BUROHAPPOLD ENGINEERING

UCL Institute of Education

Interim Sustainability Statement – Phase 1 Wing Levels 4&5

035833

4 October 2018

Revision 02

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00	Sustainability Statement	CVD	16 Apr 18	MD
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signature	
date	**04 October 2018**

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Contents

1 Executive Summary

This report sets out the interim sustainability statement for Phase 1 of the UCL Institute of Education refurbishment, covering Wing Levels 4&5. Studies contained include a summary of the baseline building performance, the energy strategy, thermal comfort assessment, BREEAM pre-assessment and responses to Camden planning criteria.

The UCL Institute of Education is a Grade II* listed building, however despite this limiting factor significant efforts are being made by the design team to enhance the sustainability of the building. Key measures include:

- Improving the thermal performance of the building fabric in line with heritage constraints, through the addition of secondary glazing, where consented, and internal insulation to cladding panels.
- Upgrading all major MEP systems and lighting. To comply with Building Regulations, all performance values are better or equal to Part L2B 2010 (including 2016 amendments) and Non-Domestic Building Services Compliance Guide 2013.
- Retaining connection to the Bloomsbury Heat and Power network, which includes boiler and combined heat and power plant, enabling up to 80% of the building's electricity to come from low carbon sources.
- BREEAM 'Excellent' strategy – this includes a wide variety of sustainability measures including the integration of low flow water fittings, responsible sourcing of construction materials, measures to enhance site ecology, security studies, acoustic measures and stringent sustainability criteria for the Contractor. Currently a BREEAM pre-assessment score of 75.1% (Excellent with a 5.1% buffer) has been identified.

In terms of total CO_2 reduction for the Phase 1 Wing levels 4&5 areas, preliminary modelling following the GLA energy statement guidance shows up to a 49% reduction in regulated CO_2 emissions compared to the existing building, from passive measures, HVAC improvements and connection to the Bloomsbury Heat and Power network.

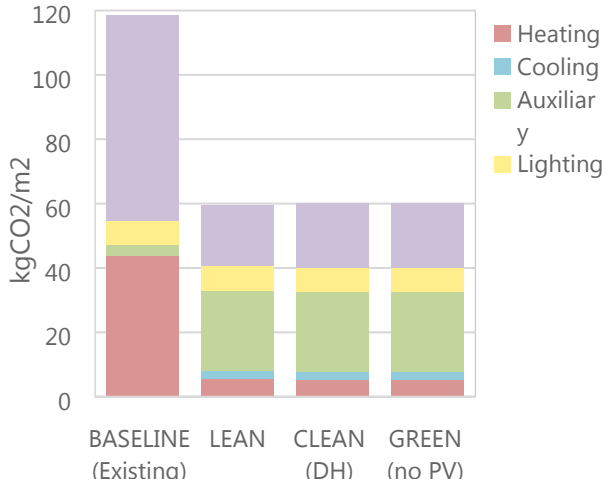

Figure 1.1: CO_2 emissions for the Baseline (existing) and lean, clean and green scenarios.

In terms of renewable energy, there is a Camden Planning requirement to target at least a 20% reduction in CO_2 emissions through the installation of on-site renewable energy technologies. Solar photovoltaic (PV) panels will not be included in the application for Levels 4&5, as it falls outside of the scope of works. The implementation of solar PV was investigated as part of a masterplan wide study, however it has not yet been confirmed as a viable technology to incorporate into any phase of the project. This is because the heritage consultant has commented it would be potentially contentious.

The overheating risk on levels 4 and 5 has been assessed using IES-Virtual Environment in accordance with the methodology described in CIBSE TM52. Results indicate that given the high-occupancy density spaces, a mixed mode ventilation approach should be considered to ensure optimum comfort in these spaces. The proposed building cooling demand is lower than the notional as shown below.

Table 1.1: Heating and cooling demand for the Notional building compared to actual

		Notional	Actual
MJ/m^2	Cooling demand	29.7	18.4

It is currently estimated that for Phase 1, 19.8% of the project budget will be spent on energy efficiency improvements (including fabric improvement measures, new HVAC plant, lighting, controls and metering. This is in line with the "Camden Council Planning Guidance – Sustainability CGP3" for guidelines existing buildings which requires 10% of project cost to be spent on energy efficiency.

In summary, there is good potential to undertake an extensive and sustainable refurbishment for the UCL Institute of Education, which achieves BREEAM Excellent, low carbon performance and good thermal comfort. The works undertaken have investigated many of the opportunities for the UCL IOE refurbishment applicable to later phases and setting a positive ethos for the project.

2 Planning requirements

2.1 Camden Planning Guidance – Sustainability CGP3

The table below outlines the Camden Council planning requirements in relation to sustainability for existing buildings. Preliminary comments in relation to the UCL IOE Phases 1 Wing levels 4&5 are given.

Table 2.1 - Camden council planning requirements on sustainability relevant for IOE.

<table>
<tr><th>Requirement</th><th>Commentary</th></tr>
<tr><td>Sustainability assessment tools (BREEAM)
Submission of a pre-assessment report at the planning application stage. The report should summarise the design strategy for achieving your chosen level of BREEAM and/or Code for Sustainable Homes and include details of the credits proposed to be achieved.
Pre-assessment report is to be carried out by a licensed assessor. The name of the assessor and their licence number should be clearly stated on the report.
You are strongly encouraged to meet the following standards in accordance with Development Policy DP22 - Promoting sustainable design and construction:
<table>
<tr><th>Time period</th><th>Minimum rating</th><th>Minimum standard for categories (% of un-weighted credits)</th></tr>
<tr><td>2010-2012</td><td>‘very good’</td><td rowspan="2">Energy 60%
Water 60%
Materials 40%</td></tr>
<tr><td>2013+</td><td>‘excellent’</td></tr>
</table></td><td>The project is targeting a BREEAM Excellent rating with a single assessment across Phases 1-3.
The project is currently targeting 75% of the energy credits.
67% of water credits are currently targeted.
61% of materials credits are currently targeted.
The licenced BREEAM assessor is Adonis Charalambous (AC61).
The licenced BREEAM AP is Mark Dowson (1000124).</td></tr>
<tr><td>Energy efficiency: existing buildings
All buildings, whether being updated or refurbished, are expected to reduce their carbon emissions by making improvements to the existing building. Work involving a change of use or an extension to an existing property is included. As a guide, at least 10% of the project cost should be spent on the improvements.
Where retro-fitting measures are not identified at application stage we will most likely secure the implementation of environmental improvements by way of condition.
Development involving a change of use or a conversion of more than 500sq m of any floorspace, will be expected to achieve 60% of the un-weighted credits in the Energy category in their BREEAM assessment.
Special consideration will be given to buildings that are protected e.g. listed buildings</td><td>Substantial works are planned to improve the energy efficiency of this Grade II* listed building.
For L2&3 and ISD L3, based on the interim cost check report, it was estimated that 19.8% of project costs are being spent on energy efficiency for Phase 1.
Levels 4&5 would be similar, given the same level of energy efficiency is being applied.</td></tr>
<tr><td>Renewable energy
All developments are to target at least a 20% reduction in carbon dioxide emissions through the installation of on-site renewable energy technologies. Special consideration will be given to heritage buildings and features to ensure that their historic and architectural features are preserved.</td><td>Solar photovoltaic (PV) panels will not be included in the application for Levels 4&5, as it falls outside of the scope of works.</td></tr>
<tr><td>Decentralised energy
Where feasible and viable your development will be required to connect to a decentralised energy network or include CHP.</td><td>Levels 4&5 will be connected to the Bloomsbury Heat and Power (BHP) district heating network</td></tr>
</table>

Water efficiency • The Council expects all developments to be designed to be water efficient by minimising water use and maximising the re-use of water. This includes new and existing buildings. • The Council will require developments over 1000sq m to include a grey water harvesting system, unless the applicant demonstrates to the Council's satisfaction that this is not feasible.	*Low flow fittings will be targeted as part of refurbishment works in line with BREEAM Wat 01. Grey water recycling feasibility to be confirmed by MEP engineer in Phases 2&3.*
Sustainable use of materials • All developments should aim for at least 10% of the total value of materials used to be derived from recycled and reused sources. This should relate to the WRAP Quick Wins assessments or equivalent. Special consideration will be given to heritage buildings and features to ensure that their historic and architectural features are preserved. • Major developments are anticipated to be able to achieve 15-20% of the total value of materials used to be derived from recycled and reused sources.	*A pre-refurbishment waste audit has been carried out on Wing L2&3 and ISD L3. This identified that 35% of materials can be re-used or recycled. The study has now been extended to capture Wing L4&5. All materials sourcing will be in line with BREEAM responsible sourcing requirements.*
Adapting to climate change • All development is expected to consider the impact of climate change and be designed to cope with the anticipated conditions.	*A climate change risk assessment was conducted for BREEAM credit Wst05 covering all of Phase 1. BREEAM thermal comfort modelling has been carried out for L4&5.*
Brown roofs, green roofs and green walls • The Council will expect all developments to incorporate brown roofs, green roofs and green walls unless it is demonstrated this is not possible or appropriate. This includes new and existing buildings. Special consideration will be given to historic buildings to ensure historic and architectural features are preserved.	*As the building is listed, the ecologist has recommended that external terrace areas include planters with native species*
Flooding • Developments must not increase the risk of flooding, and are required to put in place mitigation measures where there is known to be a risk of flooding. Within the areas shown on Core Strategy Map 5 (Development Policies Map 2) we will expect water infrastructure to be designed to cope with a 1 in 100 year storm event in order to limit the flooding of, and damage to, property.	*The site is located in flood risk zone 1 (low risk of flooding). The proposed Phase 1-3 refurbishment works will not increase surface water run-off.*
External lighting • Lighting can have particular negative impacts on biodiversity. Unnecessary lighting should be avoided. Where lighting may harm biodiversity timers or specific coloured lighting will be required to minimise any disturbance.	*BREEAM requirements for external lighting have been embedded into the project.*
Local food growing • We encourage food to be grown wherever possible and suitable. Rooftops and shared spaces such as gardens and parks provide opportunities.	*Local food growing is not incorporated into the scheme, but shall be raised to the ecologist.*
Biodiversity • Proposals should demonstrate how biodiversity considerations have been incorporated into the development; if any mitigation measures will be included; and what positive measures for enhancing biodiversity are planned.	*An ecology study has been completed, recommending planting of native species on external terrace areas.*

3 Baseline performance

3.1 Overview

This section gives an overview of the baseline performance of the UCL Institute of Education, covering running costs, energy use, CO_2 emissions and fabric performance. The study covers the whole IOE building.

3.2 Running costs

The UCL Institute of Education building is an expensive asset to run, spending over half a million pounds on energy every year. This is not sustainable and represents a key area to be considered as part of refurbishment works.

District heating costs (Aug-14 to Jul-15)	£185,000/year
Electricity costs (Aug-14 to Jul-15)	£330,000/year
Total annual running costs	**£515,000/year**

3.3 Energy use

Based on historic energy surveys, it is estimated that approximately 45% of the buildings energy use is for heating and hot water via a district heat network. The remaining 55% of energy use can be attributed to electricity consumption, with lighting being the main source of electrical energy use. 5% of total building energy use can also be attributed to electric heating, indicating that the building is currently not meeting thermal comfort standards. Measures to improve fabric performance, where appropriate and unregulated electricity consumption should therefore be prioritised.

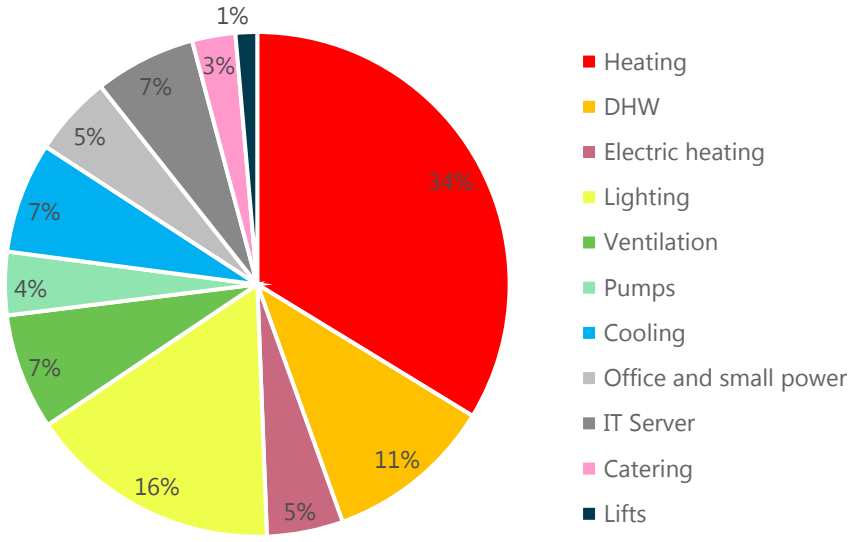

Figure 3.1 - Energy consumption by end-use for 20 Bedford Way (UCL IOE carbon management plan, 2014)

3.4 CO_2 emissions

In terms of CO_2 emissions, the UCL Institute of Education building actually performs very well. This is because the building is connected to the existing Bloomsbury Heat and Power (BHP) district heating network, which provides low-carbon heat as well as renewable electricity generated simultaneously via a CHP (combined heat and power) engine. According to the building's display energy certificate, 78.8% of the building's electricity is supplied from this renewable source. This gives the building an operational performance rating of a "B". By reducing the initial energy consumption, this can improve the operational performance further.

For Phase 1 Wing levels 4&5, both heating and domestic hot water and heating will be provided from the district heating network. The diagram below illustrates the carbon factor of this network, and the implications of this on the overall in-use carbon emissions of the existing building.

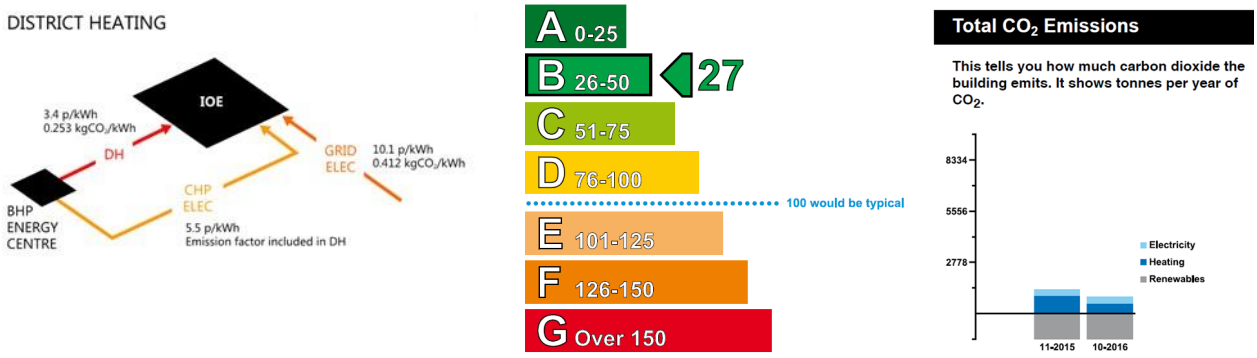

Figure 3.2 - District heating illustration (left) and operational performance rating (middle/right) (DEC number 0650-0313-7079-7509-006)

3.5 Fabric performance

Despite the good CO_2 performance, a key consideration for the UCL IOE refurbishment relates to thermal comfort for users and the building fabric performance. This is because the 1970s building has a significant amount of single glazing, large areas of original cladding panels, as well as un-insulated concrete walls. In addition, according to the facilities manager many users complain periodically about the building being too hot in summer and too cold in winter. A thermal imaging assessment has been undertaken by BuroHappold sustainability to investigate these issues.

The key findings from the study were:

- Heat loss from the IOE is much higher than that of adjacent buildings of older construction.
- Heat losses through the windows and window frames at IOE is significant; the seals on window frames could also be improved throughout the building to avoid air leakage when windows are not closed properly.
- The cladding panels perform marginally better than the glazing. Cladding joints show moderate heat loss.
- The thermal performance of glazing on the wing (by Core A) is poor
- Some windows were open during the survey. This may suggest poor heating/ventilation control.

The main recommendations (which have all now taken place) were:

- Upgrade the thermal performance of the façade, prioritising new glazing.
- Develop internal insulation strategy to treat cladding panels and thermal bridging.
- Façade engineer to be appointed to carry out investigation on improvement options / solutions to treating thermal bridging in consultation with heritage specialist.

A selection of images from the thermal imaging study, the Phase 1 wing are given below. As a result of this exercise, a façade condition survey was carried out giving 3 improvement options in correspondence with the heritage consultant. This has resulted in secondary glazing, where consented and internal insulation being applied to the Wing.

