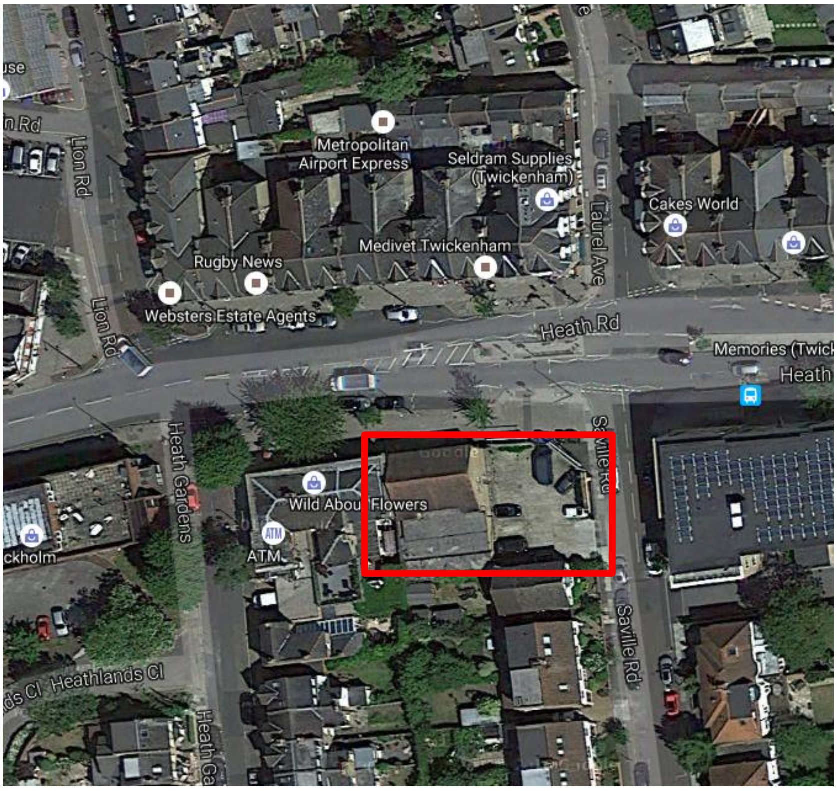


Figure 1-1 Site location © Google Maps

1.2 Objective

This report summarises the work undertaken to support the development of an energy strategy for the 149-151 Heath Road scheme. This work has resulted in a strategy that requires design, technical and commercial decisions in order to continue the design development and ultimately select the final solution for ensuring a low carbon development.

This report outlines the energy strategy for the development, including passive design, energy and CO_2 footprint of the proposed scheme, and renewable energy options.

The final proposed strategy would allow the scheme to demonstrate compliance with the guidelines set out by the London Borough of Richmond Upon Thames and the London Plan in demonstrating a positive commitment to sustainability through providing environmental improvements.

2 Policy

2.1 The London Plan Policies on Energy

The London Plan, March 2016, requires compliance with the following policies relating to climate change:

Policy 5.2: Minimising Carbon Dioxide Emissions

Planning Decisions

Development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy:

1. Be Lean: use less energy
2. Be Clean: supply energy efficiently
3. Be Green: use Renewable energy

As this is not a major development the remaining London Plan policies are not applicable to this development

2.2 London Borough of Richmond Upon Thames Policies on Energy

Policy DM SD 1: Sustainable Construction

New buildings should be flexible to respond to future social, technological and economic needs by conforming to the Borough's Sustainable Construction Checklist SPD.

New homes must achieve a minimum 40% reduction from 2013 to 2016.

Policy DM SD 2: Renewable Energy and Decentralised Energy Networks

Developments of one dwelling unit or more, or 100sqm of non-residential floor space or more will be required to reduce their total CO_2 emissions by following a hierarchy that first requires an efficient design to minimise the amount of energy used, secondly, by using low carbon technologies and finally, where feasible and viable, including a contribution from renewable sources.

The Council encourages developers to achieve a 20% reduction where feasible in total site CO_2 emissions from the use of on-site renewable energy, to improve savings beyond those generated by energy efficiency measures, as set out in Core Strategy Policy CP2.

2.3 Code for Sustainable Homes withdrawn

The Government have announced the official withdrawal of the Code for Sustainable Homes. The Deregulation Bill has been given Royal Assent. In the Ministerial Statement, the following was confirmed:

The government's policy is that planning permissions should not be granted requiring, or subject to conditions requiring, compliance with any technical housing standards other than for those areas where authorities have existing policies on access, internal space, or water efficiency.

This statement therefore addresses key sustainability criteria in relation to local and regional policy, in place of a Code for Sustainable Homes pre-assessment.

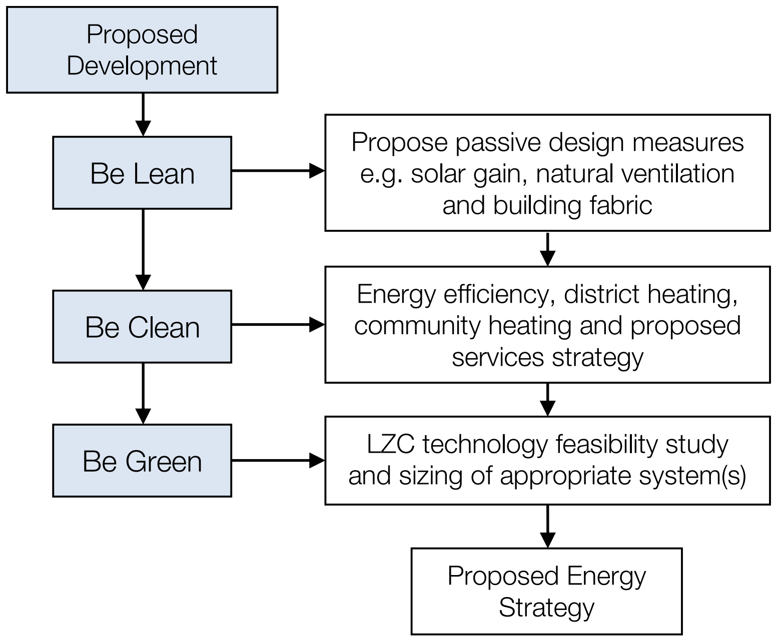
3 Approach

The approach to achieving the planning policy energy objectives has been to consider strategies and technologies to achieve a low energy and carbon footprint for the scheme.

