# The Honourable Society of Lincoln's Inn

Energy Strategy and Part L Compliance Report

July 2015

The Honourable Society of Lincoln's Inn

Mott MacDonald

# Issue and revision record

| Revision | Date | Originator | Checker | Approver | Description |
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| P1 | 06 March 2015 | R Fletton | A Long | TR Bradford | For Information |
| P2 | 13 July 2015 | R Fletton | A Long | TR Bradford | For Planning |
| P3 | 20 July 2015 | R Fletton | A Long | TR Bradford | For Planning |
| P4 | 27 July 2015 | R Fletton | A Long | TR Bradford | For Planning |

# Contents

# Executive Summary

This report addresses the aspirations for energy efficiency and carbon dioxide emission reductions the London Borough of Camden has for new buildings, and how the new east terrace education suite and north library extension at Honourable Society of Lincoln's Inn will endeavour to achieve them.

Carbon dioxide emission rates were calculated using the Apache dynamic energy model, based on the national calculation methodology templates.

Application of the Mayor's Plan energy hierarchy includes reducing heat loss from the building by incorporating very good U values and air tightness, as well as proposing efficient plant and lighting. An appraisal of renewable technologies was carried out to determine the most suitable method of achieving the required emissions reduction rate, with the result that ground source heat pumps best compliment the building's design and sensitive location.

After assessment using the Mayor's Plan energy hierarchy, the reduction in carbon dioxide emissions of the proposed new build education suite and library extension are greater than 32% of the 2013 target emission rate with over 17% reduction achieved using renewable technology alone. However, to meet the respective 35% and 20% targets in accordance with London Borough of Camden and the London Plan policies additional renewable technologies would need to be incorporated, which due to the restraints of developing within a Grade II* heritage site are not considered feasible.

# 1 Introduction

## 1.1 Development Proposal

The Honourable Society of Lincoln's Inn seek to refurbish and improve existing kitchen and catering facilities which are currently inadequate for the needs of the Inn. There is also a need to provide expansion space for the existing library alongside new advocacy training and educational facilities to enhance the function of the Inn. In providing these new facilities, the existing Under Treasurer's residence will need be relocated to another part of the Inn.

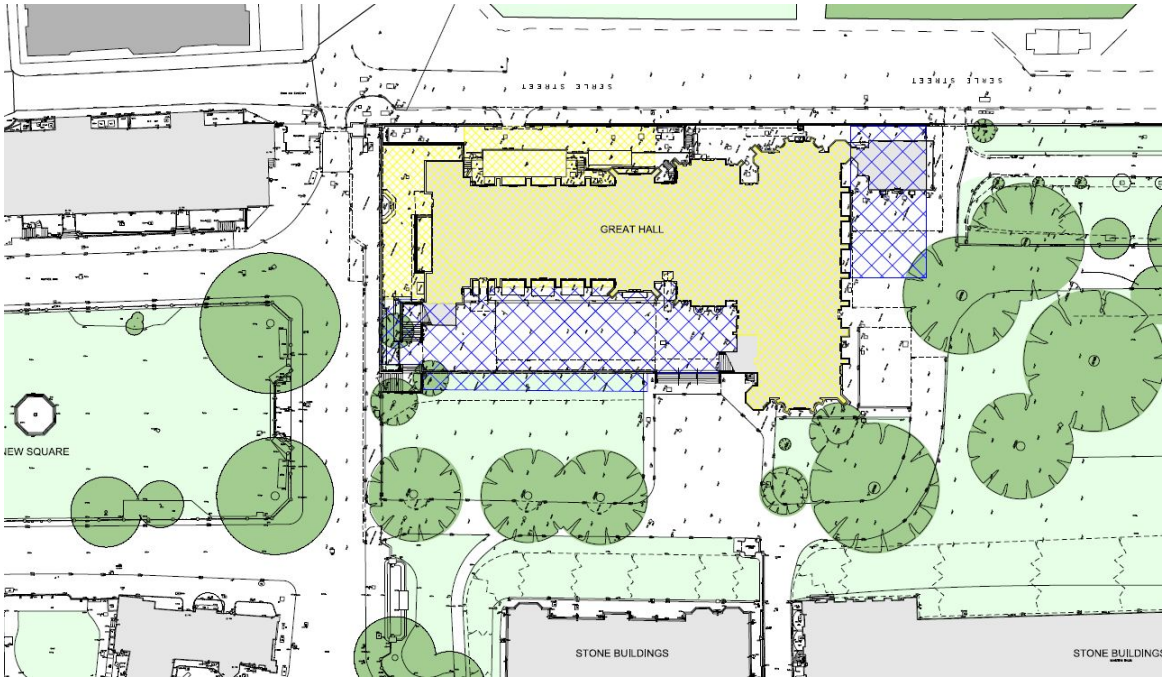
To achieve the above proposals, planning and listed building consent are sought for five separate applications proposed at Lincoln's Inn:

- Application 1 – Old Hall Kitchen Refurbishment (Submitted to LB Camden Ref 2015/2413/P & 2015/2517/L)
- Application 2 – Great Hall Refurbishment Works (including Old Hall Temporary Kitchen Works)
- Application 3 – East Terrace Development (Excavation to create a two storey basement containing a lecture theatre, advocacy rooms and study areas)
- Application 4 – Library Extension (including demolition of Under Treasurer's House)
- Application 5 – 15 New Square (Change of use from Office B1 to Residential C3)

This Energy Strategy and Part L Compliance Report has been prepared as part of applications 3 and 4.

The proposed development will consist of two new build extensions; the east terrace education suite with advocacy rooms and a lecture theatre, and the library extension with administration offices, archive storage and reading areas. The buildings are to be adjacent to the existing Grade II* listed Great Hall. Figure 1.1 shows the Great Hall with the proposed east terrace education suite and the library extension hatched in blue.

Figure 1.1: Proposed Building Locations




Source: Rick Mather Architects

## 1.2 Energy and Emissions Analysis

This report satisfies the requirement in Policy 5.2 of the London Plan for an energy assessment. This policy is discussed further in the following chapter, however the requirements of such a report include:

- Calculation of the baseline energy demand and $CO_2$ emissions;
- Proposals to reduce $CO_2$ emissions through sustainable design;
- Proposals to reduce $CO_2$ emissions by connecting to local decentralised heat networks;
- Proposals to reduce $CO_2$ emissions through the use of onsite renewable energy technologies.

This report follows the structure outlined above, and will also make reference the target emission rate of the Building Regulations Part L 2013. The relevant local and regional planning policies are discussed in the following chapters.

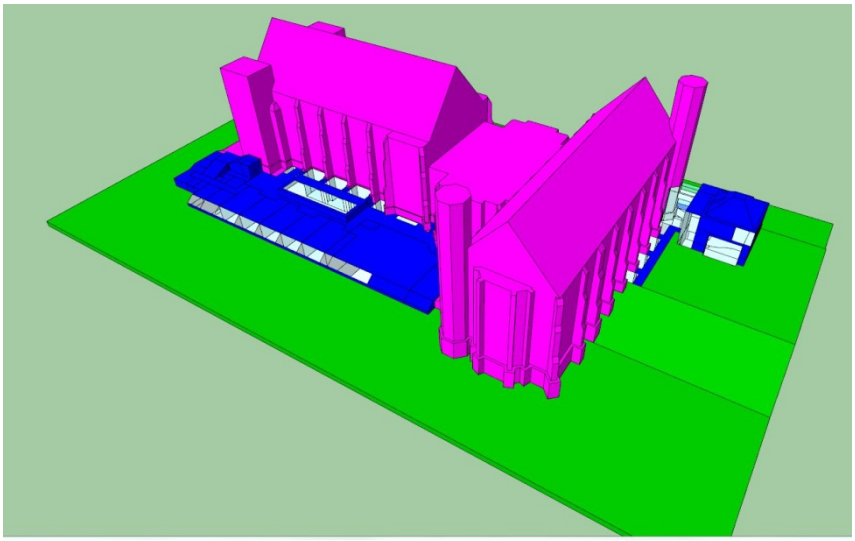
## 1.3 Calculation Methodology

The carbon dioxide emission rates cited in this report were calculated using the Apache dynamic simulation building energy model based on the national calculation methodology (NCM) templates. The simulations were carried out using IES Virtual Environment software version 2014, a Communities and Local Government approved dynamic simulation modelling tool.

