Great Ormond Street Hospital for Children
NHS Foundation Trust

Great Ormond Street Hospital Charity

UCL INSTITUTE OF CHILD HEALTH

Centre for Children's Rare Disease Research
at Great Ormond Street Hospital

Energy Strategy and BREEAM Pre-Assessment

Hoare Lea
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Audit Sheet

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Draft	For Comment	02/06/2014	PK	DB, MP
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2	Incorporating G&T comments	06/06/2014	PK	CD, MP, AL
3	For Stage D - Part L results updated in line with new report	27/08/2014	VS	PK

CONTENTS

1.0 Executive Summary

This report aims to consolidate all energy saving measures assessed to date and identify additional opportunities to reduce the operational energy demand, carbon emissions and utility costs of the Centre for Research into Rare Disease in Children (CRRDC) during operation. It also highlights the review of the BREEAM 'Excellent vs Outstanding' study undertaken as part of the Pre-assessment review. The following items summarise the conclusions and recommendations within the body of the report.

Fabric

1. Fabric performance targets exceed those of national regulations by between 40-60%, beyond which only minor energy benefits are achieved from substantial additional capital expenditure.

2. Facade design (glazing provision, external shading and glass specification) has been optimised through the use of an iterative thermal modelling exercise to achieve good daylight levels without excessive solar heat gains.

Systems

3. Numerous energy-reduction measures have been implemented on the building's fixed building services such as heat recovery and variable speed pumps/fans (section 3); however a review of the client's equipment/small power procurement policy could provide savings in unregulated energy consumption which is not assessed in compliance calculations.

Low and Zero Carbon (LZC) Technology

4. Combined Heat and Power (CHP) and Photovoltaic (PV) panels have been identified as the most applicable technologies for the CRRDC scheme (see appendix 1).

5. The PV panel array is limited by available roof space (section 6) and it is not recommended to exceed the current proposal as the lower Feed in Tariff rate applicable for systems above 50kW reduces the entire system's return on investment.

6. Tri-generation has been considered for the scheme and would improve the energy and carbon profile of the building. However, the operational energy savings would fall far short of achieving a return on investment on the additional capital expenditure within the lifespan of the plant.

District Energy

7. Connection to existing district energy networks at Great Ormond Street Hospital or the British Museum (section 4) have been discounted primarily due to the relatively minor contribution to the building's local and national energy targets in comparison to a dedicated CHP plant.

BREEAM Conclusions & Opportunities

8. The BREEAM Pre-Assessment (section 7 and appendix 2) identifies a potential rating of "Excellent" with a score of 74.32%, which also meets the minimum section scores of local planning policy.

9. Sufficient time in the building programme should be given to effective commissioning, seasonal commissioning and Post Occupancy Evaluation (POE) as they have the greatest impact on operational energy demand, combined with a sufficiently detailed metering strategy and BMS system or monitoring and recording.

10. The lighting system is typically the greatest regulated energy consumer in new non-domestic buildings but is also the most sensitive to capital cost savings. Therefore it is recommended to maintain a system budget reflective of a best practice installation.

11. Additional areas of investment that would provide an energy benefit for the client are listed as follows:

    a. Review of the fume cupboard specification to ensure the best practice energy specification is achieved

    b. Review metering/sub-metering and BMS control strategy to support the Post Occupancy Evaluation process, and ensure the system can achieve suitable levels of control without being too complicated to use

    c. Assess the client's procurement strategy for new computing equipment and white goods to ensure energy labelling requirements are suitably incorporated

12. To achieve a BREEAM 'Outstanding' rating would require an increase of 11% which is likely to translate into around 15 additional credits, depending on the weighting. However, all of the mandatory credits for a BREEAM Outstanding rating have already been targeted for the existing 'Excellent' rating.