The development will adopt the following energy hierarchy:

- Use less energy through passive design measures (Be Lean)
- Supply and consume energy efficiently (Be Clean)
- Utilise renewable energy sources to reduce carbon emissions (Be Green)

This energy strategy examines the energy performance of the proposed 149-151 Heath Road development based on the following methodology:



The performance of the development in terms of energy consumption and carbon emissions is calculated at each stage of the assessment, considering only regulated energy use to determine the performance of the proposed energy strategy.

3.1 Accredited Energy Assessor

This report has been checked and reviewed by Fraser Wilson who is an accredited On Construction Domestic Energy Assessor (OCDEA) and Deepika Singhal who is an accredited Low Carbon Energy Assessor (LCEA). The energy consumption and carbon emission figures within this report have been calculated using the approved Standard Assessment Procedure for the Energy Rating of Dwellings (SAP), current SAP 2012 version and EDSL Tas Dynamic Simulation Modelling (DSM) software.

4 Energy Targets

The target for the project is for the residential part to achieve a 35% improvement over Building Regulations Part L 2013 to meet the London Plan and the London Borough of Richmond Upon Thames policy. Due to the size of the non-residential part of the development, it is only required to meet Part L of Building Regulations. Table 4-1 details the energy broken down by fuel types and fuel use categories for the site taking into account the regulated energy. These are the target energy and carbon calculations before any passive design and energy efficient measures.

Building Regulations Target Emission Rate Breakdown													
Regulated Energy & CO_2													
Type	Gas Demand				Electricity Demand							Total Energy (kWh/yr)	Total CO_2 (kg/yr)
	Space Heating (kWh/yr)	Hot Water (kWh/yr)	Total (kWh/yr)	Gas CO_2 (kg/yr)	Space Heating (kWh/yr)	Hot Water (kWh/yr)	Cooling (kWh/yr)	Pumps & Fans (kWh/yr)	Lighting (kWh/yr)	Total (kWh/yr)	Electricity CO_2 ($kgCO_2$/yr)		
Residential	31,300	18,997	50,297	10,864	0	0	0	675	2,562	3,237	1,680	53,534	12,544
Commercial	3,866	0	3,866	835	0	197	1,158	0	5,494	6,849	3,554	10,714	4,389
Total	**35,165**	**18,997**	**54,162**	**11,699**	**0**	**197**	**1,158**	**675**	**8,056**	**10,086**	**5,235**	**64,248**	**16,934**

Table 4-1 Estimated regulated energy demand and carbon emissions per energy source

The energy consumption calculations for this and all subsequent stages of the assessment include regulated energy (space and water heating, lighting, pumps and fans) derived from outputs of the Standard Assessment Procedure.

5 Be Lean: Passive Design

As part of the Be Lean approach, passive design measures have been considered throughout the pre-planning stage to reduce energy demand.

5.1 Solar Gain Control and Daylighting

Where possible, windows and natural daylight have been provided to ensure appropriate daylighting levels throughout the development and reduce the lighting demand. The size and orientation of external windows has been considered carefully to balance daylight with excessive solar gains. Windows are specified to incorporate low emissivity coatings to limit overheating while ensuring adequate daylight.

The impact of solar gains has been incorporated into the SAP and TAS analysis for compliance with Part L 2013 and using a mechanical ventilation strategy the risk of solar overheating has been concluded to be not significant for the development.

5.2 Building Fabric Efficiency

To further improve the passive design of the development, the thermal fabric has been specified to meet or exceed current Building Regulations targets. Table 5-1 shows the proposed U-values that will be considered for the development and have been assumed for the energy strategy analysis at this stage.

Element	Measure	
	Residential	Commercial
External Walls	0.15 W/m^{2}K	0.15 W/m^{2}K
Stairwell/Lift Shelter Wall	0.15 W/m^{2}K	N/A
Penthouse Upper Panel Wall	0.15 W/m^{2}K	N/A
Penthouse Lower Panel Wall (South Facing)	0.30 W/m^{2}K	N/A
Party Walls*	0.00 W/m^{2}K*	0.45 W/m^{2}K
Roof (Main roof and terraces)	0.13 W/m^{2}K	N/A
Exposed Ground Floor	0.11 W/m^{2}K	0.11 W/m^{2}K
Windows/ Rooflights	1.20 W/m^{2}K	1.20 W/m^{2}K
French Doors	1.20 W/m^{2}K	N/A
External Doors	1.20 W/m^{2}K	1.20 W/m^{2}K
Air Tightness	Pressure test will be carried out to determine air tightness. This will be an assumed: 3 m^3/m^2/h	Pressure test will be carried out to determine air tightness. This will be an assumed: 5 m^3/m^2/h
Thermal Bridging	Independently assessed, designed to be equivalent to accredited details figures	Default value

	Details to be calculated at the detailed design stage	

Table 5-1 Proposed Be Lean passive design measures

*Where party walls have a cavity these are to meet the following requirements:
- Sealed to prevent air going in and out of any cavity
- Sealed at the top, bottom and vertically
- All cavities are to be fully filled

Thermal bridging
In order to further improve the thermal performance of the development, non-repeating thermal bridges at junctions, e.g. between walls and floors, will be designed carefully in order to ensure that they perform better than typical construction.

