150 HOLBORN
ENERGY STRATEGY

DAH REAL ESTATES SARL

APRIL 2016

DARPLUS

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DOCUMENT CONTROL

Issue	Description	Date	Prepared By	Signed Off
01	Draft	20.11.15	Clara BG	
02	Final Draft	27.11.15	Clara BG	
03	Final Issue	10.12.15	Clara BG	Edward Garrod
04	Final Issue	01.03.16	Clara BG	Adeel Ahmed
05	Final Issue	03.03.16	Clara BG	Alex Sinclair
06	Final Issue	08.03.16	Clara BG	Alex Sinclair

Change register	
04	• Amendments in line with new basement layout • Increasing the proportion of retail that is café space as per the plans • Amendments due to the revised façade (removing dynamic louvers within the glazing, adding external fixed vertical shading) • Amendments to 8th floor roof overhang
05	• Updating total area figures
06	• Updating Residential area figures

1 EXECUTIVE SUMMARY

Elementa Consulting was commissioned to prepare an energy strategy for the development of 150 Holborn. The development is required to:

- Meet the requirements of Part L2A of the Building Regulations (2013 version 5.2.b.1) for the commercial and retail sections of the development.
- Meet the requirements of Part L1A of the Building Regulations for the residential sections of the development.
- Satisfy local planning policy requirements stipulated by London Borough of Camden
- Comply with the London Plan – 35% carbon reductions beyond Part L 2013 of the building regulations.
- Achieve a BREEAM 2014 'Excellent Rating'. The project has aspirations of achieving 'Outstanding' and is committed to achieving 'Excellent'.

The purpose of this report is to;

- Demonstrate that climate change mitigation measures comply with London Plan Energy Policies. It also ensures energy remains an integral part of the development's design and evolution.
- Demonstrate that carbon dioxide emissions have been minimised in accordance with the Energy Hierarchy.
- Demonstrate how passive and active measures have been chosen to minimise the CO_2 emissions and address the risk of overheating.
- Demonstrate that the viability of decentralised energy networks has been explored.
- Establish the most appropriate local (on-site or near-site) low or zero carbon (LZC) energy source for the building/development in order to meet the above requirements.
- Demonstrate the Cooling Hierarchy has been implemented.
- Demonstrate sustainable design and construction.
- Establish the number of credits that are achievable for BREEAM criteria Ene 01 and BREEAM criteria Ene 04.

The following Energy Hierarchy, as set out in the GLA guidance (April 2015) on preparing energy assessments methodology, was adopted to help guide decisions about which energy measures are appropriate, and in order to optimise design solutions to maximise carbon reductions:

Be Lean: using less energy and utilising passive sustainable design measures
Be Clean: supplying energy efficiency, including the use of decentralised energy production
Be Green: using renewable energy where possible to further reduce carbon emissions.

A dynamic simulation of the building was carried out using thermal modelling software (IES VE version 7.0.2.0), with the building assessed as stipulated within the NCM Modelling Guide 2013.

The following low and zero carbon technology options were considered and the resulting conclusions drawn:

Table 1: LZC Technology Feasibility

LZC Technology	Technically Feasible	Recommended	Notes
Hydrogen Technology	No	No	Technology not yet economically viable
Tri-Generation	No	No	Structural limitations, height issues
CHP	Yes	No	Not enough year round load to be viable
ASHP	Yes	No	Roof space constraints
PV	Yes	Yes	Recommended for this site
GSHP	Yes	No	Reduced capacity due to existing piles and significant program issues
Wind Power	No	No	Not viable due to the urban nature of the development.
Solar thermal	Yes	No	Roof area utilised by solar thermal panels would be more effectively utilised by PV panels.
Biomass	No	No	Biomass heating will exacerbate the air quality issues of the site.

A PV array together with a high efficiency gas-fired boiler system and high efficiency water cooled chiller will be used for heating, cooling and domestic hot water.

A PV system that generates at least 31.8 MWh of electricity per year will be installed. This can be achieved with a 207m^2 horizontal array with a nominal efficiency of 21.5 %. The PV array will contribute to site wide carbon emission reductions.

Tables 2 & 3 below summarises the results obtained from the thermal model, based on the adoption of LZC technologies recommended in section 5.

Table 2: Site Wide Carbon Dioxide Emissions after Each Stage of the Energy Hierarchy

The proposed development	Carbon Dioxide emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Part L 2013 of the Building Regulations compliant development	392	439
After energy demand reduction	324	439
After CHP	324	439
After renewable energy	306	439

Table 3: Regulated Carbon Dioxide Savings from Each Stage of the Energy Hierarchy

The proposed development	Regulated Carbon Dioxide Savings	
	Tonnes CO_2 per annum	(%)
Be Lean Savings from energy demand reduction	67.28	17.2
Be Clean Savings from CHP	-	-
Be Green Savings from renewable energy	17.91	5.5
Total cumulative savings	85.18	21.8
Total target savings	137.03	35.00
Annual Shortfall (Tonnes CO2)	51.85	
Cumulative shortfall over 30 years (Tonnes CO2)	1,555.46	

This report shows that best in class mechanical and electrical system efficiencies together with a high performing building fabric significantly reduces carbon emissions, (17.2%). There is not a viable year-round load to make CHP suitable, therefore this technology has not been included to reduce carbon emissions. Photovoltaics are the only suitable renewable technology for this development.

It is understood from discussions with Camden Council, it is preferable that accessible roof spaces are utilised as roof terraces, with inaccessible unshaded roof spaces to be utilised for PVs and inaccessible shaded roof spaces be used as green roofs. In the event of surplus renewable energy from PVs being achieved, the option of integrating PVs with green roofs should be considered. In line with this guidance, the majority of the roof space will be an accessible green roof terrace.

It has been calculated that 207 m^2 of PV will fit on the developments inaccessible unshaded roof space. Using best in class efficient PV panels, this brings the development to 21.8% regulated carbon emission reductions. The remaining 13.2% of carbon emission reductions needed to achieve the 35% carbon emission reductions target will be provided off-site or through a cash in lieu contribution to Camden Council to be ring-fenced to secure delivery of carbon dioxide savings elsewhere.

Figure 1: Site Wide Energy Hierarchy

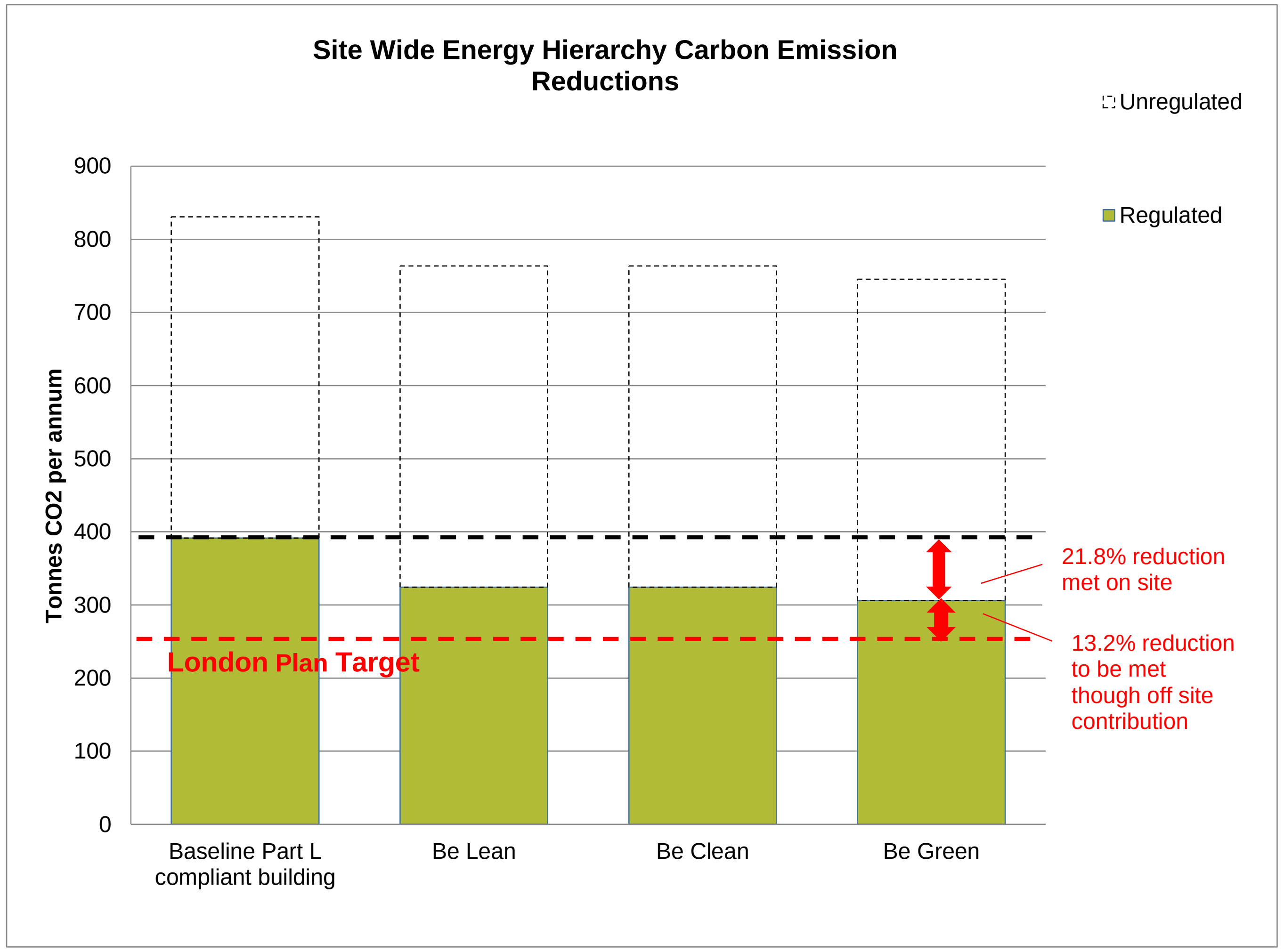


Figure 2: Residential Energy Hierarchy

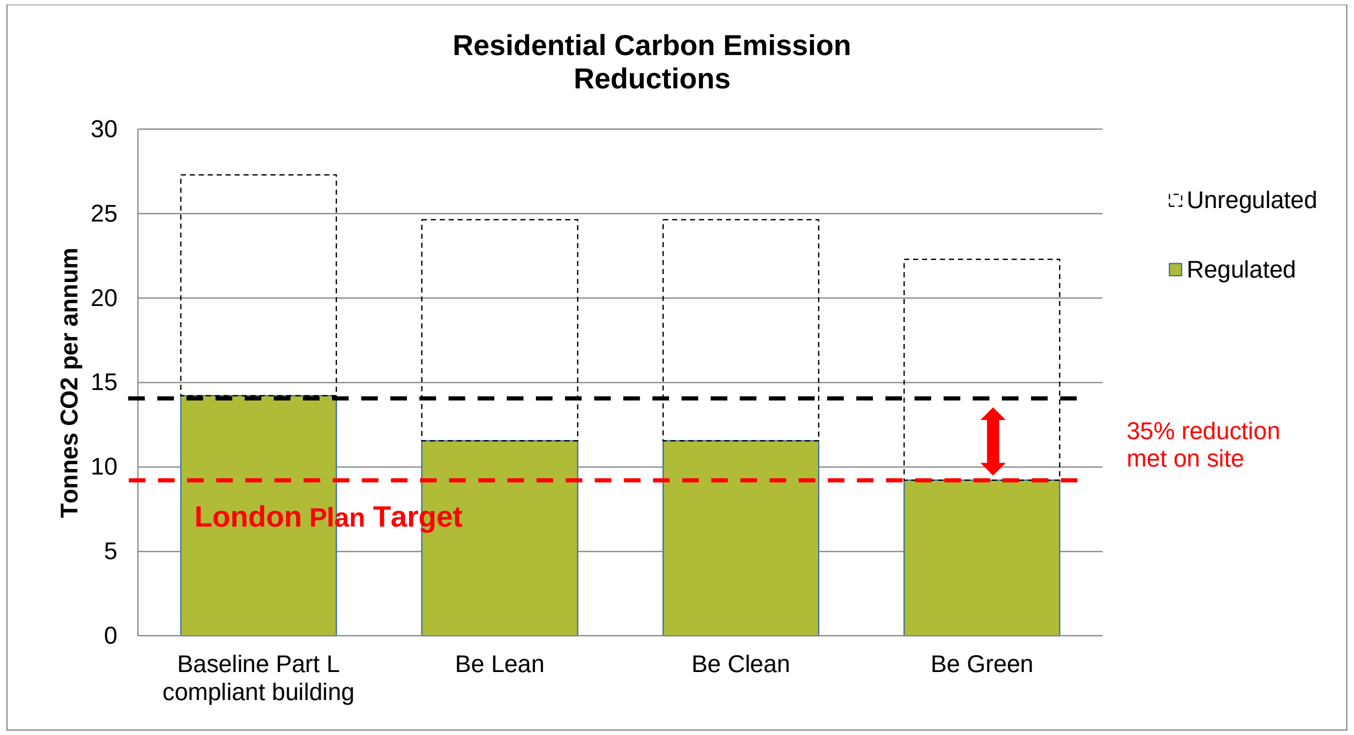


Figure 3: Commercial Energy Hierarchy

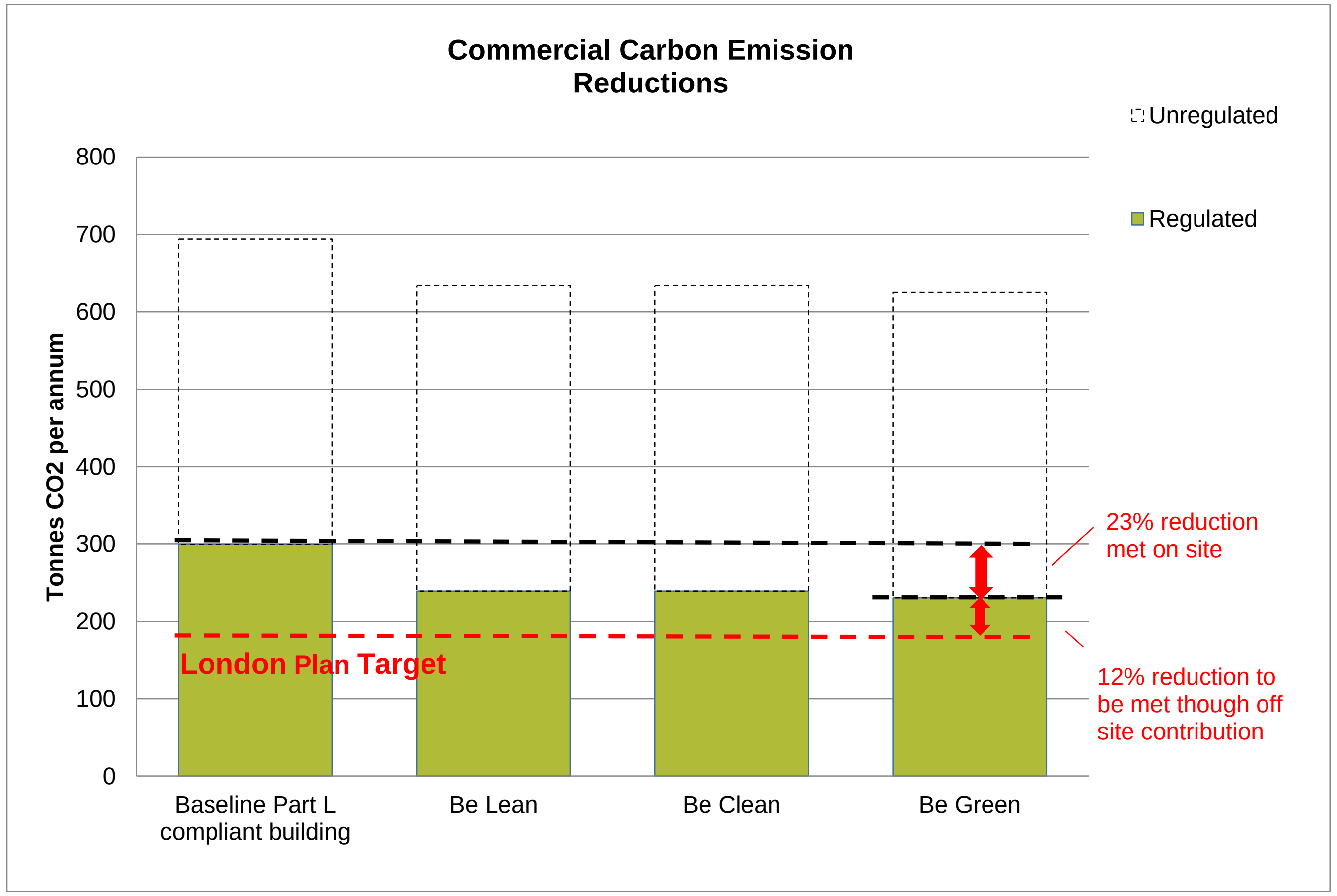
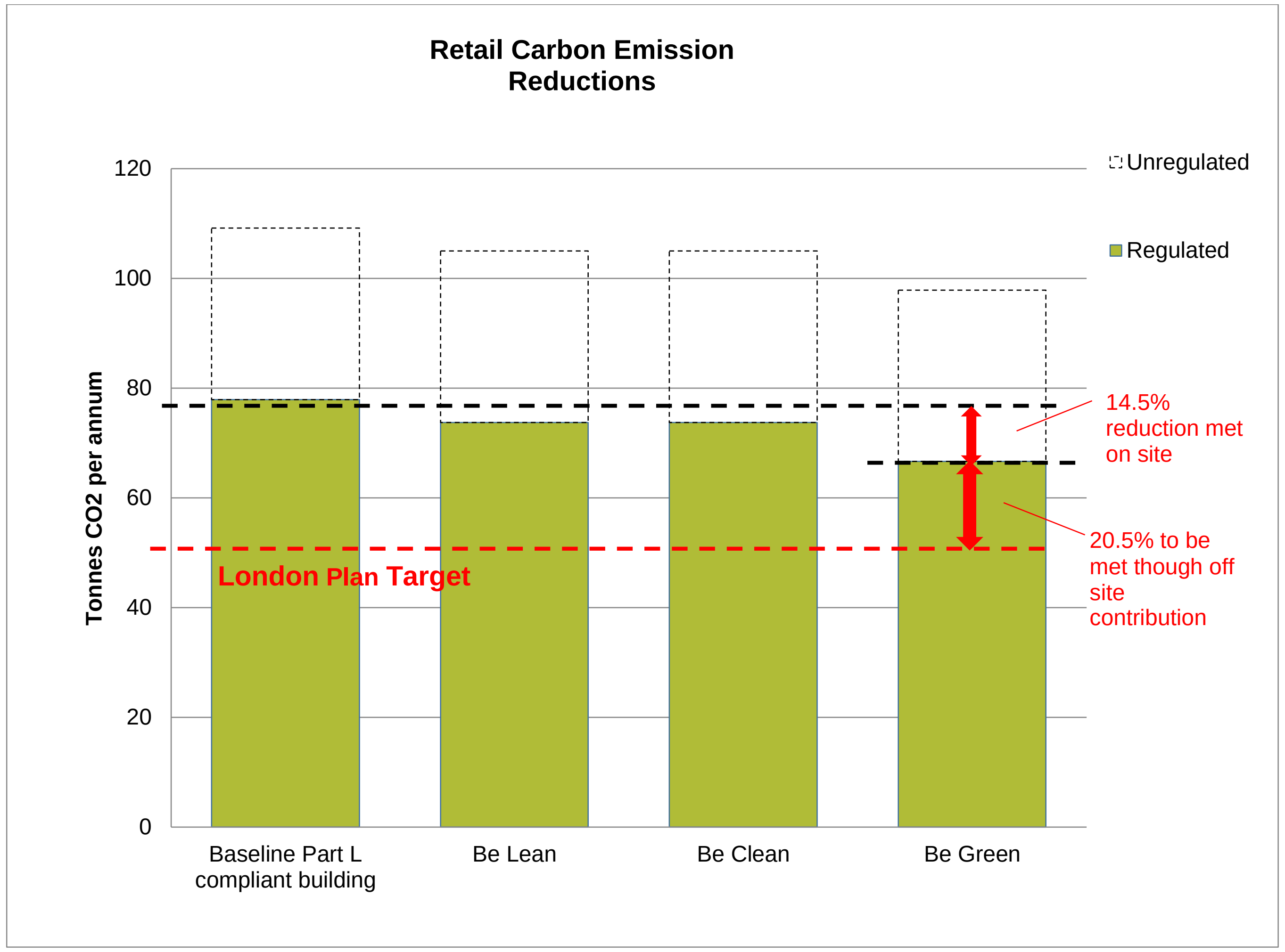


Figure 4: Retail Energy Hierarchy



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2 INTRODUCTION

This energy strategy report has been prepared by Elementa Consulting in support of a planning application for the redevelopment of 150 Holborn which is bound by Holborn to the south, Gray's Inn Road to the West and Brooke Street to the East.

The redevelopment will provide a mix of office accommodation (Class B1), retail floorspace (Class A1-A3), residential units (Class C3) and public realm improvements. The description of development is:

> "*Demolition of existing building and redevelopment for a mixed use development up to 9 storeys in height comprising 14,604 sqm GEA office floorspace (Use Class B1), 1,450 sqm GEA retail floorspace (Use Class A1-A3), 13 residential units (Use Class C3), improvements to the public realm and all other necessary enabling works.*"

In line with the Energy Hierarchy outlined within the GLA guidance on preparing energy assessments, the effects of passive design and energy efficiency measures were first analysed (such as low construction u-values and high air-tightness, the use of energy efficient services, etc.) to understand their effect on the development's annual energy consumption and carbon emissions, to ensure that the development has an energy efficient baseline (**Be Lean**). A summary of these measures is provided within Section 3 'Energy Efficient Building (Be Lean)'.

The next stage of the process was to consider the development's suitability for connection to existing district heat and electricity networks, and to look at the viability of utilising a combined heat and power (CHP) installation to serve the development (**Be Clean**). Refer to Section 4 'District Heating and CHP (Be Clean)' of this report for details of this stage of the assessment.

Various LZC Technology Options were investigated within Section 5 'LZC Technology Options (Be Green)' of this report. A summary of this assessment is provided within Section 5 'LZC Technology Options (Be Green)' of this report.

The final stage of the analysis was to choose the most appropriate LZC Technology Options in order to meet the carbon reductions (**Be Green**). A summary of this assessment is provided within Section 5 of this report.

This report is based on the planning stage information provided by Pringle Brandon Perkins + Will in February 2016.

An aerial view of the existing site is provided below:

Figure 5: Arial View (Not to Scale)

The development has an approximate internal floor area of 17439 m^2.

The glazed area within the Part L energy model for the non-domestic buildings is around 3300 m^2 (51% of the external façade area). The glazed area for the residential buildings is 906 m^2 (31% of the external façade area).

Areas in the energy model may vary from the design and access statement due to NCM modelling protocol, inherent limits to the accuracy of modelling and assumptions used.

2.1 PLANNING CONTEXT

2.1.1 The London plan

Policy 5.2 of the London plan states that non domestic buildings must achieve a 40% improvement on 2010 building regulations, this is an equivalent of 35% from a 2013 building regulations baseline. In this report the proposed development will be compared to a 2013 compliant baseline building and thus the proposal must achieve 35% carbon emission reductions.

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

- **Be Lean**: use less energy
- **Be Clean**: supply energy efficiently
- **Be Green**: use renewable energy

The London Plan also states that:
"The carbon dioxide reduction targets should be met on-site. Where it is clearly demonstrated that the specific targets cannot be fully achieved on-site, any shortfall may be provided off-site or through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere."