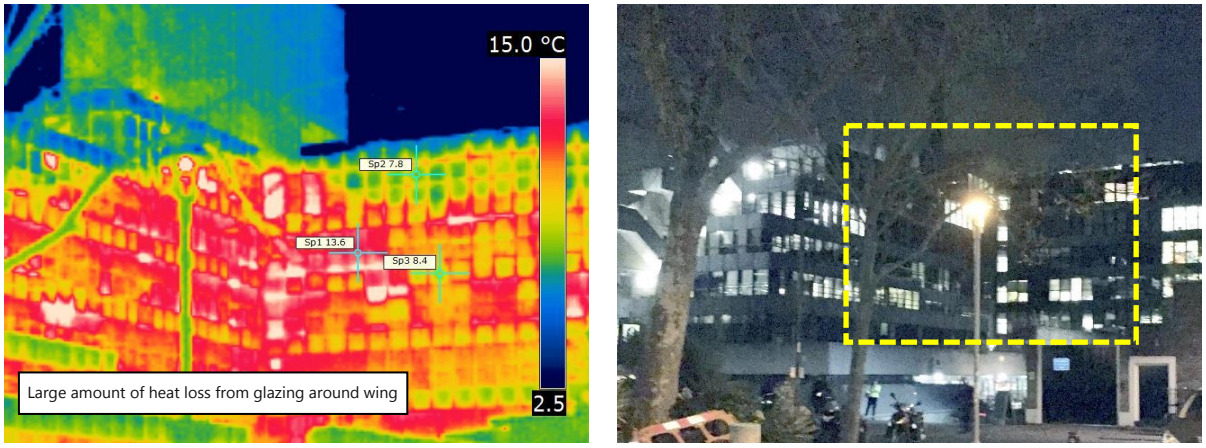

Figure 3.3 - Thermal image showing large sources of heat loss through the curtain walling

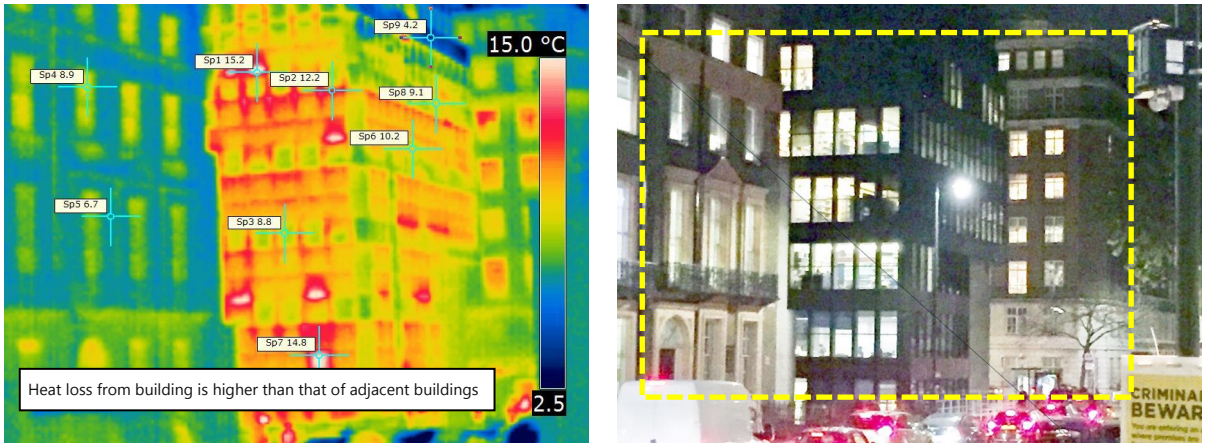

Figure 3.4 - Thermal image showing the end of the IOE building compared to adjacent buildings

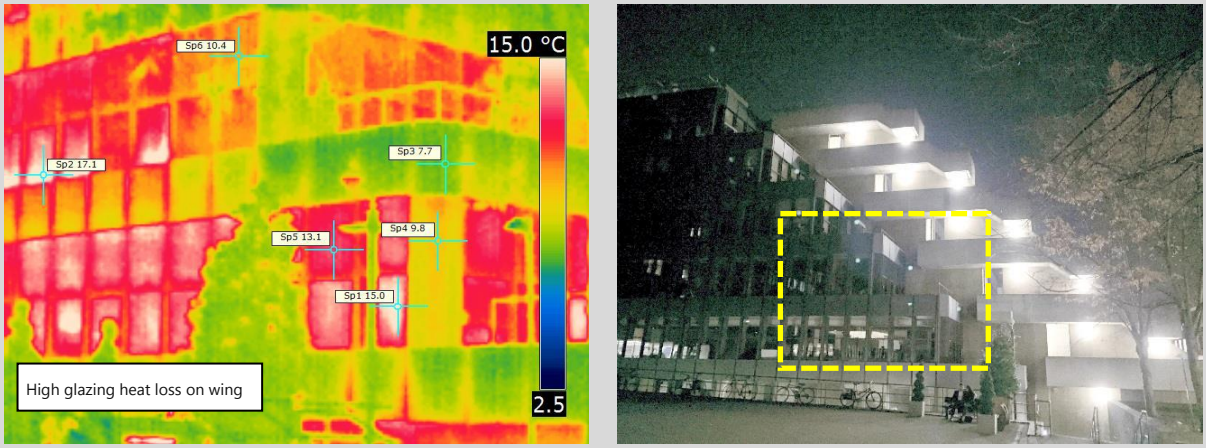

Figure 3.5 - Thermal image of the Phase 1 wing

4 Energy strategy

4.1 Overview

This section of the report describes the energy strategy for the Phase 1 level 4&5 areas of the UCL IOE refurbishment.

The modelling methodology used is consistent with the GLA energy statement guidance and reports on the existing building baseline CO_2 emissions, together with the Lean, Clean, Green results.

Note that for Building Regulations Part L2B, an "elemental compliance" route is being followed, which does not require modelling. The relevant version of the Building Regulations are Part L2B 2010, incorporating 2016 amendments. Draft proposals and mark-ups for this Building Control submission have been prepared and issued to the Contractor as part of the RIBA stage 2 submission. This includes details of fabric performance levels and system efficiencies.

4.2 Energy modelling methodology

Energy modelling calculations were undertaken using IES Virtual Environment. The modelling scenarios include:

- **Baseline performance** – Regulated CO_2 emissions of the existing building prior to refurbishment, including current building fabric installation and system specifications.
- The **Lean** model uses the improved building elements, upgraded systems and assumes heating to be provided by a gas boiler (91% efficient).
- The **Clean** model uses the improved building elements, upgraded systems, including connection to the Bloomsbury district heating network.
- The **Green** model is the same as the clean model, no PV or other renewables will be implemented as part of this refurbishment.

The energy model (see below) is based on layouts received from Hawkins Brown on 27-02-2018.

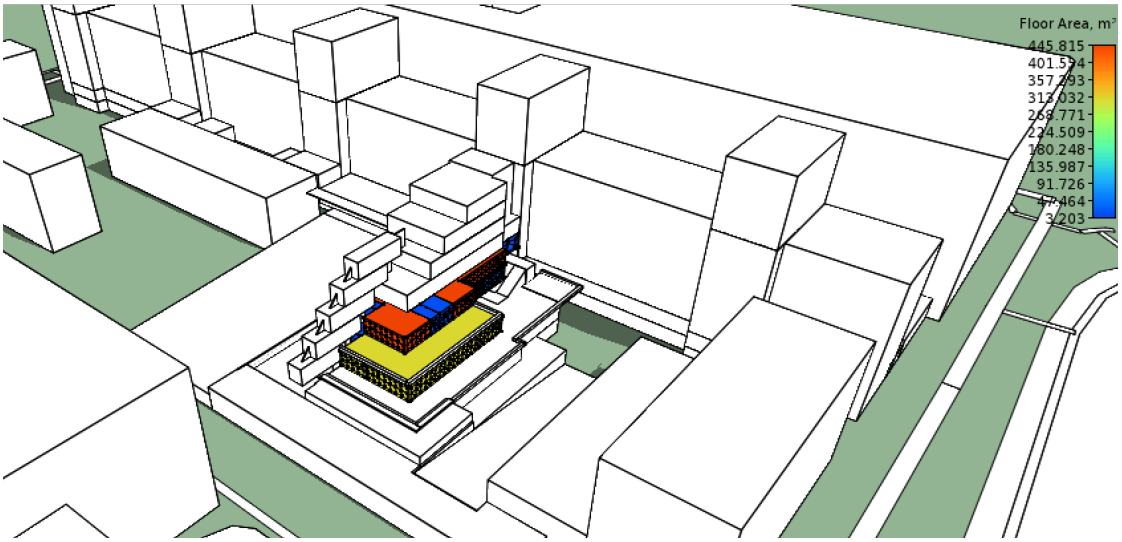

Figure 4.1 - Wing Level 4&5 IES model

Building fabric

Building fabric input parameters for the existing and proposed building models are summarised below:

Table 4.1 Modelling inputs tested (building fabric parameters) and Part L2B

		Existing: (assumed based on review of available information)	Improved (Secondary glazing + opaque wall elements and roof upgraded.)	*Part L2B 2013*		
				Threshold of retained Element	*Value of replacement element*	*New thermal elements and controlled fittings*
Fabric U-values (W/m2K)	Solid wall	2.5 (300mm cast dense concrete, membrane)	0.3 for new thermal elements	*0.7*	*0.3*	*0.28*
	Roof	2.3 (400mm concrete deck & membrane, concrete tile 100mm)	0.18 (400mm concrete deck, insulation 100mm & membrane, concrete tile 100mm) *	*0.35*	*0.18 flat roof*	
	Internal wall	2.5 (200mm cast concrete medium)	1 (lightweight plaster)	-	-	-
	Internal floor/ceiling	2.6 (300 reinforced concrete, 20mm screed)	2.6 (300 reinforced concrete, 20mm screed)	-	-	-
External glazing	U-value	6 (single glazing metal frame	2.1	*3.3*	1.8 W/m^{2}K Or heritage constraint does not allow to achieve a centre pane U value of 1.8 W/m2K.	
	G-value	0.73	0.4	-		
Air tightness	50 pa (m3/h.m2 @ 50 Pa)	19 (to be tested by contractor)	6.5 (target to be tested by contractor)	-		

* Conservative values taken – Contractor to confirm Part L compliant strategy

Building services

Building services input parameters for the existing and proposed building models are summarised below:

Table 4.2 System modelling inputs. Figures marked with * are assumed performance levels.

	Existing	Improved	Part L2B limiting efficiencies for new systems
Heating	Central heating using water, radiators		
Description	Existing rads	-	-
Heat source	District heating	-	-
Pump type	Constant speed	-	-
SCOP	0.92	0.92	-
Cooling		Water cooled fan coil systems	-
SEER / EER	-	4.5 / 3.6	-
Ventilation	Centralised balanced mech vent		
Duct air leakage standard	Not tested	Not tested	-
AHU air leakage standard	Class worse than L3 or not tested	L1	-

	Existing	Improved	Part L2B limiting efficiencies for new systems
Pump type	Constant speed	Variable speed with differential sensors	Either of B&ES DW/144, BS EN1507:2066, BS EN 12237:2003, BS EN 13403:2003
Heat recovery %	0%	70%	Thermal wheel > 65%
Extract fan SFP (W/(l/s) (e.g. toilet)	0.8 @ 10ACH	0.4 @ 10ACH	AHU to comply as a minimum with Class L2
Metering			
System metering	no	yes	-
Metering warn "out of range" values	no	no	-
DHW			
Storage volume	600L each	600L each	-
Storage losses (kWh/(l.day))	0.0063	0.0063	-
Circulation losses (W/m)	30	7	-
Pump power	0.2	0.2	-
Heating system controls			
Central time control	no	yes	To comply with as a minimum with the Non-Domestic Building Services Compliance Guide
Optimum start and stop	no	yes	-
Local temperature control	no	yes	-
Local time control	no	yes	-
Weather compensation	no	no	-
Lighting			
Efficacy lm/W	40	60 to 80	>60 lm/W
Controls	Switch	Dimming/PIR/Time	-
Parasitic power W/m2	0.1 W/m2	0.3 W/m2	-
DH carbon factor ($kgCO_2/kWh$)	0.25	0.25	-

4.2.1 Preliminary modelling results

Energy modelling and CO_2 reduction modelling results are given below.

Table 4.3 Preliminary energy and CO_2 reduction modelling results for Phase 1 levels 4&5.

		Baseline (Existing)	LEAN	CLEAN	GREEN
Building emission rate ($kgCO_2/m^2$)		118	59.5	60.2	60.2
Carbon savings (%)		-	49.6%	49%	49%
Energy kWh/m^2	Heating	150	26	21	21
	Cooling	0	5	5	5
	Auxiliary	6	49	49	49
	Lighting	15	15	15	15
	Domestic hot water	218	88	80	80
$kgCO_2/m^2$	Heating	44	6	5	5
	Cooling	0	3	3	3
	Auxiliary	3	25	25	25
	Lighting	7	8	8	8
	Domestic hot water	64	20	20	20

Table 4.4 CO_2 saving summary

	Total tCO2	Stage reduction, tCO2	Stage reduction, %
Baseline	135.9	-	-
Be Lean	68.5	67.4	49.6%
Be Clean	69.3	-0.8	-0.6%
Be Green	69.3	0.0	0.0%
TOTAL	69.3	66.6	49.0%
Target – Be Green (20%)	-	-	-
Shortfall	-	-	-

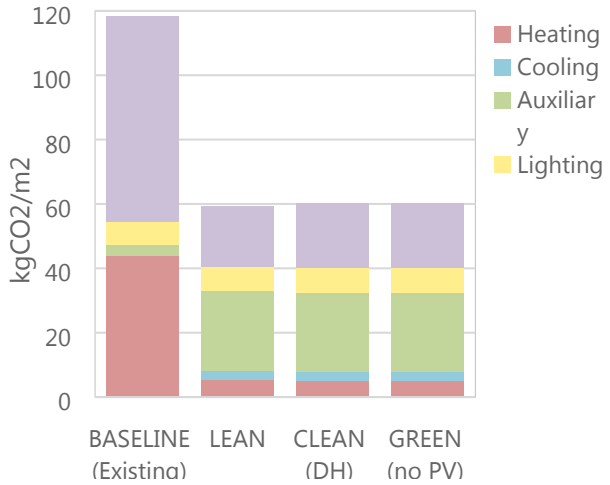

Figure 4.2: CO_2 emissions for the Baseline (existing) and lean, clean and green scenarios.

4.2.2 Summary

The energy modelling results demonstrate that a 49% reduction in regulated CO2 emissions is forecast. Of these savings, a 49.6% CO2 reduction is forecasted from lean improvements i.e. fabric and HVAC system efficiencies. With the district heat connection the overall CO_2 emissions reduces to 49%.

In terms of shortfall, the building meets overall GLA requirement for a 35% reduction in CO2 emissions. As no renewable energy systems (e.g. PV panels) are proposed specifically for levels 4&5 there is no renewable reduction.

5 Overheating assessment

This section contains a thermal comfort assessment for Phase 1 Wing levels 4&5, covering the baseline and future climate assessment. The study aims to assess the feasibility of natural ventilation in line with CIBSE guidance. Where the criteria cannot be achieved, even with appropriate mitigation measures applied, a mixed mode or fully mechanically cooled solution is required.

5.1 Methodology

Calculation method

The overheating assessment has been carried out IES Virtual Environment software 2017 version, in accordance with CIBSE AM11 Building Energy and Environmental Modelling. Results are assessed against the CIBSE TM52 criteria.

According to CIBSE TM52 methodology, a room or building that fails any two of the three criteria is classed as overheating:

1. 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).
2. 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.
3. The third criterion sets an absolute maximum daily temperature for a room, beyond which the level of overheating is unacceptable.

An image of the IES model, incorporating adjacent buildings is shown below. The model reflects the RIBA Stage 2 design and is based on drawings issued by the architect on 27-02-2018.