The building emission rates (BER) and target emission rates (TER) produced in the IES Apache model include emissions associated with heating, cooling, auxiliary energy for these systems, lighting, and domestic hot water.

Figure 1.2 below shows the proposed east terrace education suite and north library extension in blue and the existing Great Hall & library building in pink. The model is based on plans, elevations, and section drawings received from Rick Mather Architects.

Figure 1.2: View of the IES model



Source: IES Virtual Environment version 2014

# 2 The London Plan

Chapter 5 of the London Plan sets out a comprehensive range of policies forming London's response to climate change. The policies that directly relate to the energy strategy for the Lincoln's Inn are summarised below.

## 2.1 Policy 5.2 – Minimising carbon dioxide emissions

To achieve zero carbon in new developments, a series of stepped target reductions have been introduced. Development proposals after the 6th April 2014 should reduce their predicted emissions by 35% from the 2013 target emission rate.

Policy 5.2 also introduces the energy hierarchy, supplemented by the following polices, and discussed in further detail in Section 2.5.

Development proposals are also required to provide a detailed energy assessment to demonstrate how the $CO_2$ emissions targets will be met. This report satisfies this requirement.

## 2.2 Policy 5.3 – Sustainable design and construction

Policy 5.3 ties in to the "be lean" stage of the energy hierarchy, and encourages developments to incorporate sustainable design from the very start of the design process.

## 2.3 Policy 5.6 – Decentralised energy in development proposals

Developments should look to connect to existing local heating or cooling networks, where this is not feasible they should then assess the feasibility of implementing a side wide combined heat and power (CHP) network. If CHP is not viable, developments should determine the potential for installing a communal heating or cooling network.

## 2.4 Policy 5.7 – Renewable energy

To increase the proportion of energy generated from renewable sources, major developments should reduce carbon dioxide emissions through the use of onsite renewable technologies.

## 2.5 The Energy Hierarchy

The energy hierarchy introduced in Policy 5.2 of the draft London Plan is supported by Policies 5.3, 5.6, and 5.7. The hierarchy is "be lean, be clean, and be green"; in other words new developments should reduce demand, use decentralised energy networks, and implement renewable technologies. This is further developed in The Energy Planning: Greater London Authority guidance on preparing energy assessments (April 2014) which has been used to demonstrate compliance.

One: use good design to minimise the development's energy needs

### Be Lean

The development should be made as energy efficient as possible by maximising the use of sunlight, thermal mass, and the site's microclimate to provide natural lighting, heating, and cooling of buildings. The remaining mechanical heating, cooling, and ventilation also should be supplied as efficiently as possible, through selection of energy efficient plant. Electrical systems should also be designed to reduce energy consumption, through use of metering, intelligent controls and efficient lighting systems.

Two: make the most use of efficient energy, heating and cooling networks

### Be Clean

Once energy consumption has been minimised, the priority is to use local (or "decentralised") energy sources, in particular combined heat and power systems. Local CHP systems reduce transmission losses associated with grid electricity consumption, and thus increase the efficiency of onsite electricity usage. 'Waste' heat in the generation of the electricity is then used to heat the local properties through networked district heating systems, further increasing the efficiency and viability of such plant. Through use of absorption chillers, this can be extended to combined cooling, heating and power systems (CCHP).

Decentralised energy sources and district heating systems have been determined to be unfeasible for the proposed development due to the historic status of the buildings within the grounds surrounding areas of proposed design. Instead a sensible, discreet renewable technology will be used to achieve the required reduction in energy.

Three: use renewable sources of energy

### Be Green

Following application of the "lean" and "clean" design principles, there may still be demand for energy onsite. As much as possible this remaining energy demand should be met through zero and low carbon

energy sources, such as solar power, wind power, heat pumps, bio-fuel and geothermal energy.

# 3 Camden Core Strategy

The Camden Core Strategy is a major component of the Local Development Framework for Camden. The London Plan has been used as the basis for the Core Strategy.

The policies within the Core Strategy that relate directly to this energy statement are summarised below.

## 3.1 Section 3 - 13.8 Ensuring developments use less energy

Non-residential developments must be assessed against the Building Research Establishment Environmental Assessment Methodology (BREEAM), which assesses the following areas of a building's design:

- Management
- Health and wellbeing
- Energy
- Transport
- Water
- Materials
- Waster
- Land use and ecology
- Pollution

## 3.2 Section 3 - 13.11 – Generating renewable energy on site

Paragraph 13.11 of the Camden Core Strategy improves on Policy 5.2 of the London Plan, requiring developments to achieve a reduction in carbon dioxide emissions of 20% from on-site renewable energy generation. Developments should also look to implement the energy hierarchy by reducing energy demand, connecting to decentralised heat networks, and then incorporating renewable technologies onsite.

# 4 Baseline

To demonstrate the energy and carbon savings achieved through the implementation of the energy hierarchy, baseline energy consumption and carbon dioxide emission rates are needed. These were calculated by modelling the building with the minimum acceptable efficiencies required in the Building Regulations Approved Document L2A 2013 and the Non-Domestic Building Services Compliance Guide 2013.

The baseline model of the east terrace education suite and the north library extension meets or exceeds the minimum U values required by the Building Regulations Approved Document L2A 2013, shown in Table 4.1.

Table 4.1: U value standards

| External Element | Limiting U Value ($W/m^2K$) | Proposed U Value ($W/m^2K$) |
|---|---|---|
| External walls | 0.35 | 0.26 |
| Ground floors | 0.25 | 0.22 |
| Roofs | 0.25 | 0.18 |
| Windows, rooflights, doors | 2.20 | 1.80 |

Source: Building Regulations Approved Document L2A, 2013

The air permeability of the baseline model is 5 $m^3/m^2$ hour at 50 Pascals which exceeds the minimum standard of 10 $m^3/m^2$ hour at 50 Pascals outlined in the Building Regulations.

The East terrace education suite's advocacy rooms and lecture theatre will be heated and cooled with mechanical ventilation. The remaining occupied spaces will be heated with underfloor heating to the circulation spaces. The North library extension will primarily be naturally ventilated and heated with wall hung radiators to the administration offices and underfloor heating to reading room and basement stacks. The mechanical and electrical system efficiencies will meet or exceed the minimum specified in the Non-Domestic Building Services Compliance Guide 2013, outlined below:

- Heating systems:
  - Natural gas fired boilers, default efficiency of 92%
  - Air cooled chillers, default coefficient of performance (COP) of 3.125
- Ventilation system:
  - Specific fan power of value of 1.9 W/l/s
  - Untested ductwork and air handling unit (AHU) leakage rates
  - No heat recovery

- Metering and controls:
  - Basic local manual control, no sub metering of services
- Lighting:
  - Efficacy of 35 lumens/circuit Watt
  - Display lighting efficacy of 22 lumens/circuit Watt
- Power correction factor:
  - < 0.90

Table 4.2 shows the energy consumption by end use in the baseline model; note that equipment is unregulated energy consumption and is not assessed by the BER or TER.

Table 4.2: Energy end use

| End use | Baseline energy consumption (kWh/m$^2$/year |
|---|---|
| Heating | 55.56 |
| Cooling | 6.61 |
| Auxiliary energy | 16.56 |
| Lighting | 19.36 |
| Hot water | 1.32 |
| Total – regulated | 99.41 |

Source: IES VE version 2015

The BER and TER for the baseline model are listed in Table 4.3.

Table 4.3: Emission rates

| | TER (kgCO$_2$/m$^2$/year) | BER (kgCO$_2$/m$^2$/year) |
|---|---|---|
| Baseline building | 25.1 | 33.8 |

Source: IES VE version 2015

The BER exceeds the TER. Policies 5.2 and Core Strategy requires an improvement of 35% over the TER, which the baseline model clearly does not achieve.

The results in **Appendix A** conclude that the baseline exceeds the solar gain limit for the lower Advocacy Rooms 6-10 and therefor **fails Criterion 3** of the Building Regulations.

# 5 Be Lean

Passive design is a key element of sustainable building. It is design that does not require mechanical heating or cooling, and is about making the most of free, natural sources of energy, such as the sun and wind, to provide heating, cooling, ventilation and lighting. Passive design aims to maximise the comfort for people working in and using the proposed buildings while minimising energy use and the impact on the environment.

Buildings lose heat through the building fabric and from the infiltration of cold air through gaps and cracks in the building, and by reducing the heat lost via these paths; the energy efficiency of the proposed buildings will be improved.