Approved Thermal Bridging values have been used in calculations rather than default values. In order to achieve the values required, either Accredited Construction Details (ACDs) must be used or the designs should be independently assessed by a qualified energy modeller at the appropriate stage. If using ACD checklists, they should be used by the Designer, Constructor and Building Control Body to demonstrate compliance.

5.1 Carbon savings

Based on the performance of development once the passive design measures proposed in Sections 5 are incorporated energy and carbon calculations have been undertaken. Table 5-2 shows that the residential part of the development can achieve a 12% improvement over the Part L minimum baseline and the non-residential part can achieve a -1% change. This is before any energy efficiency or low or zero carbon technologies have been considered. The breakdown of energy use and carbon emissions have been calculated, as shown in Table 5-3.

	Residential			Non-Residential		
	CO_2 Emissions (tonnes /annum)	CO_2 Savings (tonnes /annum)	% Saving	CO_2 Emissions (tonnes /annum)	CO_2 Savings (tonnes /annum)	% Saving
Building Regulations 2013 Baseline	12.54			4.39		
Be Lean (after demand reduction)	10.98	1.57	12%	4.20	0.19	4%

Table 5-2 Carbon savings at Be Lean Stage

Table 5-3 breaks down the energy use for the Be Lean case.

Be Lean													
Regulated Energy & CO_2													
Type	Gas Demand				Electricity Demand							Total Energy (kWh/yr)	Total CO_2 (kg/yr)
	Space Heating (kWh/yr)	Hot Water (kWh/yr)	Total (kWh/yr)	Gas CO_2 (kg/yr)	Space Heating (kWh/yr)	Hot Water (kWh/yr)	Cooling (kWh/yr)	Pumps & Fans (kWh/yr)	Lighting (kWh/yr)	Total (kWh/yr)	Electricity CO_2 ($kgCO_2$/yr)		
Residential	23,496	17,488	40,984	8,853	0	0	0	1,541	2,556	4,097	2,126	45,081	10,979
Commercial	3,180	0	3,180	687	0	171	614	519	5,471	6,774	3,516	9,954	4,203
Total	26,676	17,488	44,164	9,539	0	171	614	2,060	8,027	10,871	5,642	55,035	15,182

Table 5-3 Estimated regulated energy demand and carbon emissions per energy source

6 Be Clean: Energy Efficiency

As part of the Be Clean approach, the use of heat networks, community heating and cooling and energy efficient equipment has been considered for this development.

6.1 District Energy Systems

District energy systems produce steam, hot water or chilled water at a central energy centre. The steam or water is distributed in pre-insulated pipework to individual buildings for space heating, domestic hot water and air conditioning. As a result, individual buildings served by a district energy system don't required their own boilers or chillers.

According to the London Heat Map Study, the potential Camden heat network has been identified in the purple shading in Figure 6-1 below.

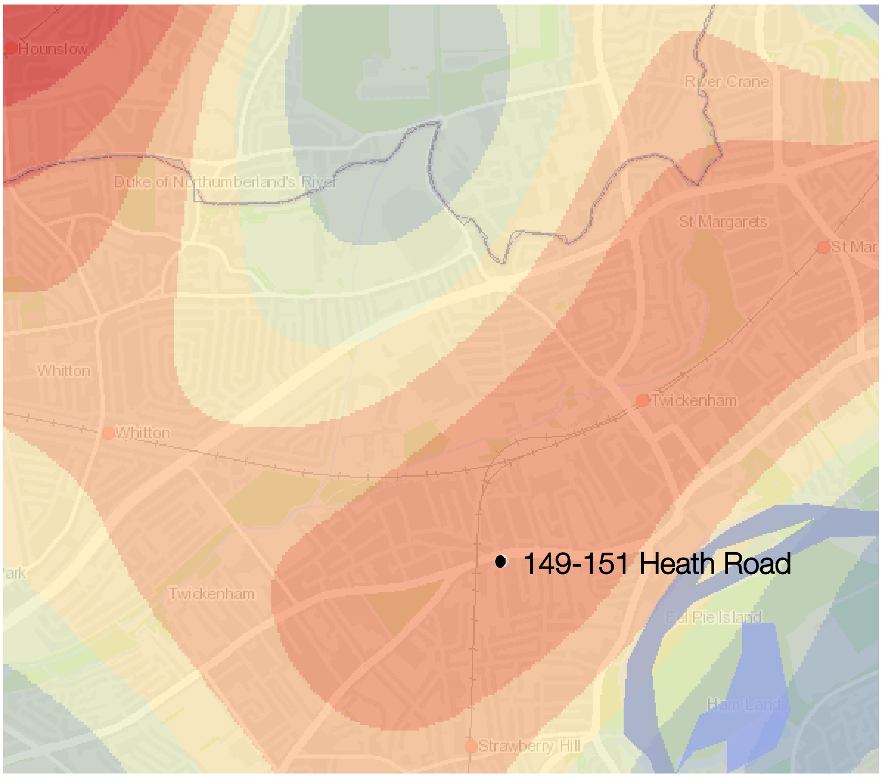


Figure 6-1 London Heat Map

This indicates that there is no existing network in the vicinity of the site to which the development could be connected at this stage. There is only a potential for a future network shown in purple. Low temperature underfloor heating is being proposed for the development to future proof it for any foreseen connections to Decentralised Energy Networks (DEN).

6.2 Community Heating

Community heating involves distributing space and water heating services throughout the development served from a central plant, making use of higher efficiencies available from larger systems.

As this development is relatively small, the installation of a community energy system would not be cost effective. A CHP system would not be viable for such small development due to low peak demand. The potential savings associated with a communal gas heating system would not be significant enough to justify the additional cost. Fabric improvements would have a greater impact and are therefore more cost effective for this development.

6.3 Services Strategy

In addition to the passive design measures identified in Section 5, energy efficient equipment has been proposed where possible to support the services strategy. Table 6-1 shows the proposed services strategy and energy efficiency measures for the development.