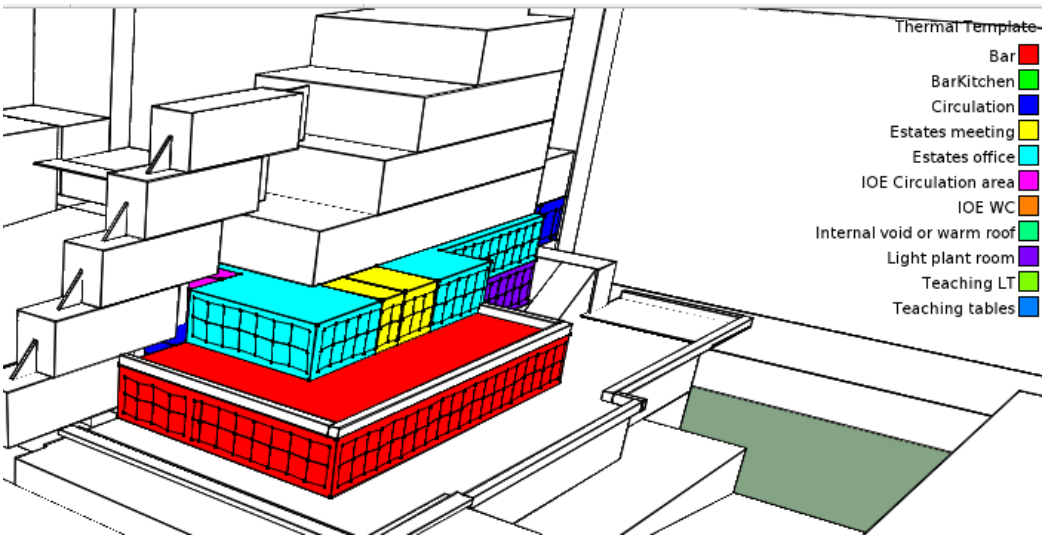

Figure 5-1 - Wing Level 4&5 IES model geometry created in IES – south easterly elevations

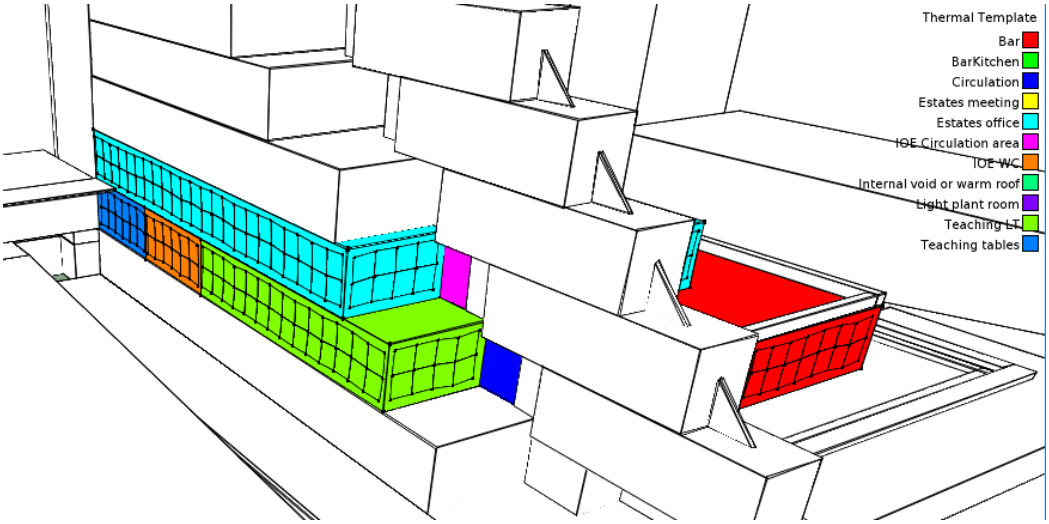

Figure 5-2 - Wing Level 4&5 IES model geometry created in IES – north westerly elevations

Weather files

As per UCL Sustainable Building Standard guidelines, two sets of weather files were tested:

- The *LWC1989_baseline.epw* CIBSE weather file, was applied to the model.
- The model (Maximum window opening) was also tested using future weather data file *LWC1989_2050Med50pct.epw*, which is the design summer year projection for 2050 for the London Weather Centre Location (accounting for urban heat island effect).

Occupancy density, equipment and lighting gains

Inputs for internal equipment and lighting heat gains are given in Table 5.1. It is assumed that the majority of equipment gains in the teaching spaces will be from personal laptop use by students, whereas in the offices there is likely to be a mix of laptops, screens, computers and additional facilities such as photocopiers.

Table 5.1 Internal gains for equipment and lighting.

	Occupancy (m^2/p)	**Lighting (w/m^2)**	**Equipment (w/m^2)**
Teaching LT	1	12	10
Teaching tables	1.5	12	10
Plant	9	8	54
WC	-	10	10
Office	5	10	25
Meeting	6	15	12
Circulation	10	10	2
BarKitchen	10	26	34
Bar	1	15	5
Profile	30% 8AM to 9AM 50% 9AM to 9.30AM 100% 9.30AM to 6PM 50% 6PM to 7PM 30% 7PM to 10PM	100% 8AM to 10PM, 10% at night	100% 9AM to 7PM, 10% at night

Assumed occupancy densities for the spaces on levels 4 and 5 are given in Figure 5-3. Circulation spaces are typically not considered occupied if not occupied for longer than 30 minutes, however, the circulation space on the fifth floor may be considered a transition space with working area, it is likely that such an area might be used by staff or students and is taken into account during the overheating analysis.

Figure 5-3: Occupancy densities for the occupied space on the fourth and fifth floors.

Window openings

Windows in the spaces on level 4 and 5 are sash windows, proposed to be designed with a secondary glazing pane. Sash windows are typically openable up to 50%. However, due to adjacency of the terrace to certain windows, these are locked and limited to an opening of 10% due to security reasons.

5.2 Baseline climate assessment results

Table 5-2 summarises modelling results for the Phase 1 wing level 4 and 5 occupies spaces. Only spaces for which no more than one criterion is failing are classed as a "pass" (in green). Most occupied spaces on both floors are high-density <3 m²/p and/or introduce large internal gains through lighting and equipment into the spaces, both affect the risk of overheating. It can be seen that under the current climate, all but the large office space on the fifth floor are classed as "overheating". These spaces would therefore require mechanical air conditioning.

Table 5.2– Overheating assessment results – baseline weather file.

	1: Operative temperature	2: Severity of overheating	3: Absolute max daily temperature	Criteria failing (not more than one failing)	Proposed Heating / cooling strategy	Proposed Ventilation strategy
5.8.Office	2.9	35	4	2	Rads	Nat vent
5.4.Circ	0.9	12	2	2	Rads	Nat vent
5.5.Circ	1.7	22	3	2	Rads	Nat vent
4.3.Teaching	4.8	37	5	1 & 2 & 3	FCUs & Rads	Nat&Mech
4.7.BarKitchen	15.7	52	5	1 & 2 & 3	FCUs & Rads	Nat&Mech
4.9.Office	35.1	58	5	1 & 2 & 3	FCUs & Rads	Nat&Mech
5.1.Meeting	58.5	41	3	1 & 2	FCUs & Rads	Nat&Mech
5.3.Meeting	43.1	36	3	1 & 2	FCUs & Rads	Nat&Mech
5.6.Meeting	5	47	5	1 & 2 & 3	FCUs	Nat&Mech
5.7.Meeting	4.5	43	4	1 & 2	FCUs & Rads	Nat&Mech
4.11.Bar	10.2	54	6	1 & 2 & 3	FCUs & Rads	Nat&Mech
4.12.Teaching	4.2	31	4	1 & 2	FCUs & Rads	Nat&Mech

In spaces with high occupancy density, such as the bar and lecture theatre, overheating occurs predominantly due to the occupant gains, as can be seen for the bar space in Figure 5-4 for a week in July. In addition, solar gains also have a large effect on the total internal gains. Temperatures in the exceed 28°C during many hours during this week.

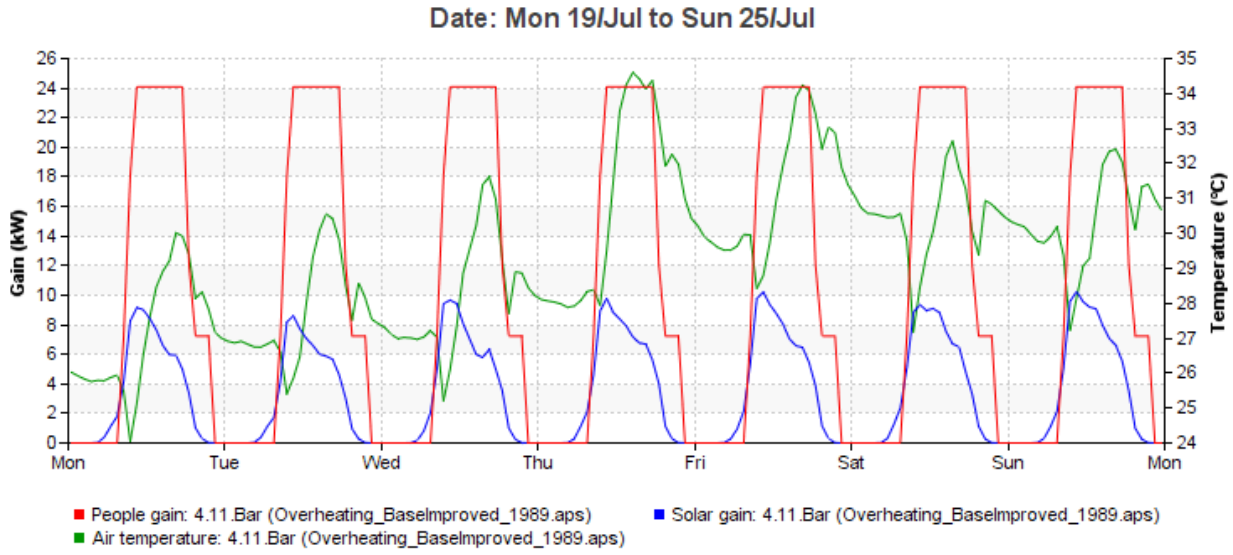

Figure 5-4 – Temperature, occupant and solar gains for the bar space during a week in July.

In contrast, the less high occupancy density spaces, such as meeting rooms and offices, have high internal gains predominantly due to solar gains, and less so due to occupants. Nevertheless, only the large office space on the fifth floor is not in risk of overheating, all other office space and meeting spaces on level 4 and 5 are in risk. An example of a small meeting room on the south-eastern façade is shown Figure 5-5.

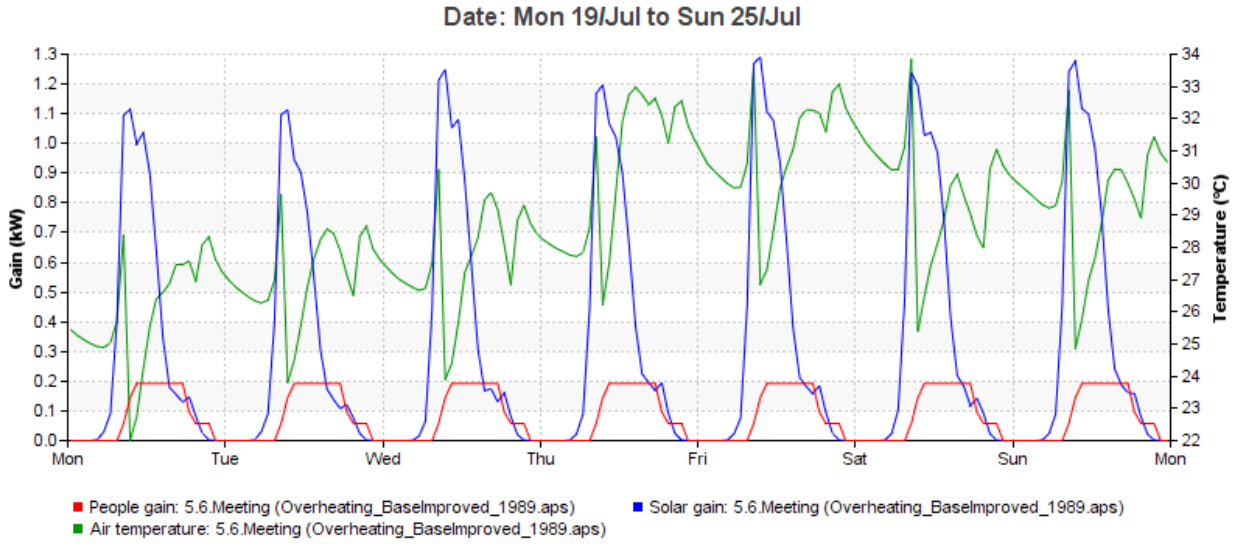

Figure 5-5 – Temperature, occupant and solar gains for a meeting space on the south-eastern façade during a week in July.

Currently, the ventilation strategy for the spaces that are not failing the overheating criteria would solely use natural ventilation as a provision of fresh air, without further cooling. Failing spaces are in need of comfort cooling to keep temperatures at a reasonable level and prevent overheating. Furthermore, these spaces need mechanical ventilation in addition to natural ventilation to provide the necessary level of fresh air, due to their high-occupancy and having windows only on a single side of the space.

People percentage dissatisfied (PPD) and predicted mean vote (PMV)

The people percentage dissatisfied and predicted mean vote in the occupied spaces are also calculated as shown in Table 5.3

Table 5.3– Predicted mean vote and people percentage dissatisfied for the occupied spaces.

	Proposed Heating / cooling strategy	Proposed Ventilation strategy	Mean PPD %	Mean PMV -
5.8.Office	Rads	Nat vent	14.93	0.54
5.4.Circulation	Rads	Nat vent	16.19	0.63
5.5.Circulation	Rads	Nat vent	14	0.53
4.3.Teaching	FCUs & Rads	Nat&Mech	17.32	0.65
4.7.BarKitchen	FCUs & Rads	Nat&Mech	25.86	0.93
4.9.Office	FCUs & Rads	Nat&Mech	28.53	1.01
5.1.Meeting	FCUs & Rads	Nat&Mech	9.84	0.24
5.3.Meeting	FCUs & Rads	Nat&Mech	9.8	0.24
5.6.Meeting	FCUs	Nat&Mech	17.64	0.63
5.7.Meeting	FCUs & Rads	Nat&Mech	17.78	0.64
4.11.Bar	FCUs & Rads	Nat&Mech	25.27	0.89
4.12.Teaching	FCUs & Rads	Nat&Mech	21.71	0.77

5.3 Future climate assessment results

Table 5.4 gives the results for the overheating assessment based on 2050 future weather data. The three spaces that were previously passing the overheating criteria from TM52 are now failing to pass, whereas several spaces that were failing for two criteria are now failing for all three.

Table 5.4– Overheating assessment results – future weather file.

	1: Operative temperature	2: Severity of overheating	3: Absolute max daily temperature	Criteria failing (not more than one failing)	Proposed Heating / cooling strategy	Proposed Ventilation strategy
5.8.Office	4	39	4	1 & 2	FCUs & Rads	Nat vent
4.12.Circulation	3.5	30	3	1 & 2	FCUs & Rads	Nat vent
4.2.Circ	13.7	42	4	1 & 2	FCUs & Rads	Nat vent
4.3.Teaching	6.4	45	5	1 & 2 & 3	FCUs & Rads	Nat&Mech
4.7.BarKitchen	20.3	64	6	1 & 2 & 3	FCUs & Rads	Nat&Mech
4.9.Office	40.2	66	6	1 & 2 & 3	FCUs & Rads	Nat&Mech
5.1.Meeting	56.1	46	4	1 & 2	FCUs & Rads	Nat&Mech
5.3.Meeting	45.1	42	3	1 & 2	FCUs & Rads	Nat&Mech
5.6.Meeting	7.7	53	5	1 & 2 & 3	FCUs	Nat&Mech
5.7.Meeting	6.9	51	5	1 & 2 & 3	FCUs & Rads	Nat&Mech
4.11.Bar	14.1	61	6	1 & 2 & 3	FCUs & Rads	Nat&Mech
4.12.Teaching	6.5	39	5	1 & 2 & 3	FCUs & Rads	Nat&Mech

As the previously compliant spaces are now failing the overheating criteria, it might be prudent to consider a mixed mode approach to ensure optimum comfort throughout the building's life. In all cases, the provision of passive measures to limit internal heat gains and increase air movement where appropriate are recommended to reduce cooling loads throughout the year (equally important for passive, active and mixed mode approaches).

5.4 Reduction in cooling demand from passive measures

The area weighted average building cooling demand (MJ/m2) from the BRUKL - both actual and notional are below. As shown, the actual is below notional.

Table 5.5: Heating and cooling demand for the Notional building compared to actual

		Notional	Actual
MJ/m^2	Cooling demand	29.7	18.4

6 Wider Sustainability (BREEAM)

6.1 Overview

BREEAM (which stands for the "Building Research Establishment Environmental Assessment Methodology") sets the standard for best practice in sustainable building design, construction and operation and has become one of the most comprehensive and widely recognised measures of a building's environmental performance.

Phases 1-3 of the UCL IOE refurbishment will be submitted together under one BREEAM 2014 (RFO) refurbishment and fit out assessment 2014. The "UCL Sustainable Building Standard" states that all refurbishment projects with building services or building fabric upgrades must achieve a **BREEAM Excellent** rating.

In order to facilitate this approach in a complex phased project will require careful project management with the Contractor providing design stage and post construction BREEAM evidence for each element of the project as if it were a single assessment in its own right.

Supporting this process, the Contractor has nominated a Sustainability Champion throughout the design and construction process to formally report progress on BREEAM items to the client and BREEAM Assessor. Providing overall leadership to the BREEAM assessment are BuroHappold, who are appointed in a client side role as BREEAM Assessor and BREEAM AP for the project.

6.2 BREEAM tracker

Appendix A sets out a detailed BREEAM tracker for the project scheduling out the BREEAM credits targeted for the Excellent rating, and current pending actions. Actions are separated out in terms of each element of the project, as well as indicating which evidence can be used at a masterplan level covering all elements in Phase 1.

6.3 BREEAM pre-assessment score – Phase 1 masterplan

The BREEAM pre-assessment score for the Phase 1 masterplan is set out in Figure 5.1. Overall, a low risk score of 75.1% is identified. Note that a 5% buffer above 70% is desired target. As shown, 29.9% of applicable design stage evidence and 15.5% of post construction evidence has already been secured (where the post construction evidence relates to design stage credits that require no further evidence to close).