The proposed buildings will incorporate U values that are significantly better than the minimum required by the Building Regulations ADL2A 2013, listed in Table 5.1.

Table 5.1: Proposed design U values

| External Element | U value ($W/m^2K$) |
|---|---|
| External walls | 0.15 |
| Ground floors | 0.13 |
| Roofs | 0.12 |
| Windows, rooflights, doors | 1.20 |

The glazing will also have a g value of 0.40 and a light transmittance value of 0.65. This will reduce the solar gains through the window whilst still allowing a significant amount of daylight in, which will reduce the artificial lighting requirements. Light coloured blinds with a shading factor of 0.61 (39% reduction in daylight) will be installed on all windows to reduce the amount of solar glare as per Criterion 3 in the building regulations.

As heat is also lost via infiltration, the air permeability the proposed building will not be more than 3 $m^3/m^2/hr$ at 50 Pascals.

Highly efficient lighting will be installed throughout, to meet the specification in Table 5.2, which will reduce electricity consumption as well as heat gains.

Table 5.2: Lighting specification

| Room type | Power Density W/m$^2$/100 Lux | Controls | Daylight sensing |
|---|---|---|---|
| Library | 2.1 | Manual on/auto off | Yes |
| Advocacy Rooms | 2.1 | Manual on/auto off | Yes |
| Lecture Theatre | 2.1 | Manual on/auto off | Yes |
| Library basement | 2.1 | Manual on/auto off | Yes |
| Library Reading Room | 2.1 | Manual on/auto off | Yes |
| Admin/Offices | 2.1 | Manual on/auto off | Yes |
| Circulation | 2.1 | Auto on/off | Yes |
| WCs | 2.1 | Auto on/off | No |
| Plant & stores | 2.1 | Manual on/off | No |

The improved efficiencies of the systems are listed below:

- Heating system:
  - gas boiler for domestic hot water with efficiency 95%
- Ventilation system:
  - Ductwork leakage no worse than Class B; AHU leakage no worse than Class L2
  - Air cooled chillers, increased coefficient of performance (COP) of 3.5
  - Heat recovery of at least 50%
- Metering and controls:
  - Local heating, cooling and ventilation controls
  - Centralised building management system control and override of local settings, with setbacks and time clock controls
  - Weather compensation
  - Metering and logging of separate energy types
  - Warns when values are out of set range

Table 5.3 shows the energy consumption by end use in the baseline and “be lean” models.

Table 5.3: Energy end use

| End use | Baseline energy consumption ($kWh/m^2/year$) | “Be lean” energy consumption ($kWh/m^2/year$) |
|---|---|---|
| Heating | 55.56 | 29.63 |
| Cooling | 6.61 | 1.49 |
| Auxiliary energy | 16.56 | 9.49 |
| Lighting | 19.36 | 16.35 |
| Hot water | 1.32 | 1.28 |
| Total – regulated | 99.41 | 58.24 |

Source: IES VE version 2015

The BER and TER for the “baseline” and “be lean” model are listed in Table 5.4.

Table 5.4: Emission rates

| | TER ($kgCO_2/m^2/year$) | BER ($kgCO_2/m^2/year$) |
|---|---|---|
| Baseline building | 25.1 | 33.8 |
| “Be lean” building | 24.4 | 20.5 |

Source: IES VE version 2015

The ‘lean’ design for the TER is an improvement on the Baseline BER by 18.32%. Policies 5.2 and the Core Strategy require an improvement for the BER of 35% over the TER, which the proposed ‘lean’ design does not achieve.

The results in **Appendix B** indicate that incorporating internal blinds to the advocacy room 6-10 reduces the potential solar glare and therefore passes Criterion 3 of the 2013 L2A Building Regulations.

# 6 Be Green

The most successful projects adopt renewable technologies as direct alternatives, rather than add-ons, to conventional solutions. It is important, therefore, to identify these technologies as early as possible in the project.

This chapter discusses potential renewable and low carbon technologies that could be incorporated into the proposed building design. It is a summary of the Low and Zero Carbon Technologies Feasibility Assessment produced by Mott MacDonald as required by ENE 5 of the BREEAM assessment. Please refer to this report for detailed calculations of predicted carbon dioxide savings and financial feasibility assessments of each technology.

## Wind

Wind power relies on the sustainable and renewable energy of the wind to generate electricity. To be efficient, wind turbines need to be located where there will be a relatively constant wind of between 3.5 and 6m/s. These conditions are unlikely to occur in a densely built urban area, such as central London.

There are potential issues of the visual impact of a wind turbine in a conservation area; this combined with the lack of sufficient wind speeds renders this technology unfeasible for inclusion at the Honourable Society of Lincoln's Inn.

## Biomass Boilers

Biomass fuels are made from biological products such as wood and plants, and may be seen as carbon neutral as the $CO_2$ released in the burning of the fuel may be considered to be equal to that of the $CO_2$ intake during the life of the tree, grass, or vegetation itself.

Consideration must be given to the harvesting, storage and delivery of biomass fuels to ensure effective operation of the technology. A local source of fuel is best practice to reduce carbon emissions in fuel transport.

Concerns with biomass boilers being utilised for the is development are could the number of deliveries required, the plant area needed to store the fuel, and concerns over particulate emissions which would require a tall chimney higher than the local surroundings.

## Solar Hot Water

Solar thermal heating systems work by capturing the sun's radiation and transferring the heat to provide hot water for use in the building. A solar hot water system does not fully replace conventional water heaters, but supplements them and reduces the energy they use. Solar panels are not capable of fully replacing a conventional system, so a conventional system would also be required to work in tandem with solar panels.

While it is one of the simplest ways of using the sun's energy, the hot water demand of office buildings is generally quite low, compared with the overall energy use. It is estimated that the hot water demand of the proposed building design comprises only 6.5% of the total building energy use. Thus, it would not be feasible to achieve the required reduction in $CO_2$ emission from the use of solar panels alone.

## Photovoltaic Cells

Photovoltaic (PV) cells convert the sun's light into electricity that can be used instead of grid electricity. PV panels have very little impact on the environment once installed, as they run quietly without emitting air pollution or hazardous waste. While they are associated with higher capital costs than solar hot water panels, PV panels can significantly reduce the running costs of a building as they replace grid electricity, which is more expensive than fossil fuels.

Photovoltaic cells are most efficient when mounted at 37°, however the proposed building design is to be located within The grounds of the Inn, which is made up of Grade I, II,II* and locally listed buildings. Visible photovoltaic panels are unlikely to be acceptable in a conservation area. Additionally there is insufficient roof area on the library extension for a photovoltaic installation to reduce the BER to less than that of the TER.

## Ground Source Systems

The earth has the capacity to absorb and store heat and forms a vast reserve of free low grade heat. In the winter the ground is warmer than the ambient air, and in summer it is significantly cooler. Ground water heating and cooling through the use of vertical boreholes take advantage of the relatively stable temperatures the ground and water maintain throughout the year deep below the surface. A closed loop system does not extract water from the ground, but cycles water

through the system to provide low grade heat in the winter, or cooling in the summer. Only a small amount of electricity is required to power the pumps cycling water through the system.

This system can be coupled with heat pumps to increase the output of the heating and cooling, with efficiencies that exceed conventional chillers and boilers.

A ground source system is the most appropriate for the proposed buildings as it should be able to produce a significant reduction in $CO_2$ emissions

It is proposed to use a ground source heat pump system to generate low temperature hot water for heating in winter. The use of heat pumps will also replace the requirement for air cooled chillers; which will reduce any potential issues of noise pollution and visual intrusion.

The specification of the mechanical systems is detailed below:

- Heating system:
  - Ground source heat pump, COP of 4.19[1]
- Cooling system:
  - Ground source heat pump, COP of 4.19[2]
- Ventilation system:
  - Ductwork leakage no worse than Class B; AHU leakage no worse than Class L2
- Metering and controls:
  - Local heating, cooling and ventilation controls
  - Centralised building management system control and override of local settings, with setbacks and time clock controls
  - Weather compensation
  - Metering and logging of separate energy types
  - Warns when values are out of set range

[1] From manufacturer's data from GI Energy

[2] From manufacturer's data from GI Energy

Table 6.1 shows the energy consumption by end use at each stage of the energy hierarchy.