Services	Measure	
	Residential	Commercial
Space Heating	Combi Gas Condensing Boiler 90% efficient (underfloor heating)	Communal Gas Boiler 95% efficient (5% distribution losses)
Heating Controls	Time and temperature zone controls	-
Hot Water Heating	Combi Gas Condensing Boiler 90% efficient	Instantaneous Electric water heaters
Ventilation	MVHR 90% efficient SFP 0.5 w/l/s Rigid Duct/ Insulated Approved Installation	MVHR SFP 1.1W/l/s seasonal efficiency 85%
Comfort Cooling	N/A	VRF (COP 3.8)
Lighting	100% low energy lighting	95 lumens/circuit-watts
Lighting Control	PIR/Daylight/Timer controls fitted to lighting in external areas	Manual on/Auto off Manual daylight control

Table 6-1 Proposed energy efficient design measures

6.4 Improvement Over Part L

Based on the performance of the passive design and energy efficient measures proposed in Sections 4 and 5, as calculated using SAP 2012, Figure 6-2 and Table 6-2 demonstrate the percentage improvement these have over Building Regulations 2013 baseline levels for the development before any low or zero carbon technologies have been considered.

	Residential			Non-Residential		
	CO_2 Emissions (tonnes /annum)	CO_2 Savings (tonnes /annum)	% Saving	CO_2 Emissions (tonnes /annum)	CO_2 Savings (tonnes /annum)	% Saving
Building Regulations 2013 Baseline	12.54			4.39		
Be Lean (after demand reduction)	10.98	1.57	12%	4.20	0.19	4%
Be Clean (after efficiency measures)	10.98	0.00	0.0%	4.20	0.00	0%
Total Cumulative Savings		1.57	12%		0.19	4%

Table 6-2 Carbon savings at Be Clean Stage

The energy use for the Be Clean case is broken down in Table 6-3.

Be Clean													
Regulated Energy & CO_2													
Type	Gas Demand				Electricity Demand							Total Energy (kWh/yr)	Total CO_2 (kg/yr)
	Space Heating (kWh/yr)	Hot Water (kWh/yr)	Total (kWh/yr)	Gas CO_2 (kg/yr)	Space Heating (kWh/yr)	Hot Water (kWh/yr)	Cooling (kWh/yr)	Pumps & Fans (kWh/yr)	Lighting (kWh/yr)	Total (kWh/yr)	Electricity CO_2 ($kgCO_2$/yr)		
Residential	23,496	17,488	40,984	8,853	0	0	0	1,541	2,556	4,097	2,126	45,081	10,979
Commercial	3,180	0	3,180	687	0	171	614	519	5,471	6,774	3,516	9,954	4,203
Total	26,676	17,488	44,164	9,539	0	171	614	2,060	8,027	10,871	5,642	55,035	15,182

Table 6-3 Estimated regulated energy demand and carbon emissions per energy source

7 Be Green: Low and Zero Carbon (LZC) Technologies Feasibility Study

The final level of the energy hierarchy is to Be Green, therefore the following table discusses the options for on-site low and zero carbon technologies and their feasibility on this development to contribute to meeting the relevant London Plan and the London Borough of Richmond Upon Thames sustainability targets.

LZC Technologies	Description	Advantages	Disadvantages	Feasibility	
Solar Thermal Collectors	Solar thermal collectors can be used to provide hot water using the irradiation from the sun They can generally provide approx. 50% of the hot water demand	No noise issues associated with Solar thermal collectors No additional land use from the installation of solar thermal collectors Low maintenance and easy to manage Favourable payback periods	The hot water cylinder will need to be larger than a traditional cylinder Needs unobstructed space on roof Low efficiencies Often not compatible with other LZC technologies Saves less carbon when offsetting gas systems	There is a flat roof spaces where solar thermal panels can be installed. However, solar PV is favoured due to greater potential carbon savings.	✗
Solar Photovoltaic Panels (PV)	Solar PV panels provide noiseless, low-maintenance, carbon free electricity	Can have significant impact on carbon emissions by offsetting grid electricity (which has a high carbon footprint) Low maintenance, No noise issues No additional land use from the installation of PV panels Bolt on technology that does not need significant amounts of auxiliary equipment Favourable payback periods	Needs unobstructed space on roof Low efficiencies per unit area of PV Often used to supplement landlord's electricity so savings not always transferred to individual properties	The architectural plans show that PV panels will be installed on the roof so they are south facing	✓

CHP (Combined Heat & Power)	CHP systems use an engine driven alternator to generate electricity while using the waste heat from the engine, jacket and exhaust to provide heating and hot water Economic viability relies on at least 4,000 hours running time per annum	Mature technology High CO_2 savings	Cost of the system is relatively high for small schemes Only appropriate for large development with high heat loads	CHP is not technically viable for a development of this scale.	✗
Biomass Heating	Solid, liquid or gaseous fuels derived from plant material can provide boiler heat for space and water heating	Potential to reduce large component of the total CO_2 A biomass boiler would supplement a standard gas heating system so some of the cost may be offset through money saved on using smaller traditional boilers	Regular maintenance is required Reliability of fuel access/supply can be a problem The noise generated by a biomass boiler is similar to that of a gas boiler. It is advisable not to locate next to particularly sensitive areas such as bedrooms A plant room and fuel store will be required which may take additional land from the proposed development or surroundings Biomass is often not a favoured technology in new development due to the potential local impacts of NO_x emissions and delivery vehicles for the fuel	Biomass is not considered feasible for this development due to issues with fuel storage, access for delivery vehicles and local NO_x emissions	✗