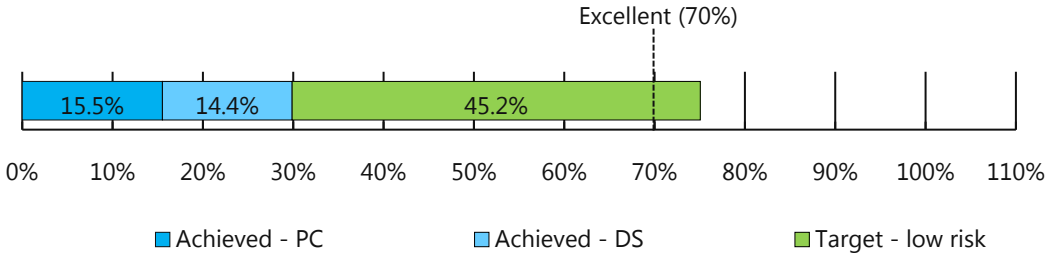

Figure 6.1 – Current BREEAM pre-assessment score for Phase 1 Wing Level 4&5

6.4 Materials sourcing and waste

As part of the BREEAM assessment a number of credits are targeted relating to materials sourcing. Overall in the materials category 61% of credits are targeted at low risk. Credits include sourcing A/A+ rated materials using the BRE green guide, responsible sourcing, designing for durability and robustness and tracking of material efficiency decisions. Regarding waste, 63% of credits in the waste category are targeted. Specifically for levels 4&5 a pre-refurbishment audit was carried out to identify opportunities for material re-use and recycling. Construction waste activities shall also be monitored throughout construction works.

6.5 Green infrastructure and biodiversity (including green/brown roofs)

In line with the ecologist's recommendations, planters with native species shall be provided to terrace areas. Overall in the ecology category 4/4 credits are targeted.

6.6 Water efficiency and SuDS (including rainwater and greywater harvesting)

Low flow water fittings have been specified achieving a reduction in potable water usage of over 40%. Overall in the water category 67% of credits are targeted.

The site is located in flood risk zone 1 (low risk of flooding). The proposed Phase 1-3 refurbishment works will not increase surface water run-off.

6.7 Building Management Systems, metering, monitoring and management

The sub-metering for levels 4&5 covers LTHW, cooling, AHUs, MCCP control panels, systems above 50kW, lighting and small power. Metering and Sub-metering for data will be made available to the UCL campus wide metering EMON System and Schneider Stuxtureware platform.

In relation to sub-metering by area, a new LTHW branch serving the North Wing (Level 4 and 5) will be fitted with heat meters on every floor and separately sub-metered. LTHW metering for constant temperature circuits provided to bar area (MVHR) and fresh air AHU. LTHW metering for variable temperature circuits provided to Level 4 teaching areas, Level 4 bar areas and Level 5 offices. Sub-metering for cooling will be for the Level 4 bar areas, Level 4 teaching space and fresh air AHU, as well as Level 5 office area.

7 Summary and vision

7.1 Summary

This report has covered an analysis of the baseline performance for the UCL Institute of Education, the Phase 1 Wing Levels 4&5 energy strategy, thermal comfort assessment, BREEAM pre-assessment and responses to Camden planning criteria.

In summary, there is good potential to undertake an extensive and sustainable refurbishment for the UCL Institute of Education, which achieves BREEAM Excellent and provides comfortable internal environments. Works undertaken to date for Phase 1 have shown that this will require investment in passive design and fabric improvements, for which an appropriate strategy has been developed in line with the heritage consultant advice.

7.2 Investing in sustainability

The IOE currently spends approximately £515,000/year on energy, which is obviously a very significant amount. Based on energy modelling conducted to date it is estimated that if the proposed fabric renovation works were applied to the whole building, the cost saving over 25 years including expected fuel price rises would be in the order of £2.2 million. Over a 60 year period the cost saving comes to an estimated £5 million, as illustrated below.

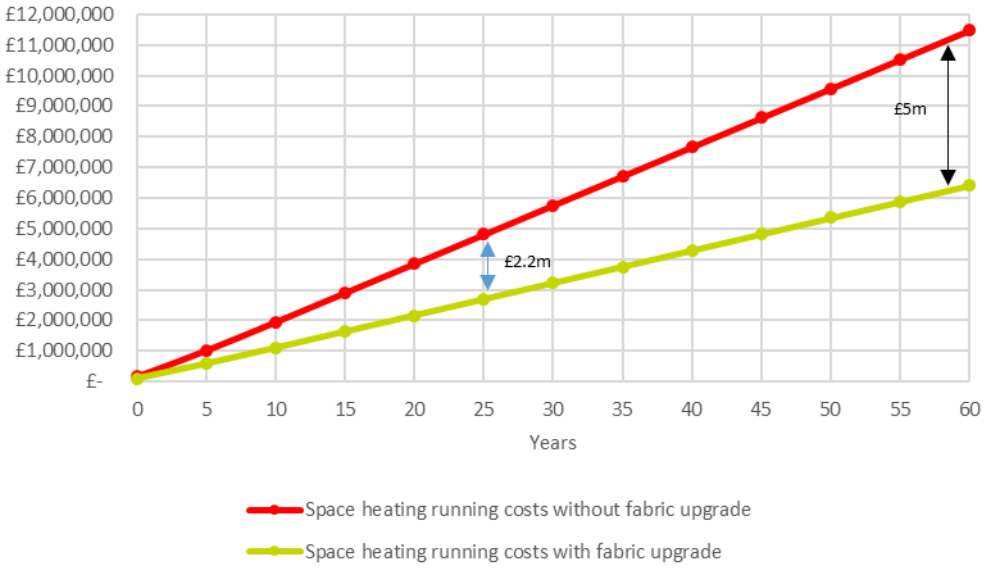

Figure 7.1 – Space heating running cost comparison with and without façade upgrade

7.3 Wider socio-economic benefits

Throughout this project, a case has been built to UCL that the investment in the façade should not be considered solely on a CapX vs. OpX model. Instead it should be appreciated that improvements to the façade will improve thermal comfort and noise, as well as light and air quality. This in turn improves health, well-being and productivity for occupants and ultimately provides wide economic savings.

In terms of quantifying this indirect productivity saving, there is a large body of research linking the internal built environment with improvements in health, well-being and productivity.

Example research papers include:

- 3% gain in productivity achieved by improved personal control over workspace temperature (Loftness et al, 2013).
- Better air quality can result in an 8-11% improvement in overall productivity (Loftness et al, 2013).
- Noise reduction in the workplace can increase productivity by up to 28% (Oseland and Burton, 2012)

In terms of quantifying this indirect cost benefit, according to published records on the 'Research Excellence Framework (REF)' portal, from 2008 and 2013 the average research income at the UCL Institute of Education was £15.5 million/year. If it was considered that the fabric refurbishment could improve overall productivity by 2% then over a 25 year period the total economic benefit could be up to £10 million. Over a 60 year period the total economic benefit could be up to £25 million.

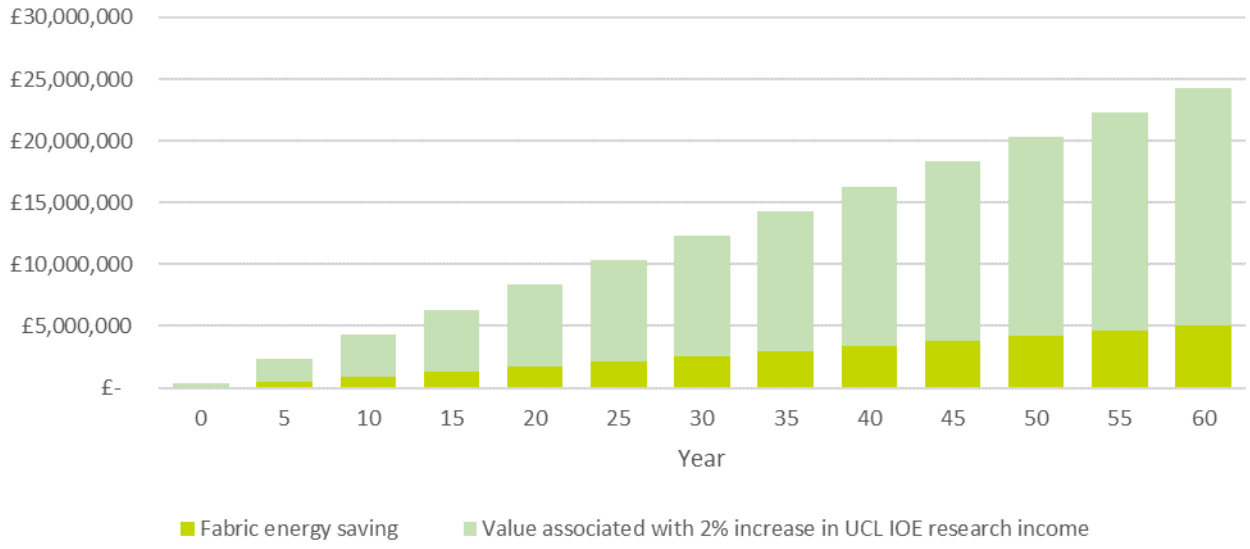

Figure 7.2 – Potential cost benefit from fabric upgrade including additional 2% productivity gain on research income

7.4 Next steps

Moving forward into the detailed design and construction stages for the Phase 1 refurbishment, further work will be undertaken to establish a set of baseline data for the IOE on metric such as thermal comfort, health, well-being and perceived productivity in the building. A user survey to support this process is currently being organised through the IOE, using the industry recognised 'Building Use Studies' (BUS) survey. This will inform the concept design stages for Phases 2 and 3 (and beyond), then also be available for benchmarking during a post occupancy evaluation as part of the client's commitment to long term sustainability.

Despite the constraints of this existing listed building, significant efforts have been made to date to improve the energy performance of the asset. As the design progresses, further work shall be carried out to develop detailed strategies for all IOE phases in line with the BREEAM Excellent requirements, the UCL Sustainable Building Standard, Building Regulations Part L2B and the Camden Planning requirements for existing buildings.

Appendix A – Planning officer comments

Energy and Sustainability Consultation Response

Scheme address	Levels 2-5 of Wing A, Institute of Education, UCL, 20 Bedford Way, WC1H 0AL
Planning reference number	2018/2874/P
Description of development	Refurbishment of Levels 2, 4 and 5 of Wing A to provide a replacement students bar to lv.4 (Use Class A4) as well as new teaching and study spaces, staff offices and associated facilities (Use Class D1). External alterations incl. to add/relocate external doors to terraces; replacement terrace rooflight; raising level of terraces to allow for added insulation; and to raise height of existing terrace balustrades. Replacement HVAC system involving the removal of existing plant to lv.4 terrace and relocation to new plant room with associated installation of external louvres.
No. residential units	-
Non-residential floor space (GIA m2)	Approximately 1,500 m^2
Type of non-residential floor space	D1 - University College London - Institute of Education *No change of use*
Building regulations requirements	Assessed under L2B (elemental compliance)
Relevant documents for reference	'Interim Sustainability Statement – Phase 1 Wing Levels 4&5 – Revision 01' dated 18/04/2018, prepared by Buro Happold on behalf of UCL Institute of Education
Recommendation	Further information required **BH Sustainability 20/08/2018**: We have reviewed your comments and are able to update the report. Please confirm that we have understood your requirements correctly so we may proceed. **BH Sustainability 04/10/2018:** Further to Ellie Bird confirming that the proposed scope of works is acceptable, on 02/Oct/2018, we have updated our report.

POLICY REQUIREMENT:

MAJOR NON-RESI CONVERSIONS OR REFURBISHMENTS TO EXISTING BUILDINGS ASSESSED UNDER PART L2B

*Applicants must submit an **energy statement** showing how the development will meet the following policy requirements:*

- *Follow the hierarchy of energy efficiency, decentralised energy and renewable energy technologies set out in the London Plan (2011) Chapter 5 (particularly Policy 5.2) to achieve the fullest contribution to CO2 reduction. GLA guidance on preparing energy assessments and CPG3 should be followed. In particular, improvements should be sought on the minimum building fabric targets set in Part L of the building regulations*

- *CC1 requires all developments to achieve a 20% reduction in CO2 emissions through renewable technologies (the 3rd stage of the energy hierarchy) wherever feasible, and this should be demonstrated through the energy statement.*

*They are also expected to submit **a sustainability statement** - the detail of which to be commensurate with the scale of the development showing how the development will:*

- *Implement the sustainable design principles as noted in policy CC2*
- *Achieve BREEAM Non-Domestic Refurbishment 'Excellent' rating and minimum credit requirements under Energy (60%), Materials (40%) and Water (60%).*

ENERGY STATEMENT

ENERGY HIERARCHY RESULTS:

	Commercial Refurbishment		
	Total tCO2	Stage reduction, tCO2	Stage reduction, %
Baseline	135.9	-	-
Be Lean	68.5	67.4	49.6%
Be Clean	69.3	-0.8	-0.6%
Be Green	69.3	0.0	0.0%
TOTAL	69.3	66.6	49.0%
Target – Be Green	-	-	-
Shortfall	-	-	-

BH Sustainability 20/08/2018: These results shall be provided. Please see comments below.

BH Sustainability 04/10/2018: Results now provided. 49% saving demonstrated from lean and clean measures. No renewable energy is included in the application for levels 4&5.

Interim Report has quoted savings on basis of BREEAM energy section.
The applicant should provide details of the regulated CO_2 emissions and stage reductions in the energy hierarchy, in line with the GLA's guidance on Preparing Energy Assessments.

The phasing/masterplan in terms of CO2 reporting should be explained. How does the applicant propose to meet the 20% renewable energy target for each phase/application? Should each application? From the planning authority's viewpoint each application stands – and potentially falls - alone unless for example the most up to date combined Masterplan information were to be developed and submitted progressively at each phase/application.

Has sampling been used to model the carbon savings and is sampling representative?	*All elements should be modelled* **BH Sustainability 20/08/2018:** From the above comments we understand that Levels 4&5 shall be treated as its own separate application. **BH Sustainability 04/10/2018:** The assumption above has been confirmed.
Have the DER/ TER worksheets/ BRUKL report been provided?	*Please provide the BRUKL reports for Baseline, Be Lean and Be Green to support the stated savings* **BH Sustainability 20/08/2018:** We shall update the energy modelling for levels 4&5 in line with the required approach. We acknowledge that we did not report the "lean", "clean", "green" results separately, so we shall do this. BRUKL reports shall also be

	provided. Please note that for the "BREEAM RFO calculation method" the baseline is the unrefurbished existing building. This is in line with the GLA energy statement requirements as per clause 9.2 below. 9.2 Where significant refurbishments are being carried out, it is expected that an estimate of the CO_2 savings from the refurbishment of the building is provided. To provide this, firstly the regulated CO_2 emissions of the unrefurbished, existing building should be modelled using building regulations compliance software to determine a BER/DER, which will be used to determine a baseline. The BER/DER of the refurbished building should also be determined at each stage of the energy hierarchy using building regulations compliance software. These figures should then be used to report the CO_2 savings at each element of the energy hierarchy in the format of Table 2 and 4 above. **BH Sustainability 04/10/2018:** Further to confirmation from the planning officer we have proceeded to run the baseline, lean, clean and green results. Please see Chapter 4 of our report for a summary of the calculations. BRUKL output documents have also been submitted with the report.

BE LEAN:

Proposed specification:

Building fabric u-values (W/m²K)

		Existing: (assumed based on review of available information)	Improved (Secondary glazing + opaque wall elements and roof upgraded.)	*Part L2B 2013*		
				Threshold of retained Element	*Value of replacement element*	*New thermal elements and controlled fittings*
Fabric U-values (W/m2K)	Solid wall	2.5 (300mm cast dense concrete, membrane)	0.3 for new thermal elements	*0.7*	*0.3*	*0.28*
	Roof	2.3 (400mm concrete deck & membrane, concrete tile 100mm)	0.18 (400mm concrete deck, insulation 100mm & membrane, concrete tile 100mm) *	*0.35*	*0.18 flat roof*	
	Internal wall	2.5 (200mm cast concrete medium)	1 (lightweight plaster)	-	-	-
	Internal floor/ceiling	2.6 (300 reinforced concrete, 20mm screed)	2.6 (300 reinforced concrete, 20mm screed)	-	-	-
External glazing	U-value	6 (single glazing metal frame	2.1	*3.3*	1.8 W/m²K Or heritage constraint does not allow to achieve a centre pane U value of 1.8 W/m2K.	
	G-value	0.73	0.4	-		

BH Sustainability 20/08/2018: No action needed.
BH Sustainability 04/10/2018: No action needed.

Air permeability (m2/hr/m2)

Air tightness	50 pa (m3/h.m2 @ 50 Pa)	19 (to be tested by contractor)	6.5 (target to be tested by contractor)

BH Sustainability 20/08/2018: No action needed.
BH Sustainability 04/10/2018: No action needed.

Approach to limiting thermal bridging

N/A

BH Sustainability 20/08/2018: No action needed.
BH Sustainability 04/10/2018: No action needed.

Glazing %

N/A

BH Sustainability 20/08/2018: No action needed.
BH Sustainability 04/10/2018: No action needed.

Low carbon technologies and building services	- Improving the thermal performance of the building fabric in line with heritage constraints, through the addition of secondary glazing, where consented, and internal insulation to cladding panels. - Upgrading all major MEP systems and lighting…. all performance values are better or equal to Part L2B 2010 (including 2016 amendments) and Non-Domestic Building Services Compliance Guide 2013. **BH Sustainability 20/08/2018**: No action needed. **BH Sustainability 04/10/2018:** No action needed.