Table 6.1: Energy end use

| End use | Baseline energy consumption (kWh/m$^2$/year) | "Be lean" energy consumption (kWh/m$^2$/year) | "Be green" energy consumption (kWh/m$^2$/year) |
|---|---|---|---|
| Heating | 55.56 | 29.63 | 6.75 |
| Cooling | 6.61 | 1.49 | 0.89 |
| Auxiliary energy | 16.56 | 9.49 | 8.84 |
| Lighting | 19.36 | 16.35 | 16.35 |
| Hot water | 1.32 | 1.28 | 1.28 |
| Total – regulated | 99.41 | 58.24 | 34.12 |

Source: IES VE version 2015

The BER and TER for each model are listed in Table 6.2.

Table 6.2: Emission rates

| REF | | TER (kgCO$_2$/m$^2$/year) | BER (kgCO$_2$/m$^2$/year) |
|---|---|---|---|
| A | Baseline building | 25.1 | 33.8 |
| B | "Be lean" building | 24.4 | 20.5 |
| C | "Be green" building | 21.9 | 16.9 |

Source: IES VE version 2015

Using the formulas obtained from the Greater London guidance on preparing energy assessments the total percentage energy reduction was calculated below:

$$\text{Savings based on Lean Design} = \frac{(Baseline\ TER - "Lean"TER)}{Baseline\ TER} \times 100$$

$$\text{Savings based on Lean Design} = \frac{(25.1 - 20.5)}{25.1} \times 100 = 18.3\%$$

$$\text{Further Savings from Renewables} = \frac{"Lean"TER - "Green"TER}{"Lean"TER} \times 100$$

$$\text{Further Savings from Renewables} = \frac{20.5 - 16.9}{20.5} \times 100 = 17.6\%$$

$$\text{Total Cumulative Savings} = \frac{(Baseline\ TER - "Green"\ TER)}{Baseline\ TER} \times 100$$

$$\text{Total Cumulative Savings} = \frac{(25.1 - 16.9)}{25.1} \times 100 = \mathbf{32.7}\%$$

A summary of the calculations can be found in table 6.3 below:

Table 6.3: Summary of Energy Reduction Results

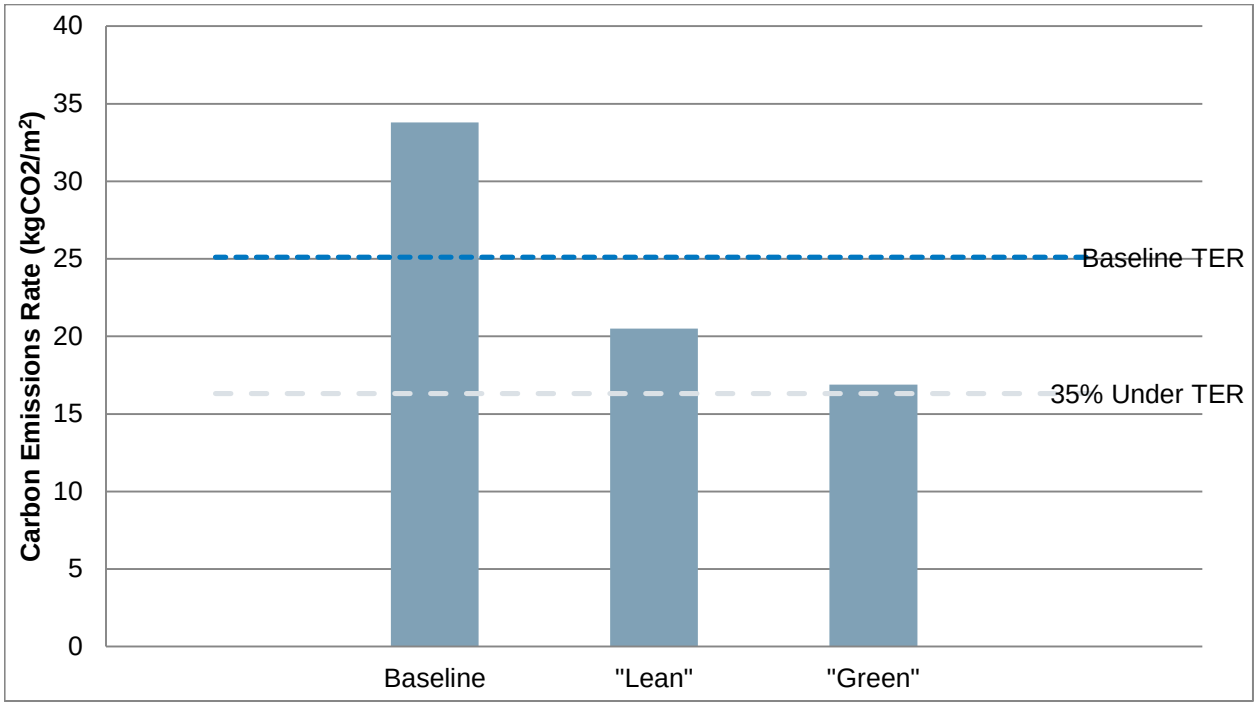
| | Formula | Tonnes CO2 per annum | Formula | (%) |
|---|---|---|---|---|
| Saving from energy demand reduction | A-B | 4.6 | (A-B)/A*100 | 18.3% |
| Saving from Renewable Energy | B-C | 3.6 | (B-C)/B*100 | 17.6% |
| Total Cumulative Savings | A-C | 8.2 | (A-C)/A*100 | 32.7% |

Source: Greater London Guidance on preparing energy assessments.

# 7 Final Development

Figure 7.1 illustrates the carbon savings from each step of the energy hierarchy, as well as the 2013 target emission rate and the 35% improvement over the target emission rate. The results in section 6 show that passive design measures are capable of providing an 18.3% reduction in carbon from the 2013 TER. The installation of the ground source heat pumps can provide a further reduction carbon of 17.6% over passive design measures. With both methods considered, the BER of the proposed buildings has been reduced by more to 32.7% from the 2013 TER.

Figure 7.1: Graphical representation of $CO_2$ emissions reductions




Source: IES VE 2015

To meet the respective 35% and 20% targets in accordance with London Borough of Camden and the London Plan additional renewable technologies would need to be incorporated, which due to the restraints of developing within a Grade II* heritage site are not considered feasible without having a detrimental effect on the location.

# Appendices

# Appendix A. Baseline BRUKL report

# BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

**Project name**

## HSLI-Baseline

As designed

**Date:** Wed Jul 08 21:55:02 2015

## Administrative information

### Building Details

**Address:** Address 1, City, Postcode

### Certification tool

**Calculation engine:** Apache

**Calculation engine version:** 7.0.3

**Interface to calculation engine:** IES Virtual Environment

**Interface to calculation engine version:** 7.0.3

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

### Owner Details

**Name:** Name

**Telephone number:** Phone

**Address:** Street Address, City, Postcode

### Certifier details

**Name:** NOT OFFICIALLY VERIFIED

**Telephone number:** Phone

**Address:** Street Address, City, Postcode

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

The building does not comply with England Building Regulations Part L 2013

| | |
|---|---|
| $CO_2$ emission rate from the notional building, $kgCO_2/m^2.annum$ | 25.1 |
| Target $CO_2$ emission rate (TER), $kgCO_2/m^2.annum$ | 25.1 |
| Building $CO_2$ emission rate (BER), $kgCO_2/m^2.annum$ | 33.8 |
| Are emissions from the building less than or equal to the target? | BER > TER |
| Are as built details the same as used in the BER calculations? | Separate submission |

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

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

**Building fabric**

| Element | $U_{a\text{-}Limit}$ | $U_{a\text{-}Calc}$ | $U_{i\text{-}Calc}$ | Surface where the maximum value occurs* |
|---|---|---|---|---|
| Wall** | 0.35 | 0.26 | 0.26 | ZN000031:Surf[0] |
| Floor | 0.25 | 0.22 | 0.22 | ZN00002D:Surf[3] |
| Roof | 0.25 | 0.12 | 0.12 | ZN000013:Surf[1] |
| Windows***, roof windows, and rooflights | 2.2 | 1.63 | 1.8 | ZN00001B:Surf[4] |
| Personnel doors | 2.2 | - | - | No Personnel doors in building |
| 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 [$W/(m^2K)$]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

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

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

## Building services

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

| | |
|---|---|
| **Whole building lighting automatic monitoring & targeting with alarms for out-of-range values** | YES |
| **Whole building electric power factor achieved by power factor correction** | >0.95 |

1- Existing Boilers Radiators

| | **Heating efficiency** | **Cooling efficiency** | **Radiant efficiency** | **SFP [W/(l/s)]** | **HR efficiency** |
|---|---|---|---|---|---|
| **This system** | 0.92 | - | 0.2 | 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.