The GLA guidance for preparing energy statements and the supplementary planning guidance (spg): sustainable design and construction has been considered in this report.

2.1.2 The London Borough of Camden

The local planning authority is Camden Council.

Policy DP22 Promoting Sustainable Design and Construction

The Council will require developments to incorporate sustainable design and construction measures. Schemes must:

a) Demonstrate how sustainable development principles, including the relevant measures set out in paragraph 22.5 below, have been incorporated into the design and proposed implementation; and
b) Incorporate green or brown roofs and green walls wherever suitable.
c) The Council will promote and measure sustainable design and construction by:
d) expecting new build housing to meet Code for Sustainable Homes Level 3 by 2010 and Code Level 4 by 2013 and encouraging Code Level 6 (zero carbon) by 2016;*
e) expecting developments (except new build) of 500 sq m of residential floor space or above or 5 or more dwellings to achieve "very good" in EcoHomes assessments prior to 2013 and encouraging "excellent" from 2013;
f) Expecting non-domestic developments of 500sqm of floor space or above to achieve "very good" in BREEAM assessments and "excellent" from 2016 and encouraging zero carbon from 2019. The Council will require development to be resilient to climate change by ensuring schemes include appropriate climate change adaptation measures, such as:
g) Summer shading and planting;
h) Limiting run-off;
i) Reducing water consumption;
j) Reducing air pollution; and
k) Not locating vulnerable uses in basements in flood-prone areas

*The code for sustainable homes scheme has been withdrawn. In line with the GLA guidance in preparing energy statements, 35% carbon reductions is applicable to both residential and non-domestic buildings. 35% reduction is slightly above the CfSH level 4 requirement.

For further information on Camden planning policy see Appendix B.

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3 ENERGY EFFICIENT BUILDING (BE LEAN)

The first stage in reducing CO_2 emissions from the development is to reduce the energy required to service the building, through the implementation of passive design and active design measures.

To ensure that 150 Holborn is inherently low in energy use, passive design measures were the initial point of focus. The site is restricted and uses the footprint of an existing building. This does not allow significant flexibility in terms of layout. The focus of the passive design measures are outlined below. For further information regarding passive design measures see the Design and Access Statement.

- Efficient fabric to reduce heating and cooling demand, see table 5 for further information
- A solar shading system that reduces the solar gains in summer.
- Enhanced airtightness that reduces infiltration heat losses.

Active design measures included in the proposed development are outlined below; see tables 4,6-7 for further details.

- Providing energy efficient heating cooling and mechanical ventilation plant;
- Providing energy efficient lighting;
- Providing adequate control of building services systems and lighting systems;
- Providing training to building users to enable them to utilise the building efficiently.

The following tables indicate how this development will reduce the baseline energy consumption required, through the implementation of passive design and energy efficient measures (i.e. Be Lean):

Table 4: Mechanical Services 'Energy Efficient' Measures

Element	Description
Natural Ventilation	Due to poor air quality, see the air quality report for more details, natural ventilation is not a suitable option.
Mechanical Ventilation	Mechanical ventilation with enhanced heat recovery will serve the office, retail and residential areas. Duct sizes will be selected to reduce specific fan power and energy demand.
Mechanical Cooling	Comfort cooling proposed to serve the retail and office areas
Pumps and Motors	Variable speed, variable frequency, variable voltage drives to be provided on all pumps and motors to reduce energy consumption to minimum on variable flow systems.
Metering and Sub-Metering	Use of water, gas and energy metering and direct sub-metering, together with automatic controls to identify area of unusual energy use and optimum operating times and durations. Use of a smart meter. Out of range monitoring and alarms to be provided via automatic control system.

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Table 5: Architectural 'Passive Design' Parameters for commercial and retail

	Element	Part L2A Notional building values	Value Proposed for non-domestic
	Wall U-Value (W/m².K)	0.26	0.15
	Ground Floor U-Value (W/m².K)	0.22	0.13
	Roof U-Value (W/m².K)	0.18	0.13
	External Door U-Value (W/m².K)	-	1.6
	External glazed Door U-Value (W/m².K)	-	1.6
	External glazed Door G-Value	-	0.3
	External glazed Door Light Transmittance	-	0.5
Main facades Floor 2-5	Window U-Value (W/m².K)	1.6	1.4
	Glazing G-Value	40%	34%
	Glazing Light Transmittance	71%	40%
East facades Floor5-7 facing courtyard	Window U-Value (W/m².K)	1.6	1.4
	Glazing G-Value	40%	30%
	Glazing Light Transmittance	71%	40%
Main facades Floor G-1	Window U-Value (W/m².K)	1.6	1.4
	Glazing G-Value	40%	28%
	Glazing Light Transmittance	71%	40%
Floor 8	Window U-Value (W/m².K)	1.6	1.4
	Glazing G-Value	40%	21%
	Glazing Light Transmittance	71%	40%
Rear fascade	Window U-Value (W/m².K)	1.6	1.4
	Glazing G-Value	40%	40%
	Glazing Light Transmittance	71%	40%
Slanted rooflight	Window U-Value (W/m².K)	1.8	1.4
	Glazing G-Value	40%	10% (shading system factor included)
	Glazing Light Transmittance	60%	30%
Slanted rooflight-7th floor	Window U-Value (W/m².K)	1.8	1.4
	Glazing G-Value	40%	8% (shading system factor included)
	Glazing Light Transmittance	60%	30%
Horizontal rooflight over atrium	Window U-Value (W/m².K)	1.8	1.6
	Glazing G-Value	40%	10%(PV system factor included)
	Glazing Light Transmittance	60%	20%
Panel in G,1,6,7th floor	U-Value (W/m².K)	1.8	2.2
	G-Value	40%	10%
	Light Transmittance	60%	10%
	Building Air Permeability (m³/h.m²)	3	3
	External Shading Measures	-	Included in g-value
	Internal shading	-	none
	Thermal massing	-	Thermally heavyweight ceilings 450mm concrete slab

*

Table 6: Mechanical Services 'Energy Efficient' Plant Design Parameters for commercial and retail

Element	Part L2A Minimum Requirements	Typical Value Proposed for Development
Heat Generator Seasonal Efficiency Natural Gas (i.e. boiler)	91%	95%*
Heat Exchanger Efficiency	50%	78% Commercial 70% for Retail
Cooling efficiency ~(EER)	2.5 (EER)	Commercial 6.7/ 10 EER/SEER Comms rooms 3/ 4.5 EER/SEER Retail 4.5/6.5 EER/SEER
Specific Fan Power of Central Ventilation Systems incorporating heating, cooling and heat recovery	2 W/l/s	1.8 W/l/s
Specific Fan Power of Central Ventilation Systems incorporating heating and heat recovery	1.9 W/l/s	1.8W/l/s
Specific Fan Power of Zonal Extract Units (fan is remote from the zone)	0.5W/l/s	0.5W/l/s
Specific Fan Power of kitchen extract, fan remote from zone with grease filter	1 W/l/s	1 W/l/s
Fan coil unit for Offices	0.5W/l/s	0.2W/l/s
Fan coil unit for Retail	0.5W/l/s	0.3W/l/s

*So that improvements from energy efficiency alone can be understood as stipulated by the GLA guidance on preparing energy assessments the 'be lean' case assumes that heating is provided by gas boilers with an efficiency of 91% for non-residential.

Table 7: Electrical Services 'Energy Efficient' System Design Parameters

Element	Part L2A Minimum Requirements	Value Proposed for Development
High Frequency Compact Fluorescent Luminaires	None	Provided throughout
Use of Natural Daylight	None	Average daylight factor to be maximised wherever possible
Daylight Dimming	None	Provided where possible
Lighting Efficiencies – General Lighting	60 luminaire lumens per circuit Watt	≥ 80 luminaire lumens per circuit Watt for Commercial ≥ 70 luminaire lumens per circuit Watt for Retail
Lighting Efficiencies – Display Lighting	22 luminaire lumens per circuit Watt	≥ 40 luminaire lumens per circuit Watt
Power Factor	None	0.95 (to be achieved through use of power factor correction plant, if necessary)
Lifts	None	Lifts to incorporate energy efficient measures (including energy efficient motors, LED lighting and controls)

For information, Table 8 below details the lux level figures and lighting controls proposed, and therefore utilised within the thermal model. It is important to note that the lux levels do not include task lighting and are measured at the floor level, (except in the case of bedrooms, office and restaurant).

Table 8: Assumed Lighting Power Density and Lighting Control Measures

The Proposed Development	Lux level	Lighting Control Proposals
Office	400	Presence detection
Store	100	Presence detection
Plant	250	Presence detection
Circulation	200	Presence Detection
Reception	300	Manual Switching
Toilets	200	Presence Detection
Changing facilities	200	Presence Detection
Retail	600	Manual Switching
Restaurant	150	Manual Switching
Kitchen	500	Manual Switching

Other 'Energy Efficient' Design Measures

In addition to the above energy efficient measures, a comprehensive commissioning programme shall be carried out, and full user training provided to ensure the building users understand how to utilise the building in an energy efficient manner, in accordance with the design intent.

Table 9: Assumptions for the residential development

Element	Value Proposed for Development
Wall U-Value (W/m^2.K)	0.15
Ground Floor U-Value (W/m^2.K)	0.13
Roof U-Value (W/m^2.K)	0.13
Glazing (W/m^2.K)	0.85
Building Air Permeability (m^3/h.m^2)	1
Boiler efficiency	95%*
MVHR heat recovery efficiency	82%
Low energy light fittings	100%

*So that improvements from energy efficiency alone can be understood as stipulated by the GLA guidance on preparing energy assessments the 'be lean' case assumes that heating is provided by gas boilers with an efficiency of 89.5% for residential.

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3.1 ENERGY EFFICIENT BUILDING (BE LEAN) RESULTS

The following tables summarise the percentage improvement from the Part L 2013 compliant development.

Table 10: Residential CO_2 emission reductions due to energy demand reduction measures (Be Lean)

The residential carbon dioxide emissions (Tonnes CO_2 per annum)		
	Regulated	Unregulated
Part L 2013 of the Building Regulations compliant development	14.33	13.19
After energy demand reduction	11.65	13.19
Regulated carbon dioxide savings		
	Tonnes CO_2 per annum	% Improvement
Savings from demand reduction	2.68	18.7%

Table 11: Commercial CO_2 emission reductions due to energy demand reduction measures (Be Lean)

The commercial carbon dioxide emissions (Tonnes CO_2 per annum)		
	Regulated	Unregulated
Part L 2013 of the Building Regulations compliant development	299.28	394.92
After energy demand reduction	238.86	394.92
Regulated carbon dioxide savings		
	Tonnes CO_2 per annum	% Improvement
Savings from demand reduction	60.42	20.2%

Table 12: Retail CO_2 emission reductions due to energy demand reduction measures (Be Lean)

The retail carbon dioxide emissions (Tonnes CO_2 per annum)		
	Regulated	Unregulated
Part L 2013 of the Building Regulations compliant development	77.91	31.24
After energy demand reduction	73.73	31.24
Regulated carbon dioxide savings		
	Tonnes CO_2 per annum	% Improvement
Savings from demand reduction	4.18	5.4%

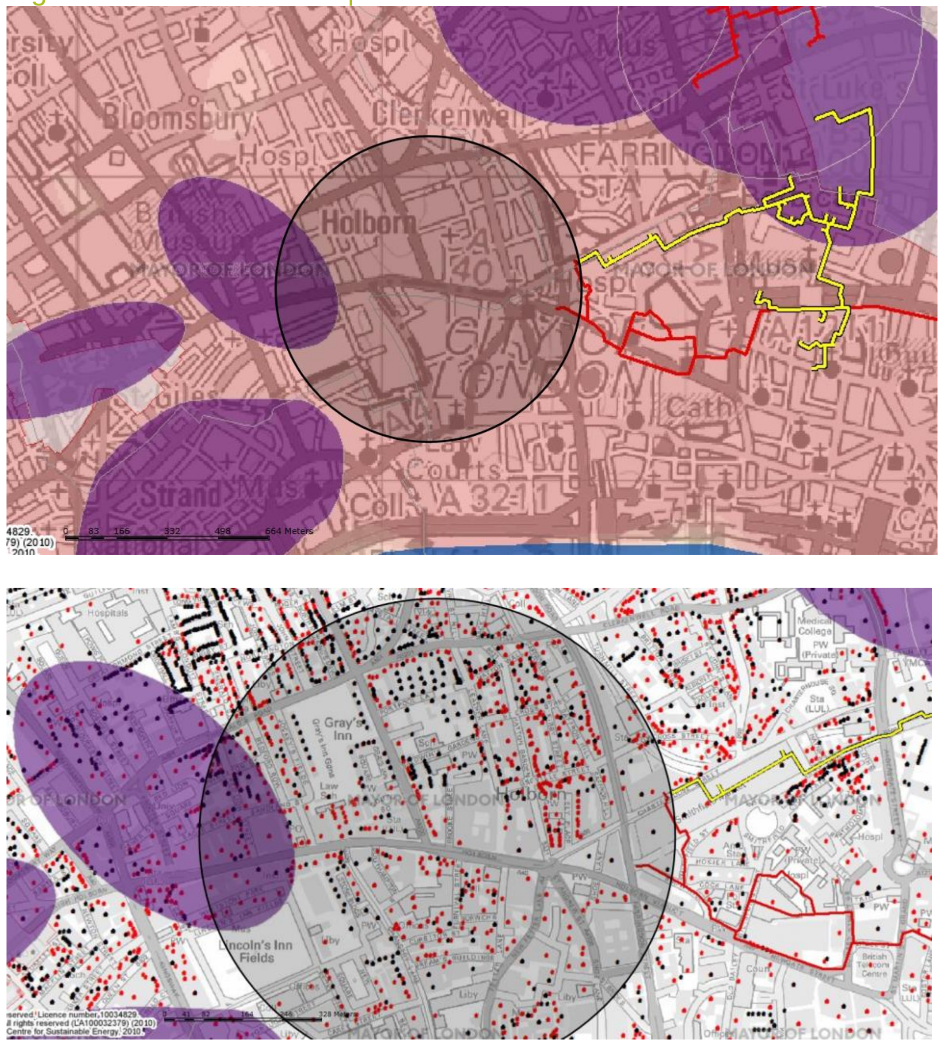
Disclaimer: The results are simulations of energy consumption and do not determine the consumption, emissions or costs of the proposed design after construction. Actual experience will differ from these calculations due to variations such as occupancy, building operation and maintenance, weather, energy use not covered by this standard, changes in carbon intensity of the electricity grid and precision of the calculation tool.

4 DISTRICT HEATING AND CHP (BE CLEAN)

4.1 DISTRICT HEATING NETWORKS

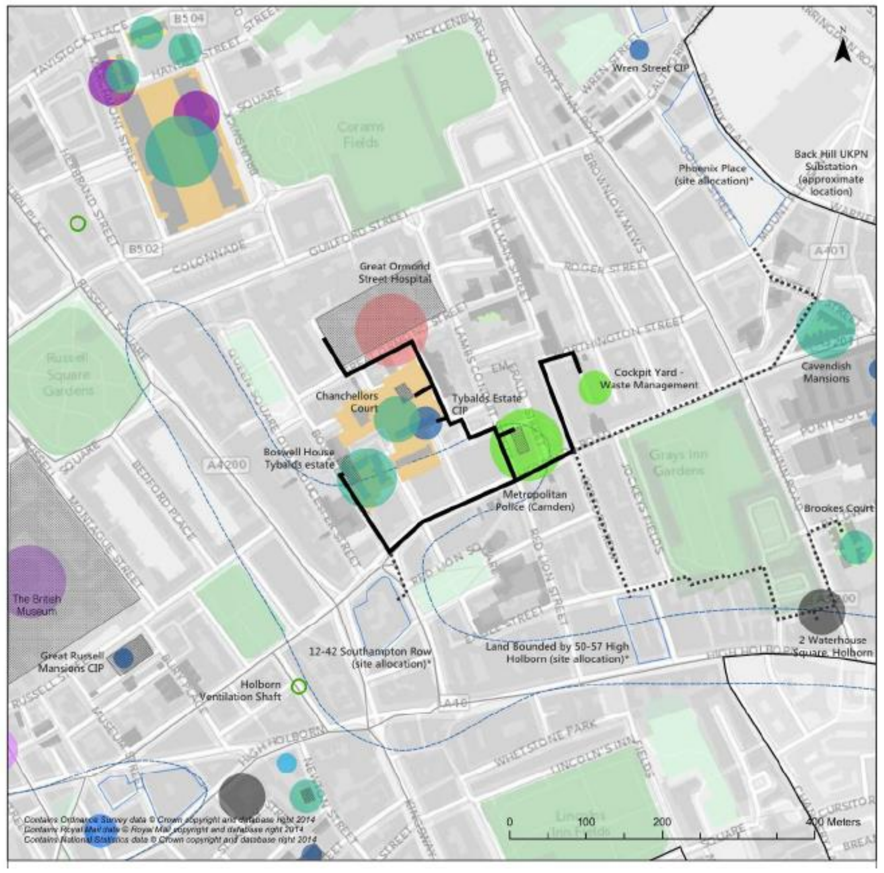
The availability of district heat and electricity networks within the local area was investigated using the London heat map and it was identified that there are no existing networks within 500m for this development to derive power or heat from the capacity or ease of connection.

Figure 6: London Heat Maps



The London heat maps show that there are potential future district heat connections just within 500m. The Camden borough wide heat demand and heat source mapping report identifies future network corridors close to the site.

Figure 7: Borough wide heat demand and heat source mapping- Great Ormond Street decentralised energy network cluster



Contact is currently being made with 2 Waterhouse square regarding plans for a district heating systems and feasibility for connection with 150 Holborn. See appendix F for evidence of communication.

In order to facilitate a future low carbon district heating network, plant space has been made available for future connection and capped connections to the site boundary will be in place, this will enable an easy connection to a future low carbon district heating network.

The plant space has been allowed for a future district heating connection with its associated heat exchangers and pumps. 15 m^2 of plant space has been ring fenced within the central energy centre for the site wide heat network, as illustrated in the diagram below.

Figure 8: Diagram showing plant space allocation for future connection to district heating (Not to Scale)

4.2 SITE WIDE HEAT NETWORK

The commercial and retail units will be served by a single site wide network. The residential unit is on a separate network as the developments have different operating hours.

4.3 CHP

The residential development has fewer than 500 apartments and therefore, CHP is not applicable. This is in line with GLA guidance on preparing energy assessments.

In order for CHP to be considered economically feasible it should run for 5000 hours per year. A typical office is occupied for 253 days a year will have a year round occupancy of 2530 hours. This means that the development will have a simultaneous demand for heat and power for less than 5000 hours per annum and thus CHP is deemed not suitable.

The heating, hot water and electricity results from the energy model confirm this, there is simultaneous electricity and heating demand for around 3000 hours a year. (A heating demand lower than 10 kW is excluded from this calculation since it would be too small to be met by a CHP system.)

Figure 9: Electricity loads

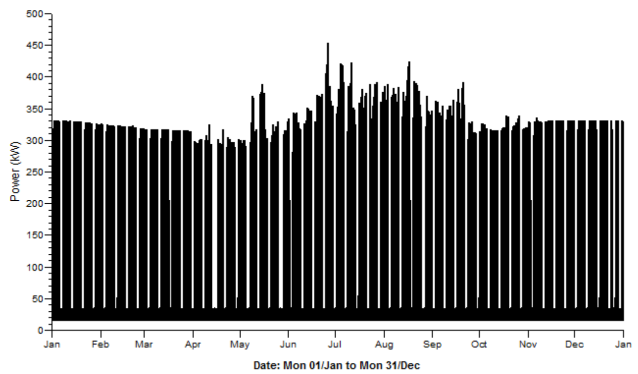
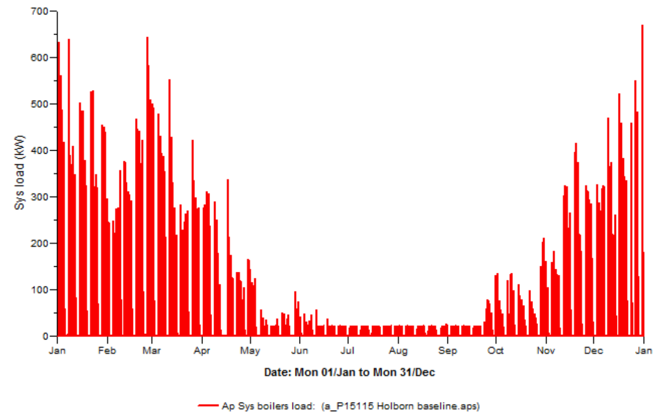


Figure 10: Heating and hot water loads



5 LZC TECHNOLOGY OPTIONS (BE GREEN)

5.1 OVERVIEW

Low and Zero Carbon (LZC) technologies that could be used for this development were evaluated utilising the methodology stipulated within the London Renewables Toolkit.

In the evaluation, carbon dioxide emissions generated by or associated with unregulated uses have not been incorporated into the low or zero carbon (LZC) technology calculations within this report, as this is not a requirement of Part L2 of the Building Regulations, nor is it a requirement for calculations associated with BREEAM.

It is also worth noting that the sizing of any potential LZC technology system needs to be carefully considered, particularly for heat generating technologies. Plant sizing effects energy efficiency, carbon emissions and system reliability for the following reasons:

- As with conventional plant, the efficiency and reliability of renewable energy plant is at its optimum when working at, or close to, its design capacity. For example, a biomass boiler of rated capacity 500kW will not function efficiently and can be expected to give operating problems if asked to work for 75% of the time at 50kW, similarly with CHP.

- The capital cost of renewable energy is generally considerably higher than that of conventional plant. Over-sizing will therefore lead to unnecessarily high capital cost. It is advisable to size heat generating renewable technology to undertake the base load of the building, and to use cheaper, conventional technologies to meet peak loads.

- In view of the dangers of over-sizing as described above, it is better to size renewable energy plant so that it is running at or near to full capacity for the majority of the time, and therefore utilise the conventional plant to meet the fluctuating peak demand.

- The following sections of this report highlight the project specific requirements for each LZC technology that could be used for this development and the carbon emission reductions that could be achieved.

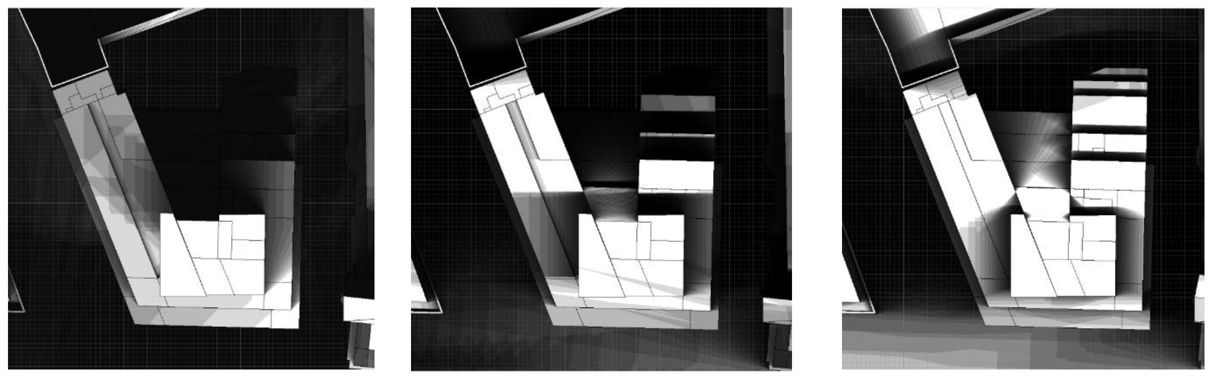
5.2 PHOTOVOLTAICS

The feasibility of Photovoltaics (PV's) has been assessed. The proposed building form creates self-shading and surrounding buildings also create obstructions to solar access, therefore it is important to analyse the shading on the roof of the proposal in order to assess the feasibility of incorporating Photovoltaics.