13. To target an 'Outstanding' rating would incur 'buying' credits to uplift the overall percentage score, which would have no benefit to the energy performance of the building during use. Therefore the design team aim to maintain the 'Excellent' rating overall but with all mandatory credits for an 'Outstanding' rating being achieved, especially with regards to energy and carbon emissions targets

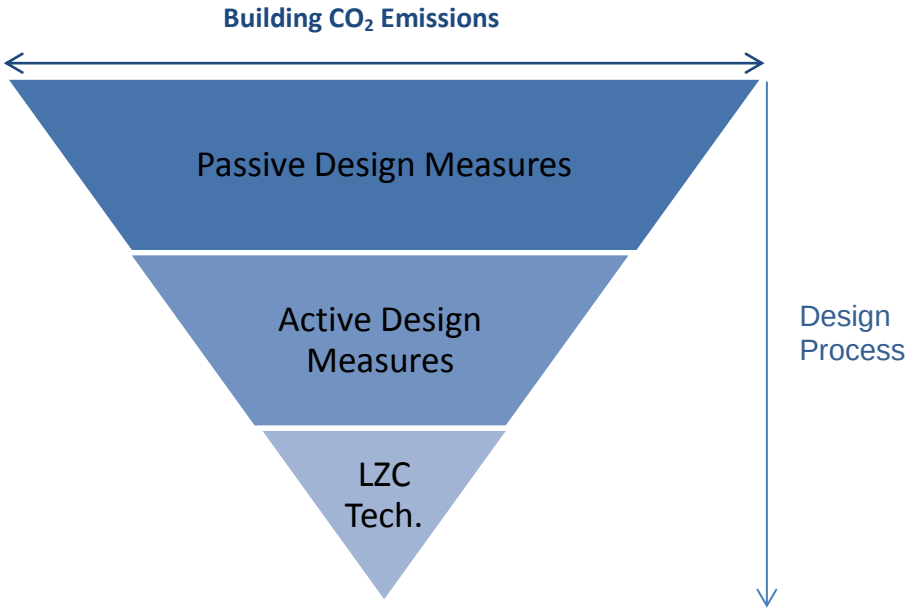
2.0 Introduction

The Centre for Research into Rare Disease in Children (CRRDC) in London is a new build development comprising predominantly of production, laboratory, write-up and healthcare areas. There are numerous local and national energy and carbon emissions-related compliance requirements that apply to the scheme, details of which have been covered in the mechanical and electrical stage C report from Hoare Lea.

This report aims to consolidate all energy saving measures assessed to date and identify additional opportunities to reduce the operational energy demand (and therefore carbon emissions) and utility costs of the development during its use.

3.0 Energy Hierarchy

In line with the most efficient approach to reducing the energy consumption (and resulting carbon emissions) from a building, passive and active design measures have been considered before the use of Low and Zero Carbon (LZC) technologies for the project.