2- Existing Boiler Rads WC

| | **Heating efficiency** | **Cooling efficiency** | **Radiant efficiency** | **SFP [W/(l/s)]** | **HR efficiency** |
|---|---|---|---|---|---|
| **This system** | 0.92 | - | 0.2 | 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- Displacement Vent

| | **Heating efficiency** | **Cooling efficiency** | **Radiant efficiency** | **SFP [W/(l/s)]** | **HR efficiency** |
|---|---|---|---|---|---|
| **This system** | 0.92 | 3.13 | 0 | 1.9 | - |
| **Standard value** | 0.91* | 2.55 | N/A | 1.6^ | N/A |
| **Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system** | | | | | NO |

* 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.

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

4- Displacement Vent

| | **Heating efficiency** | **Cooling efficiency** | **Radiant efficiency** | **SFP [W/(l/s)]** | **HR efficiency** |
|---|---|---|---|---|---|
| **This system** | 0.92 | 3.13 | 0 | 1.9 | - |
| **Standard value** | 0.91* | 2.55 | N/A | 1.6^ | N/A |
| **Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system** | | | | | NO |

* 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.

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

5- Boiler Radiators

| | **Heating efficiency** | **Cooling efficiency** | **Radiant efficiency** | **SFP [W/(l/s)]** | **HR efficiency** |
|---|---|---|---|---|---|
| **This system** | 0.92 | - | 0.2 | 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- DHW

| | **Water heating efficiency** | **Storage loss factor [kWh/litre per day]** |
|---|---|---|
| **This building** | 0.92 | - |
| **Standard value** | 0.8 | N/A |

"No zones in project where local mechanical ventilation, exhaust, or terminal unit is applicable"

| General lighting and display lighting | Luminous efficacy [lm/W] | | | |
|---|---|---|---|---|
| **Zone name** | **Luminaire** | **Lamp** | **Display lamp** | **General lighting [W]** |
| **Standard value** | 60 | 60 | 22 | |
| LE-UB-Archive Storage | - | 58 | - | 642 |
| LE-UB-WC | - | 86 | - | 81 |
| LE-GR-Kitchenette | - | 102 | - | 41 |
| LE-MEZ-Management Office | 47 | - | - | 239 |
| LE-MEZ-Admin Office | 44 | - | - | 619 |
| LE-GR-Management Office | 46 | - | - | 204 |
| LE-GR-Admin Office | 41 | - | - | 1074 |
| LE-UB-Archive Storage | - | 57 | - | 1710 |
| LE-FI-Reading Room | - | 61 | - | 564 |
| LE-FI-Corridor | - | 85 | - | 57 |
| LB Acc WC | - | 100 | - | 47 |
| LB Advocacy Room 10 | 45 | - | - | 612 |
| LB Advocacy Room 6 | 45 | - | - | 625 |
| LB Advocacy Room 7 | 45 | - | - | 612 |
| LB Advocacy Room 8 | 45 | - | - | 612 |
| LB Advocacy Room 9 | 45 | - | - | 612 |
| LB ET-C-B2-02 | - | 74 | - | 188 |
| LB ET-S-01 | - | 87 | - | 55 |
| LB Store | 76 | - | - | 9 |
| LB Store Chair | 53 | - | - | 33 |
| LB WC | - | 80 | - | 93 |
| LB WC | - | 73 | - | 188 |
| Lecture Theater | 31 | - | - | 2387 |
| UB Acc WC | - | 93 | - | 62 |
| UB Advocacy Room 1 | 40 | - | - | 520 |
| UB Advocacy Room 2 | 39 | - | - | 520 |
| UB Advocacy Room 3 | 39 | - | - | 521 |
| UB Advocacy Room 4 | 39 | - | - | 521 |
| UB Advocacy Room 5 | 40 | - | - | 519 |
| UB Bar | - | 72 | - | 96 |
| UB Breakout Space | - | 62 | - | 1972 |
| UB CI Store | 112 | - | - | 3 |
| UB Cloaks | 55 | - | - | 16 |
| UB Corridor to WC | - | 71 | - | 170 |
| UB Projection Room | 65 | - | - | 12 |
| UB Reception | - | 73 | 15 | 119 |
| UB Store | 64 | - | - | 14 |
| UB Store | 75 | - | - | 15 |
| UB WC | - | 72 | - | 208 |
| UB WC | - | 66 | - | 202 |
| LB Breakout Space | 44 | - | - | 1724 |
| zone 1692 | 46 | - | - | 3 |

## 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? |
|---|---|---|
| LE-MEZ-Management Office | NO (-81.7%) | NO |
| LE-MEZ-Admin Office | NO (-90.1%) | NO |
| LE-GR-Management Office | NO (-70.9%) | NO |
| LE-GR-Admin Office | NO (-91.6%) | YES |
| LB Advocacy Room 10 | YES (+87.3%) | NO |
| LB Advocacy Room 6 | YES (+78.2%) | NO |
| LB Advocacy Room 7 | YES (+87.7%) | NO |
| LB Advocacy Room 8 | YES (+87.6%) | NO |
| LB Advocacy Room 9 | YES (+86%) | NO |
| LB ET-C-B2-02 | N/A | N/A |
| LB ET-S-01 | N/A | N/A |
| Lecture Theater | N/A | N/A |
| UB Advocacy Room 1 | NO (-74.4%) | NO |
| UB Advocacy Room 2 | NO (-69.8%) | NO |
| UB Advocacy Room 3 | NO (-69.3%) | NO |
| UB Advocacy Room 4 | NO (-69.5%) | NO |
| UB Advocacy Room 5 | NO (-63.7%) | NO |
| UB Breakout Space | YES (+1155.1%) | NO |
| UB Corridor to WC | N/A | N/A |
| UB Reception | N/A | N/A |
| LB Breakout Space | NO (-83%) | NO |

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

Separate submission

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

Separate submission

## EPBD (Recast): Consideration of alternative energy systems

| | |
|---|---|
| **Were alternative energy systems considered and analysed as part of the design process?** | YES |
| Is evidence of such assessment available as a separate submission? | YES |
| Are any such measures included in the proposed design? | YES |

# Technical Data Sheet (Actual vs. Notional Building)

## Building Global Parameters

| | Actual | Notional |
|---|---|---|
| Area [$m^2$] | 1668.6 | 1668.6 |
| External area [$m^2$] | 3687.5 | 3687.5 |
| Weather | LON | LON |
| Infiltration [$m^3/hm^2$@ 50Pa] | 5 | 3 |
| Average conductance [W/K] | 1128.61 | 1205.15 |
| Average U-value [$W/m^2K$] | 0.31 | 0.33 |
| Alpha value* [%] | 17.53 | 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 |
| | 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 |
| **100** | **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 [$kWh/m^2$]

| | Actual | Notional |
|---|---|---|
| Heating | 55.56 | 45.42 |
| Cooling | 6.61 | 1.1 |
| Auxiliary | 16.56 | 12.34 |
| Lighting | 19.36 | 16.17 |
| Hot water | 1.32 | 1.23 |
| Equipment* | 37.08 | 37.08 |
| **TOTAL**** | **99.41** | **76.26** |

* 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 [$kWh/m^2$]

| | 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 [$MJ/m^2$] | 208.66 | 156.01 |
| Primary energy* [$kWh/m^2$] | 196.69 | 145.54 |
| Total emissions [$kg/m^2$] | 33.8 | 25.1 |