Wind Turbines	Vertical and horizontal axis wind turbines enable electricity to be generated using the power within the wind	Low noise Bolt on technology that does not need significant amounts of auxiliary equipment	Not suitable for urban environments due to low wind conditions and obstructions High visual impact Noise impact (45-65dB at 3m) High capital cost and only achieve good paybacks in locations with strong wind profiles Requires foundations or vibration supports for building installations (generally not recommended)	This development is in an urban environment and so a wind turbine will not generate much energy	✗
Ground Source Heat Pumps (GSHP)	Utilising horizontal loops or vertical boreholes, GSHP make use of the grounds almost constant temperature to provide heating and/or cooling using a heat exchanger connected to a space/water heating delivery system	Low maintenance and easy to manage High COP (ratio of energy output per energy input) Optimum efficiency with underfloor heating systems As heat pumps would replace standard heating systems, some of the cost may offset through savings on a traditional boiler	The heat pump has a noise level around 35-60dB so some attenuation may be required and it should be sensibly located Relatively high capital cost Requires electricity to run the pump, therefore limited carbon savings in some cases For communal systems a plant room is required which may take additional land from the proposed development/surroundings	GSHP are not a feasible technology for the site since there is a limited external space available for installation of boreholes	✗

Air Source Heat Pumps (ASHP)	Air Source Heat Pumps extract latent energy from the external air in a manner similar to ground source heat pumps	ASHP systems are generally cheaper than GSHP as there is no requirement for long lengths of buried piping or boreholes Low maintenance and easy to manage Optimum efficiency with underfloor heating systems As heat pumps would replace standard heating systems, some of the cost may offset through savings on a traditional boiler	The ASHP unit has a noise level around 50-60dB so some attenuation may be required and it should be sensibly located The potential noise from the external unit may mean there is local opposition to their installation Requires electricity to run the pump, therefore limited carbon savings in some cases For communal systems a plant room is required which may take additional land from the proposed development/surroundings	The use of ASHP is technically feasible for the development however it's being discounted because of high noise levels.	✗

Table 7-1 Feasibility of LZC technologies for the development

Having reviewed potential LZC technologies for the development it has been identified that the most appropriate system would be Solar PV which the architect plans show will be installed on the roof of the development. The system will only provide power to the residential units. The chosen should be accurately sized during the detailed design stages and MCS (Microgeneration Certification Scheme) approved equipment and installers used.

7.1 Summary of CO_2 Emission Savings

The most appropriate LZC technology for the development has been identified as Solar PV in order to show ambition towards meeting the London Plan and the London Borough of Richmond Upon Thames target for on-site renewables. Table 7-2 shows the proposed system size and the estimate energy and carbon emissions savings for this development. Table 7-3 shows the breakdown of energy use and carbon for the final case.

	Energy & CO_2				
Proposed LZC Technologies	Energy Generated (kWh/yr)	% site energy demand met	CO_2 saved by system ($kgCO_2$/yr)	% reduction in site CO_2 emissions	25 year CO_2 saving ($kgCO_2$)
Total Solar PV = 6.8 kWp 21 no.s High Efficiency 30 deg, S facing	5,837	10.61%	3,029	20.0%	75,737

Table 7-2 Energy, carbon and financial performance of the proposed LZC technologies

Be Green Emission Breakdown														
Regulated Energy & CO_2														
	Gas Demand				Electricity Demand									
Type	Space Heating (kWh/ yr)	Hot Water (kWh/ yr)	Total (kWh/ yr)	Gas CO2 (kg/ yr)	Space Heating (kWh/ yr)	Hot Water (kWh/ yr)	Cooling (kWh/ yr)	Pumps & Fans (kWh/yr)	Lighting (kWh/yr)	PV (kWh/ yr)	Total (kWh/ yr)	Electricity CO_2 ($kgCO_2$/ yr)	Total Energy (kWh/ yr)	Total CO_2 (kg/yr)
Residential	23,496	17,488	40,984	8,853	0	0	0	1,541	2,556	-5,837	-1,740	-903	39,244	7,949
Commercial	0	0	0	0	774	171	555	519	5,471	0	7,490	3,887	7,490	3,887
Total	23,496	17,488	40,984	8,853	774	171	555	2,060	8,027	-5,837	5,750	2,984	46,734	11,837

Table 7-3 Estimated regulated demand and carbon emissions per energy source

7.2 Carbon Savings

Table 7-4 demonstrate the percentage improvement over the Building Regulations 2013 baseline levels for the development incorporating all three stages of the energy hierarchy.

	Residential			Non-Residential		
	CO_2 Emissions (tonnes /annum)	CO_2 Savings (tonnes /annum)	% Saving	CO_2 Emissions (tonnes /annum)	CO_2 Savings (tonnes /annum)	% Saving
Building Regulations 2013 Baseline	12.54			4.39		
Be Lean (after demand reduction)	10.98	1.57	12%	4.20	0.19	4%
Be Clean (after efficiency measures)	10.98	0.00	0.0%	4.20	0.00	0%
Be Green (after renewable energy)	7.95	3.03	24%	3.89	0.32	7%
Total Cumulative Savings		4.59	37%		0.50	11%