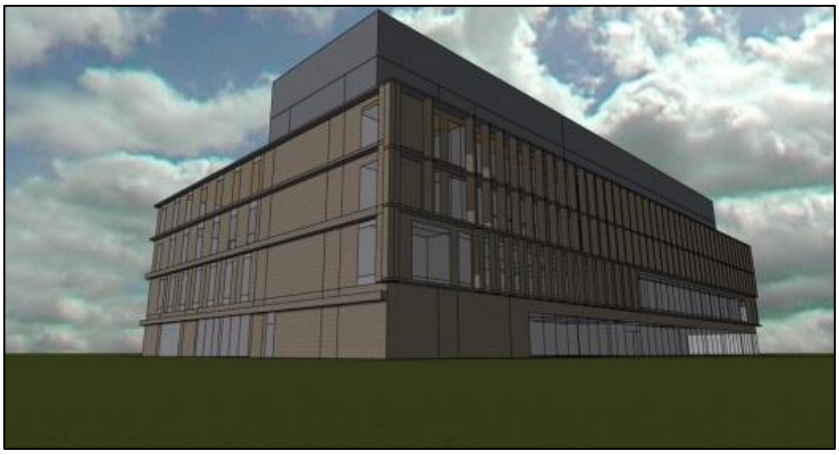


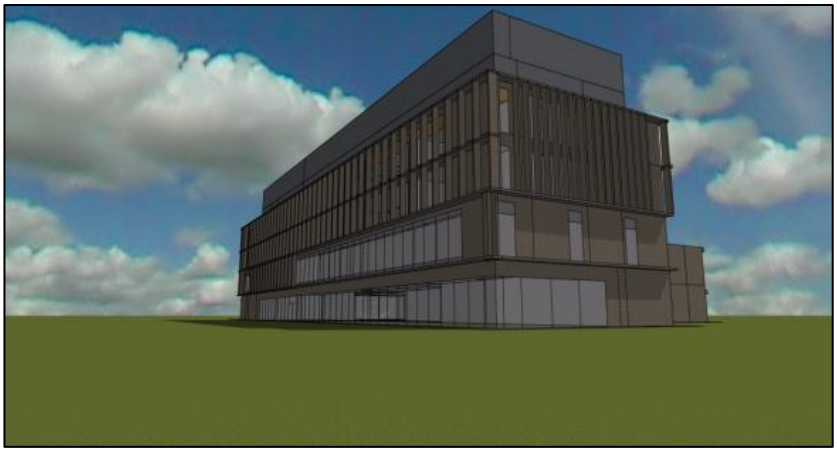
3.1 Passive Design Measures - Fabric

The performance figures in the table below identify the limiting fabric thermal transmittance (u-values) of building elements in current UK building regulations, followed by good practice and proposed design values in the subsequent columns. Lower u-values and air permeability reduce heat loss and therefore the energy consumption of the heating system. These performance standards support the design team's compliance with the energy hierarchy's 'fabric first' approach.

Element	U Values ($W/m^2.K$)		
	Acceptable Limit	Notional Building	Proposed Design Target
Roof	0.25	0.18	0.15
Walls	0.35	0.26	0.15
Floors	0.25	0.22	0.17
Windows	2.2	1.8	1.3
Air Permeability ($m^3/m^2.hr$)	10	5	3

In addition to high-performance fabric, the relationship between orientation, façade glazing percentage, shading devices and glass specification has been addressed. The glazing percentages on the relevant façade orientations have ensured that good natural daylight levels are achieved without excessive solar heat gains. External shading has helped to prevent excessive direct solar heat gains and glare to improve internal comfort and reduce the requirement for comfort cooling. This is demonstrated through the images of the thermal model below (used to assess building performance).





A lower average u-value reduces the annual heat load for the building. The extract from the BRUKL document below identifies that the building's average u-value is 0.32W/m^2.K in comparison to the Part L 2013 notional target of 0.38W/m^2.K.

Building Global Parameters

	Actual	Notional
Area [m^2]	13364.1	13364.1
External area [m^2]	12245.1	12245.1
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	3
Average conductance [W/K]	3899.27	4689.84
Average U-value [W/m^2K]	0.32	0.38

This means that the building is expected to consume around 15% less heating energy than a comparative Part L 2013 building.

3.2 Active Design Measures - Systems

It is anticipated that The CRRDC will require intensive conditioning of large air loads, particularly for the production areas, which is likely to have a significant effect on the building's overall energy profile. These loads are not typically assessed accurately under the 'compliance' Part L methodology, but do result in real energy demand.

To address this for the project it is proposed to maximise heat recovery opportunities in the air systems and minimise fan powers associated with the distribution of the air (through high-efficiency variable speed fans, and larger ductwork/risers to reduce resistance). The table on the following page highlights some of the other system-based energy reduction measures that have been considered and incorporated (unless where specified) on the CRRDC scheme.

Condensing boilers	Condensing boilers operate at a higher efficiency with suitable system temperatures.
Large temperature difference heating systems	Temperature difference to be maximised depending on heat emitter type.
Variable speed pumps	Variable speed pumps offering modulation to the heating system are now standard practice within new HVAC designs
Variable speed fans	Variable speed fans offering modulation to the ventilation system are now standard practice within new HVAC designs
Ventilation control sensors	Combination of temperature and carbon dioxide sensors to accurately control the variable speed fans to provide the required amount of fresh air to occupied areas.
Night-time ventilation	Using either natural or mechanical ventilation to cool occupied spaces overnight utilizing 'free' cooler air to reduce the energy consumption of the cooling plant during occupied hours.
Power factor correction	This requires the introduction of a PFC cubicle within the main panel.
Voltage optimisation	This represents fairly new technology that operates by maintaining a constant voltage. During detailed design stage, its applicability will be reviewed with regard to the impact upon the equipment within the building, especially the production areas and lifts.
IT equipment power management	Software to reduce energy consumption through standby mode etc. This will be considered as part of a specific BREEAM credit ENE08
Lighting Controls	Occupancy/absence detection and daylight dimming sensors where applicable.
Lighting management system	This is considered standard for all new buildings.
Task lighting	Utilisation of local control and local areas of increased illumination will contribute to lower general illumination levels.
BMS Control	Building Management System (BMS) with a suitable level of complexity to enable accurate control without deterring facilities management team.