* 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] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity** | | | | | | | | | | |
| | **Actual** | 203.9 | 0 | 62.8 | 0 | 3.5 | 0.9 | 0 | 0.92 | 0 |
| | **Notional** | 275.7 | 0 | 88.8 | 0 | 1.7 | 0.86 | 0 | ---- | ---- |
| **[ST] Induction system, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity** | | | | | | | | | | |
| | **Actual** | 110.7 | 77.1 | 38 | 12.8 | 24.5 | 0.81 | 1.67 | 0.92 | 2.5 |
| | **Notional** | 65.7 | 26.9 | 21.2 | 2 | 18.7 | 0.86 | 3.79 | ---- | ---- |
| **[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity** | | | | | | | | | | |
| | **Actual** | 55.2 | 0 | 17.8 | 0 | 1.7 | 0.86 | 0 | 0.92 | 0 |
| | **Notional** | 75.2 | 0 | 24.2 | 0 | 0.8 | 0.86 | 0 | ---- | ---- |
| **[ST] Central heating using water: convectors, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity** | | | | | | | | | | |
| | **Actual** | 40.1 | 0 | 12.9 | 0 | 2.3 | 0.86 | 0 | 0.92 | 0 |
| | **Notional** | 84.7 | 0 | 27.3 | 0 | 1.2 | 0.86 | 0 | ---- | ---- |
| **[ST] Induction system, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity** | | | | | | | | | | |
| | **Actual** | 282.9 | 49.7 | 97.1 | 8.3 | 29 | 0.81 | 1.67 | 0.92 | 2.5 |
| | **Notional** | 99.8 | 23.3 | 32.1 | 1.7 | 22.3 | 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 | 0.26 | ZN000031:Surf[0] |
| Floor | 0.2 | 0.22 | ZN00002D:Surf[3] |
| Roof | 0.15 | 0.12 | ZN000013:Surf[1] |
| Windows, roof windows, and rooflights | 1.5 | 0.72 | ZN000013:Surf[0] |
| Personnel doors | 1.5 | - | No Personnel doors in building |
| 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 |
|---|---|---|
| $m^3/(h.m^2)$ at 50 Pa | 5 | 5 |

# Appendix B. “Be Lean” BRUKL report

# BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

**Project name**

## HSLI-Lean

As designed

**Date:** Wed Jul 08 22:22:51 2015

## Administrative information

### Building Details

**Address:** Address 1, City, Postcode

### Certification tool

**Calculation engine:** Apache

**Calculation engine version:** 7.0.3

**Interface to calculation engine:** IES Virtual Environment

**Interface to calculation engine version:** 7.0.3

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

### Owner Details

**Name:** Name

**Telephone number:** Phone

**Address:** Street Address, City, Postcode

### Certifier details

**Name:** NOT OFFICIALLY VERIFIED

**Telephone number:** Phone

**Address:** Street Address, City, Postcode

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

| | |
|---|---|
| $CO_2$ emission rate from the notional building, $kgCO_2/m^2.annum$ | 24.4 |
| Target $CO_2$ emission rate (TER), $kgCO_2/m^2.annum$ | 24.4 |
| Building $CO_2$ emission rate (BER), $kgCO_2/m^2.annum$ | 20.5 |
| Are emissions from the building less than or equal to the target? | BER =< TER |
| Are as built details the same as used in the BER calculations? | Separate submission |

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

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

**Building fabric**

| Element | $U_{a\text{-}Limit}$ | $U_{a\text{-}Calc}$ | $U_{i\text{-}Calc}$ | Surface where the maximum value occurs* |
|---|---|---|---|---|
| Wall** | 0.35 | 0.15 | 0.15 | ZN000031:Surf[0] |
| Floor | 0.25 | 0.13 | 0.13 | ZN00002D:Surf[3] |
| Roof | 0.25 | 0.12 | 0.12 | ZN000013:Surf[1] |
| Windows***, roof windows, and rooflights | 2.2 | 0.86 | 1.2 | ZN00001B:Surf[0] |
| Personnel doors | 2.2 | - | - | No Personnel doors in building |
| 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 $[W/(m^2K)]$
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values $[W/(m^2K)]$
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values $[W/(m^2K)]$

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

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

**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- Existing Boilers Radiators

| | **Heating efficiency** | **Cooling efficiency** | **Radiant efficiency** | **SFP [W/(l/s)]** | **HR efficiency** |
|---|---|---|---|---|---|
| **This system** | 0.95 | - | 0.2 | 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.

2- boilers Rads WC

| | **Heating efficiency** | **Cooling efficiency** | **Radiant efficiency** | **SFP [W/(l/s)]** | **HR efficiency** |
|---|---|---|---|---|---|
| **This system** | 0.95 | - | 0.2 | 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- Ventilation System

| | **Heating efficiency** | **Cooling efficiency** | **Radiant efficiency** | **SFP [W/(l/s)]** | **HR efficiency** |
|---|---|---|---|---|---|
| **This system** | 0.95 | 3.5 | 0 | 1.86 | 0.52 |
| **Standard value** | 0.91* | 2.55 | N/A | 1.6^ | 0.45 |
| **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.

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

4- Underfloor & Nat Vent

| | **Heating efficiency** | **Cooling efficiency** | **Radiant efficiency** | **SFP [W/(l/s)]** | **HR efficiency** |
|---|---|---|---|---|---|
| **This system** | 0.95 | - | 0.2 | 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.

5- Boilers Radiators

| | **Heating efficiency** | **Cooling efficiency** | **Radiant efficiency** | **SFP [W/(l/s)]** | **HR efficiency** |
|---|---|---|---|---|---|
| **This system** | 0.95 | - | 0.2 | 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- DHW

| | **Water heating efficiency** | **Storage loss factor [kWh/litre per day]** |
|---|---|---|
| **This building** | 0.95 | - |
| **Standard value** | 0.8 | N/A |

"No zones in project where local mechanical ventilation, exhaust, or terminal unit is applicable"

| General lighting and display lighting | Luminous efficacy [lm/W] | | | |
|---|---|---|---|---|
| **Zone name** | **Luminaire** | **Lamp** | **Display lamp** | **General lighting [W]** |
| **Standard value** | 60 | 60 | 22 | |
| LE-UB-Archive Storage | - | 58 | - | 494 |
| LE-UB-WC | - | 86 | - | 47 |
| LE-GR-Kitchenette | - | 102 | - | 31 |
| LE-MEZ-Management Office | 47 | - | - | 64 |
| LE-MEZ-Admin Office | 44 | - | - | 289 |
| LE-GR-Management Office | 46 | - | - | 95 |
| LE-GR-Admin Office | 41 | - | - | 430 |
| LE-UB-Archive Storage | - | 57 | - | 1316 |
| LE-FI-Reading Room | - | 84 | - | 579 |
| LE-FI-Corridor | - | 85 | - | 33 |
| LB Acc WC | - | 100 | - | 40 |
| LB Advocacy Room 10 | 45 | - | - | 408 |
| LB Advocacy Room 6 | 45 | - | - | 417 |
| LB Advocacy Room 7 | 45 | - | - | 408 |
| LB Advocacy Room 8 | 45 | - | - | 408 |
| LB Advocacy Room 9 | 45 | - | - | 408 |
| LB ET-C-B2-02 | - | 74 | - | 326 |
| LB ET-S-01 | - | 87 | - | 95 |
| LB Store | 76 | - | - | 44 |
| LB Store Chair | 53 | - | - | 157 |
| LB WC | - | 80 | - | 80 |
| LB WC | - | 73 | - | 163 |
| Lecture Theater | 31 | - | - | 1683 |
| UB Acc WC | - | 93 | - | 36 |
| UB Advocacy Room 1 | 40 | - | - | 347 |
| UB Advocacy Room 2 | 39 | - | - | 347 |
| UB Advocacy Room 3 | 39 | - | - | 348 |
| UB Advocacy Room 4 | 39 | - | - | 347 |
| UB Advocacy Room 5 | 40 | - | - | 346 |
| UB Bar | - | 72 | - | 98 |
| UB Breakout Space | - | 62 | - | 2275 |
| UB CI Store | 112 | - | - | 8 |
| UB Cloaks | 55 | - | - | 68 |
| UB Corridor to WC | - | 71 | - | 262 |
| UB Projection Room | 65 | - | - | 33 |
| UB Reception | - | 73 | 25 | 92 |
| UB Store | 64 | - | - | 37 |
| UB Store | 75 | - | - | 40 |
| UB WC | - | 72 | - | 100 |
| UB WC | - | 66 | - | 97 |
| LB Breakout Space | 44 | - | - | 1149 |
| zone 1692 | 46 | - | - | 9 |