BE CLEAN:

Connection to an existing decentralised energy network:	
Proximity to existing decentralised energy networks and proposals to connect	"Retaining connection to the Bloomsbury Heat and Power network, which includes boiler and combined heat and power plant, enabling up to 80% of the building's electricity to come from low carbon sources." **BH Sustainability 20/08/2018**: No action needed. **BH Sustainability 04/10/2018:** No action needed.
Future proofing:	
Opportunities to connect to a future network	*N/A* **BH Sustainability 20/08/2018**: No action needed. **BH Sustainability 04/10/2018:** No action needed.
On-site CHP	
Suitability for on-site CHP	*See above* **BH Sustainability 20/08/2018**: No action needed. **BH Sustainability 04/10/2018:** No action needed.

BE GREEN

Proposed technologies:	
Solar PV:	"The only applicable on-site form of renewable energy would be solar photovoltaics (which are estimated to save 2.3% of CO_2 across Phases 1-3), however these are potentially contentious according to the heritage consultant. If PV panels are to be considered, these will be brought forward in future refurbishment phases in discussion with Camden and Historic England." *Please state in which phase(s) this is anticipated to be introduced.* **BH Sustainability 20/08/2018**: Solar photovoltaic (PV) panels will not be included in the application for Levels 4&5, as it falls outside of the scope of works. The implementation of solar PV was investigated as part of a masterplan wide study, however it has not yet been confirmed as a viable technology to incorporate into any phase of the project. This is because the heritage consultant has commented it would be potentially contentious.

	BH Sustainability 04/10/2018: The commentary above has been included in the updated report.

SUSTAINABILITY PLAN

Summary of proposed measures	
BREEAM rating	We note this is phase 1 of 3 phases, each with separate planning applications. The entire is proposed to be assessed under BREEAM Refurbishment & Fit-Out 2014. Phase 1 for levels 4&5 is currently stated to be targeting a BREEAM score of 77.5% 'Excellent', with potentially an additional 12% through potential credits. The Statement tracks credits for two scheme elements 'Phase 1 ISD Level 3' and 'Levels 4 & 5', and the combined overall IoE MasterPlan. It is not clear why only the L4&5 element is being reported. - *The scheme should also target minimum credit scores of 60% in Energy, 60% in Water, and 40% in Materials categories.* - *The applicant should explain in more detail how the BREEAM score will be assessed and reported within each planning application/phase, including this one. How do they proposed to meet BREEAM certification requirements for each application?* **BH Sustainability 20/08/2018**: It has been agreed with the client that the BREEAM assessment for IOE refurbishment (all phases) shall be submitted under one application to the BRE. This is to avoid the scenario of having to submit individual BREEAM assessments for every phase of the building. To support this workflow BuroHappold sustainability are collecting and reviewing both "design stage" and "post construction" evidence for every phase. In principal, should the masterplan works stop for any reason, then the BREEAM assessment evidence collected for all completed phases could be submitted. The BREEAM tracker has been prepared in such a way that the scores can be viewed for the whole masterplan or for the individual phases. For clarity, when we update the planning report we shall present the BREEAM score for the masterplan only. We shall clarify if the masterplan score achieves the minimum credit scores of 60% in Energy, 60% in Water, and 40% in Materials categories. **BH Sustainability 04/10/2018:** Chapter 6 of the report now only reports on the masterplan BREEAM score, which is 75.1%. Scores by category are Energy (75%), Water (67%) and Materials (61%). A copy of the masterplan BREEAM tracker is also provided. Note that this also captures comments by sub-phase.
Cooling hierarchy 1. Minimising internal heat generation through energy efficient design 2. Reducing the amount of heat entering the building in summer	Proposing water cooled fan coil systems with SEER of 4.5 / EER of 3.6. *All development should demonstrate that measures to adapt to climate change have been implemented and that overheating risk has been managed.*

3. Use of thermal mass and high ceilings to manage the heat within the building: 4. Passive ventilation: 5. Mechanical ventilation:	*Basic overheating compliance tests must be undertaken to demonstrate compliance with Building Regulation, however this test does not cover all factors which influence overheating. Therefore the GLA guidance states that developers should carry out dynamic thermal modelling.* *Where dynamic modelling is carried out, it should be undertaken in accordance with the guidance and data sets in TM49: Design Summer Years for London. It is also recommended that developers consider CIBSE TM52 The Limits of Thermal Comfort: Avoiding Overheating in European Buildings when carrying out modelling.* *Where cooling is proposed, developers should provide details, including: efficiency, ability to take advantage of free cooling and renewable cooling sources. Developers should identify elements that need cooling.* *Non-domestic developments should provide details on the area weighted average building cooling demand (MJ/m2) (from the BRUKL) both actual and notional – the actual should be below notional.* **BH Sustainability 20/08/2018**: Dynamic overheating calculations for levels 4&5 have already been completed to the required standards, so we shall include these in our updated planning report. We shall also report on the average building cooling demand MJ/m2 for the actual and notional cases. **BH Sustainability 04/10/2018:** The overheating assessment can be found in Chapter 5 of the report. The study includes baseline and future overheating assessment calculations. As shown, due to the high occupancy density of spaces a mixed mode ventilation approach has been provided. The notional vs. actual cooling demand is given in Section 5.4 and also summarised below: Notional cooling demand = 29.7 MJ/m2 Actual cooling demand = 18.4 MJ/m2
Materials, sourcing and waste	*TBC* **BH Sustainability 20/08/2018**: We shall provide a statement regarding this in our updated report. **BH Sustainability 04/10/2018:** As described in Section 6.4, As part of the BREEAM assessment a number of credits are targeted relating to materials sourcing. Overall in the materials category 61% of credits are targeted at low risk. Credits include sourcing A/A+ rated materials using the BRE green guide responsible sourcing, designing for durability and robustness and tracking of material efficiency decisions. Regarding waste, 63% of credits in the waste category are targeted. Specifically for levels 4&5 a pre-refurbishment audit was carried out to identify opportunities for material re-use and recycling. Construction waste activities shall also be monitored throughout construction works.
Green infrastructure and biodiversity (including green/brown roofs)	*TBC* **BH Sustainability 20/08/2018**: We shall provide a statement regarding this in our updated report. Please note that for levels 4&5 there are no green/brown roofs included in the scope.

	BH Sustainability 04/10/2018: As described in Section 6.5, in line with the ecologist's recommendations, planters with native species shall be provided to terrace areas. Overall in the ecology category 4/4 credits are targeted.
Water efficiency and SuDS (including rainwater and greywater harvesting)	*TBC* **BH Sustainability 20/08/2018**: We shall provide a statement regarding this in our updated report. Please note that for levels 4&5 there are no rainwater or greywater harvesting or SuDS works proposed. **BH Sustainability 04/10/2018:** As described in Section 6.6, low flow water fittings have been specified achieving a reduction in potable water usage of over 40%. Overall in the water category 67% of credits are targeted. The site is located in flood risk zone 1 (low risk of flooding). The proposed Phase 1-3 refurbishment works will not increase surface water run-off.
Building Management Systems, metering, monitoring and management	*TBC* **BH Sustainability 20/08/2018**: We shall provide a statement regarding this in our updated report. **BH Sustainability 04/10/2018:** As described in Section 6.7, The sub-metering for levels 4&5 covers LTHW, cooling, AHUs, MCCP control panels, systems above 50kW, lighting and small power. Metering and Sub-metering for data will be made available to the UCL campus wide metering EMON System and Schneider Stuxtureware platform. In relation to sub-metering by area, a new LTHW branch serving the North Wing (Level 4 and 5) will be fitted with heat meters on every floor and separately sub-metered. LTHW metering for constant temperature circuits provided to bar area (MVHR) and fresh air AHU. LTHW metering for variable temperature circuits provided to Level 4 teaching areas, Level 4 bar areas and Level 5 offices. Sub-metering for cooling will be for the Level 4 bar areas, Level 4 teaching space and fresh air AHU, as well as Level 5 office area.

FURTHER ACTIONS FOR APPLICANT

See above.

BH Sustainability 20/08/2018: Please confirm that we have understood your requirements correctly so we may proceed with updating the report.

BH Sustainability 04/10/2018: Our report has now been updated. Thank you for the comments.

Appendix B – BREEAM tracker

BREEAM Refurbishment and Fit Out 2014 Tracker

Scheme: BREEAM RFO 2014
Project: UCL Institute of Education Phase 1
BRE Ref: BREEAM-0067-3285
Stages: Phase 1 Wing L2&3 (RIBA Stage 6)
Phase 1 Wing L4&5 (RIBA Stage 4)
Phase 1 ISD L3 (RIBA Stage 4)

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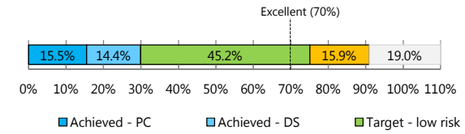
Select >> IOE Masterplan

TARGET RATING	EXCELLENT
TARGETED LOW RISK SCORE	75.1%
MINIMUM STANDARDS ON TRACK?	YES
ACHIEVED CREDITS (DS)	29.9%
ACHIEVED CREDITS (PC)	15.5%

IOE Masterplan



BUROHAPPOLD ENGINEERING

Credit Ref:	Credit Issue (Mandatory Credits for Excellent shown red)	RIBA Stage	Available	% Score Value	IOE Masterplan %	75.1	90.9	19.0	29.9	15.5	Phase 1 - L2&3	74.0	87.1	22.8	58.6	43.6	Phase 1 - L4&5	79.0	90.6	26.4	25.2	12.8	Phase 1 - ISD L3	78.3	89.8	20.1	20.3	14.1	Owner (lead, support)	Design stage actions (and risks) IOE Masterplan - Phase 1	Owner (lead, support)	Design stage actions (and risks) Phase 1 - L4&5
						Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC		Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC		Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC		Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC		Green = Design stage evidence closed Blue = Design stage masterplan credits for Overbury		Green = Design stage evidence closed Blue = Design stage credits for Overbury
MANAGEMENT																																
Man 01	**Project Brief and Design**																															
Man 01	Stakeholder Consultation - Project Delivery (Defining roles and responsibilities)	**Stage 2**	1	0.65%	1			1	1		1			1	1		1						1			1	1		Arcadis, HB	**Crit 1a-e, 2, 3a-k** - All early stage masterplan evidence covering Phases 1-3 received covering all Crit. **Crit 4** - See specific phases	Arcadis, HB	**Crit 1a-e, 2, 3a-k** - See masterplan evidence. **Crit 4** - Meeting minutes and updated project execution plan for Phase 1 levels 4&5 to be provided.
Man 01	Stakeholder Consultation -Third Parties (End users, local community, statutory consultees, etc.)	**Stage 2**	1	0.65%	1			1	1		1			1	1		1						1			1	1		HB, Arcadis	**Crit 5** - Consultation evidence from masterplan stages provided. **Crit 6** - Masterplan phasing strategy evidence provided. **Crit 7** - See specific phases. **Crit 8** - Architect leading consultation independently.	HB, Arcadis	**Crit 5** - Consultation evidence needed (UCL, MLM, heritage) **Crit 6** - Design / phasing strategy presentations needed **Crit 7** - Feedback presentations to stakeholders needed **Crit 8** - Architect leading consultation independently.
Man 01	Sustainability Champion (Design Stage) - Appointment of a BREEAM AP to set BREEAM performance targets	**Stage 1**	1	0.65%	1			1	1		1			1	1		1				1	1	1			1	1		BH sust, Arcadis	**Crit 9** - Mark Dowson (BuroHappold) appointed as BREEAM AP **Crit 10** - BREEAM Excellent target included in UCL Sust Standard **Crit 11** - BREEAM Excellent must be achieved to secure credit. Assumed this is low risk currently.	n/a	n/a
Man 01	Sustainability Champion (Design Stage) - Involvement of a BREEAM AP to monitor and advise on BREEAM progress	**Stage 2 - 4**	1	0.65%	1			1	1		1			1	1		1						1			1	1		BH sust	**Crit 12** - Dependent on securing previous credit **Crit 13** - See specific phases	BH sust	**Crit 12** - See masterplan evidence. **Crit 13** - BREEAM AP evidence at RIBA stages 2-4 to be gathered and written up.
Man 02	**Life Cycle Cost and Service Life Planning**																															
Man 02	Elemental Life Cycle Cost (LCC) analysis to PD156865:2008	**Stage 2**	2	1.30%	2			2	2		2			2	2		2				2	2	2			2	2		AECOM BH Sust	**Crit 3** - RIBA Stage 4 LCC report received from AECOM specificfor Phase 1. The LCC report included an options appraisal that recommended secondary glazing, LED lighting (over T5 tubes) and tiled carpeting (over carpet role. **Crit 3** - BH BREEAM site inspection took place. All measures above were witnessed on-site.	n/a	n/a
	Component Level LCC Plan to PD156865:2008 (Envelope, Services, Finishes and external spaces)	**Stage 4**	1	0.65%	1			2			1			2	2		1				2		1			2			AECOM	**Crit 3** - RIBA Stage 4 LCC report received from AECOM specific to the phase.	BH sust	**Crit 3** - Site photos of installed LCC measures
	Capital Cost Reporting (£/m2) to the BRE		1	0.65%	1						1				1		1						1						n/a	n/a	AECOM	**Crit 4.** RIBA Stage 4 capital cost confirmation needed for L4&5
Man 03	**Responsible Construction Practices**																															
	Pre-Requisite: Responsibly sourced timber		Pre-requisite	-	Y				Y		Y				Y		Y				Y		Y						n/a	n/a	Overbury	**Crit 1** - Overbury have provide a letter of intent confirming that all timber will be legally harvested and traded. Letter was specific to L4&5. POST CONSTRUCTION EVIDENCE WILL BE NEEDED
	Environmental Management System operated by the Principal Contractor (E.g. ISO14001, BS8555)		1	0.65%	1						1				1	1	1				1		1						n/a	n/a	Overbury	**Crit 2-3** - Overbury haved provided a letter of intent confirming PPG6 will be followed. Copy of EMS certificate has also been provided. POST CONSTRUCTION PPG6 EXAMPLES WILL BE NEEDED

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Credit Ref:	Credit Issue (Mandatory Credits for Excellent shown red)	RIBA Stage	Available	% Score Value	IOE Masterplan %					Phase 1 - L2&3					Phase 1 - L4&5					Phase 1 - ISD L3					Owner (lead, support)	Design stage actions (and risks) IOE Masterplan - Phase 1	Owner (lead, support)	Design stage actions (and risks) Phase 1 - L4&5
					75.1	90.9	19.0	29.9	15.5	74.0	87.1	22.8	58.6	43.6	79.0	90.6	26.4	25.2	12.8	78.3	89.8	20.1	20.3	14.1				
					Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC	Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC	Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC	Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC		Green = Design stage evidence closed Blue = Design stage masterplan credits for Overbury		Green = Design stage evidence closed Blue = Design stage credits for Overbury
	Sustainability Champion (Construction Stage) - BREEAM AP appointed to monitor and advise on progress	**Stage 5** **Stage 6**	1	0.65%	1					1			**1**	**1**	1			**1**		1					n/a	n/a	Mace Overbury	**Crit 4-5** - Overybury have confirmed that James Shears (BREEAM AP) will be the sustainability champion. **Crit 6** - BREEAM Excellent must be achieved to secure credit. Assumed this is low risk currently.
	Considerate Construction (CCS or equivalent) **(ONE CREDIT NEEDED FOR BREEAM EXCELLENT)**		2	1.30%	2					2			**2**	**2**	2					2					n/a	n/a	Overbury	**Crit 7-8** - Overbury to provide a letter of intent confirming that "Phase 1" will be registered for the Considerate Construction Scheme, targeting a score of 40 with 7 in all sections. CCS registration details to be confirmed.
	Monitoring of Construction-site impacts (Energy and water consumption; transport movements for delivery of materials and waste transfer)		2	1.30%	2					2			**2**		2			**2**		2					n/a	n/a	Overbury	**Crit 9** - Overbury have confirmed James Shears will be in charge of the site monitoring. **Crit 10-15** - Overybury have provided a letter confirming that energy and water shall be monitored - see BREEAM criteria. **Crit 16-19** - Overbury have provided a letter confirming transport monitoring of materials and waste shall be in line with BREEAM RFO requirements. POST CONSTRUCTION MONITORING EVIDENCE WILL BE NEEDED.
Man 04	**Commissioning and Handover**																											
	Commissioning and Testing Schedule, including assignment of responsibilities, in line with Building Regulations, CIBSE and BSRIA.		1	0.65%	1					1			**1**	**1**	1					1					n/a	n/a	Mace, Overbury	**Crit 1-4** - Mace to confirm that all BREEAM commissioning requirements are included in the RIBA Stage 4 design, and provide all supplementary evidence as per previous levels. **Crit 1-4** - Overbury to provide letter, commissioning schedule, programme, confirm responsibilitites, commitment to follow BSRIA/CIBSE standards
	Commissioning Building Services - Appointment of a specialist commissioning manager	**Stage 4**	1	0.65%	1					1			**1**	**1**	1					1					n/a	n/a	Mace, Overbury	**Crit 5** - Criteria 1-4 to be achieved. **Crit 6** - Mace to confirm that all BREEAM commissioning requirements are included in the RIBA Stage 4 design, and provide all supplementary evidence as per previous levels. **Crit 6** - Overbury to provide schedule for commissioning of building services and BMS systems.
	Testing and Inspecting Building Fabric (E.g. Thermographic survey, air tightness)		1	0.65%	1					1			**1**	**1**	1					1					n/a	n/a	Overbury	**Crit 7-8** - Overbury to provide letter confirming that levels 4&5 will also be air tightness tested and undergo thermal imaging, with any defects rectified.
	Handover - Building User Guide and Training Schedule **(Crit 10 NEEDED FOR BREEAM EXCELLENT)**		1	0.65%	1					1			**1**		1					1					n/a	n/a	Overbury	**Crit 9-10** - Overybury to provide letter for L4&5 confirming that the building user guide and training schedule will be completed in line with BREEAM requirements.
Man 05	**Aftercare**																											
	Aftercare Support for building occupants (Aftercare team for 12 months; Energy/water monitoring for 12 months)		1	0.65%	1					1			**1**	**1**	1					1					n/a	n/a	Overbury	**Crit 1-2** - Overbury to provide letter confirming that all aftercare requirements will be met.
	Seasonal Commissioning over a 12 month period post-occupation **(ONE CREDIT NEEDED FOR EXCELLENT RATING)**		1	0.65%	1					1			**1**	**1**	1					1					n/a	n/a	Overbury	**Crit 3** - Overbury to confirm that all seasonal commissioning requirements in BREEAM RFO will also be allowed for in L4&5.
	Post Occupancy Evaluation (Independent third party POE one year after occupation)		1	0.65%	1					1					1					1					UCL	**Crit 4-5** - Letter of intent has been issued to UCL. Signed copy to be sent back to close design stage action.	n/a	n/a