3.3 LZC Technologies

The table in appendix 1 summarises the LZC assessment process carried out at feasibility stage.

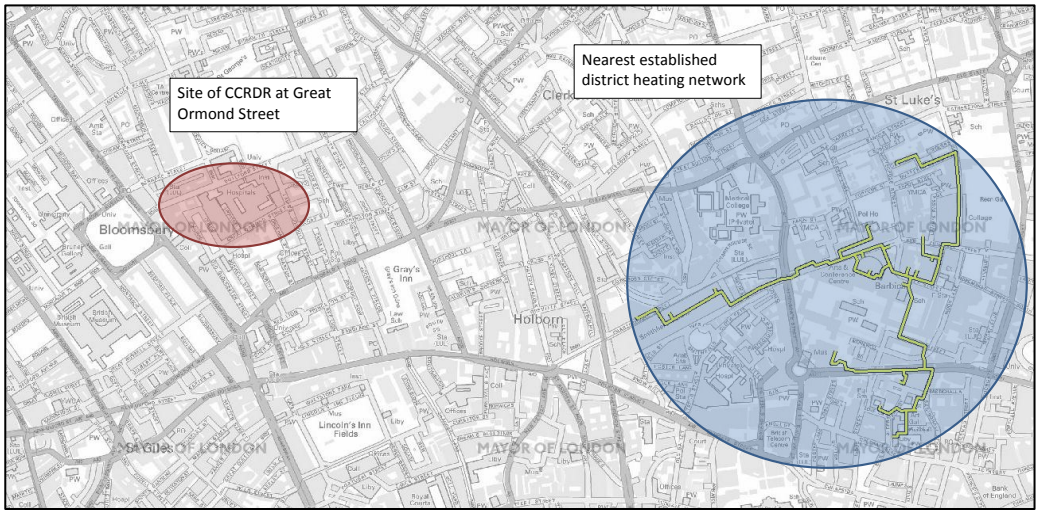
Combined Heat and Power (CHP) and Photovoltaic (PV) panels have been identified as the most applicable technologies for the CRRDC scheme based upon the site context, and the building's expected heating, cooling and power profiles.

4.0 Further Opportunities

4.1 District Energy

Great Ormond Street Hospital has a district energy network located on the existing site to the West of the new CRRDC scheme. Connection to this existing network was considered early in the design process; however the scale of excess capacity of the existing network would make only a small contribution to the energy profile of the new scheme and its energy/CO_2 emissions targets in comparison to a new dedicated unit. Furthermore, there are numerous prohibitive issues associated with this solution with regard to the complexity and cost of the ground works. In conclusion, whilst connecting to the existing CHP network would improve that system's operational hours and efficiency, it would hinder the CRRDC's ability to meet the local and national energy and carbon emissions targets in comparison to a separate additional unit for the new development. This is due to the efficiency loss through the distribution pipework, and the proportion of the annual heat load that could be satisfied.

The only other existing CHP installation near to the site is at the British Museum (as shown in the London Heat Map website extract below). The same hindrances apply to this option in addition to the complication of the Piccadilly Tube Line route.



4.2 Tri-Generation

A 1MW tri-generation scheme (option 2 below) has been assessed in comparison with the proposed services strategy (option 1 below) with respect to potential operational energy and carbon emissions savings. This alternative system utilises an absorption chiller as the primary source of cooling which utilises heat from the combined heat and power (CHP) engine, thus increasing its annual operating hours, and improving the overall energy profile of the building.

For the purpose of this study, energy benchmarks from the CIBSE TM46 publication have been used to estimate the heat and power requirements of the various parts of the building. The energy results from this study identify that by utilising a tri-generation scheme, the building's heating and cooling system is expected to consume an additional 927MWh of gas per year, but consuming almost 500MWh less electricity in comparison to the proposed scheme design. Due to the comparative embodied carbon values between the fuels, this results in a saving of 77tCO_2 per year.

	Gas Consumption (kWh/yr)	Electricity Consumption (kWh/yr)	Electricity Generation (kWh/yr)	Total Carbon Emission savings ($kgCO_2$/yr)	Total Utility Cost Savings (£/yr)
Option 1	3,891,154	140,588	432,266	N/A	N/A
Option 2	4,819,057	84,353	868,107	77	£21,371

However, whilst the energy and carbon savings appear favourable, the utility cost savings are only £21k per year (based upon a typical utility rate cost) which would not provide a return on investment on the substantial additional capital expenditure within the lifespan of the plant.