5.2.1 Shading study

The proposal was modelled in Ecotect Analysis Software to analyse the useable roof area, (i.e. areas of the roof that are not shaded). The images below show the shadow range between 09.00-17.00.

Figure 11: Shading study (Not to Scale)



December 21st March 21st June 21st

This study shows that the roof above the 8th floor is suitable for PV as it remains unshaded throughout the whole year. Most of the other roof spaces are allocated to accessible green roof gardens and are therefore not suitable for PV.

One section on the rear east wing is inaccessible roof space, however the roof is in shade for most of the year, and thus not suitable for PV.

The PV system would be used to generate electricity to contribute towards the developments overall electricity consumption, and exported to the national grid when not required by the building.

5.3 SOLAR THERMAL

Solar thermal technologies generate hot water from the sun's energy through the use of solar collectors. The sun's heat energy is accumulated by the solar cells and then water is pumped through these thus heating the water. The heated water is then stored or distributed for domestic use. These systems tend to be incorporated on to roof space so that they are clear of obstacles (obstructions on the roof can have an effect on the solar array). Demand for domestic hot water from the offices will be minimal on the weekends, whereas there is a consistent demand for electricity. It is more effective to use the available roof space for photovoltaic panels rather than solar thermal panels. Therefore solar thermal panels are not recommended for this proposal.

5.4 GROUND SOURCE HEAT PUMP

Heat pumps use electricity to raise the temperature of water from a heat source, such as the ground, to a suitable level. Ground source heat pumps extract heat from the heat source via plastic piping (ground loops) containing a mixture of water and antifreeze, which is connected to a pump. Ground loops absorb low-grade heat from the heat source, which is delivered to the heat pump. Ground loops can either be horizontal pipes in trenches usually approximately 1.8m below ground (a slinky solution), or a series of boreholes, typically 100m to 150m deep.

Reduced capacity due to existing piles on site means that vertical loop GSHP is not viable as GSHP will only be able to provide a small proportion of the load. Impacts on project program would also be problematic.

5.5 AIR SOURCE HEAT PUMP

An air source heat pump works in a similar manner to a ground source heat pump, except the heat source is ambient air rather than the ground. In lieu of ground loops are fan-assisted heat exchangers, located in locations with a free air supply. Air is driven across the heat exchangers, and heat energy extracted. Like GSHPs, ASHPs can be reversed to provide cooling during summer operation.

There is limited space on the roof for plant. It has been deemed more efficient to install a highly efficient water cooled chillers in the basement with hybrid dry air coolers on the roof, this maximises roof space for solar PV and green roof gardens. Furthermore if heating were to be provided through ASHP, future connection to the district heating would be much more problematic and costly, and would include installation of new pipework. Therefore ASHPs are not recommended.

5.6 BIOMASS HEATING SYSTEM

Biomass is the burning of any plant-derived organic material (such as wood) that renews itself over a short period to generate energy. This fuel type is usually used for heating.
Since the CO_2 released during the burning process is offset by the CO_2 absorbed during the life of the biomass source, biomass is considered to be close to carbon neutral.
Typically a biomass system will burn wood in either a chip or pellet form instead of the conventional gas system. Biomass can save large amounts of carbon at a relatively low capital cost.

The combustion of biomass will lead to a degradation of air quality, not appropriate to the location of the project within an area of poor air quality. Furthermore the delivery and storage of fuel may cause significant issues of access and storage on a constrained site, therefore biomass is deemed not feasible.

5.7 WIND TURBINES

Wind turbines convert the kinetic energy of the wind into rotational mechanical energy using an aerodynamic rotor. This is then converted into electrical energy via a generator. There are two types of wind turbine available, smaller units which are roof mounted or fixed to the building, and larger free standing turbines. Due to the urban nature of the site, wind speeds are relatively low and the wind is turbulent reducing the efficiency of the turbines. Therefore it is deemed that wind turbines are not suitable for this development.

5.8 LZC CONCLUSIONS

The results of the Low and Zero Carbon (LZC) technologies analysis show PV is the most appropriate low and zero carbon technology that can contribute to meeting the development's carbon reduction targets.

Table 13: LZC Technology Feasibility

LZC Technology	Technically Feasible	Recommended	Notes
Hydrogen Technology	No	No	Technology not yet economically viable
Tri-Generation	No	No	Structural limitations, height issues
CHP	Yes	No	Not enough year round load to be viable
ASHP	Yes	No	Roof space constraints
PV	Yes	Yes	Recommended for this site
GSHP	Yes	No	Reduced capacity due to existing piles and significant program issues
Wind Power	No	No	Not viable due to the urban nature of the development
Solar thermal	Yes	No	Roof area utilised by solar thermal panels would be more effectively utilised by PV panels
Biomass	No	No	Biomass heating will exacerbate the air quality issues of the site

5.8.1 Roof space allocation

It is understood from discussions with Camden Council, it is preferable that accessible roof spaces are utilised as roof terraces, with inaccessible unshaded roof spaces to be utilised for PVs and inaccessible shaded roof spaces be used as green roofs.
This approach has been followed in the proposed development, see the figure below that explains the roof strategy

Figure 12: Roof space allocation (Not to Scale)

The above figure shows that only the roof area of the pavilion on the 8th floor is available for PV.

Table 14: Maximum area of PV on the roof

Section of roof	Total area available (m^2)	Layout Factor	Area of PV panels (m^2)
PV integrated glazing	207	0.4	82.8
Flat roof above 8th floor	178	0.7	124.6
Total	385		207.4

5.9 RENEWABLE ENERGY (BE GREEN) RESULTS

The following energy consumption and carbon emission figures for the chosen combination of the LZC Technologies have been derived:

Table 15: Residential carbon dioxide emission reductions due to energy demand reduction measures and renewables (Be Green)

The residential carbon dioxide emissions (Tonnes CO_2 per annum)		
	Regulated	Unregulated
Part L 2013 of the Building Regulations compliant development	14.33	13.19
After energy demand reduction	11.65	13.19
After renewable energy	9.28	13.19
Regulated carbon dioxide savings		
	Tonnes CO_2 per annum	% Improvement
Savings from demand reduction	2.68	18.7%
Savings from renewable energy	2.37	20.3%
Cumulative savings	5.05	35.2%

Table 16: Commercial carbon dioxide emission reductions due to energy demand reduction measures and renewables (Be Green)

The commercial carbon dioxide emissions (Tonnes CO_2 per annum)		
	Regulated	Unregulated
Part L 2013 of the Building Regulations compliant development	299.28	394.92
After energy demand reduction	238.86	394.92
After renewable energy	230.43	394.92
Regulated carbon dioxide savings		
	Tonnes CO_2 per annum	% Improvement
Savings from demand reduction	60.42	20.2%
Savings from renewable energy	8.43	3.5%
Cumulative savings	68.85	23.0%

Table 17: Retail carbon dioxide emission reductions due to energy demand reduction measures and renewables (Be Green)

The retail carbon Dioxide emissions (Tonnes CO_2 per annum)		
	Regulated	Unregulated
Part L 2013 of the Building Regulations compliant development	77.91	31.24
After energy demand reduction	73.73	31.24
After renewable energy	66.62	31.24
Regulated carbon dioxide savings		
	Tonnes CO_2 per annum	% Improvement
Savings from demand reduction	4.18	5.4%
Savings from renewable energy	7.11	9.6%
Cumulative savings	11.29	14.5%

The estimated unregulated load energy consumption and carbon dioxide emission figures have been extracted from the thermal model (based on pre-defined NCM database figures), and should not be used to try and estimate actual buildings unregulated energy consumption, as these loads are highly variable and predominately determined by the building user. See table below.

Table 18: Estimated Unregulated Load Consumption and Emission Figures

Annual Energy Consumption (total kWh per year)	Annual Energy Consumption (kWh/m^2 per year)	Annual Carbon Dioxide Emissions (total kgCO_2 per year)	Annual Carbon Dioxide Emissions (kgCO_2/m^2 per year)
846,522	51.89	439,345	26.93

It is understood from discussions with Camden Council, it is preferable that accessible roof spaces are utilised as roof terraces, with inaccessible unshaded roof spaces to be utilised for PVs and inaccessible shaded roof spaces be used as green roofs. In line with this guidance, the majority of the roof space will be an accessible green roof terrace.

It has been calculated that 207 m^2 of PV will fit on the developments inaccessible unshaded roof space. This will generate approximately 31.8 MWh of electricity per annum, using best in class efficient PV panels (21.5% nominal efficiency).

This brings the development to 21.8% carbon emission reductions. The remaining 14.2% of carbon emission reductions needed to achieve the 35% carbon emission reductions will be met off-site or through a cash-in-lieu contribution to Camden Council to be ring fenced to secure delivery of carbon dioxide savings elsewhere.

The results and conclusions documented above demonstrate that through the implementation of passive design and energy efficiency measures, and through the provision of photovoltaics the CO_2 reductions will enable the development to:

- Meet the requirements of Part L2A of the Building Regulations (2013 version 5.2.b.1) for the commercial and retail sections of the development.
- Meet the requirements of Part L1A of the Building Regulations for the residential sections of the development.
- Satisfy local planning policy requirements stipulated by London Borough of Camden
- Comply with the London Plan – 35% carbon reductions beyond Part L 2013 of the building regulations
- Achieve 8 No. credits for Ene 01 under BREEAM 2014 fulfils minimum criteria for Ene 01 BREEAM excellent and BREEAM outstanding.

Disclaimer: The results are simulations of energy consumption and do not determine the consumption, emissions or costs of the proposed design after construction. Actual experience will differ from these calculations due to variations such as occupancy, building operation and maintenance, weather, energy use not covered by this standard, changes in carbon intensity of the electricity grid and precision of the calculation tool.

6 COOLING AND OVERHEATING

Policy 5.9 in the London Plan addresses overheating and cooling. Major development proposals should reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the following cooling hierarchy:

1) Minimise internal heat generation through energy efficient design.
2) Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls.
3) Manage the heat within the building through exposed internal thermal mass and high ceilings.
4) Passive ventilation.
5) Mechanical ventilation.
6) Active cooling systems (ensuring they are the lowest carbon options).

1) Internal heat generation has been minimised though the use of energy efficient lighting and appliances. Heat loss of the heat distribution infrastructure is minimised by increased insulation.

2) The amount of heat entering the building in summer has been reduced by installing fixed vertical shading louvres on the main facades.

   A fixed external shading device will be installed above the sloped glazed roof to the rear.

3) The benefits of thermal mass are utilised in this proposal, concrete soffits will be exposed at ceiling level.

4) Passive ventilation is not an option due to air quality and noise pollution, see air quality report for further details.

5) Mechanical ventilation is provided to the residential areas

6) Active cooling will be provided to the commercial and retail areas, the majority of the cooling will be delivered though passive chilled beams or radiant surfaces, which are seen as one of the lowest carbon methods of delivering cooling. Fan coil units will only be used when thermal loads are too high for the operation of passive radiant systems, for example in meeting rooms. Highly efficient water cooled chillers will be utilised.

The cooling demand for the zones that are cooled are shown below, this is taken from the BRUKL document.

Table 19: Cooling Demand

Room	Cooling demand – Actual Building (MJ/m^2)	Cooling demand – Notional Building (MJ/m^2)
Office- passive chilled beams	85.5	103.9
Office- meeting rooms	69.9	106.8
Office- below glazed roof	51.1	78.2
Retail	90.2	146.6

The cooling demand is lower in the actual building than the notional building in all of the spaces.

6.1 TM 52 OVERHEATING ANALYSIS OF RESIDENTIAL UNITS

Overheating analysis has been carried out to the residential units. In line with SPG (par 3.2.3) guidance dynamic thermal modelling has been undertaken to assess the overheating risk. In line with GLA guidance on preparing energy assessments, overheating analysis has been carried out using TM52 methodology. The overheating analysis has been carried out using three Design Summer year weather files;

1976: a year with a prolonged period of sustained warmth
1989: a moderately warm summer (current design year for London)
2003: a year with a very intense single warm spell

The 1989 is the current DSY file that is used in overheating analysis and currently has a return period of nine years, (there is a one in nine chance of a summer as warm or warmer than the 1989 DSY weather file.) The 1989 DSY weather file was therefore used to inform whether cooling will need to be installed in the residential units or not.

The analysis also included the 1976 and 2003 DSY weather files, however as recommended by TM29: Design summer years for London, they were used to investigate the sensitivity of the design to different weather conditions.

The flats that had the highest overheating risk were modelled. The top duplex flats on floors 5 and 6, and all of the flats on floor 4 were tested. These flats are seen as worst case in terms of overheating risk, as they are at the top of the residential block, this means that they receive more solar radiation than the lower flats, as they receive less shading from the surrounding buildings.

All of the occupied spaces of the modelled flats were found to pass the TM52 overheating criteria using the 1989 DSY weather file, it is therefore deemed that all of the flats will pass the overheating criteria and thus no active cooling is necessary in the residential development.

Some of the spaces failed the TM52 overheating criteria using the 1976 DSY and 2003 DSY weather files. This overheating analysis was carried out to investigate the sensitivity of the design to different weather conditions. These weather files currently have return periods of 27 and 19 years respectively. This analysis shows that in extremely hot years, (estimated to occur only every 19 years or so) the residential units will experience overheating. These conditions are rare and it is concluded that presently it is unnecessary to provide active cooling for such events. However, to provide additional resilience to the uncertain impacts of future climate change, and to meet the needs of user groups that are more vulnerable to the impacts of overheating, consideration will be given to how cooling could be provided to residential units at a later date.

See Appendix E for the full report.

7 SUSTAINABLE DESIGN AND CONSTRUCTION

Policy 5.3 of the London plan considers sustainable design and construction. The highest standards of sustainable design and construction should be achieved in London to improve the environmental performance of new developments and to adapt to the effects of climate change over their lifetime.

Sustainable design standards are integral to the proposal, including its construction and operation, and have been considered at the beginning of the design process. The following sustainable design principles have been included in the development.

- Carbon dioxide emissions across the site, including the building and services.
- Internal overheating and contributing to the urban heat island effect have been minimised.
- Natural resources are used efficiently. Gas and electricity usage has been minimised.
- Pollution (including noise, air and urban runoff) is minimised.
- The generation of waste is minimised and reuse or recycling is maximised.
- Impacts from natural hazards (including flooding) are avoided.
- It will be ensured that the development is comfortable and secure for users.
- Sustainable procurement of materials, using local supplies where feasible will be secured.
- Biodiversity is promoted and protected and green infrastructure is encouraged.

For details on how the above principles have been included in the development please see the Sustainability Report.

8 BREEAM 2014 – ENE 01 CREDIT ANALYSIS

The screenshot below has been taken from the BREEAM 2014 ‘Technical Manual’ and demonstrates the guidance for achieving the credits for Ene 01:

Ene 01 Reduction of energy use and carbon emissions

Number of credits available	Minimum standards
12	Yes

Aim

To recognise and encourage buildings designed to minimise operational energy demand, primary energy consumption and CO_2 emissions.

Assessment criteria

The following is required to demonstrate compliance:

Up to twelve credits - Energy performance

1. Calculate an Energy Performance Ratio for New Constructions (EPR_{NC}). Compare the EPR_{NC} achieved with the benchmarks in Table - 24 and award the corresponding number of BREEAM credits.

Table - 24: Ene 01 EPR_{NC} benchmark scale

BREEAM credits	EPR_{NC}	Minimum standards
1	0.075	Requires a performance improvement progressively better than the relevant national building regulations compliant standard (See Other information).
2	0.15	
3	0.225	
4	0.30	
5	0.375	Excellent
6	0.45	
7	0.525	

BREEAM credits	EPR_{NC}	Minimum standards
8	0.60	Outstanding
9	0.675	
10	0.75	
11	0.825	
12	0.90	Zero net regulated CO_2 emissions.

The table below has been reproduced from information contained within the BRUKL Output Document. This combines the commercial and the retail BRUKL outputs and is based on the Be Green models.

Table 20: ENE01 Proposed Development

Key Performance Indicator	Ene 01 Output
Building Floor Area (m^2)	15,445
Notional Building Energy Demand (MJ/m^2/annum)	100.23
Actual Building Energy Demand (MJ/m^2/annum)	91.84
Notional Building Primary Energy (kWh/m^2/annum)	139.86
Actual Building Primary Energy (kWh/m^2/annum)	118.68
Target Emissions Rate, TER ($kgCO_2/m^2$.annum)	24.42
Building Emissions Rate, BER ($kgCO_2/m^2$.annum)	19.23
Building Improvement Over TER, %	21.25%*
Demand Energy Performance Ratio, EPR	0.15
Consumption Energy Performance Ratio, EPR	0.25
CO_2 Energy Performance Ratio, EPR	0.24
Overall Energy Performance Ration, EPR_{NC}	0.64
Total BREEAM 'Ene 01' Credits Achievable	8
Total BREEAM Innovation Credits Achieved	0

To summarise, at least 8 **No. credits** could be achieved for credit reference Ene 01.

As the EPR_{NC} is above 0.6 therefore the minimum requirement for BREEAM Outstanding is also satisfied.

* The Building improvement over TER is calculated using the TER of the Be Green model as a baseline, rather than using the TER from the Be Lean model, that is used as a baseline when calculating the carbon reduction for GLA compliance.

Disclaimer: The results are simulations of energy consumption and do not determine the consumption, emissions or costs of the proposed design after construction. Actual experience will differ from these calculations due to variations such as occupancy, building operation and maintenance, weather, energy use not covered by this standard, changes in carbon intensity of the electricity grid and precision of the calculation tool.

9 BREEAM 2014 – ENE 04 CREDIT ANALYSIS

The screenshot below has been taken from the BREEAM 2014 'Technical Manual', and demonstrates the guidance for achieving the first credit for Ene 04:

Ene 04 Low carbon design

Number of credits available	Minimum standards
3	No

Aim

To encourage the adoption of design measures, which reduce building energy consumption and associated carbon emissions and minimise reliance on active building services systems.

Assessment criteria

This issue is split into two parts:

- Passive design (2 credits)
- Low or zero carbon technologies (1 credit).

The following is required to demonstrate compliance.

Passive design

One credit - Passive design analysis

1. The first credit within issue Hea 04 Thermal comfort has been achieved to demonstrate the building design can deliver appropriate thermal comfort levels in occupied spaces.
2. The project team carries out an analysis of the proposed building design/development by Concept Design stage (RIBA Stage 2 or equivalent) to identify opportunities for the implementation of passive design solutions that reduce demands for energy consuming building services (see Compliance note 2).
3. The building uses passive design measures to reduce the total heating, cooling, mechanical ventilation and lighting demand in line with the findings of the passive design analysis and the analysis demonstrates a reduction in the total energy demand as a result.

One credit - Free cooling

4. The passive design analysis carried out under criterion 2 above includes an analysis of free cooling and identifies opportunities for the implementation of free cooling solutions.
5. The building uses ANY of the free cooling strategies listed in Compliance note CN3 to reduce the cooling energy demand, i.e. it does not use active mechanical cooling.

Low and zero carbon technologies

One credit - Low zero carbon (LZC) feasibility study

6. A feasibility study has been carried out by the completion of the Concept Design stage (RIBA Stage 2 or equivalent) by an energy specialist (see Compliance notes) to establish the most appropriate recognised local (onsite or near-site) low or zero carbon (LZC) energy source(s) for the building/development (see Compliance note CN6).
7. A ocal LZC energy technology/technologies has/have been specified for the building/development in line with the recommendations of this feasibility study.

The table below summarises the location of the requested evidence within this report in order to obtain the first credit available under Ene 04:

Table 21: ENE04 Proposed Development

1.	See 'Section 5 'of this report for details of energy generated from LZC Technology Source
2.	Lifecycle costs required to gain the BREEAM credits are provided within Appendix D of this report.
3.	A summary of local planning requirements is included within Appendix B of this report, and is also summarised within "Section 1 – Executive Summary".
4.	Details of exporting heat/electricity for the specified LZC technology are included within "Section 5 – LZC Technology Options (Be Green)" of this report, under the relevant technology.
5.	Details of available grants for the specified LZC technology are included within "Section 5 - LZC Technology Options (Be Green)" of this report under the relevant technology, and within Appendix C.
6.	The table within "Section 5" provides a summary of which LZC technologies are feasible for this site.
7.	The table within "Section 5" provides a summary of which LZC technologies which are not feasible for this site, and why they have been rejected.
8.	Possibilities relating to district heat and electricity networks and the potential to install a CHP have been assessed in the "Section 4 - District Heating and CHP (Be Clean)" of this report
9.	It is the responsibility of the main contractor to provide evidence that the recommendations of this report have been implemented
10.	This feasibility study has been carried out during RIBA Stage 2 (see 'Document Control' section of this report.

The tables within Section 5 of this report demonstrate that a local low and zero carbon (LZC) technology has been specified for the development in line with the recommendations of this feasibility study. Therefore at least **1 No. credit** could be achieved for credit reference Ene 04.

10 APPENDICES

10.1 APPENDIX A – THERMAL MODELLING METHODOLOGY

INTRODUCTION

Appendix A has been provided to supplement this report in respect of the reduction of energy usage and carbon emissions through the use of passive design, energy efficiency measures and renewable energy measures, in line with methodology detailed within the London Plan.

For information, please find details relating to the accredited energy assessor and the dynamic simulation software utilised to generate this report:

Dynamic Simulation Software	-	IES Version 7.0.2.0
Energy Assessor	-	Adeel Ahmed of Elementa Consulting Ltd.
Energy Assessors Accreditation Body	-	CIBSE
Energy Assessors Accreditation Number	-	LCEA125791
Energy Assessor Status	-	Level 3, Level 4 and Level 5 EPC and DEC
Energy Assessor Qualifications	-	BEng, MSc, CIBSE Low Carbon Consultant

METHODOLOGY

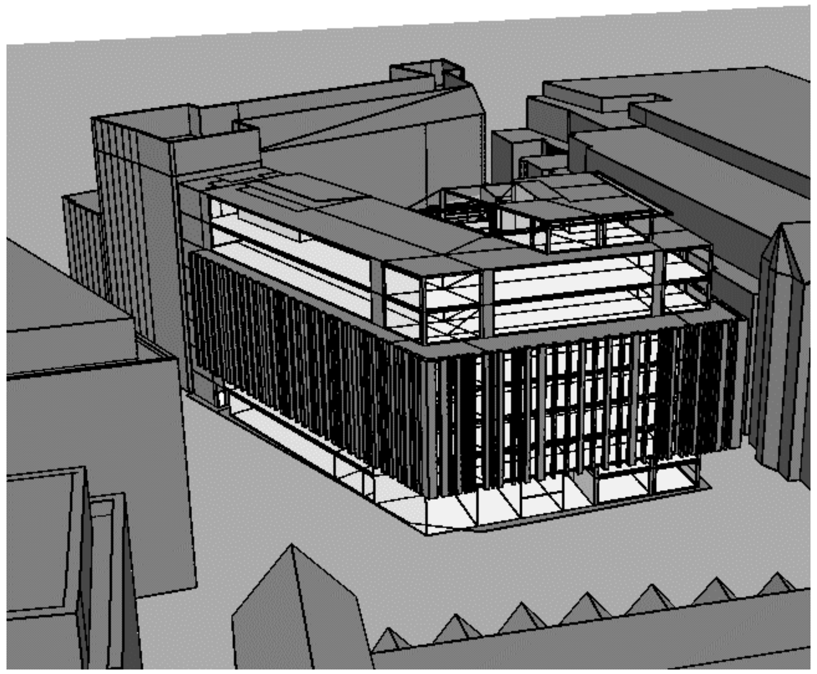
IES Virtual Environment software, provided by Integrated Environmental Solutions (IES) version 7.0.2.0 has been used and is accredited for use in demonstrating compliance with Building Regulations L2A, and the production of Energy Performance Certificates in accordance with the National Calculation Method (NCM). This software is accredited for level 3 to 5 assessments. The complexity of this project requires the use of Level 5.