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					Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC	Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC	Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC	Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC				
HEALTH & WELLBEING																											
Hea 01	**Visual comfort**																										
	Glare Control Strategy (E.g. Building integrated measures, brise soleil, blinds)		1	0.77%	1					1			1	1	1			1		1			1		n/a	n/a	HB, Mace	**Crit 1-2** - Mace have provided drawings showing all windows on L4&5 will also have blinds installed.
	Daylighting		3	2.32%	1	2						3	0	0	1		2	1	1			3	0	0	n/a	n/a	Mace, RES, BH sust	**Crit 3-5** - RES (appointed by Mace) has provided RIBA Stage 4 daylight results, 1 credit awarded under method 2.
	View Out		2	1.55%	1	1					1	1			1	1				1	1				n/a	n/a	HB, Mace	**Crit 6-9** - Provide mark-up showing what % of the building area is within 7m of a window. It is noted that redit is challenging for these areas, however Phase 1 areas still need to be assessed at Stage 4 for inclusion in wider masterplan assessment. Depending on room depth check breeam guidance from BS 8206
	Internal and External Lighting Levels to CIBSE codes; Adequate zoning and local occupant control		1	0.77%	1					1			1		1					1					n/a	n/a	Mace	**Crit 10,11,12,14,15,16** - As built lighting layouts for L4&5 have been provided together with Contractor CPs detailing lighting types, zoning and lux levels. **Crit 13 - Letter to be provided in relation to external lighting standards BS5489-1:2003 and BS EN12464-2-2014, as they are not referenced in the CP proposals.**
Hea 02	**Indoor air quality**																										
	Indoor Air Quality Plan		1	0.77%	1		1	1		1			1	1	1					1					BH IAQ team, Mace	**Crit 1** - The BH environment team have prepared in the indoor air quality plan for the project in line with BREEAM RFO requirements. Mace/overbury to note requirements.	Overbury	**Crit 1** - Overbury to confirm how the air quality plan requirements will be followed during construction of Phase 1 L4&5.
	Minimising sources of external air pollution - Ventilation Strategy		1	0.77%		1				1			1		1					1					n/a	n/a	Mace	**Crit 2,5** - Contrator CPs are provided as evidence. Ventilation strategy is included including details of CO2 sensors to mechanically ventilated spaces. **Crit 3 - Confirm ventilation intakes and exhausts comply with BREEAM requirements (are they the same locations as L2&3?).** **Crit 4 - Confirm filtration meets requirements in BS EN 13779:2007 Annex A3.**
	Minimising sources of internal air pollution - Specification of Low VOC finishes and fittings		1	0.77%	1					1			1		1					1					n/a	n/a	Mace	**Crit 6-7** - Mace to provide details of VOC standards to be applied for levels 4&5. Specifications to be provided for each product type.

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					Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC	Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC	Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC	Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC				
	Minimising sources of internal air pollution - Pre-completion indoor air quality testing		1	0.77%		1				1			1		1				1					n/a	n/a	Overbury	**Crit 8-12** - Overbury to provide letter confirming that the VOC testing shall also take place 'post construction, but pre-occupancy' on L4&5.
	Potential for Natural Ventilation		1	0.77%			1				1						1					1			n/a	Credit not achievable. Early modelling showed the need for mechanical cooling. BREEAM credit requires full nat vent everywhere.	n/a	n/a
Hea 03	**Safe Containment in Laboratories**																										
	Laboratory containment devices and containment areas	**Stage 3**	0	0.00%																					n/a (Phase 1)	Confirmed 19 Jan 2017, that labs are likely to be included in Phase 2 & 3 scope of works, n/a to Phase 1.	n/a	n/a for this phase
	Buildings with containment level 2 and 3 laboratory facilities		0	0.00%																					n/a (Phase 1)	Scope for labs on project TBC. If labs are Cat 2 or 3, then these credits would be required also.	n/a	n/a for this phase
Hea 04	**Thermal Comfort**																										
	Thermal Modelling		1	0.77%	1			1	1	1			1	1	1			1	1	1			1	1		n/a	n/a	Mace, RES, BH sust	**Crit 1-5** - RES carried out thermal comfort modelling for L4&5 at RIBA Stage 4.
	Adaptability - For a Projected Climate Change Scenario		1	0.77%	1			1	1	1			1	1	1			1	1	1			1	1		n/a	n/a	Mace, RES, BH sust	**Crit 6-9** - RES caried out future climate modelling for levels 4&5 in line with BREEAM requirements.
	Thermal Zoning and Controls		1	0.77%	1					1			1		1					1					n/a	n/a	Mace, BH Mech	**Crit 10-12a** - Mace to provide zoning strategy drawings and confirm how modelling has informed the approach. **Crit 12b-e** - BH MEP / Mace to confirm that UCL have been consulted on decisions relating to heating/cooling controls and zoning.
Hea 05	**Acoustic performance**																										
	Acoustic performance standards and testing (Sound insulation, indoor ambient noise level and reverberation times)		3	2.32%	3			3		3			3		3			3		3					BH acoustics	Crit 1-3 - The BH RIBA Stage 3 acoustics report has been provided confirming that 3 of 3 credits are achievable.	Mace, HB, Overbury	**Crit 1-3** - Mace have provided acoustics mark-up for levels 4&5. **Crit 1-3** - Overbury to provide letter confirming that acoustics testing shall take place in line with BREEAM requirements.
Hea 06	**Safety and security**																										
Hea 06	Security of Site and Building (Security Needs Assessment)	**Stage 2**	1	0.77%	1			1		1			1		1					1					BH security	**Crit 1-2** - BH security team has been appointed as the SQSS. A CV has been provided. BH security provided an SNA for Phase 1 during RIBA stage 2, and also consulted with the DOCO. The report included reference to measures applicable to level 4.	BH security, New security consultant	**Crit 3** - Security drawings for L4&5 to be prepared (e.g. by security specialist again). BH security to provide similar sign off at RIBA stage 4.
ENERGY																											
Ene 01	**Reduction of CO2 emissions**																										

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					Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC	Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC	Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC	Targeted - Low Risk	High risk - TBC	Not Targeted	Achieved - DS	Achieved - PC				
	Energy Performance **(SIX CREDITS NEEDED FOR BREEAM EXCELLENT UNDER THE RFO ASSESSMENT)**		15	9.11%	9	2	4	**2**	**2**	9	2	4	**2**		13		2	**2**		13		2	**2**		Heritage consultant	Crit 3-7 - Energy efficiency study compliant with BREEAM undertaken by heritage consultant securing 2 credits (applicable to historic buildings only).	Mace, RES	**Crit 1-2** - RIBA Stage 4 BREEAM RFO energy modelling results will be required by RES. This includes preparing the EPC for the existing and proposed levels 4&5.
Ene 02	**Energy monitoring**																										
	Sub-Metering of Major Energy Consuming Systems **(ONE CREDIT NEEDED FOR BREEAM VERY GOOD OR EXCELLENT RATING)**		1	0.61%	1					1			**1**	**1**	1			**1**		1					n/a	n/a	Mace, BH Mech, BH Elec	**Crit 1-4** - Mace have provided metering schematics together with contractor proposals.
	Sub-Metering of High Energy Load and Tenancy Areas		1	0.61%	1					1			**1**	**1**	1			**1**		1					n/a	n/a	Mace, BH Mech, BH Elec	**Crit 1-4** - Mace have provided metering schematics together with contractor proposals.
Ene 03	**External lighting**																										
	External Lighting - Energy efficient specification		1	0.61%	1					1			**1**	**1**	1			**1**		1					n/a	n/a	Mace, BH Elec	**Crit 2,3** - Mace have provided drawings showing external lighting on L4 layouts. Timeclock controls only, but this is ok as it is for the bar area which has a high level of pedestrian traffic. **Crit 2 - External lighting calculations needed to demonstrate average initial luminous efficacy of the external light fittings within the construction zone is not less than 60 luminaire lumens per circuit Watt.**
Ene 04	**Low Carbon Design**																										
Ene 04	Passive Design Analysis	**Stage 2**	1	0.61%	1		**1**	**1**		1			**1**	**1**	1			**1**		1			**1**		BH sust	**Crit 1** - Hea04 achieved **Crit 2-3** - RIBA Stage 2 passive design analysis was completed covering the IOE masterplan. Can be used for all stages.	n/a	n/a
Ene 04	Free Cooling	**Stage 2**	1	0.61%		1					1	0	0			1					1				n/a	Credit not achievable. Early modelling showed the need for mechanical cooling. BREEAM credit requires all passive cooling.	n/a	n/a
Ene 04	Low and Zero Carbon Feasibility Study	**Stage 2**	1	0.61%	1		**1**	**1**		1			**1**	**1**	1			**1**	**1**	1			**1**	**1**	BH sust	**Crit 7-8** - BH sustainability carried out a masterplan LZC study at RIBA Stage 2. The study identified the Bloomsbury Heat & Power network as a key strategy, which the building is connecting to. Solar PV was also identified as a potential option.	n/a	n/a
Ene 05	**Energy efficient cold storage**																										
	Refrigeration Energy Consumption		1	0.61%	1					1					1					1					n/a	n/a	Mace Overbury	**Crit 1-2** - Mace to ensure that controls and components associated with cold storage areas (e.g. serving bar) have been designed in line with Code of Conduct for carbon reduction and BS EN 378-2. Products to be in line with Enhanced Capital Allowance (ECA) Energy Technology Product List (ETPL), or approved equivalent. **Crit 1-2 -** Overbury to confirm systems will be installed and commissioned to the above standards. Letter needed.
	Indirect Greenhouse Gas Emissions (Carbon Trust Refrigeration Road Map)		1	0.61%	1					1					1					1					n/a	n/a	Mace Overbury	**Crit 3-** Criteria 1-2 to be achieved **Crit 4 -** Mace to provide manufacturers evidence confirming the installed refrigeration system demonstrates a saving in indirect greenhouse gas emissions (CO_2 eq.) over the course of its operational life. **Crit 4** - Overbury to provide commitment letter.
Ene 06	**Energy efficient transportation systems**																										

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	Energy Consumption (Lift analysis, energy options appraisal)		1	0.61%	1					1					1					1					n/a	n/a	Mace, lift supplier	**Crit 1**- Mace to provide lift energy use study compliant with BS EN ISO 25745 and/or request compliant study from lift supplier. Regenerative drives to be considered.
	Energy Efficient Features - Three of the following that offer most energy savings: Standby, energy efficient lighting, VVVF, Regenerative drive.		2	1.22%	2					2					2					2					n/a	n/a	Mace, lift supplier	**Crit 2-4** - Mace to provide technical submittal confirming that all energy efficiency features in lifts will be included.
Ene 07	**Energy efficient laboratory systems**																										
	Pre-requisite - Hea 03 criterion 1 (objective risk assessment)		Pre-requisite	-																					n/a (Phase 1)	Confirmed 19 Jan 2017, that labs are likely to be included in Phase 2 & 3 scope of works, n/a to Phase 1.	n/a	n/a for this phase
	Design specification		0	0.00%																					n/a (Phase 1)	Confirmed 19 Jan 2017, that labs are likely to be included in Phase 2 & 3 scope of works, n/a to Phase 1.	n/a	n/a for this phase
	Best practice energy efficient measures		0	0.00%																					n/a (Phase 1)	Confirmed 19 Jan 2017, that labs are likely to be included in Phase 2 & 3 scope of works, n/a to Phase 1.	n/a	n/a for this phase
Ene 08	**Energy efficient equipment**																										
	Energy Efficient Equipment		2	1.22%	2					2					2					2					n/a	n/a	Mace, RES, UCL	**Crit 1-2** - Consultant leading modelling at RIBA Stage 4 to undertake the TM54 for the levels 4&5. **Crit 3** - If unregulated load for catering is highest, then the UCL letter will need updating.
TRANSPORT																											
Tra 01	**Public Transport Accessibility**																										
	Public Transport Accessibility Index (AI)		5	2.94%	5			5	5	5			5	5	5			5	5	5			5	5	BH sust	**Crit 1-2** - The transport index has been calculated for the masterplan and achieves maximum score. No further action needed.	n/a	n/a
Tra 02	**Proximity to Amenities**																										
	Proximity to Amenities		1	0.59%	1			1	1	1			1	1	1			1	1	1			1	1	BH sust, UCL	**Crit 1** - Maps have been produced indicating the safe pedestrian routes to amenities. Ben Stubbs has confirmed these are valid.	n/a	n/a
Tra 03	**Cyclist Facilities**																										
	Cycle Storage		1	0.59%		1					1					1					1				UCL, HB, Arcadis	**Crit 1** - Number of cycle racks to be confirmed based on proposed occupancy of building. Should be ample space for external cycle racks. This has not been included part of Phase 1, but could easily be targeted.	n/a	n/a
	Cyclist Facilities		1	0.59%		1					1					1					1				UCL, HB, Arcadis	**Crit 2-3** - Credit is contingent on achieving criteria 1 above. Then in addition, compliant showers/lockers/drying space etc would be needed in line with the required occupancy.	n/a	n/a
Tra 05	**Travel plan**																										
	Travel plan based on site specific travel survey/assessment	**Stage 3**	1	0.59%	1					1					1					1					Iceni, BH sust, UCL	**Crit 1, 2b-f, 3** - Iceni has prepared a travel plan for IOE. **Crit 2a** - Transport survey data for IOE is required for the travel plan. It was agreed this would captured in the BUS user survey. **Crit 4** - A letter of confirmation will be needed from UCL	n/a	n/a
WATER																											
Wat 01	**Water Consumption**																										