Table 7-4 Carbon savings at the Be Green stage

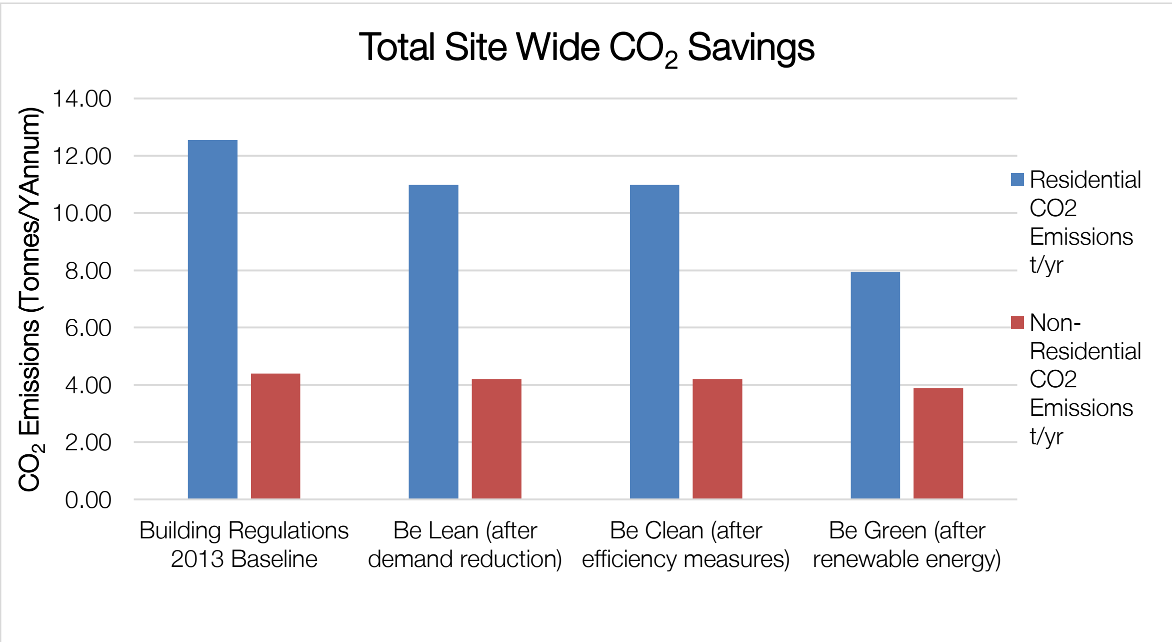


Figure 7-1 Summary of CO_2 savings (tonnes CO_2/annum) over Buildings Regulations 2013 baseline

8 Conclusion

The design team have made all reasonable endeavours to achieve the minimum requirements of the London Plan and the London Borough of Richmond Upon Thames. The energy hierarchy has been followed, fabric improvements have been prioritised for the development, which will have a longer lasting impact on energy use than renewable technologies with a finite lifetime. The fabric U-Values are low and exceed current Building Regulations, improved thermal detailing for the thermal bridges will be considered in the design of the residential unit and shall be calculated at a later stage. PV panels have been incorporated into the design to reduce carbon emissions from the site. The strategy therefore represents the best possible savings that could be achieved for this development.

Following the measures mentioned above, through the energy hierarchy, passive design measures, energy efficient equipment and LZC technologies, the residential part of the development provides a 37% improvement over the Building Regulations Part L 2013 Target Emissions Rate (TER) and the overall development is able to achieve a 20% saving in carbon emissions from the LZCs technologies. The non-residential part of the development provides an 11% improvement over Building Regulations Part L 2013.

The figures within this report are based on preliminary analysis only and further detailed studies will be required at the detailed design stage before specifying any of the proposed systems.

Appendix A

The following tables show figures used in the energy and CO_2 calculations to estimate energy produced and CO_2 savings from LZC technologies. These figures can be used to validate the results.

CO_2 Intensity Values	
Gas Intensity	0.216 $kgCO_2/kWh$
Electricity Intensity	0.519 $kgCO_2/kWh$

Table A-1 Energy intensity values

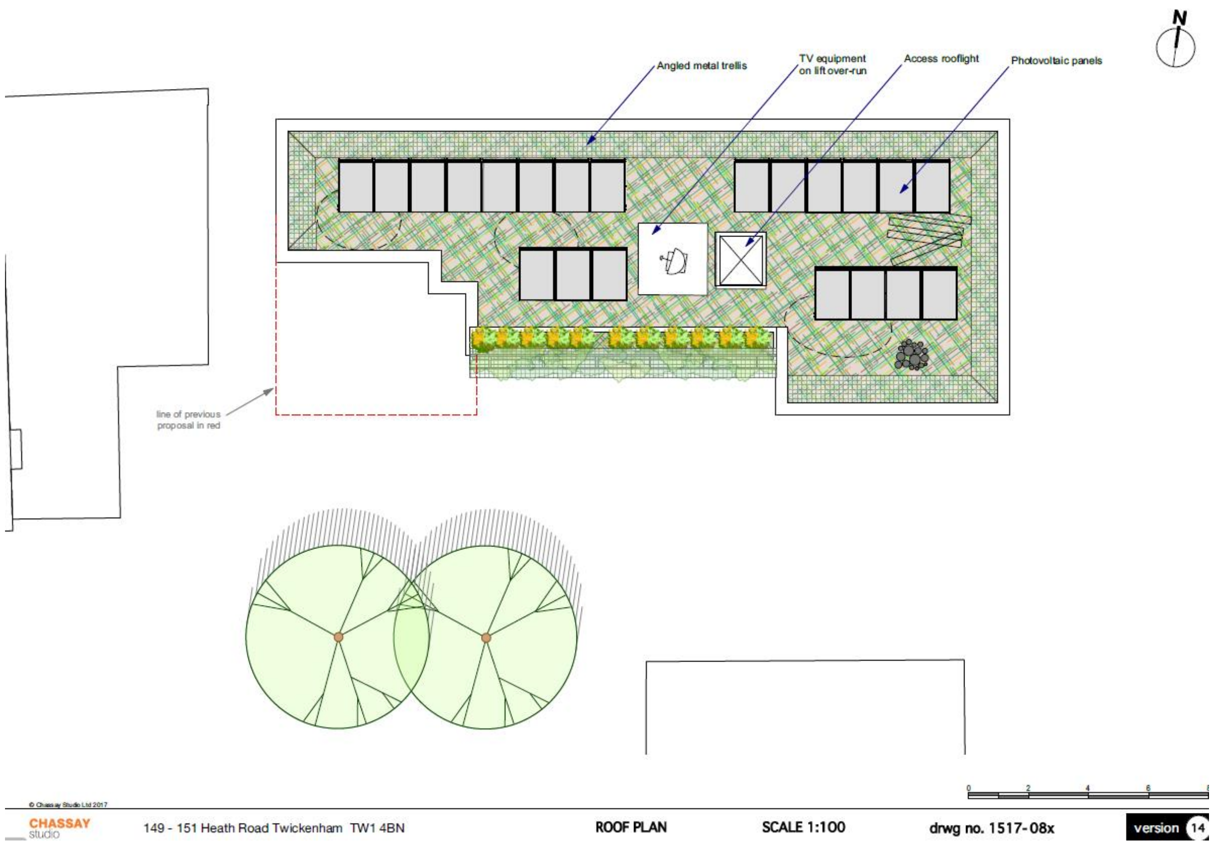
Fuel Prices (as of March 2017)	
Natural Gas	3.80 p/kWh
Electricity (Grid)	14.37 p/kWh