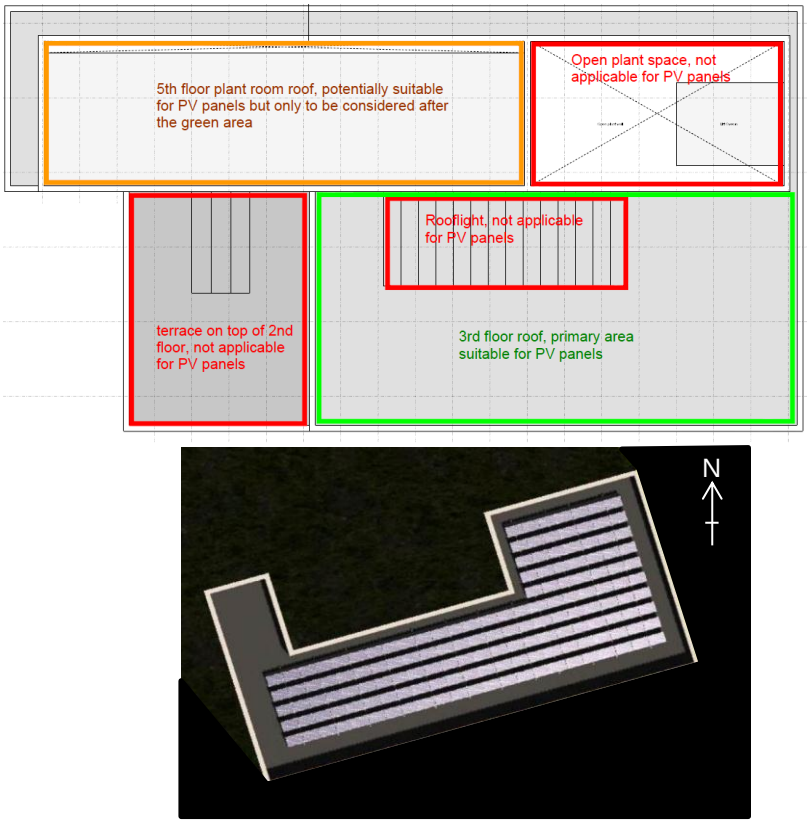
Gardiner and Theobald have confirmed that the net extra over cost for the Tri-gen plant above the proposed services strategy is expected to be in the region of £570,000 but once all the on costs are applied (sub contract and main contract prelims, builders work, ohp, fees, contingency and inflation) this rises to circa £1.1m. This results in the additional capital expenditure being circa three times the operational savings achieved excluding accounting for life cycle cost and maintenance. This is based upon a typical electrical tariff of 10p/kWh, and even if this were to increase to 12p/kWh, this margin would only reduce closer to two times the operational savings.

5.0 PV Panels

In light of the GLA and Camden's requirements to include renewable energy generation within the scheme, the absence of local shading from high-rise buildings, and the high power requirements of the building, PV panels are considered a suitable technology for the development.

Initial indications from the Part L analysis indicate that an overall generation of around 34,000kWh/yr will be required to meet the building's various energy and CO_2 targets.

An initial study into the potential array design to achieve this output has been carried out with a Micro-generation Certification Scheme (MCS) approved installer (which is required in order to be eligible for Feed-in Tariff income). The details of the roof areas considered are shown in the roof plan image below.



The bottom image reflects the true orientation of the roof and then places the panels in an array that would satisfy the output requirements. The calculations have demonstrated that a 49.05kW array, consisting of 245m^2 of PV active area (excluding frame) could generate 39,780kWh per year, mitigating 21tCO_2 per year. This array would take up the majority of the 3rd floor roof surrounding the rooflight.

An investigation has also been carried out to assess the potential to uplift the photovoltaic panel array on the roof of the development to further improve the energy profile of the building. Based upon the fact that there is no opportunity to utilise the plantroom roof for PV panels due to planning height restrictions on the building, and structural capacity of the plantroom roof, the additional panels could only be accommodated in the remaining area on the 3rd floor roof.

By placing additional panels in the remaining space to the left of the roof area shown previously, an additional 5kW and 4,000kWh (and an additional saving of 2tCO_2/yr) could be achieved. However, the Feed-in-Tariff (FiT) rate for this array would reduce as there is a boundary difference between 10-50kW and 50kW-150kW arrays.