The process of producing the thermal model and generating the required output is summarised below:

BUILDING GEOMETRY

A three dimensional computer model of the building is 'constructed' to represent the building geometry. IES is able to represent complex room shapes, external shading features and shading from other buildings, correct orientation and geographical placement etc:

A 3D image of the proposed development is shown below:



CONSTRUCTION ELEMENTS

Thermal elements are defined in IES and are specified by inputting each layer of the construction as an element. IES is able to take account of thermal mass of buildings, and calculates heating and cooling demands accordingly.

NCM TEMPLATES

Each space defined within the model has an associated internal template. The space is firstly defined by type (e.g. occupied and heated, unoccupied and unheated, buffer space (e.g. an unheated garage), etc.). Occupied spaces are then assigned NCM templates which have the following fixed parameters:

- Patterns of heat gain from lighting, occupancy and other sources such as small power
- Heating, cooling and humidity control settings
- Domestic hot water usage rate
- Ventilation rate
- Lighting level

Lighting levels are inputted per zone, and lighting efficacy is input as luminaire lumens per circuit-watt in order for improvements in lighting efficacy to be taken into account. Controls such as PIRs and daylight compensation can also be taken into account.

SYSTEM DESCRIPTION

The user then specifies building specific data for the systems such as:

- Extent of servicing (heating only, heating with mechanical ventilation, heating and cooling, etc.)
- The system efficiencies associated with the anticipated installations of heating, cooling and domestic hot water
- Controls for heating, cooling and domestic hot water
- Specific fan power and heat recovery efficiency of mechanical ventilation where appropriate

OTHER INPUTS

IES requires other building data to be input, which includes:

- Air permeability. This relates to how well sealed the building is and is expressed in m3/m2/hour@50Pa
- The appropriate NCM weather data file. The nearest weather data file must be used and is known as the Test Reference Year (TRY). It contains data relating to a "typical" weather year for that location.
- Details of whether metering, sub-metering and out-of-range monitoring and alarms are to be installed
- Whether power factor correction is to be installed within the building.

ACTUAL AND NOTIONAL / TARGET BUILDING MODELS

The user inputs all the above information into the model to produce the "actual" building model. From this, IES creates the notional/target building model which will be used to benchmark the actual building against. The building emission rate (BER) from the actual building must be lower than that of the target emission rate (TER) from the notional/target building, in order to satisfy Criterion 1 of Part L2A of the Building Regulations.

The notional/target building is the same size and shape as the actual building and contains the same rooms and servicing strategies (i.e. where rooms are "heated only" in the actual building, they are "heated only" in the notional/target building). User input parameters such as system efficiencies and controls,

elementa
Member of Integral Group

constructions, glazing parameters, air infiltration rates, etc. are set to standard defaults in order to calculate the TER.

BUILDING REGULATIONS CARBON / ENERGY CALCULATIONS

Appended to this report are 4 No. BRUKL output documents (i.e. Part L2A calculations) and 4 No sample SAP calculations.

The first BRUKL calculation demonstrates the TER and BER for the energy efficient building ('Be Lean' building); i.e. the building incorporating all proposed passive design and energy efficient measures, but excluding any renewable or LZC technologies (i.e. photovoltaics) for the commercial development.

The second BRUKL calculation demonstrates the TER and BER for the actual building ('Be Lean, Clean and Green' building); i.e. the building incorporating all proposed passive design and energy efficient measures, and including the recommended renewable or LZC technology (i.e. photovoltaics) for the commercial development.

The third BRUKL calculation demonstrates the TER and BER for the energy efficient building ('Be Lean' building); i.e. the building incorporating all proposed passive design and energy efficient measures, but excluding any renewable or LZC technologies (i.e. photovoltaics) for the retail development.

The fourth BRUKL calculation demonstrates the TER and BER for the actual building ('Be Lean, Clean and Green' building); i.e. the building incorporating all proposed passive design and energy efficient measures, and including the recommended renewable or LZC technology (i.e. photovoltaics) for the retail development.

The first SAP calculation demonstrates the TER and BER for the energy efficient building ('Be Lean' building); i.e. the building incorporating all proposed passive design and energy efficient measures, but excluding any renewable or LZC technologies (i.e. photovoltaics) for the residential development- top flat.

The second SAP calculation demonstrates the TER and BER for the actual building ('Be Lean, Clean and Green' building); i.e. the building incorporating all proposed passive design and energy efficient measures, and including the recommended renewable or LZC technology (i.e. photovoltaics) for the residential development- top flat

The third SAP calculation demonstrates the TER and BER for the energy efficient building ('Be Lean' building); i.e. the building incorporating all proposed passive design and energy efficient measures, but excluding any renewable or LZC technologies (i.e. photovoltaics) for the residential development- mid floor flat.

The fourth SAP calculation demonstrates the TER and BER for the actual building ('Be Lean, Clean and Green' building); i.e. the building incorporating all proposed passive design and energy efficient measures, and including the recommended renewable or LZC technology (i.e. photovoltaics) for the residential development- mid floor flat.

10.2 APPENDIX B – PLANNING POLICY DOCUMENTS

The energy strategy proposals have been developed in accordance with the relevant national, regional and local policy guidance which is reviewed within this section. Reference has been made to the London Renewables Toolkit (LRT) calculation methodology, which meets most Council's stipulated outline planning requirements. This energy strategy proposal has therefore been produced with due regard to the following key policy guidance:

PPS22 – RENEWABLE ENERGY (USED FOR REFERENCE ONLY)

PPS 22 (2004) states that local development documents should contain policies designed to promote and encourage, rather than restrict, the development of renewable energy resources.

THE LONDON PLAN – SPATIAL DEVELOPMENT STRATEGY FOR GREATER LONDON 2014 (USED FOR REFERENCE ONLY)

The London Plan provides a competitive strategy, and if properly supported by adequate public investment, economic growth will help to pay for the many improvements in services, transport and the environment that are needed, resulting in improved the quality of life. Some of the key policies are:

POLICY 5.1 CLIMATE CHANGE MITIGATION (USED FOR REFERENCE ONLY)

The Mayor seeks to achieve an overall reduction in London's carbon dioxide emissions of 60 per cent (below 1990 levels) by 2025. It is expected that the GLA Group, London boroughs and other organisations will contribute to meeting this strategic reduction target, and the GLA will monitor progress towards its achievement annually.

Within LDFs boroughs should develop detailed policies and proposals that promote and are consistent with the achievement of the Mayor's strategic carbon dioxide emissions reduction target for London.

POLICY 5.2 MINIMISING CARBON DIOXIDE EMISSIONS (USED FOR REFERENCE ONLY)

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

- Be lean: use less energy
- Be clean: supply energy efficiently
- Be green: use renewable energy

The Mayor will work with boroughs and developers to ensure that major developments meet the targets for carbon dioxide emissions reduction in buildings. These targets are expressed as minimum improvements over the Target Emission Rate (TER) outlined in the national Building Regulations leading to zero carbon residential buildings from 2016 and zero carbon non-domestic buildings from 2019.

Major development proposals should include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction outlined above are to be met within the framework of the energy hierarchy.

As a minimum, energy assessments should include the following details:

- Calculation of the energy demand and carbon dioxide emissions covered by Building Regulations and, separately, the energy demand and carbon dioxide emissions from any other part of the development, including plant or equipment, that are not covered by the Building Regulations (see paragraph 5.22) at each stage of the energy hierarchy
- Proposals to reduce carbon dioxide emissions through the energy efficient design of the site, buildings and services
- Proposals to further reduce carbon dioxide emissions through the use of decentralised energy where feasible, such as district heating and cooling and combined heat and power (CHP)
- Proposals to further reduce carbon dioxide emissions through the use of on-site renewable energy technologies.

The carbon dioxide reduction targets should be met on-site. Where it is clearly demonstrated that the specific targets cannot be fully achieved on-site, any shortfall may be provided off-site or through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere.

POLICY 5.3 SUSTAINABLE DESIGN AND CONSTRUCTION (USED FOR REFERENCE ONLY)

The highest standards of sustainable design and construction should be achieved in London to improve the environmental performance of new developments and to adapt to the effects of climate change over their lifetime.

Development proposals should demonstrate that sustainable design standards are integral to the proposal, including its construction and operation, and ensure that they are considered at the beginning of the design process.

Major development proposals should meet the minimum standards outlined in the Mayor's supplementary planning guidance and this should be clearly demonstrated within a design and access statement. The standards include measures to achieve other policies in this Plan and the following sustainable design principles:

- Minimising carbon dioxide emissions across the site, including the building and services (such as heating and cooling systems)
- Avoiding internal overheating and contributing to the urban heat island effect
- Efficient use of natural resources (including water), including making the most of natural systems both within and around buildings
- Minimising pollution (including noise, air and urban runoff)
- Minimising the generation of waste and maximising reuse or recycling
- Avoiding impacts from natural hazards (including flooding)
- Ensuring developments are comfortable and secure for users, including avoiding the creation of adverse local climatic conditions
- Securing sustainable procurement of materials, using local supplies where feasible, and
- Promoting and protecting biodiversity and green infrastructure.

Within LDFs boroughs should consider the need to develop more detailed policies and proposals based on the sustainable design principles outlined above and those which are outlined in the Mayor's supplementary planning guidance that are specific to their local circumstances.

POLICY 5.4 RETROFITTING (USED FOR REFERENCE ONLY)

The environmental impact of existing urban areas should be reduced through policies and programmes that bring existing buildings up to the Mayor's standards on sustainable design and construction. In particular, programmes should reduce carbon dioxide emissions, improve the efficiency of resource use (such as water) and minimise the generation of pollution and waste from existing building stock.

Within LDFs boroughs should develop policies and proposals regarding the sustainable retrofitting of existing buildings. In particular they should identify opportunities for reducing carbon dioxide emissions from the existing building stock by identifying potential synergies between new developments and existing buildings through the retrofitting of energy efficiency measures, decentralised energy and renewable energy opportunities (see Policies 5.5 and 5.7).

POLICY 5.5 DECENTRALISED ENERGY NETWORKS (USED FOR REFERENCE ONLY)

The Mayor expects 25 per cent of the heat and power used in London to be generated through the use of localised decentralised energy systems by 2025. In order to achieve this target the Mayor prioritises the development of decentralised heating and cooling networks at the development and area wide levels, including larger scale heat transmission networks.

Within LDFs boroughs should develop policies and proposals to identify and establish decentralised energy network opportunities. Boroughs may choose to develop this as a supplementary planning document and work jointly with neighbouring boroughs to realise wider decentralised energy network opportunities. As a minimum boroughs should:

- Identify and safeguard existing heating and cooling networks
- Identify opportunities for expanding existing networks and establishing new networks. Boroughs should use the London Heat Map tool and consider any new developments, planned major infrastructure works and energy supply opportunities which may arise
- Develop energy master plans for specific decentralised energy opportunities which identify:
    - major heat loads (including anchor heat loads, with particular reference to sites such as universities, hospitals and social housing)
    - major heat supply plant
    - possible opportunities to utilise energy from waste
    - possible heating and cooling network routes
    - implementation options for delivering feasible projects, considering issues of procurement, funding and risk and the role of the public sector
- Require developers to prioritise connection to existing or planned decentralised energy networks where feasible.

POLICY 5.6 DECENTRALISED ENERGY IN DEVELOPMENT PROPOSALS (USED FOR REFERENCE ONLY)

Development proposals should evaluate the feasibility of Combined Heat and Power (CHP) systems, and where a new CHP system is appropriate also examine opportunities to extend the system beyond the site boundary to adjacent sites.

Major development proposals should select energy systems in accordance with the following hierarchy:

- Connection to existing heating or cooling networks;
- Site wide CHP network;
- Communal heating and cooling;

Potential opportunities to meet the first priority in this hierarchy are outlined in the London Heat Map tool. Where future network opportunities are identified, proposals should be designed to connect to these networks.

POLICY 5.7 RENEWABLE ENERGY (USED FOR REFERENCE ONLY)

The Mayor seeks to increase the proportion of energy generated from renewable sources, and expects that the projections for installed renewable energy capacity outlined in the Climate Change Mitigation and Energy Strategy and in supplementary planning guidance will be achieved in London.

Planning Decisions

Within the framework of the energy hierarchy (see Policy 5.2), major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible.

LDF Preparation

Within LDFs boroughs should, and other agencies may wish to, develop more detailed policies and proposals to support the development of renewable energy in London – in particular, to identify broad areas where specific renewable energy technologies, including large scale systems and the large scale deployment of small scale systems, are appropriate. The identification of areas should be consistent with any guidelines and criteria outlined by the Mayor.

All renewable energy systems should be located and designed to minimise any potential adverse impacts on biodiversity, the natural environment and historical assets, and to avoid any adverse impacts on air quality.

POLICY 5.8 INNOVATIVE ENERGY TECHNOLOGIES (USED FOR REFERENCE ONLY)

The Mayor supports and encourages the more widespread use of innovative energy technologies to reduce use of fossil fuels and carbon dioxide emissions. In particular the Mayor will seek to work with boroughs and other partners in this respect, for example by stimulating:

- The uptake of electric and hydrogen fuel cell vehicles
- Hydrogen supply and distribution infrastructure
- The uptake of advanced conversion technologies such as anaerobic digestion, gasification and pyrolysis for the treatment of waste.

Within LDFs boroughs may wish to develop more detailed policies and proposals to support the use of alternative energy technologies (particularly in infrastructure and master planning opportunities).

POLICY 5.9 OVERHEATING AND COOLING (USED FOR REFERENCE ONLY)

The Mayor seeks to reduce the impact of the urban heat island effect in London and encourages the design of places and spaces to avoid overheating and excessive heat generation, and to reduce overheating due to the impacts of climate change and the urban heat island effect on an area wide basis. Planning decisions

Major development proposals should reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the following cooling hierarchy:

- Minimise internal heat generation through energy efficient design
- Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls
- Manage the heat within the building through exposed internal thermal mass and high ceilings
- Passive ventilation
- Mechanical ventilation
- Active cooling systems (ensuring they are the lowest carbon options).

Major development proposals should demonstrate how the design, materials, construction and operation of the development would minimise overheating and also meet its cooling needs. New development in London should also be designed to avoid the need for energy intensive air conditioning systems as much as possible. Further details and guidance regarding overheating and cooling are outlined in the London Climate Change Adaptation Strategy.

Within LDFs boroughs should develop more detailed policies and proposals to support the avoidance of overheating and to support the cooling hierarchy.

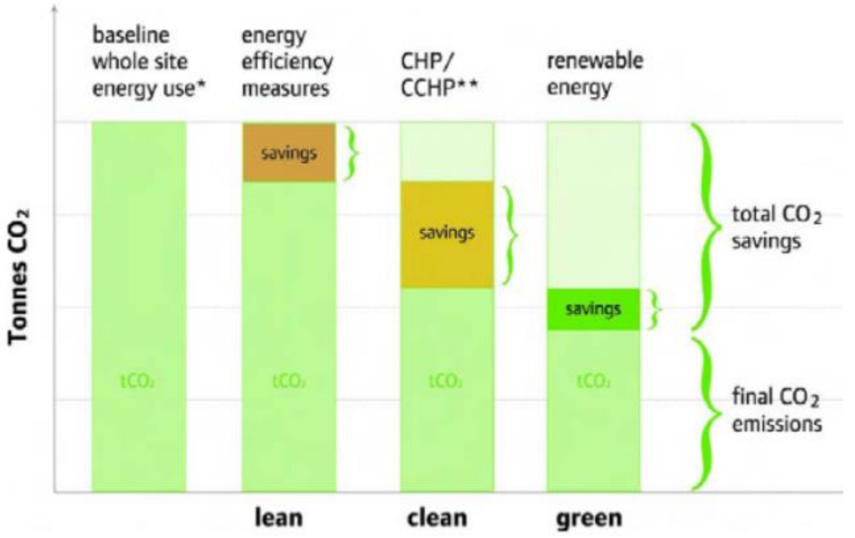
THE MAYOR'S ENERGY STRATEGY (USED FOR REFERENCE ONLY)

The guidelines set out in the Sustainable Design and Construction SPG requires consideration of a development's whole energy use when calculating the carbon dioxide emissions baseline for the assessment.

The Mayors Energy Hierarchy is the backbone of the energy and CO_2 emissions reduction (Policy 5.2):

- Using less energy, in particular by adopting sustainable design and construction measures
- Supplying energy efficiently, in particular by prioritising decentralised energy generation
- Using renewable energy

Calculation of energy/carbon dioxide savings:



LOCAL PLANNING REQUIREMENTS (CAMDEN COUNCIL)

Camden Core Strategy 2010-2015 Local development framework

CS13 – Tackling climate change through promoting higher environmental standards

Reducing the Effects of and Adapting to Climate Change

The Council will require all development to take measures to minimise the effects of, and adapt to, climate change and encourage all development to meet the highest feasible environmental standards that are financially viable during construction and occupation by:

a) Ensuring patterns of land use that minimise the need to travel by car and help support local energy networks;
b) Promoting the efficient use of land and buildings;
c) Minimising carbon emissions from the redevelopment, construction and occupation of buildings by implementing, in order, all of the elements of the following energy hierarchy:

1. Ensuring developments use less energy,
2. making use of energy from efficient sources, such as the King's Cross, Gower Street, Bloomsbury and proposed Euston Road decentralised energy networks;
3. Generating renewable energy on-site;

and

d) Ensuring buildings and spaces are designed to cope with, and minimise the effects of, climate change.

The Council will have regard to the cost of installing measures to tackle climate change as well as the cumulative future costs of delaying reductions in carbon dioxide emissions

Local Energy Generation

The Council will promote local energy generation and networks by:
e) Working with our partners and developers to implement local energy networks in the parts of Camden most likely to support them, i.e. in the vicinity of:

– Housing estates with community heating or the potential for community heating and other uses with large heating loads;
– The growth areas of King's Cross; Euston; Tottenham Court Road; West Hampstead Interchange and Holborn;
– Schools to be redeveloped as part of Building Schools for the Future programme;
– Existing or approved combined heat and power/local energy networks (see Map 4);
And other locations where land ownership would facilitate their implementation.
f) Protecting existing local energy networks where possible (e.g. at Gower Street and Bloomsbury) and safeguarding potential network routes (e.g. Euston Road);

Water and Surface Water Flooding

We will make Camden a water efficient borough and minimise the potential for surface water flooding by:
g) protecting our existing drinking water and foul water infrastructure, including Barrow Hill Reservoir, Hampstead Heath Reservoir, Highgate Reservoir and Kidderpore Reservoir;
h) Making sure development incorporates efficient water and foul water infrastructure;
i) requiring development to avoid harm to the water environment, water quality or drainage systems and prevents or mitigates local surface water and downstream flooding, especially in areas up-hill from, and in, areas known to be at risk from surface water flooding such as South and West Hampstead, Gospel Oak and King's Cross (see Map 5).

Camden's Carbon Reduction Measures

The Council will take a lead in tackling climate change by:
j) Taking measures to reduce its own carbon emissions;
k) Trialling new energy efficient technologies, where feasible; and
l) Raising awareness on mitigation and adaptation measures.

Reducing the Effects of, and Adapting to, Climate Change
Sustainable Patterns of Development

13.6 The location of development and mix of land uses have a significant influence on the amount of energy we use for transport, as well as whether we can generate or supply local energy efficiently.
We will make the most efficient use of Camden's limited land and steer growth and uses that will generate a large number of journeys to the most accessible parts of the borough. We will also encourage an appropriate mix of uses to support sustainable modes of travel such as walking and cycling as well as local energy networks. Development will be focussed in Camden's growth areas, with other highly accessible locations, such as central London and most of our town centres, also considered suitable for development that significantly increases travel demand (please see policy CS1 – *Distribution of growth* and the Key Diagram – Map 1).

Efficient Use of Land and Buildings

13.7 The efficient use of land and buildings will reduce pressure to develop undeveloped, 'greenfield' sites. Camden's historic and built up nature means most of our greenfield sites are designated open spaces. The Council will encourage higher densities in line with policy CS1 – *Distribution of growth*. To enable buildings to last longer it is important that they are designed and built to a high standard and to accommodate the changing requirements of occupants over time. Buildings can be designed to be adaptable in the future if consideration is given to:
- the design of the structure, to enable expansion;
- the layout of the internal space;
- mechanical services, to allow for expansion or changing expectations and technologies; and
- enabling 'retro-fitting', for example for renewable energy generation.

elementa
Member of Integral Group

Ensuring developments use less energy

13.8 A building's use, design, choice of materials and other measures can minimise its energy needs during both construction and occupation. The Council will encourage all developments to meet the highest feasible environmental standards taking into account the mix of uses, the possibility of reusing buildings and materials and the size and location of the development. In addition to design and materials, a building's internal heating and cooling design, lighting and source of energy can further reduce energy use. Policy DP22 – *Promoting sustainable design and construction* in Camden Development Policies provides further guidance on what measures can be implemented to achieve an environmentally sustainable building. The Building Research Establishment's Environmental Assessment Method (BREEAM) and the Code for Sustainable Homes provide helpful assessment tools for general sustainability. Further details on these assessment tools can be found in
Development Policy DP22 and our Camden Planning Guidance supplementary document.

13.9 Camden's existing dense built form with many conservation areas and other heritage assets means that there are often limits to the contribution that orientation, height and footprint can make towards the energy efficiency of a building. This dense character, along with the varying heights of buildings in central London, can also make the installation of various technologies, including renewable energy technologies more difficult. For example, the efficient use of photovoltaics in Central London can be constrained by overshadowing from taller buildings. We will expect high quality and innovative design to help combat these constraints. Energy efficiency measures relating to heritage assets will be welcomed provided that they do not cause harm to the significance of the heritage asset and its setting. The refurbishment of some existing properties in the borough, such as Camden's EcoHouse in Camden Town and a home in Chester Road in Highgate have demonstrated how Victorian properties can be upgraded to meet Level 4 of the Code for Sustainable Homes energy performance standards. Given the large proportion of development in the borough that relates to existing buildings, we will expect proportionate measures to be taken to improve their environmental sustainability, where possible. Further details on this can be found in our Camden Planning Guidance supplementary document.

Making use of energy from efficient sources

13.10 Once a development has been designed to minimise its energy consumption in line with the approach above, the development should assess its remaining energy needs and the availability of any local energy networks or its potential to generate its own energy from low carbon technology. The Council's full approach to local energy generation and local energy networks is set out below (paragraphs 13.16 – 13.22).

Generating renewable energy on-site

13.11 Buildings can also generate energy, for example, by using photovoltaic panels to produce electricity, or solar thermal panels, which produce hot water. Once a building and its services have been designed to make sure energy consumption will be as low as possible and the use of energy efficient sources has been considered, the Council will expect developments to achieve a reduction in carbon dioxide emissions of 20% from on-site renewable energy generation (which can include sources of site-related decentralised renewable energy) unless it can be demonstrated that such provision is not feasible. Details on ways to generate renewable energy can be found in our Camden Planning Guidance supplementary document.