Table A-2 Natural Gas and Electricity fuel prices

Appendix B

PV efficiency and Roof Plan

Energy & Renewable Technology Outputs	
PV panel size	1.046 x 1.56
PV panel area per panel (m2)	1.63
PV panel rated output (kWp)	0.327 kWp
Efficiency of PV Panels	0.20 kWp/m^2



Appendix C

SAP Block Compliance Report for Residential – Be Lean/Be Clean Stage and Green Stage
BRUKL Report

BLOCK COMPLIANCE
Calculation Type: New Build (As Designed)

Design SAP
elmhurst energy

Block Reference	25498	**Issued on Date**	24/07/2017
Block Name	149-151 Heath Road		

Surveyor	admin Admin, Tel: 4, Fax: s@l.f	**Surveyor ID**	Admin
Client			

Block Compliance Report - DER

Block Reference: 25498		**Block Name: 149-151 Heath Road**		
Property-Survey Reference	**Multiplier**	**Floor Area (m^2)**	**DER ($kgCO_2/m^2$)**	**TER ($kgCO_2/m^2$)**
25498 - Flat 02-Be Clean PT3	1	52.65	17.09	20.82
25498 - Flat 03-Be Clean PT3	1	60.48	18.66	20.81
25498 - Flat 04-Be Clean PT3	1	51.12	19.10	22.15
25498 - Flat 06-Be Clean PT3	1	70.63	16.92	20.85
25498 - Flat 07-Be Clean PT3	1	60.87	18.56	20.96
25498 - Flat 08-Be Clean PT3	1	51.11	18.26	21.49
25498 - Flat 01-Be Lean PT3 V1	1	53.47	20.66	24.22
25498 - Flat 05-Be Lean PT3 v2	1	91.71	19.09	21.33
25498 - Flat 09 v1-Be Clean PT3	1	77	24.17	25.44
Totals:	9	569.04	172.51	198.07
Average DER = 19.29 $kgCO_2/m^2$			PASS	
Average TER = 22.04 $kgCO_2/m^2$				

Block Compliance Report - DFEE

Block Reference: 25498		**Block Name: 149-151 Heath Road**		
Property-Survey Reference	**Multiplier**	**Floor Area (m^2)**	**DFEE ($kWh/m^2/yr$)**	**TFEE ($kWh/m^2/yr$)**
25498 - Flat 02-Be Clean PT3	1	52.65	41.32	53.83
25498 - Flat 03-Be Clean PT3	1	60.48	51.20	58.14
25498 - Flat 04-Be Clean PT3	1	51.12	49.83	60.97
25498 - Flat 06-Be Clean PT3	1	70.63	46.58	61.78
25498 - Flat 07-Be Clean PT3	1	60.87	51.79	58.98
25498 - Flat 08-Be Clean PT3	1	51.11	47.38	57.61
25498 - Flat 01-Be Lean PT3 V1	1	53.47	54.81	71.75
25498 - Flat 05-Be Lean PT3 v2	1	91.71	59.99	70.42
25498 - Flat 09 v1-Be Clean PT3	1	77	79.46	87.98
Totals:	9	569.04	482.38	581.46
Average DFEE = 54.89 $kWh/m^2/yr$			PASS	
Average TFEE = 65.79 $kWh/m^2/yr$				

BLOCK COMPLIANCE
Calculation Type: New Build (As Designed)

Design SAP
elmhurst energy

Block Reference	25498	**Issued on Date**	25/07/2017
Block Name	149-151 Heath Road		

Surveyor	admin Admin, Tel: 4, Fax: s@l.f	**Surveyor ID**	Admin
Client			

Block Compliance Report - DER

Block Reference: 25498		**Block Name: 149-151 Heath Road**		
Property-Survey Reference	**Multiplier**	**Floor Area (m^2)**	**DER ($kgCO_2/m^2$)**	**TER ($kgCO_2/m^2$)**
25498 - Flat 01-Be Green PT3 v1	1	53.47	15.34	24.22
25498 - Flat 02-Be Green PT3 v1	1	52.65	11.77	20.82
25498 - Flat 03-Be Green PT3 v1	1	60.48	13.30	20.81
25498 - Flat 04-Be Green PT3 v1	1	51.12	13.78	22.15
25498 - Flat 05-Be Green PT3 v1	1	91.71	13.77	21.33
25498 - Flat 06-Be Green PT3 v1	1	70.63	11.60	20.85
25498 - Flat 07-Be Green PT3 v1	1	60.87	13.24	20.96
25498 - Flat 08-Be Green PT3 v1	1	51.11	12.94	21.49
25498 - Flat 09 v1-Be Green PT3 v1	1	77	18.85	25.44
Totals:	9	569.04	124.59	198.07
Average DER = 13.97 $kgCO_2/m^2$			PASS	
Average TER = 22.04 $kgCO_2/m^2$				