## 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? |
|---|---|---|
| LE-MEZ-Management Office | NO (-81.8%) | NO |
| LE-MEZ-Admin Office | NO (-90.2%) | NO |
| LE-GR-Management Office | NO (-78%) | NO |
| LE-GR-Admin Office | NO (-91.8%) | YES |
| LB Advocacy Room 10 | NO (-17.9%) | YES |
| LB Advocacy Room 6 | NO (-21.6%) | YES |
| LB Advocacy Room 7 | NO (-17.5%) | YES |
| LB Advocacy Room 8 | NO (-17.6%) | YES |
| LB Advocacy Room 9 | NO (-18.4%) | YES |
| Lecture Theater | N/A | N/A |
| UB Advocacy Room 1 | NO (-97.8%) | NO |
| UB Advocacy Room 2 | NO (-97.4%) | NO |
| UB Advocacy Room 3 | NO (-97.3%) | NO |
| UB Advocacy Room 4 | NO (-97.3%) | NO |
| UB Advocacy Room 5 | NO (-96.8%) | NO |
| UB Reception | N/A | N/A |
| LB Breakout Space | NO (-87.4%) | NO |

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

Separate submission

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

Separate submission

## EPBD (Recast): Consideration of alternative energy systems

| | |
|---|---|
| **Were alternative energy systems considered and analysed as part of the design process?** | YES |
| Is evidence of such assessment available as a separate submission? | YES |
| Are any such measures included in the proposed design? | YES |

# Technical Data Sheet (Actual vs. Notional Building)

## Building Global Parameters

| | Actual | Notional |
|---|---|---|
| Area [$m^2$] | 1668.6 | 1668.6 |
| External area [$m^2$] | 3687.5 | 3687.5 |
| Weather | LON | LON |
| Infiltration [$m^3/hm^2$@ 50Pa] | 3 | 3 |
| Average conductance [W/K] | 726.99 | 1205.15 |
| Average U-value [$W/m^2K$] | 0.2 | 0.33 |
| Alpha value* [%] | 16.24 | 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 |
| | 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 |
| **100** | **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 [$kWh/m^2$]

| | Actual | Notional |
|---|---|---|
| Heating | 29.63 | 54.28 |
| Cooling | 1.49 | 0.04 |
| Auxiliary | 9.49 | 8.27 |
| Lighting | 16.35 | 16.17 |
| Hot water | 1.28 | 1.23 |
| Equipment* | 37.08 | 37.08 |
| **TOTAL**** | **58.24** | **79.98** |

* 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 [$kWh/m^2$]

| | 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 [$MJ/m^2$] | 106.19 | 168.82 |
| Primary energy* [$kWh/m^2$] | 119.52 | 140.97 |
| Total emissions [$kg/m^2$] | 20.5 | 24.4 |

* 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] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity** | | | | | | | | | | |
| | **Actual** | 149.8 | 0 | 46.2 | 0 | 3.5 | 0.9 | 0 | 0.95 | 0 |
| | **Notional** | 275.7 | 0 | 88.8 | 0 | 1.7 | 0.86 | 0 | ---- | ---- |
| **[ST] Induction system, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity** | | | | | | | | | | |
| | **Actual** | 43.9 | 25.4 | 13.1 | 3.8 | 19.2 | 0.93 | 1.84 | 0.95 | 2.5 |
| | **Notional** | 65 | 1 | 20.9 | 0.1 | 18.7 | 0.86 | 2.84 | ---- | ---- |
| **[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity** | | | | | | | | | | |
| | **Actual** | 27.5 | 0 | 8.6 | 0 | 1.7 | 0.89 | 0 | 0.95 | 0 |
| | **Notional** | 75 | 0 | 24.2 | 0 | 0.8 | 0.86 | 0 | ---- | ---- |
| **[ST] Central heating using water: convectors, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity** | | | | | | | | | | |
| | **Actual** | 25.6 | 0 | 8.2 | 0 | 2.3 | 0.86 | 0 | 0.95 | 0 |
| | **Notional** | 84.6 | 0 | 27.3 | 0 | 1.2 | 0.86 | 0 | ---- | ---- |
| **[ST] Central heating using water: floor heating, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity** | | | | | | | | | | |
| | **Actual** | 145.4 | 0 | 45.3 | 0 | 3.7 | 0.89 | 0 | 0.95 | 0 |
| | **Notional** | 239.2 | 0 | 77.1 | 0 | 1.9 | 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 | ZN000031:Surf[0] |
| Floor | 0.2 | 0.13 | ZN00002D:Surf[3] |
| Roof | 0.15 | 0.12 | ZN000013:Surf[1] |
| Windows, roof windows, and rooflights | 1.5 | 0.72 | ZN000013:Surf[0] |
| Personnel doors | 1.5 | - | No Personnel doors in building |
| 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 |
|---|---|---|
| $m^3/(h.m^2)$ at 50 Pa | 5 | 3 |

# Appendix C. “Be Green” BRUKL report

# BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

**Project name**

## HSLI-Green

As designed

**Date:** Thu Jul 09 08:47:45 2015

## Administrative information

### Building Details

**Address:** Address 1, City, Postcode

### Certification tool

**Calculation engine:** Apache

**Calculation engine version:** 7.0.3

**Interface to calculation engine:** IES Virtual Environment

**Interface to calculation engine version:** 7.0.3

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

### Owner Details

**Name:** Name

**Telephone number:** Phone

**Address:** Street Address, City, Postcode

### Certifier details

**Name:** NOT OFFICIALLY VERIFIED

**Telephone number:** Phone

**Address:** Street Address, City, Postcode

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

| | |
|---|---|
| $CO_2$ emission rate from the notional building, $kgCO_2/m^2.annum$ | 21.9 |
| Target $CO_2$ emission rate (TER), $kgCO_2/m^2.annum$ | 21.9 |
| Building $CO_2$ emission rate (BER), $kgCO_2/m^2.annum$ | 16.9 |
| Are emissions from the building less than or equal to the target? | BER =< TER |
| Are as built details the same as used in the BER calculations? | Separate submission |

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

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

**Building fabric**

| Element | $U_{a\text{-}Limit}$ | $U_{a\text{-}Calc}$ | $U_{i\text{-}Calc}$ | Surface where the maximum value occurs* |
|---|---|---|---|---|
| Wall** | 0.35 | 0.15 | 0.15 | ZN000031:Surf[0] |
| Floor | 0.25 | 0.13 | 0.13 | ZN00002D:Surf[3] |
| Roof | 0.25 | 0.12 | 0.12 | ZN000013:Surf[1] |
| Windows***, roof windows, and rooflights | 2.2 | 0.86 | 1.2 | ZN00001B:Surf[0] |
| Personnel doors | 2.2 | - | - | No Personnel doors in building |
| 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 [$W/(m^2K)$]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

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

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

**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- GSHP Radiators

| | **Heating efficiency** | **Cooling efficiency** | **Radiant efficiency** | **SFP [W/(l/s)]** | **HR efficiency** |
|---|---|---|---|---|---|
| **This system** | 4.19 | - | 0.2 | 0 | - |
| **Standard value** | 2.5* | 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 all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards. | | | | | |

2- GSHP Rads WC

| | **Heating efficiency** | **Cooling efficiency** | **Radiant efficiency** | **SFP [W/(l/s)]** | **HR efficiency** |
|---|---|---|---|---|---|
| **This system** | 4.19 | - | 0.2 | 0 | - |
| **Standard value** | 2.5* | 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 all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards. | | | | | |

3- Ventilation System

| | **Heating efficiency** | **Cooling efficiency** | **Radiant efficiency** | **SFP [W/(l/s)]** | **HR efficiency** |
|---|---|---|---|---|---|
| **This system** | 4.19 | 4.19 | 0 | 1.86 | 0.52 |
| **Standard value** | 2.5* | 2.55 | N/A | 1.6^ | 0.45 |
| **Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system** | | | | | YES |
| * Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.<br>^ Allowed SFP may be increased by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide. | | | | | |

4- GSHP Underfloor & Nat Vent

| | **Heating efficiency** | **Cooling efficiency** | **Radiant efficiency** | **SFP [W/(l/s)]** | **HR efficiency** |
|---|---|---|---|---|---|
| **This system** | 4.19 | - | 0.2 | 0 | - |
| **Standard value** | 2.5* | 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 all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards. | | | | | |

5- GSHP Radiators

| | **Heating efficiency** | **Cooling efficiency** | **Radiant efficiency** | **SFP [W/(l/s)]** | **HR efficiency** |
|---|---|---|---|---|---|
| **This system** | 4.19 | - | 0.2 | 0 | - |
| **Standard value** | 2.5* | 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 all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards. | | | | | |