Policy DP22 Promoting Sustainable Design and Construction

The Council will require development to incorporate sustainable design and construction measures. Schemes must:

a) demonstrate how sustainable development principles, including the relevant measures set out in paragraph 22.5 below, have been incorporated into the design and proposed implementation; and
b) incorporate green or brown roofs and green walls wherever suitable.
The Council will promote and measure sustainable design and construction by:
c) expecting new build housing to meet Code for Sustainable Homes Level 3 by 2010 and Code Level 4 by 2013 and encouraging Code Level 6 (zero carbon) by 2016;*
d) expecting developments (except new build) of 500 sq m of residential floor space or above or 5 or more dwellings to achieve "very good" in EcoHomes assessments prior to 2013 and encouraging "excellent" from 2013;
e) expecting non-domestic developments of 500sqm of floor space or above to achieve "very good" in BREEAM assessments and "excellent" from 2016 and encouraging zero carbon from 2019. The Council will require development to be resilient to climate change by ensuring schemes include appropriate climate change adaptation measures, such as:
f) summer shading and planting;
g) limiting run-off;
h) reducing water consumption;
i) reducing air pollution; and
j) not locating vulnerable uses in basements in flood-prone areas

10.3 APPENDIX C- LZC TECHNOLOGIES OVERVIEW

Appendix C provides an overview of the various low and zero carbon technologies that are currently available.

COMBINED HEAT AND POWER (CHP)

CHP plant utilises a reciprocating engine to generate electricity on-site, whilst making use of the waste heat generated in the process. Gas is predominantly the fuel used for CHP systems, although renewable CHP engines are available that utilise biofuel (e.g. wood pellets).

Typically, for CHP engines used within buildings, the associated electricity efficiency is between 25-30% (depending on the size of the engine), with 40-50% of waste heated being re-usable for heat distribution within a building (the remainder is lost through heat via the flue).

The use of waste heat can make a CHP system very efficient if the balance of electrical and heating loads are suitable. CHP plants are normally best suited to large communal heating developments or leisure facilities, where they would be sized to meet the base heat load, but the site may still require additional electricity from the national grid. During low or zero periods of heat demand, the CHP plant may be switched off, at which time grid electricity would be used.

For CHP to be effective in terms of carbon reduction and cost effectiveness, it is very important that the engine operates for substantial periods of the day, throughout the year.

Noise issues associated with the continuous running of a CHP system therefore need to be considered, and suitable attenuation measures provided. Primarily, the majority of the noise emitted by a CHP system is from the 'prime mover' (electrical generator), which emits breakout noise into the adjacent area, and exhaust noise from the exhaust stream).

The land take of a CHP system is generally more than that of a floor-mounted boiler providing a similar thermal duty, especially if biomass CHP systems are utilised, due to fuel storage requirements.

The Renewable Heat Incentive (RHI), a government funding scheme administered by Ofgem, became live for non-domestic generators on 28th November 2011. Similar to the FIT scheme, the RHI scheme provides the operator with a payment for every kWh generated by qualifying technologies and installations, over a 20 year period. CHP installations are classified as a qualifying technology.

GROUND SOURCE HEAT PUMPS (GSHP)

Heat pumps use electricity to raise the temperature of water from a heat source, such as the ground, to a suitable level. Ground source heat pumps extract heat from the heat source via plastic piping (ground loops) containing a mixture of water and antifreeze, which is connected to a pump. Ground loops absorb low-grade heat from the heat source, which is delivered to the heat pump. Ground loops can either be horizontal pipes in trenches usually approximately 1.8m below ground (a slinky solution), or a series of boreholes, typically 100m to 150m deep. In both cases, the exact ground loop design depends on the soil/geological conditions and required plant duty.

This heat can then be utilised to heat the building. A heat pump operates more efficiently with a higher heat source temperature. The ground is typically 10°C at 1 metre below the surface throughout the year, and so during the heating season acts as a better source of heat than air, where the heat source temperature in winter can drop to/below freezing.

The heating cycle can be reversed in summer to provide cooling via a low grade heat sink. Using GSHP's in this way is generally recommended in order to replenish the grounds heat store

GSHP systems can provide heat or coolth to either a wet secondary side (e.g. LTHW heating or chilled water circuit), or to a refrigerant based secondary side (i.e. a refrigerant-based VRF system, serving fan coil units).

For a GSHP serving an LTHW heating system, it is best utilised in conjunction with underfloor heating (UFH) coils, due to the relatively low temperatures that UFH systems operate at, therefore improving system efficiency.

The extraction of heat from the heat source requires electrical energy to drive the compressor and pumps of the GSHP equipment. The ratio of electrical energy supplied to the heat energy delivered is known as the Coefficient of Performance (COP). The seasonal COP of a GSHP system is dependent on a number of factors, but is generally in the region of 4.5.

A GSHP system can be designed to supply space heating only, or it can be designed to supply the space heating and to generate domestic hot water.

In the case of the domestic hot water generation, a GSHP system will only be able to provide a pre-heat to a conventional gas boiler system. The COP of the GSHP drops below an acceptable level if temperatures of over 45ºC are required, thus it can heat the hot water to 45ºC but above this temperature it is more efficient to utilise gas.

GSHP systems need to be sized carefully to work within the constraints of the site.

GSHP systems represent an unobtrusive technology, with no active external plant required. It should be noted that there is little noise associated with GSHP's systems, with the only source being from the heat pumps compressor, which can be minimised by taking appropriate attenuation measures (i.e. locating the plant within an indoor plantroom, on anti-vibration mountings).

As with CHP, GSHP installations are classified as a qualifying technology under the RHI scheme, which is a potential source of funding.

AIR SOURCE HEAT PUMPS (ASHP)

An air source heat pump works in a similar manner to a ground source heat pump, except the heat source is ambient air rather than the ground. In lieu of ground loops are fan-assisted heat exchangers, located in locations with a free air supply. Air is driven across the heat exchangers, and heat energy extracted. Like GSHP's, ASHP's can be reversed to provide cooling during summer operation.

ASHP have a significant advantage over GSHP in that no ground loop is required. This leads to reduced capital costs and the "peace of mind" that no equipment is buried. It also removes the risk of unknown ground conditions at the time of design and installation. However, the performance of GSHP's is now well understood, whereas the performance of ASHP, particularly for large installations, is less certain.

The coefficient of performance (COP) of GSHP and ASHP systems is critical to the success of the installation. The COP is reduced as the difference between external temperature and delivered heat temperature increases. Therefore, during the coldest parts of the year, the efficiency of the ASHP will drop as air temperature falls.

In comparison, the COP of a GSHP will only fall slightly because the ground temperature remains more or less constant. In addition to this, the external heat exchangers will, during winter, frequently reduce the air temperature to sub-zero. This causes condensation in the air stream which freezes on to the heat exchanger; unless this is removed the system will cease to operate.

The solution to this is to pass heat back into the heat exchanger. This use of energy further reduces the ASHP COP. The extent of the effect of this problem will differ from situation to situation; the commonly quoted COP figure provided by manufacturers of ASHP equipment is generally approximately 3.5. However, with the provision of high efficiency plant, higher COP's are achievable.

The compressor/s and fan/s located within the external unit/s of an ASHP system generate some noise, so the location of the external plant compound therefore needs to be carefully considered during the early design stages, to ensure that the noise emitted does not create any issues. If necessary, attenuation measures can be applied to the external units, to ensure noise levels are kept at an acceptable level.

ASHP installations do not currently qualify for potential funding under the RHI. However, 'Enhanced Capital Allowances' can be claimed for air to air (e.g. variable refrigerant flow systems) and air to water systems. In order to qualify for ECA's, the ASHP plant needs to be present on the 'Energy Technology List'. This will enable the Client to claim 100% of first year capital gain allowances on their spending on qualifying plant and/or machinery.

WIND TURBINES

Wind turbines convert the kinetic energy of the wind into rotational mechanical energy using an aerodynamic rotor. This is then converted into electrical energy via a generator. The UK is the windiest country in Europe, and therefore wind power is one of the UK's most promising technologies.

There are two types of wind turbine available, smaller units which are roof mounted or fixed to the building, and larger free standing turbines.

The roof mounted units are limited in size due to wind induced stresses which are transmitted to the building structure. Most roof mounted turbines currently on the market are approximately 2m diameter and are capable of producing 1-1.5kW each, and produce significant levels of noise locally. However, electrical output is dependent on the surrounding obstructions and local wind speed (wind turbines work best with laminar wind flows). In developed urban areas, outputs can be greatly reduced. Small scale wind turbines would not make any meaningful impact on a site such as this.

Large free standing turbines are capable of producing hundreds of kilowatts of electrical energy which makes them a more attractive proposition in terms of energy generation. However, there are problems with noise, obtrusiveness and shadow flicker which means that generally large wind turbines need to be located at least 300m from any residential properties.

PHOTOVOLTAIC (PV) SYSTEM

Photovoltaic cells, or solar cells as they are often referred to, are silicon semi-conductor devices that convert light energy emitted by the sun into direct current (DC) electricity.

Groups of PV cells are electrically configured into modules and arrays which form the building block of solar arrays. With the use of appropriate power conversion equipment (inverters), PV systems convert the generated DC current into alternating current (AC) compatible with conventional operating appliances, and operate in parallel with the utility grid.

PV systems require only daylight to generate electricity (although more is produced with more sunlight); therefore, energy can be produced in overcast or cloudy conditions and are successfully utilised in all parts of the UK.

Arrays would normally be formed of panels mounted on the roof, and preferable face between South-East and South-West at an elevation of 20° to 40° to horizontal for maximum efficiency.

PV's require minimal maintenance during the period of their life, normally estimated at 25 years, and carbon emissions associated with PV are considered to be zero.

From a noise perspective, PV's produce virtually no noise at all (only negligible sound from the inverter fan/s), and if roof-mounted require no additional land take.

Photovoltaics have traditionally represented a relatively expensive form of renewable technology, although installed costs have reduced significantly over the last couple of years.

PV SYSTEM GRANTS

The introduction of the government 'Feed-in Tariff' initiative on 1st April 2010,' made the use of PV's a much more attractive option than they had been prior to this initiative.

The Feed-in Tariff scheme provides the system owner with a payment for every kW of electricity generated by the PV system (the generation tariff). An additional payment is also received for any excess energy generated by the PV system which is exported to the grid (export tariff). The system owner will also benefit financially from the savings generated by utilising the energy generated on site, in lieu of purchasing the equivalent electrical energy from their electricity provider.

The Feed-in Tariff scheme will provide payments for 20 years from the date of installation for PV installations, and all payments are linked to the retail price index.

SOLAR THERMAL

Solar thermal technologies generate hot water from the sun's energy through the use of solar collectors. The sun's heat energy is accumulated by the solar cells and then water is pumped through these thus heating the water. The heated water is then stored or distributed for domestic use. These systems tend to be incorporated on to roof space so that they are clear of obstacles (obstructions on the roof can have an effect on the solar cell array). As with photovoltaic panels, the solar collectors are more effective if they are in a south-facing position.

There are two main types of solar thermal system; flat panel and thermal vacuum (evacuated) tubes. Flat panels consist of a flat "radiator" absorber, covered by glass and insulated. Their efficiency depends on the insulation properties and type of construction. More expensive double-glazed units have a better efficiency, so that a smaller area of solar thermal panels is required; a compromise would need to be made between efficiency and cost. Solar thermal panels are especially worth considering for new buildings, since they can be effectively built into roof structures during the construction stage.
Thermal vacuum tubes are a more recently developed technology designed for obtaining heat from the sun. These have been developed over the last thirty years into units that are now up to 90% efficient. Water is passed through an evacuated tube, which contains a black absorber plate. Vacuum tubes are more efficient and therefore a smaller area of collector is required. Solar vacuum tubes are capable of operating at higher working temperatures than flat plate collectors. Thermal losses for vacuum tubes also tend to be lower than those of flat plate collectors due to improved heat insulation. The vacuum provides insulation, and this allows the water to be heated to higher temperatures, and remain very effective even on cloudy days.

In the UK, solar thermal is most effective during the summer months, when space heating is not normally required, hence solar thermal systems are normally utilised to provide a heating source for domestic hot water.

From a noise perspective, solar thermal systems produce virtually no noise at all (only negligible sound from the associated water circulation pump), and if roof-mounted require no additional land take.

As with CHP, solar thermal installations are classified as a qualifying technology under the RHI scheme, which is a potential source of funding.

BIOFUEL

Biomass is the burning of any plant-derived organic material (such as wood) that renews itself over a short period to generate energy. This fuel type is usually used for heating.

Since the CO_2 released during the burning process is offset by the CO_2 absorbed during the life of the biomass source, biomass is considered to be close to carbon neutral.

Typically a biomass system will burn wood in either a chip or pellet form instead of the conventional gas system. Biomass can save large amounts of carbon at a relatively low capital cost.

Non-domestic biomass boilers mainly use either wood pellet or wood chip burners. Wood pellets are comprised of wood chips and sawdust that are compacted into smaller volumes.

This means that they have lower moisture content and they can be produced in a consistent size. However wood pellet fuel is more expensive costing around 4.5p/kWh (price varies with required load). Wood chips are a cheaper source of fuel costing around 2.5p/kWh (price varies with required load).

Biomass boilers tend to be larger and more expensive than their gas equivalents. This is due to the higher temperatures required for efficient combustion which requires a larger fire box. Fuel storage and handling is less simple than for conventional oil or gas fuels. Fuel is typically delivered by truck and is generally stored in a bunker adjacent to the boiler room, or a silo within the respective boiler room. This has implications for delivery as lorries need to be able to draw up alongside the store to deliver the fuel. If fuel delivery from a reliable source within a reasonable distance of the site can be achieved and the logistics surrounding lorry deliveries can be overcome, then this can be a viable option to serve a proportion of the heating and hot water requirements of the site.

It is worth noting that in common with other types of combustion appliances, biomass boilers are potentially a source of air pollution. Pollutants associated with biomass combustion include particulate matter (PM_{10}/$PM_{2.5}$) and nitrogen oxides (NOx) emissions. These pollution emissions can have an impact on local air quality and affect human health.

The operation of a biomass boiler and its associated ancillary plant (e.g. fuel supply system) will generate noise, which will need to be carefully considered throughout all stages of the design process. Effective management of delivery schedules will help to minimise any potential noise issues associated with fuel supply.

The land take of a biomass boiler will be more than that of a comparable floor-mounted boiler providing a similar thermal duty. Additional space will also be required for the associated fuel storage and fuel distribution requirements.

As with CHP, biomass installations are classified as a qualifying technology under the RHI scheme, which is a potential source of funding.

10.4 APPENDIX D – INITIAL LIFE CYCLE COST ANALYSIS OF RENEWABLE OPTIONS

Renewable Source	Year 1 Capital Cost	Annual Maintenance Cost	Replacement Cost		Estimated 25 Year Cost	Estimated 25 Year Saving / Income	Estimated Net 25 Year Savings
			Years	Cost			
PV	£51,750	£500	25	£51,750	£64,250	£81,428	£17,178

15 years payback

Year	Efficiency	Energy Generated	Energy Saved	Financial Saving	Cumulative saving
			(Potentially 13p/kWh)		
1	100.00	31,800	31,800	£4,134	£4,134
2	99.20	31,546	31,546	£3,601	£7,735
3	98.40	31,291	31,291	£3,568	£11,303
4	97.60	31,037	31,037	£3,535	£14,838
5	96.80	30,782	30,782	£3,502	£18,339
6	96.00	30,528	30,528	£3,469	£21,808
7	95.20	30,274	30,274	£3,436	£25,243
8	94.40	30,019	30,019	£3,402	£28,646
9	93.60	29,765	29,765	£3,369	£32,015
10	92.80	29,510	29,510	£3,336	£35,352
11	92.00	29,256	29,256	£3,303	£38,655
12	91.20	29,002	29,002	£3,270	£41,925
13	90.40	28,747	28,747	£3,237	£45,162
14	89.60	28,493	28,493	£3,204	£48,366
15	88.80	28,238	28,238	£3,171	£51,537
16	88.00	27,984	27,984	£3,138	£54,675
17	87.20	27,730	27,730	£3,105	£57,780
18	86.40	27,475	27,475	£3,072	£60,852
19	85.60	27,221	27,221	£3,039	£63,891
20	84.80	26,966	26,966	£3,006	£66,896
21	84.00	26,712	26,712	£2,973	£69,869
22	83.20	26,458	26,458	£2,939	£72,808
23	82.40	26,203	26,203	£2,906	£75,715
24	81.60	25,949	25,949	£2,873	£78,588
25	80.80	25,694	25,694	£2,840	£81,428
			TOTAL:	**£81,428.40**	

Assumptions

The price of the PV assumes all of the PV panels on a flat roof, it does not include the cost for PV integrated glazing.
All costs relate to present day figures (i.e. inflation, fuel cost increase, etc. have been excluded), and exclude VAT.
Generation and export tariffs have not been included in the calculation.
It has been assumed that 100% of the electricity will be used on site.

10.5 APPENDIX E – SUPPORTING OVERHEATING REPORT 150 HOLBORN- RESIDENTIAL UNITS

DOCUMENT CONTROL

Issue	Description	Date	Prepared By	Signed Off
P1	For Information	27th Nov	Clara Bagenal George	

1 EXECUTIVE SUMMARY

This report provides an overheating assessment for the residential units in the 150 Holborn development.

Based on the design parameters detailed within this report, the assessed building was found **TO PASS** CIBSE TM52 overheating criteria.

2 INTRODUCTION

2.1 AIM OF ASSESSMENT

This report has been produced to demonstrate the developments compliance with:

a) The summertime overheating criteria for non-air conditioned buildings, provided within "CIBSE Guide A 2015: Environmental Design" (CIBSE TM52)

2.2 CIBSE GUIDE A: ENVIRONMENTAL DESIGN 'SUMMERTIME OVERHEATING CRITERIA' COMPLIANCE

The following three criteria - defined by CIBSE TM52 – The limits of Thermal comfort: avoiding overheating in European buildings - taken together, are used to assess the risk of overheating of buildings in the UK and Europe. A room or building that fails any two of the three criteria is classed as overheating.

- The first criterion sets a limit for the number of hours that the operative temperature can exceed the threshold comfort temperature (upper limit of the range of comfort temperature) by 1°K or more during the occupied hours of a typical non-heating season (1st May to 30th September).
- The second criterion deals with the severity of overheating within any one day, which can be as important as its frequency, the level of which is a function of both temperature rise and its duration. This criterion sets a daily limit for acceptability.
- The third criterion sets an absolute maximum daily temperature for a room, beyond which the level of overheating is unacceptable.

The weather file to be used within the assessment is LWC1989_baseline.epw, the Design Summer Year for central London. Design Summer Year weather files consist of an actual 1-year sequence of hourly data, selected from the 20-year data sets to represent a year with a hot summer.

2.3 MODELLING METHODOLOGY

The flats which were most at risk of overheating were tested. The proposal was modelled as worst case, in terms of overheating and assumed fully glazed where the drawings were not showing solid walls.

To carry out the dynamic thermal simulations, Elementa Consulting uses the industry standard IES VE 2014 version 7.0.2.0 software suite from Integrated Environmental Solutions Ltd. The software is CLG approved and compliant with CIBSE Guide AM11 (Building Energy and Environmental Modelling).

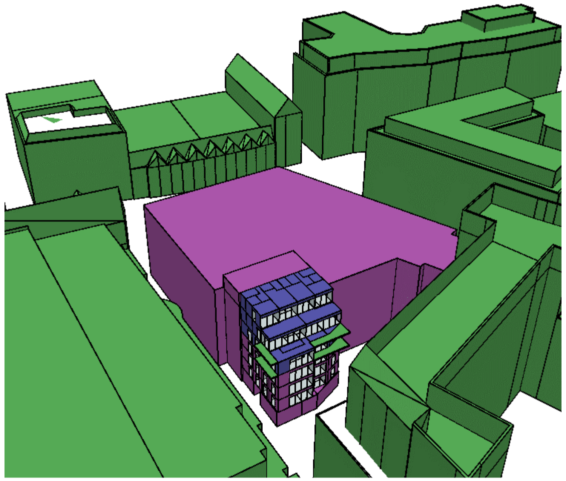
IES is an integrated suite of applications based around one 3D geometrical model. The modules used for this project include "SunCast" for solar shading analysis, "Apache-Sim" for thermal simulation calculations, "MacroFlo" for bulk air flow modelling and "VE Compliance" for Part L2A assessment.

SunCast generates shadows and internal solar insulation from any sun position defined by date, time, orientation, site latitude and longitude. This shading information is stored in a database and used to take account of shading from surroundings in subsequent thermal simulation calculations.

Apache-Sim is a dynamic thermal simulation program based on first-principles mathematical modelling of the heat transfer processes occurring within and around a building. It qualifies as a Dynamic Model in the CIBSE system of model classification, and exceeds the requirements of such a model in many areas. The program provides an environment for the detailed evaluation of building and system designs, allowing them to be optimised with regard to comfort criteria and energy use.
MacroFlo is a program for analysing bulk air movement in buildings, driven by buoyancy induced pressures and external wind flow.

A three-dimensional thermal model of the proposed development was created based on drawings provided by Pringle Brandon Perkins + Will. Figure 1 below indicates a 3D rendered image obtained from the thermal model. The building fabric, occupancy densities and profiles, lighting and small power gains were inputted for each zone in the thermal model based on assumptions detailed in this report.

Figure 1 - 3D Image:



3 OVERHEATING ASSESSMENT

The overheating assessment has been carried out in accordance with the requirements set out in CIBSE TM52.

3.1 OVERHEATING RESULTS: TM52

The following three criteria - taken together, are used to assess the risk of overheating of rooms within a building. A room that fails any two of the three criteria is classed as overheating.

- The first criterion sets a limit for the number of hours that the operative temperature can exceed the threshold comfort temperature (upper limit of the range of comfort temperature) by 1°K or more during the occupied hours of a typical non-heating season (1st May to 30th September).
- The second criterion deals with the severity of overheating within any one day, which can be as important as its frequency, the level of which is a function of both temperature rise and its duration. This criterion sets a daily limit for acceptability.
- The third criterion sets an absolute maximum daily temperature for a room, beyond which the level of overheating is unacceptable.

The results of the results of the TM52 overheating analysis is shown below.
Table 1 – Analysis against TM52 Criteria
(Two out of these three criteria must be met)

Room	Criteria 1 (%Hours Top-Tmax>=1K) Target ≤ 3%	Criteria 2 (Max. Daily Deg.Hours) Target ≤ 6	Criteria 3 (Max. DeltaT) Target ≤ 4K	Criteria failing	TM52
4th floor - East unit - living room	3	40	4	Criteria 2	Pass
4th floor - East unit - bedroom	0	0	0	-	Pass
4th floor - West Unit - Bedroom	0	0	0	-	Pass
4th floor - West Unit - Bedroom	0.3	3	2	-	Pass
5th floor - East unit - bedroom	0.3	2	1	-	Pass
5th floor - West unit - bedroom	0.3	3	2	-	Pass
6th floor - East Unit - bedroom	0	0	0	-	Pass
6th floor - East Unit - bedroom	0	0	0	-	Pass
6th floor - West unit - bedroom	0	0	0	-	Pass
6th floor - West unit - bedroom	0	0	0	-	Pass
4th floor - East Unit - bedroom	0.3	3	2	-	Pass
5th floor - East unit - living	1	25	4	Criteria 2	Pass
5th floor - East unit - kitchen	1.1	27	4	Criteria 2	Pass
5th floor - West unit - kitchen	1.2	28	4	Criteria 2	Pass
5th floor - West unit - living	1.1	28	4	Criteria 2	Pass
4th floor - East Unit - living area	1	22	3	Criteria 2	Pass
4th floor - East Unit - kitchen	1	23	3	Criteria 2	Pass
4th floor - West unit - Lounge	1.3	28	4	Criteria 2	Pass

4 CONCLUSIONS

A computer simulation of the development was carried out to provide an assessment of its compliance with:

a) The summertime overheating criteria for non-air conditioned buildings, provided within "CIBSE Guide A 2015: Environmental Design"

The assessed units in mixed mode was found **TO PASS** TM52 overheating requirements for all occupied spaces.