Block Compliance Report - DFEE

Block Reference: 25498		**Block Name: 149-151 Heath Road**		
Property-Survey Reference	**Multiplier**	**Floor Area (m^2)**	**DFEE ($kWh/m^2/yr$)**	**TFEE ($kWh/m^2/yr$)**
25498 - Flat 01-Be Green PT3 v1	1	53.47	54.81	71.75
25498 - Flat 02-Be Green PT3 v1	1	52.65	41.32	53.83
25498 - Flat 03-Be Green PT3 v1	1	60.48	51.20	58.14
25498 - Flat 04-Be Green PT3 v1	1	51.12	49.83	60.97
25498 - Flat 05-Be Green PT3 v1	1	91.71	59.99	70.42
25498 - Flat 06-Be Green PT3 v1	1	70.63	46.58	61.78
25498 - Flat 07-Be Green PT3 v1	1	60.87	51.79	58.98
25498 - Flat 08-Be Green PT3 v1	1	51.11	47.38	57.61
25498 - Flat 09 v1-Be Green PT3 v1	1	77	79.46	87.98
Totals:	9	569.04	482.38	581.46
Average DFEE = 54.89 $kWh/m^2/yr$			PASS	
Average TFEE = 65.79 $kWh/m^2/yr$				

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name Be Green

149-151 Heath Road

As designed

Date: Mon Aug 01 11:54:34 2016

Administrative information

Building Details

Address: Twickenham, London, TW1 4BH

Certification tool

Calculation engine: TAS

Calculation engine version: "v9.3.3"

Interface to calculation engine: TAS

Interface to calculation engine version: v9.3.3

BRUKL compliance check version: v5.2.d.2

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name:

Telephone number:

Address: , ,

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	41.6
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	41.6
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	35.8
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values not achieving standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.15	0.15	External Wall
Floor	0.25	0.11	0.11	Ground Floor
Roof	0.25	0.11	0.11	Roof
Windows***, roof windows, and rooflights	2.2	1.21	1.21	E. Window 1x3.3
Personnel doors	2.2	-	-	No personal doors in project
Vehicle access & similar large doors	1.5	-	-	No vehicle doors in project
High usage entrance doors	3.5	-	-	No high usage entrance doors in project

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	5

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs.
Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	>0.95

1- Commercial (4 Zones)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3.71	4.2	-	1.1	0.85
Standard value	2.5*	2.6	N/A	1.6^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

^ Allowed SFP may be increased by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

1- New DHW Circuit

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0
Standard value	0.9*	N/A

* Standard shown is for gas boilers >30 kW output. For boilers <=30 kW output, limiting efficiency is 0.73.

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
GF_Commercial1	-	-	-	1.1	-	-	-	-	-	-	N/A
GF_Commercial2	-	-	-	1.1	-	-	-	-	-	-	N/A
GF_Commercial3	-	-	-	1.1	-	-	-	-	-	-	N/A
GF_Commercial4	-	-	-	1.1	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
GF_Commercial1	-	95	22	310
GF_Commercial2	-	95	22	287
GF_Commercial3	-	95	22	212
GF_Commercial4	-	95	22	340

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
GF_Ent to flats	-	95	-	52
FF_Resi 1	-	95	-	63
FF_Resi 2	-	95	-	50
FF_Resi 3	-	95	-	45
FF_Resi 4	-	95	-	72
FF_Resi 5	-	95	-	58
FF_Resi 2_1	-	95	-	10
FF_resi Circulation	-	95	-	27
FF_Resi 3_1	-	95	-	22
FF_Resi 3_2	-	95	-	20
FF_Resi 4_1	-	95	-	41
FF_Resi 5_1	-	95	-	14
FF_Resi 5_2	-	95	-	14
FF_resi Circulation-1	-	95	-	11
FF_Resi 6	-	95	-	88

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
GF_Commercial1	NO (-76%)	NO
GF_Commercial2	NO (-64%)	NO
GF_Commercial3	NO (-74%)	NO
GF_Commercial4	NO (-75%)	NO
FF_Resi 1	N/A	N/A
FF_Resi 2	N/A	N/A
FF_Resi 3	N/A	N/A
FF_Resi 4	N/A	N/A
FF_Resi 5	N/A	N/A
FF_Resi 2_1	N/A	N/A
FF_Resi 3_1	N/A	N/A
FF_Resi 3_2	N/A	N/A
FF_Resi 4_1	N/A	N/A
FF_Resi 5_1	N/A	N/A
FF_Resi 5_2	N/A	N/A
FF_Resi 6	N/A	N/A

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	106	106
External area [m²]	4215	4215
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	5	3
Average conductance [W/K]	795	1119
Average U-value [W/m²K]	0.19	0.27
Alpha value* [%]	11.15	11.15

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

Building Use

% Area	Building Type
100	**A1/A2 Retail/Financial and Professional services**
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	7.3	22.43
Cooling	5.24	10.97
Auxiliary	4.9	4.15
Lighting	51.61	51.83
Hot water	1.61	1.86
Equipment*	20.26	20.26
TOTAL**	**70.67**	**91.24**

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

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	186.01	219.24
Primary energy* [kWh/m²]	211.52	227.1
Total emissions [kg/m²]	35.8	41.6

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	102.6	83.4	7.7	5.5	5.2	3.71	4.2	3.71	4.2
	Notional	68.3	149.6	23.2	11.6	4.4	0.82	3.6	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	**$U_{i\text{-}Typ}$**	**$U_{i\text{-}Min}$**	**Surface where the minimum value occurs***
Wall	0.23	0.15	External Wall
Floor	0.2	0.11	Ground Floor
Roof	0.15	0.11	Roof
Windows, roof windows, and rooflights	1.5	1.21	N. Window 2.4x3.3
Personnel doors	1.5	-	No personal doors in project
Vehicle access & similar large doors	1.5	-	No vehicle doors in project
High usage entrance doors	1.5	-	No high usage entrance doors in project

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	**Typical value**	**This building**
$m^3/(h.m^2)$ at 50 Pa	5	5