1- DHW

| | **Water heating efficiency** | **Storage loss factor [kWh/litre per day]** |
|---|---|---|
| **This building** | 0.95 | - |
| **Standard value** | 0.8 | N/A |

"No zones in project where local mechanical ventilation, exhaust, or terminal unit is applicable"

| General lighting and display lighting | Luminous efficacy [lm/W] | | | |
|---|---|---|---|---|
| **Zone name** | **Luminaire** | **Lamp** | **Display lamp** | **General lighting [W]** |
| **Standard value** | 60 | 60 | 22 | |
| LE-UB-Archive Storage | - | 58 | - | 494 |
| LE-UB-WC | - | 86 | - | 47 |
| LE-GR-Kitchenette | - | 102 | - | 31 |
| LE-MEZ-Management Office | 47 | - | - | 64 |
| LE-MEZ-Admin Office | 44 | - | - | 289 |
| LE-GR-Management Office | 46 | - | - | 95 |
| LE-GR-Admin Office | 41 | - | - | 430 |
| LE-UB-Archive Storage | - | 57 | - | 1316 |
| LE-FI-Reading Room | - | 84 | - | 579 |
| LE-FI-Corridor | - | 85 | - | 33 |
| LB Acc WC | - | 100 | - | 40 |
| LB Advocacy Room 10 | 45 | - | - | 408 |
| LB Advocacy Room 6 | 45 | - | - | 417 |
| LB Advocacy Room 7 | 45 | - | - | 408 |
| LB Advocacy Room 8 | 45 | - | - | 408 |
| LB Advocacy Room 9 | 45 | - | - | 408 |
| LB ET-C-B2-02 | - | 74 | - | 326 |
| LB ET-S-01 | - | 87 | - | 95 |
| LB Store | 76 | - | - | 44 |
| LB Store Chair | 53 | - | - | 157 |
| LB WC | - | 80 | - | 80 |
| LB WC | - | 73 | - | 163 |
| Lecture Theater | 31 | - | - | 1683 |
| UB Acc WC | - | 93 | - | 36 |
| UB Advocacy Room 1 | 40 | - | - | 347 |
| UB Advocacy Room 2 | 39 | - | - | 347 |
| UB Advocacy Room 3 | 39 | - | - | 348 |
| UB Advocacy Room 4 | 39 | - | - | 347 |
| UB Advocacy Room 5 | 40 | - | - | 346 |
| UB Bar | - | 72 | - | 98 |
| UB Breakout Space | - | 62 | - | 2275 |
| UB CI Store | 112 | - | - | 8 |
| UB Cloaks | 55 | - | - | 68 |
| UB Corridor to WC | - | 71 | - | 262 |
| UB Projection Room | 65 | - | - | 33 |
| UB Reception | - | 73 | 25 | 92 |
| UB Store | 64 | - | - | 37 |
| UB Store | 75 | - | - | 40 |
| UB WC | - | 72 | - | 100 |
| UB WC | - | 66 | - | 97 |
| LB Breakout Space | 44 | - | - | 1149 |
| zone 1692 | 46 | - | - | 9 |

## 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? |
|---|---|---|
| LE-MEZ-Management Office | NO (-81.8%) | NO |
| LE-MEZ-Admin Office | NO (-90.2%) | NO |
| LE-GR-Management Office | NO (-78%) | NO |
| LE-GR-Admin Office | NO (-91.8%) | YES |
| LB Advocacy Room 10 | NO (-17.9%) | YES |
| LB Advocacy Room 6 | NO (-21.6%) | YES |
| LB Advocacy Room 7 | NO (-17.5%) | YES |
| LB Advocacy Room 8 | NO (-17.6%) | YES |
| LB Advocacy Room 9 | NO (-18.4%) | YES |
| Lecture Theater | N/A | N/A |
| UB Advocacy Room 1 | NO (-97.8%) | NO |
| UB Advocacy Room 2 | NO (-97.4%) | NO |
| UB Advocacy Room 3 | NO (-97.3%) | NO |
| UB Advocacy Room 4 | NO (-97.3%) | NO |
| UB Advocacy Room 5 | NO (-96.8%) | NO |
| UB Reception | N/A | N/A |
| LB Breakout Space | NO (-87.4%) | NO |

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

Separate submission

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

Separate submission

## EPBD (Recast): Consideration of alternative energy systems

| | |
|---|---|
| **Were alternative energy systems considered and analysed as part of the design process?** | YES |
| Is evidence of such assessment available as a separate submission? | YES |
| Are any such measures included in the proposed design? | YES |

# Technical Data Sheet (Actual vs. Notional Building)

## Building Global Parameters

| | Actual | Notional |
|---|---|---|
| Area [$m^2$] | 1668.6 | 1668.6 |
| External area [$m^2$] | 3687.5 | 3687.5 |
| Weather | LON | LON |
| Infiltration [$m^3/hm^2$@ 50Pa] | 3 | 3 |
| Average conductance [W/K] | 726.99 | 1205.15 |
| Average U-value [$W/m^2K$] | 0.2 | 0.33 |
| Alpha value* [%] | 16.24 | 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 |
| | 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 |
| **100** | **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 [$kWh/m^2$]

| | Actual | Notional |
|---|---|---|
| Heating | 6.75 | 18.29 |
| Cooling | 0.89 | 0.04 |
| Auxiliary | 8.84 | 8.27 |
| Lighting | 16.35 | 16.17 |
| Hot water | 1.28 | 1.23 |
| Equipment* | 37.08 | 37.08 |
| **TOTAL**** | **34.12** | **44** |

* 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 [$kWh/m^2$]

| | 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 [$MJ/m^2$] | 106.19 | 168.82 |
| Primary energy* [$kWh/m^2$] | 120.05 | 184.26 |
| Total emissions [$kg/m^2$] | 16.9 | 21.9 |

* 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] Central heating using water: radiators, [HS] Heat pump (electric): ground or water source, [HFT] Electricity, [CFT] Electri** | | | | | | | | | | |
| | **Actual** | 149.8 | 0 | 10.6 | 0 | 3.5 | 3.94 | 0 | 4.19 | 0 |
| | **Notional** | 275.7 | 0 | 29.9 | 0 | 1.7 | 2.56 | 0 | ---- | ---- |
| **[ST] Induction system, [HS] Heat pump (electric): ground or water source, [HFT] Electricity, [CFT] Electricity** | | | | | | | | | | |
| | **Actual** | 43.9 | 25.4 | 3 | 2.3 | 17.9 | 4.1 | 3.08 | 4.19 | 4.19 |
| | **Notional** | 65 | 1 | 7.1 | 0.1 | 18.7 | 2.56 | 2.84 | ---- | ---- |
| **[ST] Central heating using water: radiators, [HS] Heat pump (electric): ground or water source, [HFT] Electricity, [CFT] Electri** | | | | | | | | | | |
| | **Actual** | 27.5 | 0 | 1.9 | 0 | 1.7 | 3.94 | 0 | 4.19 | 0 |
| | **Notional** | 75 | 0 | 8.1 | 0 | 0.8 | 2.56 | 0 | ---- | ---- |
| **[ST] Central heating using water: convectors, [HS] Heat pump (electric): ground or water source, [HFT] Electricity, [CFT] Elec** | | | | | | | | | | |
| | **Actual** | 25.6 | 0 | 1.8 | 0 | 2.3 | 3.94 | 0 | 4.19 | 0 |
| | **Notional** | 84.6 | 0 | 9.2 | 0 | 1.2 | 2.56 | 0 | ---- | ---- |
| **[ST] Central heating using water: floor heating, [HS] Heat pump (electric): ground or water source, [HFT] Electricity, [CFT] Ele** | | | | | | | | | | |
| | **Actual** | 145.4 | 0 | 10.3 | 0 | 3.1 | 3.94 | 0 | 4.19 | 0 |
| | **Notional** | 239.2 | 0 | 26 | 0 | 1.9 | 2.56 | 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 | ZN000031:Surf[0] |
| Floor | 0.2 | 0.13 | ZN00002D:Surf[3] |
| Roof | 0.15 | 0.12 | ZN000013:Surf[1] |
| Windows, roof windows, and rooflights | 1.5 | 0.72 | ZN000013:Surf[0] |
| Personnel doors | 1.5 | - | No Personnel doors in building |
| 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 |
|---|---|---|
| $m^3/(h.m^2)$ at 50 Pa | 5 | 3 |