The flats that had the highest overheating risk were modelled. The top duplex flats on floors 5 and 6, and all of the flats on floor 4 were tested. These flats are seen as worst case in terms of overheating risk, as they are at the top of the residential block, this means that they receive more solar radiation than the lower flats as they receive less shading from the surrounding buildings.

All of the occupied spaces of the modelled flats were found to pass the TM52 overheating criteria, it is therefore deemed that all of the flats will pass the overheating criteria and thus no active cooling is necessary in the residential development.

REFERENCES

i. CIBSE Application Manual AM11: Building Energy and Environmental Modelling

ii. CIBSE Application Manual AM10: Natural Ventilation in Non-Domestic Buildings

iii. CIBSE Guide A: Environmental Design (2015)

iv. CIBSE Guide F: Energy Efficiency in Buildings

v. CIBSE TM52 The Limits of Thermal Comfort: Avoiding Overheating in European Buildings

vi. CIBSE TM49 Design Summer Year for London

APPENDICES

APPENDIX 1 –TM52: 2013 'THE LIMITS OF THERMAL COMFORT: AVOIDING OVERHEATING IN EUROPEAN BUILDINGS

Figure 2: Operative temperature

Box 1: Operative temperature (from CIBSE Guide A (CIBSE, 2006))

The operative temperature (T_{op}) combines the air temperature and the mean radiant temperature into a single value to express their joint effect. It is a weighted average of the two, the weights depending on the heat transfer coefficients by convection (h_c), which depends on the air velocity, and by radiation (h_r) at the clothed surface of the occupant.

The operative temperature is defined as:

$$T_{op} = H\,T_a + (1 - H)\,T_r \qquad (1.1)$$

where T_a is the indoor air temperature (°C), T_r is the mean radiant temperature (°C), H is the ratio $h_c/(h_c + h_r)$ and $(1 - H)$ is the ratio $h_r/(h_c + h_r)$ where h_c and h_r are the surface heat transfer coefficients by convection and by radiation respectively ($W \cdot m^{-2} \cdot K^{-1}$).

Researchers have differed in their estimates of the values of these heat transfer coefficients, and hence of the value of H. In this publication, the value of $\sqrt{(10\,v)}$, where v is the air speed ($m \cdot s^{-1}$) is used for the ratio of h_c to h_r, and so:

$$T_{op} = \frac{T_a \sqrt{(10\,v)} + T_r}{1 + \sqrt{(10\,v)}} \qquad (1.2)$$

At indoor air speeds below 0.1 $m \cdot s^{-1}$, natural convection is assumed to be equivalent to $v = 0.1$, and equation 1.2 becomes:

$$T_{op} = \tfrac{1}{2}\,T_a + \tfrac{1}{2}\,T_r \qquad (1.3)$$

Operative temperature approximates closely to the temperature at the centre of a painted globe of some 40 mm diameter. A table-tennis ball is a suitable size, and may be used to construct a globe thermometer appropriate for indoor spaces.

In well-insulated buildings and away from direct radiation from the sun or from other high temperature radiant sources, the difference between air and the mean radiant temperatures (and hence between the air and operative temperatures) is small.

Note: from the presence of the air speed in the equation 1.2, it has sometimes been assumed that operative temperature fully allows for the effect of air speed on the occupant. This is not so. Increased air movement has two related effects:

- It alters the ratio $h_c/(h_c + h_r)$, thus potentially altering operative temperature.
- It alters the absolute value of the combined heat transfer coefficient between the clothed surface and the enclosure $(h_c + h_r)$.

Thus the surface temperature of the occupant requires for its estimation both the operative temperature and the air speed.

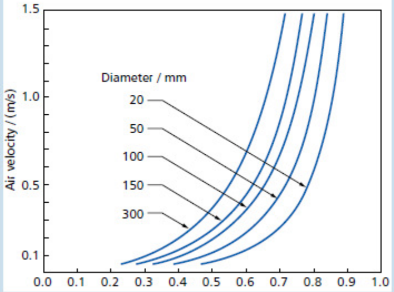


Figure B1.1 The relative importance of the air temperature in the temperature of a globe thermometer. The operative temperature is close to that of a 40 mm sphere. At an air speed of 0.1 $m \cdot s^{-1}$ the relative importance is about 0.5 but as air speed increases the relative importance of air temperature also increases (source: BS EN ISO 7726 (BSI, 2001)).

Figure 3: Running mean

Box 2: Exponentially weighted running mean of the daily mean outdoor air temperature

The adaptive model of thermal comfort has found that the comfort temperature inside free-running buildings is related to the outdoor air temperature. The measure of outdoor temperature has often been the monthly mean. The comfort temperature is related to the thermal history of the subject with more recent experiences being more influential. This makes the exponentially weighted running mean an attractive measure for past temperatures. Such running means had previously shown their usefulness in describing changes in clothing in response to changing temperatures (Humphreys, 1979). The exponentially weighted running mean temperature, T_{rm}, for any day is expressed in the series:

$$T_{rm} = (1 - \alpha)\,(T_{od-1} + \alpha\,T_{od-2} + \alpha^2\,T_{od-3}\ \ldots.) \qquad (2.1)$$

where α is a constant (<1) and T_{od-1}, T_{od-2}, etc. are the daily mean temperatures for yesterday, the day before, and so on.

(Note that 'today's' daily mean temperature is not used because it remains unknown until the end of the day.) Since α <1, this series puts greater weight on the temperature for days closer to the present. The larger the value of α, the more important the past experience will be. For a series of days the value of T_{rm} for any day can be simply calculated from the value of the running mean and of the mean outdoor temperature for the previous day (T_{rm-1} and T_{od-1}):

$$T_{rm} = (1 - \alpha)\,T_{od-1} + \alpha\,T_{rm-1} \qquad (2.2)$$

This makes the running mean very simple to use once a starting value has been established. The optimal value of α to use in calculating the changes in indoor comfort temperature has been investigated using the data from comfort surveys conducted throughout Europe. The value of T_{rm} calculated using equation 2.1 correlates best with T_c when $\alpha = 0.8$.

Where an extensive run of days is not available, BS EN 15251 (BSI, 2007) gives an approximate calculation method using the mean temperatures for the last seven days ($\alpha = 0.8$):

$$T_{rm} = (T_{od-1} + 0.8\,T_{od-2} + 0.6\,T_{od-3} + 0.5\,T_{od-4} + 0.4\,T_{od-5} + 0.3\,T_{od-6} + 0.2\,T_{od-7})/3.8 \qquad (2.3)$$

This approximate value can also be used to 'start off' a longer run of T_{rm}.

APPENDIX 2 –MODEL INPUT DATA

BUILDING CONSTRUCTION DATA

The following table indicates the building fabric design parameters utilised within the model to carry out the assessment.

Table 2: Assumptions for the residential development

Element	Value Proposed for Development
Wall U-Value ($W/m^2.K$)	0.15
Ground Floor U-Value ($W/m^2.K$)	0.13
Roof U-Value ($W/m^2.K$)	0.13
Glazing U-Value ($W/m^2.K$)	0.85
Glazing g-Value	0.4
Building Air Permeability ($m^3/h.m^2$) @ 50 pa	1

Note: G-value: Solar Energy Transmission Coefficient [BS EN 410]

LOCATION DATA

Building type: Residential
Weather Location: London
Weather File: LWC1989baseline.epw
Latitude: 51.48° North
Longitude: 0.45° W
Altitude: 24m
Model orientation: 0° from real North

Figure 4 - Model Orientation:

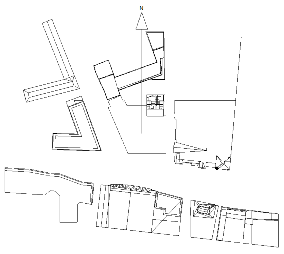


Figure 5 – Site plan Google maps view

An overview of the internal gains applied to each room is provided in Table 3 below.

Table 3 - Internal Gains Applied to the Thermal Model:

ROOM TYPE	No. OF PEOPLE	LIGHTING W/m²	SMALL POWER	PROFILE (Mon-Sun)
Bedroom	1 person	8 W/m²	1 TV and DVD player 120W	Occupied between 10pm-7 am
Kitchen area	1 person	8 W/m²	1 Oven 270 W (a utilisation factor of 0.1 has been applied to the oven) 1 Fridge freezer 36 W	Always occupied
Living area	1 person	8 W/m²	1 TV and DVD player 120W 2 laptop 180W	Always occupied
Circulation/ WC	0 person	8 W/m²		

Table 4: Natural ventilation assumptions applied to the Thermal Model:

Windows	Description	Free area	Opening profile assumptions
Window A	Full length windows that open onto a balcony	80%	Open when the internal temperature is above 22°C and/or the carbon dioxide concentration is above 1000 ppm.
Window B	Windows that do not open onto a balcony	25%	Open when the internal temperature is above 22°C and/or the carbon dioxide concentration is above 1000 ppm.

Table 5: Mechanical ventilation assumptions applied to the Thermal Model

Windows	Mechanical ventilation rate	Opening profile assumptions
Living area	12.5 l/s	On continuously
Bedroom	5 l/s	On continuously

Table 6: TM52 assumptions applied to the Thermal Model:

Assumption	Value
Normal design air speed	0.15 m/s
Summer air speed	0.8 m/s
Activity level	58.2 (seated at rest)
Clothing level	0.7
Building category	Category II (New building)

APPENDIX 3- PLANS

RESIDENTIAL BLOCK
Level 06

RESIDENTIAL BLOCK
Level 05

RESIDENTIAL BLOCK
Levels 03-04

10.6 APPENDIX F – SUPPORTING BRUKL AND SAP OUTPUT DOCUMENTS

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

150 Holborn

As designed

Date: Tue Mar 01 12:53:43 2016

Administrative information

Building Details

Address: 150 Holborn, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

BRUKL compliance check version: v5.2.b.1

Owner Details

Name:

Telephone number: Phone

Address: , ,

Certifier details

Name:

Telephone number:

Address: , ,

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

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	21.3
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	21.3
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	17
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	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 which do not meet standards in the 2013 Non-Domestic Building Services Compliance Guide are displayed in red.

2.a 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	GB000004:Surf[1]
Floor	0.25	0.13	0.13	ST000025:Surf[0]
Roof	0.25	0.13	0.13	ST000021:Surf[1]
Windows***, roof windows, and rooflights	2.2	1.26	1.8	GH000003:Surf[0]
Personnel doors	2.2	1.6	1.61	RS000002:Surf[5]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	1.61	1.61	ST00001F:Surf[0]

$U_{a\text{-}Limit}$ = 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
m³/(h.m²) at 50 Pa	10	3

2.b 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	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- passive chilled beams

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	6.7	0.67	1.8	0.78
Standard value	0.91*	3.9	N/A	1.6	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

2- WC

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.29	0	0.78
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

3- coridors/circ

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

4- comms room

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	3	-	0	0.78
Standard value	0.91*	3.2	N/A	N/A	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

5- Fan coil units

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	6.7	0	1.8	0.78
Standard value	0.91*	3.9	N/A	1.6	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

6- atrium ground floor

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

7- Reception

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0	0	0.78
Standard value	0.91*	N/A	N/A	N/A	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system	YES				

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

8- office- under atrium roof

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	6.7	0	1.8	0.78
Standard value	0.91*	3.9	N/A	1.6	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system	YES				

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

1- DHW 1A

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

2- DHW 1B

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

3- DHW 2A

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

4- DHW 2B

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

5- DHW 3B

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

6- DHW 3A

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

7- DHW 4A

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

8- DHW 4B

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

9- DHW 5A

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

10- DHW 5B

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

11- DHW 6A

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

12- DHW 6B

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

13- DHW 7A

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

14- DHW 7B

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

15- DHW GA

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

16- DHW (Basement)

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.93	0.005
Standard value	0.8	N/A

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
3 BS F	-	-	-	0.4	-	-	-	1.8	-	-	N/A
3 central office	-	-	-	0.4	-	-	-	1.8	-	-	N/A
3 GI F	-	-	-	0.4	-	-	-	1.8	-	-	N/A
3 GI.HH Corner	-	-	-	0.4	-	-	-	1.8	-	-	N/A
3 HH .BS corner	-	-	-	0.4	-	-	-	1.8	-	-	N/A
3 HH F	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Reception desks	-	-	-	1.8	-	-	-	-	-	-	N/A
GF security office	-	-	-	0.4	-	-	-	1.8	-	-	N/A
GF FM room	-	-	-	0.4	-	-	-	1.8	-	-	N/A
8 HH GI F	-	-	-	0.4	-	-	-	1.8	-	-	N/A
3 central office	-	-	-	0.4	-	-	-	1.8	-	-	N/A
8 office	-	-	-	0.4	-	-	-	1.8	-	-	N/A
8 BS F	-	-	-	0.4	-	-	-	1.8	-	-	N/A
G reception waiting	-	-	-	1.8	-	-	-	-	-	-	N/A
G reception waiting cafe	-	-	-	0.4	-	-	-	1.8	-	-	N/A
8 BS Rear	-	-	-	0.4	-	-	-	1.8	-	-	N/A

General lighting and display lighting

Zone name	Luminous efficacy [lm/W] Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
1 BS B	80	-	-	1359
1 BS F	80	-	-	1141
1 Core- WC	-	80	-	181
1 Core- circ	-	80	-	122
1 HH BS corner	80	-	-	264
1 HH F	80	-	-	322
1 Rear B	80	-	-	1262
1 Rear B	80	-	-	141
1 Rear F	80	-	-	922
1F Core- circulation	-	80	-	110

General lighting and display lighting

Zone name	Luminous efficacy [lm/W] Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
1F Core- WC	-	80	-	142
2 BS F	80	-	-	1321
2 central office	80	-	-	2704
2 central office	80	-	-	3762
2 core stair	-	80	-	124
2 core toilets	-	80	-	177
2 Core- circulation	-	80	-	114
2 Core-WC	-	80	-	149
2 GI F	80	-	-	1918
2 GI.HH Corner	80	-	-	297
2 HH .BS corner	80	-	-	272
2 HH F	80	-	-	1052
2 Rear corner- comms	80	-	-	207
2 Rear F	80	-	-	964
3 BS F	80	-	-	1321
3 central office	80	-	-	2704
3 core stair	-	80	-	124
3 core toilets	-	80	-	177
3 Core-Circ	-	80	-	116
3 Core-WC	-	80	-	147
3 GI F	80	-	-	1918
3 GI.HH Corner	80	-	-	297
3 HH .BS corner	80	-	-	272
3 HH F	80	-	-	1052
3 Rear corner	80	-	-	281
3 Rear F	80	-	-	953
4 Atrium	-	80	-	0
4 BS F- comms	80	-	-	871
4 central office	80	-	-	2838
4 core stair	-	80	-	124
4 core toilets	-	80	-	177
4 Core-circ	-	80	-	116
4 Core-WC	-	80	-	147
4 GI F	80	-	-	1918
4 GI.HH Corner	80	-	-	297
4 HH .BS corner	80	-	-	289
4 HH F	80	-	-	1052
4 Rear corner-comms	80	-	-	207
4 Rear F	80	-	-	964
5 BS F	80	-	-	1321
5 central office	80	-	-	2704
5 core stair	-	80	-	124
5 core toilets	-	80	-	177

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
5 Core-circ	-	80	-	116
5 Core-WC	-	80	-	147
5 Gl F	80	-	-	1918
5 Gl.HH Corner	80	-	-	297
5 HH .BS corner	80	-	-	272
5 HH F	80	-	-	1052
6 BS F	80	-	-	1142
6 core stair	-	80	-	124
6 core toilets	-	80	-	177
6 core-circ	-	80	-	110
6 core-WC	-	80	-	142
6 Gl F	80	-	-	1709
6 Gl HH corner	80	-	-	298
6 HH BS Corner	80	-	-	263
6 HH F	80	-	-	936
6 Office centre 2	80	-	-	1746
7 Atrium	-	80	-	26
7 BS F	80	-	-	600
7 core-Stair	-	80	-	112
7 core-WC	-	80	-	147
7 Gl HH corner	80	-	-	298
7 HH BS Corner	80	-	-	264
7 HH F	80	-	-	937
7 BS F 2	80	-	-	264
7 Rear Corridor	-	80	-	48
GF Core- circ	-	80	-	118
GF Core- lift	80	-	-	81
GF Core-circ	-	80	-	65
atrium 1	-	80	-	1040
1 Gl F	80	-	-	1593
1 Gl B	80	-	-	2001
Reception desks	-	80	40	221
Reception entrance	-	80	40	231
G Circ	-	80	-	82
G Circ	-	80	-	72
GF security office	80	-	-	124
GF FM room	80	-	-	163
GF Core WC	-	80	-	117
GF Core- circ	-	80	-	112
Resi- bike store	80	-	-	45
Resi	80	-	-	71
Resi- circ	-	80	-	213
plant	80	-	-	184

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
Resi- plant	80	-	-	162
Resi- plant	80	-	-	90
plant	80	-	-	72
Resi- circ	-	80	-	38
1 circ	-	80	-	149
2 circ	-	80	-	149
3 circ	-	80	-	149
4 circ	-	80	-	149
5 circ	-	80	-	149
8 HH Gl F	80	-	-	359
7 wc	-	80	-	117
7 Rear F	80	-	-	160
4 central office	80	-	-	3428
4 central office	80	-	-	237
3 central office	80	-	-	3539
3 central office	80	-	-	221
-01 Plant	80	-	-	1346
-01 plant	80	-	-	295
-01 Bike store	80	-	-	145
-01 Circ	-	80	-	171
-01 drying room	80	-	-	78
-01 shower	-	80	-	45
-01 WC	-	80	-	43
-01 WC	-	80	-	47
-01 CIRC	-	80	-	68
-01 shower	-	80	-	9
-01 wc	-	80	-	60
-01 plant	80	-	-	244
5 Atrium	-	80	-	0
-01 Circ	-	80	-	642
-01 Circ	-	80	-	133
-01 Plant	80	-	-	25
-01 Plant	80	-	-	26
-01 Bike store	80	-	-	93
-01 Bike store	80	-	-	141
-01 Circ	-	80	-	171
-01 Plant	80	-	-	2935
-01 circ	-	80	-	106
-01 circ	-	80	-	398
-01 shower	-	80	-	81
5 central office	80	-	-	2590
5 central office	80	-	-	118
7 Rear	80	-	-	477

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
7 Rear BS corner	80	-	-	275
6 front	80	-	-	727
5 R	80	-	-	1264
5 F	80	-	-	632
7 floor office under atrium	80	-	-	259
6 roof	80	-	-	521
6 Office centre 1	80	-	-	1902
6 Rear corner	80	-	-	706
8 office	80	-	-	373
8 BS F	80	-	-	307
G reception waiting	-	80	40	264
G reception waiting cafe	-	80	-	219
7 GI F	80	-	-	1549
7 plant	80	-	-	151
7 GI R	80	-	-	1416
5 Rear corner	80	-	-	432
8 BS Rear	80	-	-	358
7 Office centre	80	-	-	1153
6 Atrium	-	80	-	91
7 plant	80	-	-	245
7 Rear corner (plant)	80	-	-	450

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?
1 BS B	NO (-97.5%)	NO
1 BS F	NO (-82%)	NO
1 HH BS corner	NO (-82%)	NO
1 HH F	NO (-76.9%)	NO
1 Rear B	NO (-95.7%)	NO
1 Rear B	NO (-99.6%)	NO
1 Rear F	NO (-57.4%)	NO
2 BS F	NO (-64.2%)	NO
2 central office	NO (-95.5%)	NO
2 central office	NO (-96.1%)	NO
2 GI F	NO (-51.9%)	NO
2 GI.HH Corner	NO (-48.5%)	NO
2 HH .BS corner	NO (-60.3%)	NO
2 HH F	NO (-30.5%)	NO
2 Rear corner- comms	NO (-39.8%)	NO
2 Rear F	NO (-54.3%)	NO
3 BS F	NO (-60%)	NO
3 central office	NO (-95.2%)	NO
3 GI F	NO (-44.7%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
3 GI.HH Corner	NO (-46.8%)	NO
3 HH .BS corner	NO (-58.7%)	NO
3 HH F	NO (-28%)	NO
3 Rear corner	NO (-29.9%)	NO
3 Rear F	NO (-51.4%)	NO
4 BS F- comms	NO (-48.6%)	NO
4 central office	NO (-96.5%)	NO
4 GI F	NO (-37.6%)	NO
4 GI.HH Corner	NO (-45.6%)	NO
4 HH .BS corner	NO (-55.4%)	NO
4 HH F	NO (-26.9%)	NO
4 Rear corner-comms	NO (-3.2%)	NO
4 Rear F	NO (-45.3%)	NO
5 BS F	NO (-37%)	NO
5 central office	NO (-93.5%)	NO
5 GI F	NO (-28.3%)	NO
5 GI.HH Corner	NO (-43.3%)	NO
5 HH .BS corner	NO (-53.7%)	NO
5 HH F	NO (-23.8%)	NO
6 BS F	NO (-16.7%)	NO
6 GI F	NO (-14.1%)	NO
6 GI HH corner	NO (-17.5%)	NO
6 HH BS Corner	NO (-24%)	NO
6 HH F	NO (-8.1%)	NO
6 Office centre 2	NO (-89.3%)	NO
7 BS F	NO (-8.6%)	NO
7 GI HH corner	NO (-12%)	NO
7 HH BS Corner	NO (-15%)	NO
7 HH F	NO (-4.1%)	NO
7 BS F 2	NO (-10.5%)	NO
GF Core- lift	N/A	N/A
1 GI F	NO (-75.6%)	NO
1 GI B	NO (-96.2%)	NO
Reception desks	NO (-8.7%)	NO
Reception entrance	NO (-21.8%)	NO
GF security office	N/A	N/A
GF FM room	N/A	N/A
Resi	N/A	N/A
8 HH GI F	NO (-60.7%)	NO
7 Rear F	NO (-76.8%)	NO
4 central office	NO (-95.4%)	NO
4 central office	NO (-89.8%)	NO
3 central office	NO (-95.7%)	NO
3 central office	NO (-87.1%)	NO
5 central office	NO (-93.5%)	NO
5 central office	NO (-93.6%)	NO
7 Rear	NO (-95.9%)	NO
7 Rear BS corner	NO (-52.8%)	NO
6 front	NO (-1.9%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
5 R	NO (-96.6%)	NO
5 F	NO (-21.4%)	NO
7 floor office under atrium	NO (-2.2%)	NO
6 roof	NO (-35.3%)	NO
6 Office centre 1	NO (-89.4%)	NO
6 Rear corner	NO (-6.7%)	NO
8 office	NO (-42.8%)	NO
8 BS F	NO (-13.3%)	NO
G reception waiting	NO (-6.5%)	NO
G reception waiting cafe	NO (-17.8%)	NO
7 Gl F	NO (-1.4%)	NO
7 Gl R	NO (-4.6%)	NO
5 Rear corner	NO (-44.5%)	NO
8 BS Rear	NO (-47%)	NO
7 Office centre	NO (-85.8%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the 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?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	14050.7	14050.7
External area [m²]	10607.8	10607.8
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	5713.35	4929.15
Average U-value [W/m²K]	0.54	0.46
Alpha value* [%]	10.21	10

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

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
100	**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	10.11	5.96
Cooling	4.86	5.68
Auxiliary	9.2	12.55
Lighting	11.97	19.14
Hot water	4.12	3.7
Equipment*	55.54	55.54
TOTAL**	**40.26**	**47.02**

* 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]	91.03	95.94
Primary energy* [kWh/m²]	100.01	123.29
Total emissions [kg/m²]	17	21.3

* 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] Chilled ceilings or passive chilled beams and displacement ventilation, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Elect										
	Actual	33	85.5	11.2	6.8	9.8	0.82	3.5	0.91	10
	Notional	13.8	103.9	4.4	7.6	15.8	0.86	3.79	----	----
[ST] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	27.2	69.9	9.2	5.5	13.2	0.82	3.5	0.91	10
	Notional	16.5	106.8	5.3	7.8	15.8	0.86	3.79	----	----
[ST] Constant volume system (fixed fresh air rate), [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	89.7	51.1	30.4	4.1	48.9	0.82	3.5	0.91	10
	Notional	5.9	78.2	1.9	5.7	13.4	0.86	3.79	----	----
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	15.5	0	5.2	0	1	0.82	0	0.91	0
	Notional	11.8	0	3.8	0	1	0.86	0	----	----
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	63.2	0	21.4	0	7.1	0.82	0	0.91	0
	Notional	12.1	0	3.9	0	4.1	0.86	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	14.3	0	4.8	0	0.5	0.82	0	0.91	0
	Notional	23.9	0	7.7	0	0.5	0.86	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	47.8	0	16.2	0	15	0.82	0	0.91	0
	Notional	98	0	31.6	0	17.8	0.86	0	----	----
[ST] Single room cooling system, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	0	0	0	0	0	0.82	2.25	0.91	4.5
	Notional	0	0	0	0	0	0.86	3.79	----	----

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	GB000004:Surf[1]
Floor	0.2	0.13	1R000001:Surf[0]
Roof	0.15	0.13	ST000021:Surf[1]
Windows, roof windows, and rooflights	1.5	0.91	7T000002:Surf[1]
Personnel doors	1.5	1.6	GF000009:Surf[5]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	1.61	ST00001F:Surf[0]

$U_{i\text{-}Typ}$ = 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
m³/(h.m²) at 50 Pa	5	3

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

150 Holborn

As designed

Date: Tue Mar 01 12:54:19 2016

Administrative information

Building Details

Address: 150 Holborn, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

BRUKL compliance check version: v5.2.b.1

Owner Details

Name:

Telephone number: Phone

Address: , ,

Certifier details

Name:

Telephone number:

Address: , ,

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

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	21.3
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	21.3
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	16.4
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	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 which do not meet standards in the 2013 Non-Domestic Building Services Compliance Guide are displayed in red.