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	Minimising water consumption **(ONE CREDIT NEEDED FOR BREEAM VERY GOOD AND EXCELLENT RATING, WHERE APPLICABLE)**		5	3.79%	3		2			3		2	**4**	**4**	3		2			3		2			n/a	n/a	Mace, HB	**Crit 1-3** - Mace have provided sanitary ware schedule and datasheets with flow rates for levels 4&5. **Flow rates for kitchen taps in bar area to be confirmed, together with any dishwashers and waste disposal units in bar.** **Crit 4-5** - Greywater not specified for Phase 1.
Wat 02	**Water Monitoring**																											
	Water Monitoring **(Crit 1 NEEDED FOR BREEAM VERY GOOD OR EXCELLENT RATING)**		1	0.76%	1					1			**1**	**1**	1					1					Arcadis, Overbury BH PH	**Crit 1** - Mains water meter for IOE to meet minimum standards for BREEAM. Arcadis/UCL to confirm. New meter may be needed. **Crit 2** - Separate water meter for Phase 1 wing. **Crit 3-5** - Each main and sub have pulsed output connected to BMS. Relevant contractor to provide meter schematics and relevant evidence.	Mace, BH PH	**Crit 2** - Bar area to be fitted with separate accesible water meter. Mace to include in specification and schematic in line with BREEAM requirements. **Crit 2 - Cold water metering schematics to be provided.**
Wat 03	**Water Leak Detection**																											
	Leak Detection System - mains water supply		1	0.76%		1					1					1					1				Arcadis, Ovebury BH PH	**Crit 1** - Leak detection system will need to be installed on the mains water supply in line with BREEAM requirements. This would de-risk credit for all phases. Arcadis/UCL to confirm. Alternatively, Overbury to provide leak detection to Phase 1.	n/a	n/a
	Flow control devices to WC areas		1	0.76%	1					1			**1**	**1**	1			**1**		1			**1**		n/a	n/a	Mace, BH PH	**Crit 2** - Mace have provided design stage drawings showing solenoid shut of valves for WC areas for levels 4&5.
Wat 04	**Water Efficient Equipment**																											
	Water Efficient Equipment		1	0.76%	1					1			**1**	**1**	1					1					Mace Overbury UCL, HB, Arcadis	**Crit 1-2** - Scope of irrigation for Phase 1 TBC. All planters to be low water use. Where there are soft landscaped areas however no irrigation systems are specified, and therefore there are no unregulated water demands for the building, the credit available under this assessment issue can be awarded by default. Where there are no soft landscaped areas and no other unregulated water demands for the building, this credit is filtered out of the assessment.	Overbury	**Crit 2** - Planters on terraces to be low water usage and have native plant species (also see ecology credits).
MATERIALS																												
Mat 01	**Life Cycle Impacts**																											
	Green Guide rating of main building elements		6	6.56%	3	1	2			3	1	2	**3**		3	1	2			3	1	2			n/a	n/a	HB, Mace, BH MEP	**Crit 1-7** - Option 1 compliance route (full LCA) not taken **Crit 8-10** - Option 2 compliance route taken. In this approach, the green guide rating of all newly specified materials is needed (as per a normal BREEAM assessment) with detailed area calculations not needed. For all elements, the overall % of elements retained in situ should be estimated (from 0%, <25%, >25%, >50%, >75%, 95%). In addition the overall % of newly specified materials or products with robust environmental information should be estimated (again from 0%, <25%, >25%, >50%, >75%, 95%). Note that the calculation also requires building services and Fit Out items must also be included in the schedule with 'robust environmental product information' provided - e.g. ISO 14000 compliant suppliers. The output of these results gives the Mat01 score with a maximum of 4 credits available. Mace/HB to provide relevant information.
Mat 03	**Responsible sourcing of materials**																											
	Pre-Requisite: Responsible sourced timber (Crit 1 NEEDED FOR BREEAM VERY GOOD OR EXCELLENT RATING)		Pre-requisite	-	Y					Y			**Y**		Y			**Y**		Y					n/a	n/a	Overbury	**Crit 1-2** - Overbury have provide a letter of intent confirming that all timber will be legally harvested and traded. Letter was specific to L4&5. POST CONSTRUCTION EVIDENCE WILL BE NEEDED

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	Sustainable Procurement Plan		1	1.09%	1					1					1			1	1	1			1	1	n/a	n/a	Overbury	**Crit 3** - Overbury haved provided a copy of the Sustainable Procurement Plan for L4&5 and ISD L3. The document, cover aims, objectives and targets, material tracking procedures, risks & opportunities.
	Responsible Sourcing of Materials		3	3.28%	1	2				1	2				1	2				1	2				n/a	n/a	Mace	**Crit 3-4** - As per Levels 2&3, Mace to ensure materials are procured following FSC/PEFC, BES 6001 standards, with ISO 14001 (supply chain and process) as a minimum requirement. Mace to provide required schedule of materials for design stage evidence. Mat03 spreadsheet to be completed - e.g. volumes for all materials and required certification levels.
Mat 04	**Insulation**																										
	Embodied impact of insulation (fabric and building services)		1	1.09%	1					1			1	1	1					1					n/a	n/a	Mace	**Crit 1-2** - Mace to provide schedule of insulation volumes for each element (external walls, GF, Roof, Building services), conductivity and green guide rating (A or A+) with manufacturer EPD where available.
Mat 05	**Designing for Durability and Resilience**																										
	Protecting Vulnerable Parts of the Building From Damage (criteria below also needed for credit)		1	1.09%	1					1			1	1	1					1					n/a	n/a	Mace, HB	**Crit 1** - Mace / HB to provide L4&5 drawings marking up durability measures e.g. protection to entrance areas, corridoors, lifts, stairs, protection in kitchen areas, trolley movement, protection against vehicle collision where vehicle movement and parkin occurs within 1m of building.
	Protecting Parts of the Building from Material Degradation (criteria above also needed for credit)																									HB, AECOM, Arcadis,	**Crit 2,3,5** - HB/AECOM to complete the materials degredation schedule for Phase 1 areas (BH sust have template), listing all applicable new and existing elements and protection standards. **Crit 4** - AECOM/Arcadis to provide structural survey reports assessing the severity of any degredation effects.	n/a	n/a
Mat 06	**Material Efficiency**																										
Mat 06	Material Efficiency	**Stage 1-5**	1	1.09%	1					1					1					1					n/a	n/a	Mace BH MEP, HB, AECOM, Overbury	**Crit 1-2 -** Team to review Mat06 template at each RIBA Stage (produced initially for Wing levels 2&3 and ISD L3). Any new comments for L4&5 to be added where relevant. RIBA Stage 1 - Phase 1 template completed at masterplan stage RIBA Stage 2 - Template updated and/or confirmed no changes RIBA Stage 3 - Mace to complete template for RIBA Stage 3 RIBA Stage 4 - Mace to complete template for RIBA Stage 5 RIBA Stage 5 - Overbury to provide RIBA Stage 5 evidence.
WASTE																											
Wst 01	**Construction Waste Management**																										
Wst 01	Pre refurbishment audit	**Stage 2**	1	0.71%	1					1			1	1	1					1			1	1	n/a	n/a	Mace	**Crit 1** - Pre-refurbishment audit report for L4&5 to be issued.

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	Reuse and direct recycling of materials		2	1.42%		2				1		1	**1**	**1**		2					2					n/a	n/a	Mace Overbury	**Crit 2-4** - As per L2&3, Mace to confirm approach against Wst01 schedule (table 61) for L4&5. **Crit 2-4** - Provide written confirmation of routes & tracking procedures for each material type listed in Mace report.
	Construction Resource Efficiency		3	2.13%	2	1				2	1				2	1				2	1				n/a	n/a	Overbury	**Crit 5-6** - Overbury to provide SWMP to cover levels 4&5 making reference to BREEAM RFO requirements for total waste. Aciheve less than 4.5m3/100m2 GIA (less than 1.2 tonnes/100m2
	Diversion of Resources from Landfill		1	0.71%	1					1					1					1					n/a	n/a	Overbury	**Crit 5-6 -** Overbury to provide SWMP to cover levels 4&5 making reference to BREEAM RFO requirements for total diversion from landfill. - Non-demolition, 85% volume and 90% tonnage - Demolition, 90% volume and 95% tonnage.
Wst 02	**Recycled Aggregates**																										
	Recycled Aggregates for high grade use		1	0.71%			1					1					1					1			AECOM	Credit not targeted. Structural engineer to review requirements and confirm if feasible to target for the project.	AECOM	Credit not targeted. Structural engineer to review requirements and confirm if feasible to target for the project.
Wst 03	**Operational waste**																										
	Operational Waste **(ONE CREDIT NEEDED FOR BREEAM EXCELLENT)**		1	0.71%	1					1					1					1					UCL	**Crit 1-2** - UCL to confirm waste streams and sizing figures for the project. Requirements for waste store to be reviewed in line with BREEAM requirements and operational FM strategy.	n/a	n/a
Wst 05	**Adaptation to Climate Change**																										
Wst 05	Adaptation to Climate Change - Structural and Fabric Resilience	**Stage 2**	1	0.71%	1			**1**	**1**	1			**1**	**1**	1			**1**	**1**	1			**1**	**1**	BH sust, BH MEP, AECOM, HB	**Crit 1** - Climate change risk assessment was conducted for the IOE masterplan at RIBA Stage 2. Credit closed.	n/a	n/a
Wst 06	**Functional Adaptability**																										
Wst 06	Functional adaptability strategy	**Stage 2 Stage 4**	1	0.71%	1					1			**1**	**1**	1			**1**		1			**1**		n/a	n/a	HB, BH MEP, Mace	**Crit 1** - HB have provided the RIBA Stage 2 functional adaptability mark-ups for wing levels 4&5 together with narrative. The Stage 2 MEP report has also been provided as supplementary evidence. **Crit 2** - Mace will need to provide RIBA Stage 4 evidence.
LAND USE & ECOLOGY																											
Le 02	**Ecological Value of Site and Protection of Ecological Features**																										
	Protection of existing ecological features		1	2.27%	1			**1**		1			**1**	**1**	1					1					Ecologist	**Crit 1-2** - An ecology report has been prepared. Requirements include protection of trees with trunks over 100mm diameter in accordance with BS5837:2012. Checks on any works that may disturb nests and eggs in areas such as trees, roof, gutters, soffit boxes, external beams. An ecologist is required on site should the Contractor's biodiversity champion deem necessary to check for any black redstart birds that may be nesting in roof areas and on gravel areas of the roof.	Overbury	**Crit 1-2 -** Overbury sustainability champion to ensure measures are implemented in line with ecologist's report. Overbury to provide evidence before work starts on site that sustainability champion undertook survey-survey report and pictures of protection measures in place required as evidence. Overbury to provide program and justification how activities have been timed to to avoid negative impact on biodiversity- check ecologist report
Le 04	**Enhancing Site Ecology**																										

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LE 04	Ecologist's Report and Reccomendations	**Stage 1 Stage 2**	1	2.27%		1			**1**			1			**1**	**1**		1						1					Ecologist	Crit 1-3 - An ecology report was prepared. The report identifed that external terraces should include planters.	Overbury HB	**Crit 3** - Overbury to provide letter confirming planters will be provided on external terraces with native species. (must be native species with low water use requirements).
Le 05	**Long Term Impact on Biodiversity**																														
	Long Term Impact on Biodiversity (Landscape and habitat management plan; Site management for minimal impact on biodiversity)		2	4.55%		2			**2**			2			**2**	**2**		2						2					Ecologist	Crit 1-3 - An ecology report was prepared. The SQE confirmed that a landscape and habitat management plan is not necessary. Although the contractor will be required to appoint a biodiversity champion and monitor on-site activities.	Overbury	**Crit 3** - Overbury to provide finalised letter confirming the name, scope of the biodiversity champion, and provide evidence of checks undertaken to date.
POLLUTION																															
Pol 01	**Impact of Refrigerants**																														
	No Refrigerant Use		0	0.00%																									n/a	n/a building has refrigerants	n/a	n/a building has refrigerants
	Pre-Requisite for buildings that use refrigerants (compliance with industry standards and best practice)		Pre-requisite	-		Y						Y			**Y**			Y						Y					n/a	n/a	Mace	**Crit 2** - Mace to provide evidence that all systems will comply with the requirements of BS EN 378:20081 (parts 2 and 3) and where refrigeration systems containing ammonia are installed, the Institute of Refrigeration Ammonia Refrigeration Systems Code of Practice.
	Impact of Refrigerant (Low DELC C02 refrigerants)		2	1.75%		1		1					1	1	0	0		1		1				1		1			n/a	n/a	Mace	Crit 3-4 - Not targeted **Crit 5** - Mace to provide design stage evidence table listing the system capacity (kW), total refrigerant charge (kg) and refrigerant type for all cooling systems. Supporting datasheets & tech-subs for each unit to be provided.
	Leak detection and containment		1	0.87%		1							1		0	0		1						1					n/a	n/a	Mace	**Crit 6-7** - Mace to provide schematics and manufacturer specs for leak detection on systems with refrigerant charge above 6kg.
Pol 02	**NOx Emissions**																														
	Low N0x Emissions plant for space heating and hot water		3	2.62%			3						3						3						3				UCL Arcadis	**Crit 1** - Arcadis/UCL to request information about the NOx emissions for the BHP energy centre.	Mace	**Crit 1 -** Mace to confirm the heating and hot water loads for Phase 1 L4&5 served by each item on plant (e.g. DH, heat pumps, any new boilers etc). Calculation is then rated to heat output from each system as per BREEAM method.
Pol 03	**Surface Water Run Off**																														
	Flood Risk Management		2	1.75%		2			**2**	**2**		2			**2**	**2**		2			**2**	**2**		2			**2**	**2**	AECOM	**Crit 1-6** - FRA report confirms that the site is located in flood risk zone 1 (low risk of flooding).	n/a	n/a
	Surface Water Run Off - neutral impact		1	0.87%		1			**1**	**1**		1			**1**	**1**		1			**1**	**1**		1			**1**	**1**	AECOM	**Crit 7-8** - The FRA report confirms the proposed Phase 1-3 refurbishment works will not increase surface water run off.	n/a	n/a
	Surface Water Run Off - 50% reduction		1	0.87%				1						1						1						1			n/a	Credit not targeted as these works are not included in the scope of the refurbishment strategy.	n/a	n/a
	Minimising Watercourse Pollution		1	0.87%				1						1						1						1			n/a	Credit not targeted as these works are not included in the scope of the refurbishment strategy.	n/a	n/a
Pol 04	**Reduction of Night Time Light Pollution**																														

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	Reduction of Night Time Light Pollution		1	0.87%	1					1			1	1	1					1					n/a	n/a	Mace, BH Elec	**Crit 1-3** - BH MEP specifications made refence to BREEAM requirements. Mace to confirm the scope and external lighting and provide drawings, calculations and tech-subs confirming controls and ILP guidance has been followed.
Pol 05	**Reduction of Noise Pollution**																										
	Reduction of Noise Pollution		1	0.87%	1			1		1			1		1			1		1			1		BH acoustics	**Crit 2-5** - Acoustics study was carried out for Phase 1. To comply with the planning requirements of Camden Council, noise emissions from new plant should be a minimum of 5dB below the lowest measured background noise level. Since the requirements of the LA are more stringent, BREEAM criteria can automatically be met when the local planning requirements are satisfied.	Mace Overbury	**Crit 2-5** - Mace to confirm acoustics strategy for the reduction of noise pollution in line with BREEAM requirements. **Crit 2-5** - Overbury to provide letter confirming that noise testing shall be carried out in line with BREEAM requirements.
INNOVATION																											
Man 03	Exemplary Level Credit: CCS score of 40 or above		1	1.00%	1						1				1					1					n/a	n/a	Overbury	**Crit 7-8** - Overbury to provide a letter of intent confirming that "Phase 1" will be registered for the Considerate Construction Scheme, targeting a score of 40 with 7 in all sections. CCS registration details to be confirmed.
Man 05	Exemplary Level Crit: Building performance review at quarterly intervals over first 3 years of occupation		1	1.00%		1				1						1					1				UCL	**Crit 4-5** - Letter of intent to be signed by UCL.	n/a	n/a
Hea 02	Exemplary Level Crit: - Minimising sources of internal air pollution through specification of exemplary low VOC products		1	1.00%		1					1					1					1				n/a	n/a	Mace	**Crit 6-7** - Mace to provide details of VOC standards to be applied for levels 4&5. Specifications to be provided for each product type.
	Exemplary Level Crit:																										
Wat 01	Exemplary water efficiency and rain/water recycling for WC/urinal flushing		1	1.00%		1					1					1					1				BH MEP, Mace	Credit to be reviewed at masterplan level. Phase 1 areas are not currently targeting this level of performance.	n/a	n/a
Mat 01	Exemplary Level Crit Green Guide to Specification (Elemental Approach)		1	1.00%		1					1					1					1				Mace, HB	Very high scoring would be required on the BREEAM RFO Mat01 (option 2) tool to achieve this. The main limitation is providing 'robust environmental information' for MEP items.	n/a	n/a
Mat 01	Exemplary Level Crit Compliant Life Cycle Assessment Software Tools (Whole Building Approach)		2	2.00%		2					2					2					2				BH sust. Mace	IES IMPACT software would need to be used to carry out a whole building LCA. This is currently not included in the scope.	n/a	n/a
Mat 03	Exemplary Level Crit - At least 70% of the available RSM points are achieved		1	1.00%		1					1					1					1				Mace	Very stringent responsible sourcing would be required to achieve this innovation credit.	n/a	n/a
Wst 01	Exemplary Level Crit - ≤ 1.4m3 per 100m2 waste, and 95% diversion from landfill.		1	1.00%		1					1					1					1				Mace	Waste generation targets are likely to be too challenging for the project to achieve. (Mace have already flagged that the target of 4.5m3/100m2 is already challenging).	n/a	n/a
Wst 05	Exemplary Credit - Responding to Adaptation to Climate Change		1	1.00%		1					1					1					1				AECOM, Mace, BH sust	A number of requirements have been met. In order to achieve this credit, the key limitation is that 2 credits are needed on "Pol 03 - 50% reduction in surface water run-off" which is currently outside of the scope of the project. 8 credits would also be needed on Ene01.	n/a	n/a
	BESPOKE BRE Approved Innovations		Varies																						UCL, BH Sust, Mace	Identify any possible opportunities for masterplan level bespoke innovation credits UCL sustainablity may be able to fund (e.g. wellness facilties, air quality enhancers, innovative PV solutions, window traffic light systems, living lab sensors, phase change materials, productivity surveys, flow batteries, outdoor gym etc).	n/a	n/a

[1] Note: a maximum of 10 credits can be awarded from the available innovation credits

Appendix C – Lean BRUKL report

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

UCL IOE

As designed

Date: Wed Aug 22 09:54:04 2018

Administrative information

Building Details

Address: 20 Bedford Way, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.8

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.8

BRUKL compliance check version: v5.3.a.0

Owner Details

Name: University College London

Telephone number:

Address: , ,

Certifier details

Name: BuroHappold

Telephone number:

Address: 17 Newman street, London, W1T 1PD

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

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

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	33.9
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	33.9
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	65.7
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 fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the 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	0.31	0.58	RM000014:Surf[11]
Floor	0.25	0.48	0.48	58000000:Surf[136]
Roof	0.25	0.21	0.21	RM000014:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.8	1.8	RM00000B:Surf[0]
Personnel doors	2.2	1.27	2.2	RM000014: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
$m^3/(h.m^2)$ 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- New_Rads_ToiletsCIrc

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0	0	0.7
Standard value	N/A	N/A	N/A	N/A	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

2- New_Rads_AHU(FCUs)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	3.6	0	2.2	0.7
Standard value'	N/A	3.9	N/A	1.6^	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

^ 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.