2.a Building fabric

Element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	Surface where the maximum value occurs*
Wall**	0.35	0.15	0.15	GB000004:Surf[1]
Floor	0.25	0.13	0.13	ST000025:Surf[0]
Roof	0.25	0.13	0.13	ST000021:Surf[1]
Windows***, roof windows, and rooflights	2.2	1.26	1.8	GH000003:Surf[0]
Personnel doors	2.2	1.6	1.61	RS000002:Surf[5]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	1.61	1.61	ST00001F:Surf[0]

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]
U_{i-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
m³/(h.m²) at 50 Pa	10	3

2.b 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	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- passive chilled beams

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	6.7	0.67	1.8	0.78
Standard value	0.91*	3.9	N/A	1.6	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

2- WC

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	-	0.29	0	0.78
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

3- coridors/circ

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	-	0	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

4- comms room

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	3	-	0	0.78
Standard value	0.91*	3.2	N/A	N/A	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

5- Fan coil units

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	6.7	0	1.8	0.78
Standard value	0.91*	3.9	N/A	1.6	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

6- atrium ground floor

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	-	0	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

7- Reception

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	-	0	0	0.78
Standard value	0.91*	N/A	N/A	N/A	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system	YES				
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

8- office- under atrium roof

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	6.7	0	1.8	0.78
Standard value	0.91*	3.9	N/A	1.6	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system	YES				
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

1- DHW 1A

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

2- DHW 1B

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

3- DHW 2A

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

4- DHW 2B

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

5- DHW 3B

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

6- DHW 3A

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

7- DHW 4A

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

8- DHW 4B

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

9- DHW 5A

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

10- DHW 5B

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

11- DHW 6A

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

12- DHW 6B

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

13- DHW 7A

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

14- DHW 7B

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

15- DHW GA

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.022
Standard value	1	N/A

16- DHW (Basement)

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.93	0.005
Standard value	0.8	N/A

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
3 BS F	-	-	-	0.4	-	-	-	1.8	-	-	N/A
3 central office	-	-	-	0.4	-	-	-	1.8	-	-	N/A
3 GI F	-	-	-	0.4	-	-	-	1.8	-	-	N/A
3 GI.HH Corner	-	-	-	0.4	-	-	-	1.8	-	-	N/A
3 HH .BS corner	-	-	-	0.4	-	-	-	1.8	-	-	N/A
3 HH F	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Reception desks	-	-	-	1.8	-	-	-	-	-	-	N/A
GF security office	-	-	-	0.4	-	-	-	1.8	-	-	N/A
GF FM room	-	-	-	0.4	-	-	-	1.8	-	-	N/A
8 HH GI F	-	-	-	0.4	-	-	-	1.8	-	-	N/A
3 central office	-	-	-	0.4	-	-	-	1.8	-	-	N/A
8 office	-	-	-	0.4	-	-	-	1.8	-	-	N/A
8 BS F	-	-	-	0.4	-	-	-	1.8	-	-	N/A
G reception waiting	-	-	-	1.8	-	-	-	-	-	-	N/A
G reception waiting cafe	-	-	-	0.4	-	-	-	1.8	-	-	N/A
8 BS Rear	-	-	-	0.4	-	-	-	1.8	-	-	N/A

General lighting and display lighting

Zone name	Luminous efficacy [lm/W]			General lighting [W]
	Luminaire	Lamp	Display lamp	
Standard value	60	60	22	
1 BS B	80	-	-	1359
1 BS F	80	-	-	1141
1 Core- WC	-	80	-	181
1 Core- circ	-	80	-	122
1 HH BS corner	80	-	-	264
1 HH F	80	-	-	322
1 Rear B	80	-	-	1262
1 Rear B	80	-	-	141
1 Rear F	80	-	-	922
1F Core- circulation	-	80	-	110

General lighting and display lighting

Zone name	Luminous efficacy [lm/W]			General lighting [W]
	Luminaire	Lamp	Display lamp	
Standard value	60	60	22	
1F Core- WC	-	80	-	142
2 BS F	80	-	-	1321
2 central office	80	-	-	2704
2 central office	80	-	-	3762
2 core stair	-	80	-	124
2 core toilets	-	80	-	177
2 Core- circulation	-	80	-	114
2 Core-WC	-	80	-	149
2 GI F	80	-	-	1918
2 GI.HH Corner	80	-	-	297
2 HH .BS corner	80	-	-	272
2 HH F	80	-	-	1052
2 Rear corner- comms	80	-	-	207
2 Rear F	80	-	-	964
3 BS F	80	-	-	1321
3 central office	80	-	-	2704
3 core stair	-	80	-	124
3 core toilets	-	80	-	177
3 Core-Circ	-	80	-	116
3 Core-WC	-	80	-	147
3 GI F	80	-	-	1918
3 GI.HH Corner	80	-	-	297
3 HH .BS corner	80	-	-	272
3 HH F	80	-	-	1052
3 Rear corner	80	-	-	281
3 Rear F	80	-	-	953
4 Atrium	-	80	-	0
4 BS F- comms	80	-	-	871
4 central office	80	-	-	2838
4 core stair	-	80	-	124
4 core toilets	-	80	-	177
4 Core-circ	-	80	-	116
4 Core-WC	-	80	-	147
4 GI F	80	-	-	1918
4 GI.HH Corner	80	-	-	297
4 HH .BS corner	80	-	-	289
4 HH F	80	-	-	1052
4 Rear corner-comms	80	-	-	207
4 Rear F	80	-	-	964
5 BS F	80	-	-	1321
5 central office	80	-	-	2704
5 core stair	-	80	-	124
5 core toilets	-	80	-	177

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
5 Core-circ	-	80	-	116
5 Core-WC	-	80	-	147
5 Gl F	80	-	-	1918
5 Gl.HH Corner	80	-	-	297
5 HH .BS corner	80	-	-	272
5 HH F	80	-	-	1052
6 BS F	80	-	-	1142
6 core stair	-	80	-	124
6 core toilets	-	80	-	177
6 core-circ	-	80	-	110
6 core-WC	-	80	-	142
6 Gl F	80	-	-	1709
6 Gl HH corner	80	-	-	298
6 HH BS Corner	80	-	-	263
6 HH F	80	-	-	936
6 Office centre 2	80	-	-	1746
7 Atrium	-	80	-	26
7 BS F	80	-	-	600
7 core-Stair	-	80	-	112
7 core-WC	-	80	-	147
7 Gl HH corner	80	-	-	298
7 HH BS Corner	80	-	-	264
7 HH F	80	-	-	937
7 BS F 2	80	-	-	264
7 Rear Corridor	-	80	-	48
GF Core- circ	-	80	-	118
GF Core- lift	80	-	-	81
GF Core-circ	-	80	-	65
atrium 1	-	80	-	1040
1 Gl F	80	-	-	1593
1 Gl B	80	-	-	2001
Reception desks	-	80	40	221
Reception entrance	-	80	40	231
G Circ	-	80	-	82
G Circ	-	80	-	72
GF security office	80	-	-	124
GF FM room	80	-	-	163
GF Core WC	-	80	-	117
GF Core- circ	-	80	-	112
Resi- bike store	80	-	-	45
Resi	80	-	-	71
Resi- circ	-	80	-	213
plant	80	-	-	184

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
Resi- plant	80	-	-	162
Resi- plant	80	-	-	90
plant	80	-	-	72
Resi- circ	-	80	-	38
1 circ	-	80	-	149
2 circ	-	80	-	149
3 circ	-	80	-	149
4 circ	-	80	-	149
5 circ	-	80	-	149
8 HH Gl F	80	-	-	359
7 wc	-	80	-	117
7 Rear F	80	-	-	160
4 central office	80	-	-	3428
4 central office	80	-	-	237
3 central office	80	-	-	3539
3 central office	80	-	-	221
-01 Plant	80	-	-	1346
-01 plant	80	-	-	295
-01 Bike store	80	-	-	145
-01 Circ	-	80	-	171
-01 drying room	80	-	-	78
-01 shower	-	80	-	45
-01 WC	-	80	-	43
-01 WC	-	80	-	47
-01 CIRC	-	80	-	68
-01 shower	-	80	-	9
-01 wc	-	80	-	60
-01 plant	80	-	-	244
5 Atrium	-	80	-	0
-01 Circ	-	80	-	642
-01 Circ	-	80	-	133
-01 Plant	80	-	-	25
-01 Plant	80	-	-	26
-01 Bike store	80	-	-	93
-01 Bike store	80	-	-	141
-01 Circ	-	80	-	171
-01 Plant	80	-	-	2935
-01 circ	-	80	-	106
-01 circ	-	80	-	398
-01 shower	-	80	-	81
5 central office	80	-	-	2590
5 central office	80	-	-	118
7 Rear	80	-	-	477

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
7 Rear BS corner	80	-	-	275
6 front	80	-	-	727
5 R	80	-	-	1264
5 F	80	-	-	632
7 floor office under atrium	80	-	-	259
6 roof	80	-	-	521
6 Office centre 1	80	-	-	1902
6 Rear corner	80	-	-	706
8 office	80	-	-	373
8 BS F	80	-	-	307
G reception waiting	-	80	40	264
G reception waiting cafe	-	80	-	219
7 GI F	80	-	-	1549
7 plant	80	-	-	151
7 GI R	80	-	-	1416
5 Rear corner	80	-	-	432
8 BS Rear	80	-	-	358
7 Office centre	80	-	-	1153
6 Atrium	-	80	-	91
7 plant	80	-	-	245
7 Rear corner (plant)	80	-	-	450

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?
1 BS B	NO (-97.5%)	NO
1 BS F	NO (-82%)	NO
1 HH BS corner	NO (-82%)	NO
1 HH F	NO (-76.9%)	NO
1 Rear B	NO (-95.7%)	NO
1 Rear B	NO (-99.6%)	NO
1 Rear F	NO (-57.4%)	NO
2 BS F	NO (-64.2%)	NO
2 central office	NO (-95.5%)	NO
2 central office	NO (-96.1%)	NO
2 GI F	NO (-51.9%)	NO
2 GI.HH Corner	NO (-48.5%)	NO
2 HH .BS corner	NO (-60.3%)	NO
2 HH F	NO (-30.5%)	NO
2 Rear corner- comms	NO (-39.8%)	NO
2 Rear F	NO (-54.3%)	NO
3 BS F	NO (-60%)	NO
3 central office	NO (-95.2%)	NO
3 GI F	NO (-44.7%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
3 GI.HH Corner	NO (-46.8%)	NO
3 HH .BS corner	NO (-58.7%)	NO
3 HH F	NO (-28%)	NO
3 Rear corner	NO (-29.9%)	NO
3 Rear F	NO (-51.4%)	NO
4 BS F- comms	NO (-48.6%)	NO
4 central office	NO (-96.5%)	NO
4 GI F	NO (-37.6%)	NO
4 GI.HH Corner	NO (-45.6%)	NO
4 HH .BS corner	NO (-55.4%)	NO
4 HH F	NO (-26.9%)	NO
4 Rear corner-comms	NO (-3.2%)	NO
4 Rear F	NO (-45.3%)	NO
5 BS F	NO (-37%)	NO
5 central office	NO (-93.5%)	NO
5 GI F	NO (-28.3%)	NO
5 GI.HH Corner	NO (-43.3%)	NO
5 HH .BS corner	NO (-53.7%)	NO
5 HH F	NO (-23.8%)	NO
6 BS F	NO (-16.7%)	NO
6 GI F	NO (-14.1%)	NO
6 GI HH corner	NO (-17.5%)	NO
6 HH BS Corner	NO (-24%)	NO
6 HH F	NO (-8.1%)	NO
6 Office centre 2	NO (-89.3%)	NO
7 BS F	NO (-8.6%)	NO
7 GI HH corner	NO (-12%)	NO
7 HH BS Corner	NO (-15%)	NO
7 HH F	NO (-4.1%)	NO
7 BS F 2	NO (-10.5%)	NO
GF Core- lift	N/A	N/A
1 GI F	NO (-75.6%)	NO
1 GI B	NO (-96.2%)	NO
Reception desks	NO (-8.7%)	NO
Reception entrance	NO (-21.8%)	NO
GF security office	N/A	N/A
GF FM room	N/A	N/A
Resi	N/A	N/A
8 HH GI F	NO (-60.7%)	NO
7 Rear F	NO (-76.8%)	NO
4 central office	NO (-95.4%)	NO
4 central office	NO (-89.8%)	NO
3 central office	NO (-95.7%)	NO
3 central office	NO (-87.1%)	NO
5 central office	NO (-93.5%)	NO
5 central office	NO (-93.6%)	NO
7 Rear	NO (-95.9%)	NO
7 Rear BS corner	NO (-52.8%)	NO
6 front	NO (-1.9%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
5 R	NO (-96.6%)	NO
5 F	NO (-21.4%)	NO
7 floor office under atrium	NO (-2.2%)	NO
6 roof	NO (-35.3%)	NO
6 Office centre 1	NO (-89.4%)	NO
6 Rear corner	NO (-6.7%)	NO
8 office	NO (-42.8%)	NO
8 BS F	NO (-13.3%)	NO
G reception waiting	NO (-6.5%)	NO
G reception waiting cafe	NO (-17.8%)	NO
7 GI F	NO (-1.4%)	NO
7 GI R	NO (-4.6%)	NO
5 Rear corner	NO (-44.5%)	NO
8 BS Rear	NO (-47%)	NO
7 Office centre	NO (-85.8%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the 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?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	14050.7	14050.7
External area [m²]	10607.8	10607.8
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	5713.35	4929.15
Average U-value [W/m²K]	0.54	0.46
Alpha value* [%]	10.21	10

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

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
100	**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	9.69	5.96
Cooling	4.86	5.68
Auxiliary	9.2	12.55
Lighting	11.97	19.14
Hot water	4.12	3.7
Equipment*	55.54	55.54
TOTAL**	**39.83**	**47.02**

* 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	0.97	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]	91.03	95.94
Primary energy* [kWh/m²]	99.49	123.29
Total emissions [kg/m²]	16.4	21.3

* 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] Chilled ceilings or passive chilled beams and displacement ventilation, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Elect										
	Actual	33	85.5	10.7	6.8	9.8	0.86	3.5	0.95	10
	Notional	13.8	103.9	4.4	7.6	15.8	0.86	3.79	----	----
[ST] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	27.2	69.9	8.8	5.5	13.2	0.86	3.5	0.95	10
	Notional	16.5	106.8	5.3	7.8	15.8	0.86	3.79	----	----
[ST] Constant volume system (fixed fresh air rate), [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	89.7	51.1	29.2	4.1	48.9	0.86	3.5	0.95	10
	Notional	5.9	78.2	1.9	5.7	13.4	0.86	3.79	----	----
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	15.5	0	5	0	1	0.86	0	0.95	0
	Notional	11.8	0	3.8	0	1	0.86	0	----	----
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	63.2	0	20.5	0	7.1	0.86	0	0.95	0
	Notional	12.1	0	3.9	0	4.1	0.86	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	14.3	0	4.6	0	0.5	0.86	0	0.95	0
	Notional	23.9	0	7.7	0	0.5	0.86	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	47.8	0	15.5	0	15	0.86	0	0.95	0
	Notional	98	0	31.6	0	17.8	0.86	0	----	----
[ST] Single room cooling system, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	0	0	0	0	0	0.86	2.25	0.95	4.5
	Notional	0	0	0	0	0	0.86	3.79	----	----

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	GB000004:Surf[1]
Floor	0.2	0.13	1R000001:Surf[0]
Roof	0.15	0.13	ST000021:Surf[1]
Windows, roof windows, and rooflights	1.5	0.91	7T000002:Surf[1]
Personnel doors	1.5	1.6	GF000009:Surf[5]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	1.61	ST00001F:Surf[0]

$U_{i\text{-}Typ}$ = 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
m³/(h.m²) at 50 Pa	5	3

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

150 Holborn

As designed

Date: Tue Mar 01 12:12:57 2016

Administrative information

Building Details

Address: 150 Holborn, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

BRUKL compliance check version: v5.2.b.1

Owner Details

Name:

Telephone number: Phone

Address: , ,

Certifier details

Name:

Telephone number:

Address: , ,

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

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	55.9
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	55.9
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	52.9
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	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 which do not meet standards in the 2013 Non-Domestic Building Services Compliance Guide are displayed in red.

2.a Building fabric

Element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	Surface where the maximum value occurs*
Wall**	0.35	0.15	0.15	GG000003:Surf[1]
Floor	0.25	0.13	0.13	GG000003:Surf[2]
Roof	0.25	0.13	0.13	01000000:Surf[2]
Windows***, roof windows, and rooflights	2.2	1.7	1.8	GB000003:Surf[0]
Personnel doors	2.2	1.61	1.61	GG000000:Surf[1]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]
U_{i-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
m³/(h.m²) at 50 Pa	10	3

2.b 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	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- retail/ resturant Fan coil units

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	4.5	0	1.8	0.7
Standard value	0.91*	3.9	N/A	1.6	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system	YES				

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

2- Retail kitchen

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system	YES				

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

3- retail WC

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system	YES				

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

4- coridors/circ

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system	YES				

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

1- Retail DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.009
Standard value	1	N/A

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	Zone	Standard
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
G Retail	-	-	-	0.4	-	-	-	1.8	-	-	N/A
G Retail food prep	-	-	-	1	-	-	-	-	-	-	N/A
G HH BS corner	-	-	-	0.4	-	-	-	1.8	-	-	N/A
G HH F	-	-	-	0.4	-	-	-	1.8	-	-	N/A
G BS F cafe	-	-	-	0.4	-	-	-	1.8	-	-	N/A
G GI F	-	-	-	0.4	-	-	-	1.8	-	-	N/A
G GI B	-	-	-	0.4	-	-	-	1.8	-	-	N/A
G retial	-	-	-	0.4	-	-	-	1.8	-	-	N/A
G BS R cafe	-	-	-	0.4	-	-	-	1.8	-	-	N/A
-01 Retail	-	-	-	0.4	-	-	-	1.8	-	-	N/A
-01 Retail	-	-	-	0.4	-	-	-	1.8	-	-	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	
G Retail	-	70	40	1178
G Retail food prep	-	70	-	405
G HH BS corner	-	70	40	450
G HH F	-	70	40	549
G retail WC	-	70	-	78
G BS F cafe	-	70	40	454
G GI F	-	70	40	1788
G GI B	-	70	40	1108
G retial	-	70	40	1054
G BS R cafe	-	70	40	489
G BS R WC	-	70	-	85
-01 Retail- store	70	-	-	290
-01 Retail	-	70	40	4824
-01 Retail	-	70	40	888

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?
G Retail	NO (-48.8%)	NO
G HH BS corner	NO (-70.2%)	NO
G HH F	NO (-54.1%)	NO
G BS F cafe	NO (-77.3%)	NO
G GI F	NO (-68.2%)	NO
G GI B	NO (-97.8%)	NO
G retial	NO (-62.5%)	NO
G BS R cafe	NO (-97.5%)	NO
-01 Retail	N/A	N/A
-01 Retail	N/A	N/A

Criterion 4: The performance of the building, as built, should be consistent with the 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?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	1393.8	1393.8
External area [m²]	1250.2	1250.2
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	511.48	488.16
Average U-value [W/m²K]	0.41	0.39
Alpha value* [%]	10	10

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

Building Use

% Area	Building Type
74	**A1/A2 Retail/Financial and Professional services**
26	**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	7.54	5.5
Cooling	7.58	9.27
Auxiliary	26.98	26.32
Lighting	39.09	53.8
Hot water	27.67	29.66
Equipment*	44.29	44.29
TOTAL**	**108.87**	**124.55**

* 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]	100.05	143.53
Primary energy* [kWh/m²]	312.49	306.91
Total emissions [kg/m²]	52.9	55.9

* 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] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity									
Actual	16.4	90.2	5.6	8.8	21.6	0.82	2.85	0.91	6.5
Notional	9	146.6	2.9	10.7	23.9	0.86	3.79	---	---
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity									
Actual	75.9	0	25.7	0	1.2	0.82	0	0.91	0
Notional	92.5	0	29.8	0	1.2	0.86	0	---	---
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity									
Actual	11.3	0	3.8	0	27.6	0.82	0	0.91	0
Notional	14.3	0	4.6	0	32.7	0.86	0	---	---
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity									
Actual	33.1	0	11.2	0	328.2	0.82	0	0.91	0
Notional	14.8	0	4.8	0	211.5	0.86	0	---	---

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	GG000003:Surf[1]
Floor	0.2	0.13	GG000003:Surf[2]
Roof	0.15	0.13	01000000:Surf[2]
Windows, roof windows, and rooflights	1.5	1.66	GG000000:Surf[0]
Personnel doors	1.5	1.61	GG000000:Surf[1]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

$U_{i\text{-}Typ}$ = 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
m³/(h.m²) at 50 Pa	5	3

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

150 Holborn

As designed

Date: Tue Mar 01 12:16:24 2016

Administrative information

Building Details

Address: 150 Holborn, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

BRUKL compliance check version: v5.2.b.1

Owner Details

Name:

Telephone number: Phone

Address: , ,

Certifier details

Name:

Telephone number:

Address: , ,

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

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	55.9
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	55.9
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	47.8
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	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 which do not meet standards in the 2013 Non-Domestic Building Services Compliance Guide are displayed in red.

2.a 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	GG000003:Surf[1]
Floor	0.25	0.13	0.13	GG000003:Surf[2]
Roof	0.25	0.13	0.13	01000000:Surf[2]
Windows***, roof windows, and rooflights	2.2	1.7	1.8	GB000003:Surf[0]
Personnel doors	2.2	1.61	1.61	GG000000:Surf[1]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-Limit}}$ = 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
m³/(h.m²) at 50 Pa	10	3

2.b 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	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- retail/ resturant Fan coil units

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	4.5	0	1.8	0.7
Standard value	0.91*	3.9	N/A	1.6	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

2- Retail kitchen

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	-	0	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

3- retail WC

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	-	0	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

4- coridors/circ

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	-	0	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

1- Retail DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0.009
Standard value	1	N/A

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
G Retail	-	-	-	0.4	-	-	-	1.8	-	-	N/A
G Retail food prep	-	-	-	1	-	-	-	-	-	-	N/A
G HH BS corner	-	-	-	0.4	-	-	-	1.8	-	-	N/A
G HH F	-	-	-	0.4	-	-	-	1.8	-	-	N/A
G BS F cafe	-	-	-	0.4	-	-	-	1.8	-	-	N/A
G GI F	-	-	-	0.4	-	-	-	1.8	-	-	N/A
G GI B	-	-	-	0.4	-	-	-	1.8	-	-	N/A
G retial	-	-	-	0.4	-	-	-	1.8	-	-	N/A
G BS R cafe	-	-	-	0.4	-	-	-	1.8	-	-	N/A
-01 Retail	-	-	-	0.4	-	-	-	1.8	-	-	N/A
-01 Retail	-	-	-	0.4	-	-	-	1.8	-	-	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	
G Retail	-	70	40	1178
G Retail food prep	-	70	-	405
G HH BS corner	-	70	40	450
G HH F	-	70	40	549
G retail WC	-	70	-	78
G BS F cafe	-	70	40	454
G GI F	-	70	40	1788
G GI B	-	70	40	1108
G retial	-	70	40	1054
G BS R cafe	-	70	40	489
G BS R WC	-	70	-	85
-01 Retail- store	70	-	-	290
-01 Retail	-	70	40	4824
-01 Retail	-	70	40	888

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?
G Retail	NO (-48.8%)	NO
G HH BS corner	NO (-70.2%)	NO
G HH F	NO (-54.1%)	NO
G BS F cafe	NO (-77.3%)	NO
G GI F	NO (-68.2%)	NO
G GI B	NO (-97.8%)	NO
G retial	NO (-62.5%)	NO
G BS R cafe	NO (-97.5%)	NO
-01 Retail	N/A	N/A
-01 Retail	N/A	N/A

Criterion 4: The performance of the building, as built, should be consistent with the 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?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	1393.8	1393.8
External area [m²]	1250.2	1250.2
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	511.48	488.16
Average U-value [W/m²K]	0.41	0.39
Alpha value* [%]	10	10

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

Building Use

% Area	Building Type
74	**A1/A2 Retail/Financial and Professional services**
26	**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	7.23	5.5
Cooling	7.58	9.27
Auxiliary	26.98	26.32
Lighting	39.09	53.8
Hot water	27.67	29.66
Equipment*	44.29	44.29
TOTAL**	**108.55**	**124.55**

* 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	9.77	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]	100.05	143.53
Primary energy* [kWh/m²]	312.1	306.91
Total emissions [kg/m²]	47.8	55.9

* 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] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity									
Actual	16.4	90.2	5.3	8.8	21.6	0.86	2.85	0.95	6.5
Notional	9	146.6	2.9	10.7	23.9	0.86	3.79	---	---
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity									
Actual	75.9	0	24.7	0	1.2	0.86	0	0.95	0
Notional	92.5	0	29.8	0	1.2	0.86	0	---	---
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity									
Actual	11.3	0	3.7	0	27.6	0.86	0	0.95	0
Notional	14.3	0	4.6	0	32.7	0.86	0	---	---
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity									
Actual	33.1	0	10.7	0	328.2	0.86	0	0.95	0
Notional	14.8	0	4.8	0	211.5	0.86	0	---	---

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	GG000003:Surf[1]
Floor	0.2	0.13	GG000003:Surf[2]
Roof	0.15	0.13	01000000:Surf[2]
Windows, roof windows, and rooflights	1.5	1.66	GG000000:Surf[0]
Personnel doors	1.5	1.61	GG000000:Surf[1]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

$U_{i\text{-}Typ}$ = 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
m³/(h.m²) at 50 Pa	5	3

Project Information
Building type Top-floor flat

Reference
Date 18 November 2015
Client PBW Project 150 Holborn
London
EC1N 2NS

REGULATION COMPLIANCE REPORT - Approved Document L1A, 2012 Edition, England
assessed by program JPA Designer version 6.01a1, printed on 20/11/2015 at 13:00:19

New dwelling as designed

1 TER and DER
Fuel for main heating system: Gas (mains) (fuel factor = 1.00)

Target Carbon Dioxide Emission Rate	TER = 16.47	
Dwelling Carbon Dioxide Emission Rate	DER = 13.39	OK

1b TER and DER

Target Fabric Energy Efficiency (TFEE)	TFEE = 55.1	
Dwelling Carbon Dioxide Emission Rate (DFER)	DFEE = 37.3	OK

2a Thermal bridging
Thermal bridging calculated from linear thermal transmittances for each junction

2b Fabric U-values

Element	Average	Highest	
Wall	0.15 (max. 0.30)	0.15 (max. 0.70)	OK
Floor	0.00 (max. 0.25)	0.00 (max. 0.70)	OK
Roof	0.13 (max. 0.20)	0.13 (max. 0.35)	OK
Openings	0.85 (max. 2.00)	0.85 (max. 3.30)	OK

3 Air permeability

Air permeability at 50 pascals:	1.00	OK
Maximum :	10.00	

4 Heating efficiency
Main heating system:
Boiler and underfloor heating, mains gas
Source of efficiency: from manufacturer

Efficiency: 89.5% SEDBUK2009
Minimum: 88.0% OK
Secondary heating system:
None -

5 Cylinder insulation
Hot water storage No cylinder

6 Controls
(Also refer to "Domestic Building Services Compliance Guide" by the DCLG)

Space heating controls	Programmer + at least 2 room thermostats	OK
Hot water controls	No cylinder	
Hot water controls	No cylinder	

7 Low energy lights
Percentage of fixed lights with low-energy fittings: 100.0%
Minimum: 75.0% OK

8 Mechanical ventilation
Specific fan power : 0.77 Efficiency : 86.00
Maximum : 1.5W/(litre/sec) and efficiency not less than 70% OK

9 Summertime temperature
Overheating risk (Thames Valley): OK
Medium OK
Based on:
Thermal mass parameter : 100.00
Overshading : Average or unknown (20-60 % sky blocked)
Orientation : North
Ventilation rate : 4.00
Blinds/curtains :
None with blinds/shutters closed 0.00% of daylight hours

10 Key features
Double-glazed, air-filled, low-E, En=0.2, hard coat U-value 0.85 W/m²K
Party wall U-value 0.00 W/m²K
Design air permeability 1.0 m³/h.m²

Project Information
Building type Top-floor flat

Reference
Date 18 November 2015
Client PBW Project 150 Holborn
London
EC1N 2NS

REGULATION COMPLIANCE REPORT - Approved Document L1A, 2012 Edition, England
assessed by program JPA Designer version 6.01a1, printed on 20/11/2015 at 12:59:50

New dwelling as designed

1 TER and DER

Fuel for main heating system: Gas (mains) (fuel factor = 1.00)

Target Carbon Dioxide Emission Rate	TER = 16.47	
Dwelling Carbon Dioxide Emission Rate	DER = 10.67	OK

1b TER and DER

Target Fabric Energy Efficiency (TFEE)	TFEE = 55.1	
Dwelling Carbon Dioxide Emission Rate (DFER)	DFEE = 37.3	OK

2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

2b Fabric U-values

Element	Average	Highest	
Wall	0.15 (max. 0.30)	0.15 (max. 0.70)	OK
Floor	0.00 (max. 0.25)	0.00 (max. 0.70)	OK
Roof	0.13 (max. 0.20)	0.13 (max. 0.35)	OK
Openings	0.85 (max. 2.00)	0.85 (max. 3.30)	OK

3 Air permeability

Air permeability at 50 pascals:	1.00	OK
Maximum :	10.00	

4 Heating efficiency

Main heating system:
Boiler and underfloor heating, mains gas
Source of efficiency: from manufacturer

Efficiency: 95.0% SEDBUK2009
Minimum: 88.0% OK

Secondary heating system:
None -

5 Cylinder insulation

Hot water storage No cylinder

6 Controls

(Also refer to "Domestic Building Services Compliance Guide" by the DCLG)

Space heating controls	Programmer + at least 2 room thermostats	OK
Hot water controls	No cylinder	
Hot water controls	No cylinder	

7 Low energy lights

Percentage of fixed lights with low-energy fittings: 100.0%
Minimum: 75.0% OK

8 Mechanical ventilation

Specific fan power : 0.77 Efficiency : 86.00
Maximum : 1.5W/(litre/sec) and efficiency not less than 70% OK

9 Summertime temperature

Overheating risk (Thames Valley): OK
Medium OK

Based on:

Thermal mass parameter :	100.00
Overshading :	Average or unknown (20-60 % sky blocked)
Orientation : North	
Ventilation rate :	4.00
Blinds/curtains :	

None with blinds/shutters closed 0.00% of daylight hours

10 Key features

Double-glazed, air-filled, low-E, En=0.2, hard coat U-value 0.85 W/m²K
Party wall U-value 0.00 W/m²K
Design air permeability 1.0 m³/h.m²
Photovoltaic array

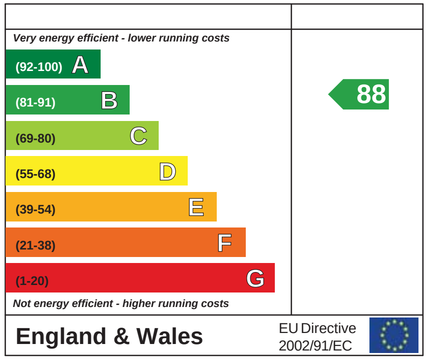
Predicted Energy Assessment

150 Holborn	Dwelling type:	Top-floor flat
London	Date of assessment:	20 November 2015
EC1N 2NS	Produced by	Elementa Consulting
	Total floor area:	128 m²

This is a Predicted Energy Assessment for a property which is not yet complete. It includes a predicted energy rating which might not represent the final energy rating of the property on completion. Once the property is completed, an Energy Performance Certificate is required providing information about the energy performance of the completed property.

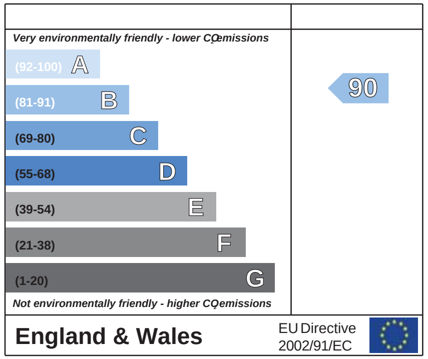
Energy performance has been assessed using the SAP 2012 methodology and is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs and environmental impact based on carbon dioxide (CO_2) emissions.

Energy Efficiency Rating



The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

Environmental Impact (CO_2) Rating



The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO_2) emissions. The higher the rating the less impact it has on the environment.

Project Information
Building type Mid-floor flat

Reference
Date 18 November 2015
Client PBW Project 150 Holborn
EC1N 2NS

REGULATION COMPLIANCE REPORT - Approved Document L1A, 2012 Edition, England
assessed by program JPA Designer version 6.01a1, printed on 20/11/2015 at 12:58:44

New dwelling as designed

1 TER and DER
Fuel for main heating system: Gas (mains) (fuel factor = 1.00)

Target Carbon Dioxide Emission Rate	TER = 16.21	
Dwelling Carbon Dioxide Emission Rate	DER = 12.64	OK

1b TER and DER

Target Fabric Energy Efficiency (TFEE)	TFEE = 45.7	
Dwelling Carbon Dioxide Emission Rate (DFER)	DFEE = 27.6	OK

2a Thermal bridging
Thermal bridging calculated from linear thermal transmittances for each junction

2b Fabric U-values

Element	Average	Highest	
Wall	0.15 (max. 0.30)	0.15 (max. 0.70)	OK
Floor	0.00 (max. 0.25)	0.00 (max. 0.70)	OK
Roof	0.00 (max. 0.20)	0.00 (max. 0.35)	OK
Openings	0.85 (max. 2.00)	0.85 (max. 3.30)	OK

3 Air permeability

Air permeability at 50 pascals:	1.00	OK
Maximum :	10.00	

4 Heating efficiency
Main heating system:
Boiler and underfloor heating, mains gas
Source of efficiency: from manufacturer

Efficiency: 89.5% SEDBUK2009
Minimum: 88.0% OK

Secondary heating system:
None -

5 Cylinder insulation
Hot water storage No cylinder

6 Controls
(Also refer to "Domestic Building Services Compliance Guide" by the DCLG)

Space heating controls	Programmer + at least 2 room thermostats	OK
Hot water controls	No cylinder	
Hot water controls	No cylinder	

7 Low energy lights
Percentage of fixed lights with low-energy fittings: 100.0%
Minimum: 75.0% OK

8 Mechanical ventilation
Specific fan power : 0.72 Efficiency : 86.00
Maximum : 1.5W/(litre/sec) and efficiency not less than 70% OK

9 Summertime temperature
Overheating risk (Thames Valley): OK
Slight OK
Based on:
Thermal mass parameter : 250.00
Overshading : Average or unknown (20-60 % sky blocked)
Orientation : North
Ventilation rate : 4.00
Blinds/curtains :
None with blinds/shutters closed 0.00% of daylight hours

10 Key features
Double-glazed, air-filled, low-E, En=0.2, hard coat U-value 0.85 W/m²K
Party wall U-value 0.00 W/m²K
Design air permeability 1.0 m³/h.m²

Approval of JPA Designer by BRE applies only to the software, data is not subject to quality control procedures, users are themselves responsible for the accuracy of the data. The results of the calculation should not be accepted without first checking the input data.

Project Information
Building type Mid-floor flat

Reference
Date 18 November 2015
Client PBW Project 150 Holborn
EC1N 2NS

REGULATION COMPLIANCE REPORT - Approved Document L1A, 2012 Edition, England
assessed by program JPA Designer version 6.01a1, printed on 20/11/2015 at 12:58:03

New dwelling as designed

1 TER and DER

Fuel for main heating system: Gas (mains) (fuel factor = 1.00)		
Target Carbon Dioxide Emission Rate	TER = 16.21	
Dwelling Carbon Dioxide Emission Rate	DER = 10.51	OK

1b TER and DER

Target Fabric Energy Efficiency (TFEE)	TFEE = 45.7	
Dwelling Carbon Dioxide Emission Rate (DFER)	DFEE = 27.6	OK

2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

2b Fabric U-values

Element	Average	Highest	
Wall	0.15 (max. 0.30)	0.15 (max. 0.70)	OK
Floor	0.00 (max. 0.25)	0.00 (max. 0.70)	OK
Roof	0.00 (max. 0.20)	0.00 (max. 0.35)	OK
Openings	0.85 (max. 2.00)	0.85 (max. 3.30)	OK

3 Air permeability

Air permeability at 50 pascals:	1.00	OK
Maximum :	10.00	

4 Heating efficiency
Main heating system:
Boiler and underfloor heating, mains gas
Source of efficiency: from manufacturer

Efficiency: 95.0% SEDBUK2009
Minimum: 88.0% OK

Secondary heating system:
None -

5 Cylinder insulation
Hot water storage No cylinder

6 Controls
(Also refer to "Domestic Building Services Compliance Guide" by the DCLG)

Space heating controls	Programmer + at least 2 room thermostats	OK
Hot water controls	No cylinder	
Hot water controls	No cylinder	

7 Low energy lights

Percentage of fixed lights with low-energy fittings: 100.0%
Minimum: 75.0% OK

8 Mechanical ventilation

Specific fan power : 0.72 Efficiency : 86.00
Maximum : 1.5W/(litre/sec) and efficiency not less than 70% OK

9 Summertime temperature

Overheating risk (Thames Valley):		OK
	Slight	OK
Based on:		
Thermal mass parameter :	250.00	
Overshading :	Average or unknown (20-60 % sky blocked)	
Orientation : North		
Ventilation rate :	4.00	
Blinds/curtains :		
None with blinds/shutters closed 0.00% of daylight hours		

10 Key features

Double-glazed, air-filled, low-E, En=0.2, hard coat U-value 0.85 W/m²K
Party wall U-value 0.00 W/m²K
Design air permeability 1.0 m³/h.m²
Photovoltaic array

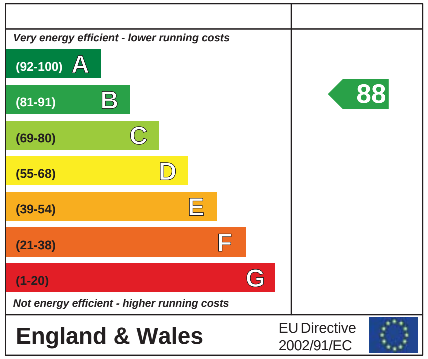
Predicted Energy Assessment

150 Holborn EC1N 2NS	Dwelling type: Date of assessment: Produced by Total floor area:	Mid-floor flat 20 November 2015 Elementa Consulting 93 m²

This is a Predicted Energy Assessment for a property which is not yet complete. It includes a predicted energy rating which might not represent the final energy rating of the property on completion. Once the property is completed, an Energy Performance Certificate is required providing information about the energy performance of the completed property.

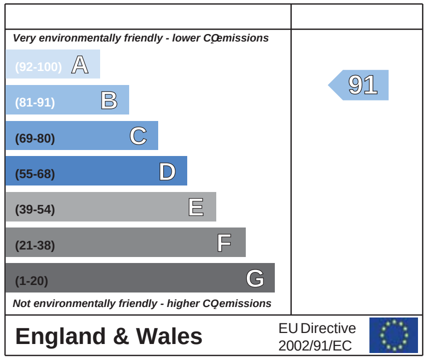
Energy performance has been assessed using the SAP 2012 methodology and is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs and environmental impact based on carbon dioxide (CO_2) emissions.

Energy Efficiency Rating



The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

Environmental Impact (CO_2) Rating



The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO_2) emissions. The higher the rating the less impact it has on the environment.

10.7 APPENDIX G – COMMUNICATION WITH 2 WATERHOUSE SQUARE

From: Clara Bagenal George
Sent: 07 December 2015 16:32
To: 'Nathan.Barry@CBREMS.com'
Cc: 'Nicola.Storry@CBRE.com'; Ed Garrod; Alex Sinclair
Subject: District heating

Dear Nathan,

We are looking at redeveloping 150 Holborn and wanted to enquire if there are any plans to install district heating to 2 water house square and if so if there is potential for 150 Holborn to be connected to this system.

Kind regards,
Clara Bagenal George | Environmental Design Engineer

One Valentine Place, London, SE1 8QH
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www.elementaconsulting.com
Supporting Teenage Cancer Trust – Helping young people fight cancer

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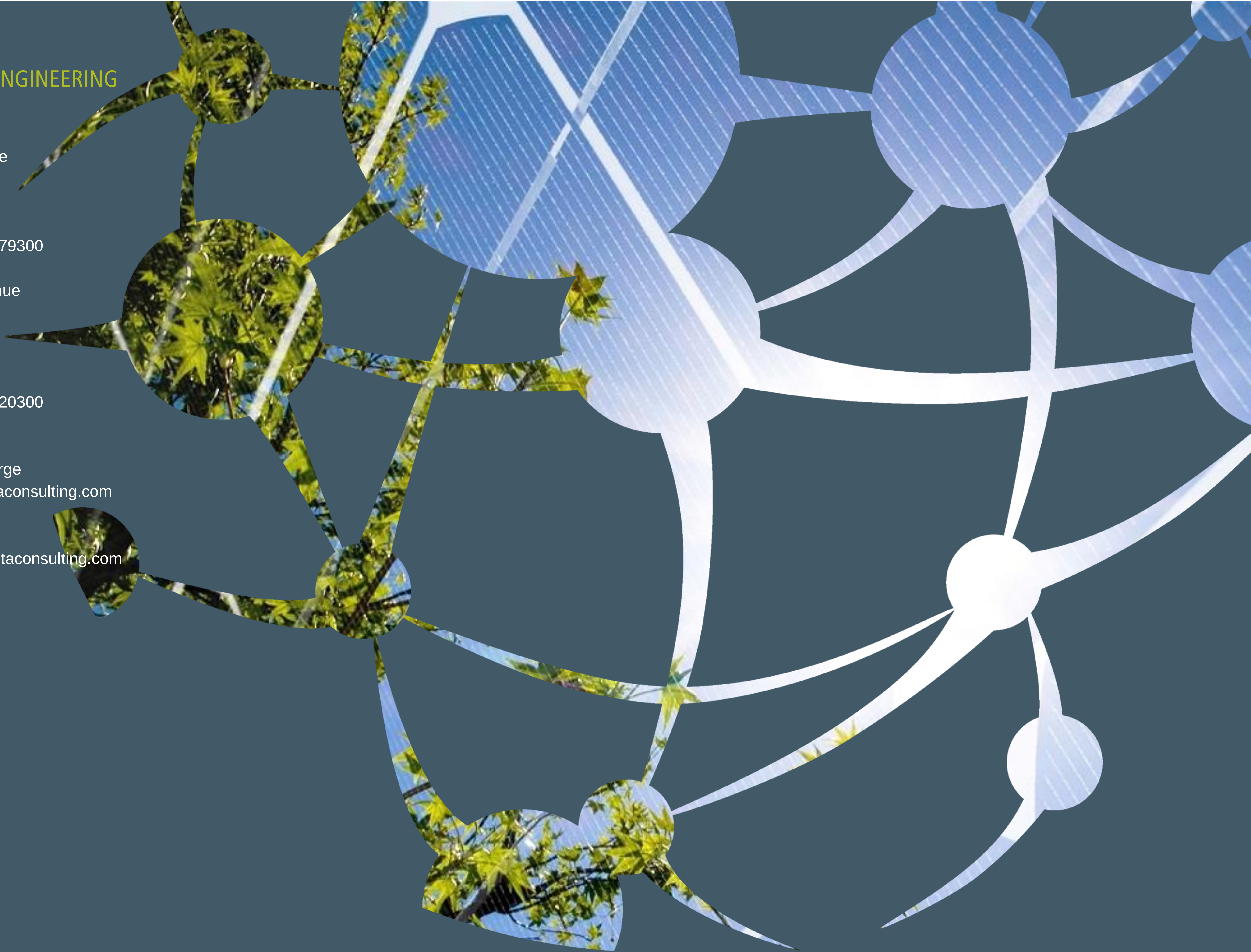
We are operating a new flexible working hours for our staff. Please note the office will close early on Fridays. Click here for more information.

DEEP GREEN ENGINEERING



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Ed.garrod@elementaconsulting.com