"No HWS in project, or hot water is provided by HVAC system"

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
4.2.Circ	-	-	-	0.8	-	-	-	-	-	-	N/A
4.7.BarKitchen	-	-	-	-	-	-	-	0.8	-	-	N/A
4.9.Office	-	-	-	-	-	-	-	0.8	-	-	N/A
5.1.Meeting	-	-	-	-	-	-	-	0.8	-	-	N/A
5.3.Meeting	-	-	-	-	-	-	-	0.8	-	-	N/A
5.4.Circ	-	-	-	0.8	-	-	-	-	-	-	N/A
5.5.Circ	-	-	-	0.8	-	-	-	-	-	-	N/A
5.6.Meeting	-	-	-	-	-	-	-	0.8	-	-	N/A
5.7.Meeting	-	-	-	-	-	-	-	0.8	-	-	N/A
4.11.Circulation	-	-	-	0.8	-	-	-	-	-	-	N/A
5.8.Circulation	-	-	-	0.8	-	-	-	-	-	-	N/A
5.8.Office	-	-	-	-	-	-	-	0.8	-	-	N/A

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
4.11.Bar	-	-	-	-	-	-	-	0.8	-	-	N/A
4.12.Circulation	-	-	-	0.8	-	-	-	-	-	-	N/A
4.12.Teaching	-	-	-	-	-	-	-	0.8	-	-	N/A
4.3.Teaching	-	-	-	-	-	-	-	0.8	-	-	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	
4.2.Circ	-	76	-	62
4.4.WC	-	63	-	418
4.7.BarKitchen	-	72	-	558
4.9.Office	53	-	-	187
5.1.Meeting	61	-	-	89
5.2.DisabledWC	-	142	-	32
5.3.Meeting	69	-	-	73
5.4.Circ	-	65	-	116
5.5.Circ	-	69	-	94
5.6.Meeting	49	-	-	228
5.7.Meeting	55	-	-	149
4.11.Circulation	-	73	-	149
5.8.Circulation	-	115	-	19
5.8.Office	39	-	-	6674
4.11.Bar	-	57	-	2392
4.12.Circulation	-	63	-	349
4.12.Teaching	45	-	-	312
4.3.Teaching	41	-	-	1212

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?
4.7.BarKitchen	NO (-98.7%)	NO
4.9.Office	N/A	N/A
5.1.Meeting	NO (-99.6%)	NO
5.3.Meeting	NO (-99.7%)	NO
5.6.Meeting	NO (-32%)	YES
5.7.Meeting	NO (-33.5%)	YES
5.8.Office	NO (-43%)	YES
4.11.Bar	NO (-46.5%)	YES
4.12.Teaching	NO (-54.7%)	YES
4.3.Teaching	NO (-39.8%)	YES

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

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

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	1151.9	1151.9
External area [m²]	1084.1	1084.1
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	983.78	576.51
Average U-value [W/m²K]	0.91	0.53
Alpha value* [%]	9.13	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 Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
100	**C2 Residential Institutions: Universities and colleges**
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: 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	21.2	6.68
Cooling	5.1	8.26
Auxiliary	49.87	18.53
Lighting	15.5	14.11
Hot water	81.29	38.22
Equipment*	56.75	56.75
TOTAL**	172.97	85.8

* 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]	129.59	136.66
Primary energy* [kWh/m²]	333.93	176.29
Total emissions [kg/m²]	65.7	33.9

* 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] District heating, [HFT] District Heating, [CFT] Electricity										
	Actual	73.2	72.5	22.3	6.1	54.9	0.91	3.28	1	4.5
	Notional	0	0	0	0	0	0	0	----	----
[ST] Central heating using water: radiators, [HS] District heating, [HFT] District Heating, [CFT] Electricity										
	Actual	50.8	0	15.8	0	7.4	0.89	0	1	0
	Notional	23.3	135.6	6.5	9.9	21	1	3.79	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	27.7	0	7.7	0	6.4	1	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 Building Control Body is advised to give particular attention to items whose specifications 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	0.17	41000001:Surf[24]
Floor	0.2	0.48	58000000:Surf[136]
Roof	0.15	0.21	RM000014:Surf[0]
Windows, roof windows, and rooflights	1.5	1.8	RM00000B:Surf[0]
Personnel doors	1.5	0.4	41000001:Surf[25]
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 D – Clean BRUKL report

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name **Shell and Core**

UCL IOE

As designed

Date: Wed Aug 22 10:02:43 2018

Administrative information

Building Details

Address: 20 Bedford Way, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.8

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.8

BRUKL compliance check version: v5.3.a.0

Owner Details

Name: University college London

Telephone number:

Address: , London,

Certifier details

Name: BuroHappold

Telephone number:

Address: 17 Newman Street, London, W1T 1PD

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

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

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	31.9
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	31.9
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	61.3
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 fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the 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	0.31	0.58	RM000014:Surf[11]
Floor	0.25	0.48	0.48	58000000:Surf[136]
Roof	0.25	0.21	0.21	RM000014:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.8	1.8	RM00000B:Surf[0]
Personnel doors	2.2	1.27	2.2	RM000014: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
$m^3/(h.m^2)$ 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- New_Rads_ToiletsCIrc

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0	0	0.7
Standard value	N/A	N/A	N/A	N/A	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

2- New_Rads_AHU(FCUs)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	3.6	0	2.2	0.7
Standard value	N/A	3.9	N/A	1.6^	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

^ 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.

"No HWS in project, or hot water is provided by HVAC system"

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
4.2.Circ	-	-	-	0.8	-	-	-	-	-	-	N/A
4.7.BarKitchen	-	-	-	-	-	-	-	0.8	-	-	N/A
4.9.Office	-	-	-	-	-	-	-	0.8	-	-	N/A
5.1.Meeting	-	-	-	-	-	-	-	0.8	-	-	N/A
5.3.Meeting	-	-	-	-	-	-	-	0.8	-	-	N/A
5.4.Circ	-	-	-	0.8	-	-	-	-	-	-	N/A
5.5.Circ	-	-	-	0.8	-	-	-	-	-	-	N/A
5.6.Meeting	-	-	-	-	-	-	-	0.8	-	-	N/A
5.7.Meeting	-	-	-	-	-	-	-	0.8	-	-	N/A
4.11.Circulation	-	-	-	0.8	-	-	-	-	-	-	N/A
5.8.Circulation	-	-	-	0.8	-	-	-	-	-	-	N/A
5.8.Office	-	-	-	-	-	-	-	0.8	-	-	N/A

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
4.11.Bar	-	-	-	-	-	-	-	0.8	-	-	N/A
4.12.Circulation	-	-	-	0.8	-	-	-	-	-	-	N/A
4.12.Teaching	-	-	-	-	-	-	-	0.8	-	-	N/A
4.3.Teaching	-	-	-	-	-	-	-	0.8	-	-	N/A

Shell and core configuration

Zone	Assumed shell?
4.2.Circ	NO
4.4.WC	NO
4.7.BarKitchen	NO
4.9.Office	NO
5.1.Meeting	NO
5.2.DisabledWC	NO
5.3.Meeting	NO
5.4.Circ	NO
5.5.Circ	NO
5.6.Meeting	NO
5.7.Meeting	NO
4.11.Circulation	NO
5.8.Circulation	NO
5.8.Office	NO
4.11.Bar	NO
4.12.Circulation	NO
4.12.Teaching	NO
4.3.Teaching	NO

General lighting and display lighting

	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
4.2.Circ	-	76	-	62
4.4.WC	-	63	-	418
4.7.BarKitchen	-	72	-	558
4.9.Office	53	-	-	187
5.1.Meeting	61	-	-	89
5.2.DisabledWC	-	142	-	32
5.3.Meeting	69	-	-	73
5.4.Circ	-	65	-	116
5.5.Circ	-	69	-	94
5.6.Meeting	49	-	-	228
5.7.Meeting	55	-	-	149
4.11.Circulation	-	73	-	149
5.8.Circulation	-	115	-	19
5.8.Office	39	-	-	6674

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
4.11.Bar	-	57	-	2392
4.12.Circulation	-	63	-	349
4.12.Teaching	45	-	-	312
4.3.Teaching	41	-	-	1212

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?
4.7.BarKitchen	NO (-98.7%)	NO
4.9.Office	N/A	N/A
5.1.Meeting	NO (-99.6%)	NO
5.3.Meeting	NO (-99.7%)	NO
5.6.Meeting	NO (-32%)	YES
5.7.Meeting	NO (-33.5%)	YES
5.8.Office	NO (-43%)	YES
4.11.Bar	NO (-46.5%)	YES
4.12.Teaching	NO (-54.7%)	YES
4.3.Teaching	NO (-39.8%)	YES

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?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	1151.9	1151.9
External area [m^2]	1084.1	1084.1
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	3
Average conductance [W/K]	983.78	576.51
Average U-value [W/m^2K]	0.91	0.53
Alpha value* [%]	9.13	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 Institutions Hospitals and Care Homes
	C2 Residential Institutions Residential schools
100	**C2 Residential Institutions: Universities and colleges**
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions Community/Day Centre
	D1 Non-residential Institutions Libraries, Museums, and Galleries
	D1 Non-residential Institutions Education
	D1 Non-residential Institutions Primary Health Care Building
	D1 Non-residential Institutions 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	21.2	6.68
Cooling	5.1	8.26
Auxiliary	49.87	18.53
Lighting	15.5	14.11
Hot water	81.29	38.22
Equipment*	56.75	56.75
TOTAL**	172.97	85.8

* 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]	129.59	136.66
Primary energy* [kWh/m^2]	333.93	176.29
Total emissions [kg/m^2]	61.3	31.9

* 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] District heating, [HFT] District Heating, [CFT] Electricity										
	Actual	73.2	72.5	22.3	6.1	54.9	0.91	3.28	1	4.5
	Notional	0	0	0	0	0	0	0	---	---
[ST] Central heating using water: radiators, [HS] District heating, [HFT] District Heating, [CFT] Electricity										
	Actual	50.8	0	15.8	0	7.4	0.89	0	1	0
	Notional	23.3	135.6	6.5	9.9	21	1	3.79	---	---
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	27.7	0	7.7	0	6.4	1	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 Building Control Body is advised to give particular attention to items whose specifications 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	0.17	41000001:Surf[24]
Floor	0.2	0.48	58000000:Surf[136]
Roof	0.15	0.21	RM000014:Surf[0]
Windows, roof windows, and rooflights	1.5	1.8	RM00000B:Surf[0]
Personnel doors	1.5	0.4	41000001:Surf[25]
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 E – Green BRUKL report

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name Shell and Core

UCL IOE (20 Bedford Way) - GREEN

As designed

Date: Wed Aug 22 10:12:04 2018

Administrative information

Building Details

Address: 20 Bedford Way, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.8

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.8

BRUKL compliance check version: v5.3.a.0

Owner Details

Name: University college London

Telephone number:

Address: , London,

Certifier details

Name: BuroHappold

Telephone number:

Address: 17 Newman Street, London, W1T 1PD

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

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

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	31.9
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	31.9
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	61.3
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 fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the 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	0.31	0.58	RM000014:Surf[11]
Floor	0.25	0.48	0.48	58000000:Surf[136]
Roof	0.25	0.21	0.21	RM000014:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.8	1.8	RM00000B:Surf[0]
Personnel doors	2.2	1.27	2.2	RM000014: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
$m^3/(h.m^2)$ 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- New_Rads_ToiletsCIrc

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0	0	0.7
Standard value	N/A	N/A	N/A	N/A	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

2- New_Rads_AHU(FCUs)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	3.6	0	2.2	0.7
Standard value	N/A	3.9	N/A	1.6^	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

^ 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.

"No HWS in project, or hot water is provided by HVAC system"

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
4.2.Circ	-	-	-	0.8	-	-	-	-	-	-	N/A
4.7.BarKitchen	-	-	-	-	-	-	-	0.8	-	-	N/A
4.9.Office	-	-	-	-	-	-	-	0.8	-	-	N/A
5.1.Meeting	-	-	-	-	-	-	-	0.8	-	-	N/A
5.3.Meeting	-	-	-	-	-	-	-	0.8	-	-	N/A
5.4.Circ	-	-	-	0.8	-	-	-	-	-	-	N/A
5.5.Circ	-	-	-	0.8	-	-	-	-	-	-	N/A
5.6.Meeting	-	-	-	-	-	-	-	0.8	-	-	N/A
5.7.Meeting	-	-	-	-	-	-	-	0.8	-	-	N/A
4.11.Circulation	-	-	-	0.8	-	-	-	-	-	-	N/A
5.8.Circulation	-	-	-	0.8	-	-	-	-	-	-	N/A
5.8.Office	-	-	-	-	-	-	-	0.8	-	-	N/A

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
4.11.Bar	-	-	-	-	-	-	-	0.8	-	-	N/A
4.12.Circulation	-	-	-	0.8	-	-	-	-	-	-	N/A
4.12.Teaching	-	-	-	-	-	-	-	0.8	-	-	N/A
4.3.Teaching	-	-	-	-	-	-	-	0.8	-	-	N/A

Shell and core configuration

Zone	Assumed shell?
4.2.Circ	NO
4.4.WC	NO
4.7.BarKitchen	NO
4.9.Office	NO
5.1.Meeting	NO
5.2.DisabledWC	NO
5.3.Meeting	NO
5.4.Circ	NO
5.5.Circ	NO
5.6.Meeting	NO
5.7.Meeting	NO
4.11.Circulation	NO
5.8.Circulation	NO
5.8.Office	NO
4.11.Bar	NO
4.12.Circulation	NO
4.12.Teaching	NO
4.3.Teaching	NO

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
4.2.Circ	-	76	-	62
4.4.WC	-	63	-	418
4.7.BarKitchen	-	72	-	558
4.9.Office	53	-	-	187
5.1.Meeting	61	-	-	89
5.2.DisabledWC	-	142	-	32
5.3.Meeting	69	-	-	73
5.4.Circ	-	65	-	116
5.5.Circ	-	69	-	94
5.6.Meeting	49	-	-	228
5.7.Meeting	55	-	-	149
4.11.Circulation	-	73	-	149
5.8.Circulation	-	115	-	19
5.8.Office	39	-	-	6674

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
4.11.Bar	-	57	-	2392
4.12.Circulation	-	63	-	349
4.12.Teaching	45	-	-	312
4.3.Teaching	41	-	-	1212

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?
4.7.BarKitchen	NO (-98.7%)	NO
4.9.Office	N/A	N/A
5.1.Meeting	NO (-99.6%)	NO
5.3.Meeting	NO (-99.7%)	NO
5.6.Meeting	NO (-32%)	YES
5.7.Meeting	NO (-33.5%)	YES
5.8.Office	NO (-43%)	YES
4.11.Bar	NO (-46.5%)	YES
4.12.Teaching	NO (-54.7%)	YES
4.3.Teaching	NO (-39.8%)	YES

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 [m²]	1151.9	1151.9
External area [m²]	1084.1	1084.1
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	983.78	576.51
Average U-value [W/m²K]	0.91	0.53
Alpha value* [%]	9.13	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 Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
100	**C2 Residential Institutions: Universities and colleges**
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: 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	21.2	6.68
Cooling	5.1	8.26
Auxiliary	49.87	18.53
Lighting	15.5	14.11
Hot water	81.29	38.22
Equipment*	56.75	56.75
TOTAL**	172.97	85.8

* 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]	129.59	136.66
Primary energy* [kWh/m²]	333.93	176.29
Total emissions [kg/m²]	61.3	31.9

* 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] District heating, [HFT] District Heating, [CFT] Electricity										
	Actual	73.2	72.5	22.3	6.1	54.9	0.91	3.28	1	4.5
	Notional	0	0	0	0	0	0	0	----	----
[ST] Central heating using water: radiators, [HS] District heating, [HFT] District Heating, [CFT] Electricity										
	Actual	50.8	0	15.8	0	7.4	0.89	0	1	0
	Notional	23.3	135.6	6.5	9.9	21	1	3.79	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	27.7	0	7.7	0	6.4	1	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 Building Control Body is advised to give particular attention to items whose specifications 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	0.17	41000001:Surf[24]
Floor	0.2	0.48	58000000:Surf[136]
Roof	0.15	0.21	RM000014:Surf[0]
Windows, roof windows, and rooflights	1.5	1.8	RM00000B:Surf[0]
Personnel doors	1.5	0.4	41000001:Surf[25]
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

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