Energy Source	Scale	Type / Rate	Tariff (p/kWh)	
			< 31/3/14	> 1/4/14
Anaerobic digestion	≤250kW		15.57	12.13
Anaerobic digestion	>250kW - 500kW		14.40	11.22
Anaerobic digestion	>500kW		9.49	9.24
Hydro	≤15 kW		22.23	20.57
Hydro	>15 - 100kW		20.76	19.20
Hydro	>100kW - 500kW		16.41	15.18
Hydro	>500kW - 2MW		12.82	11.86
Hydro	>2MW - 5MW		3.32	3.23
Micro-CHP	<2 kW	(limited)	11.65	13.24
Solar PV	≤4 kW	Higher rate	14.90	14.38
Solar PV	≤4 kW	Medium rate	13.41	12.94
Solar PV	>4 - 10kW	Higher rate	13.50	13.03
Solar PV	>4 - 10kW	Medium rate	12.15	11.73
Solar PV	>10 - 50kW	Higher rate	12.57	12.13
Solar PV	>10 - 50kW	Medium rate	11.31	10.92
Solar PV	>50 - 150kW	Higher rate	10.71	10.71
Solar PV	>50 - 150kW	Medium rate	9.64	9.64
Solar PV	>150 - 250kW	Higher rate	10.25	10.25
Solar PV	>150 - 250kW	Medium rate	9.22	9.22
Solar PV	≤250kW	Lower rate	6.61	6.61
Solar PV	>250kW - 5MW		6.61	6.61
Solar PV	≤5MW	Standalone	6.61	6.61
Wind	≤100kW		22.23	17.32
Wind	>100 - 500kW		18.53	14.43
Wind	>500kW - 1.5MW		10.05	7.83
Wind	>1.5MW - 5MW		4.26	3.32
Any	existing systems transferred from RO		10.49	10.49

The table above identifies the FIT tariffs available for various electricity-generating technologies in the UK. The only instance whereby the higher rate would not apply is if the building has an EPC certificate rating of less than a D, or where the system owner already has a total of 25 FIT-registered PV installations.

It can be seen that the tariffs decrease at certain kW rating boundaries. By extending the proposed array above 50kW would reduce the rate applications. This would reduce the total annual income by around £130 which reduces the return on investment for the entire array from 12% to 10.1%. It is therefore recommended to maintain an array below 50kW.

Please note that the FIT levels reduce frequently, and the values in the table above are only expected to be applicable for installations commissioned between April 2014 and April 2015. Therefore an estimated degression has been taken into account when calculating the potential income.

6.0 Local & National Targets

The key sustainability targets for this building are as follows:

Source	*Details*
London Plan 2011 (with 2013 updates)	Achieve 35% reduction in CO_2 emissions beyond Part L 2013
Planning Requirement	Reduce CO_2 emissions by 20% through the use of on-site renewable technology
Planning/Client Requirement	Achieve a BREEAM Excellent rating

When combined, these requirements will ensure that the energy performance of the scheme fall within the top 5% of UK non-domestic properties. The London Plan 2011 document has been revised recently to incorporate the updated 2013 Part L of UK Building Regulations. The required 35% improvement upon 2013 Part L replaces the 40% reduction upon Part L 2010 target. The current design achieved a 40.1% reduction upon 2010 regulations, and having re-run the thermal model on the new software it now achieves a 36.8% improvement upon 2013 regulations, therefore we do not envisage a risk to the project from this London Plan update. Whilst the target reduction is 35%, we suggest maintaining the 1.8% buffer at this early design stage as changes may occur throughout the future design and construction phases of the building that may have an impact on the carbon emissions calculations.

Compliance with the above three targets is demonstrated primarily through thermal modelling software in line with UK Building Regulations procedures. The standardised calculations generate Part L compliance documents (BRUKLs), Energy Performance Certificates (EPCs) and also estimate renewable technology outputs.

The results obtained from these calculations are typically not representative of the actual expected energy profile of the building during operation. Primarily this is due to the omission of unregulated loads (small power and equipment etc.) which can typically be greater than all regulated loads combined (heating, cooling, ventilation and lighting etc.). Additionally, the operational profiles and occupancy density are locked within approved templates for these calculations which may not reflect the intended use of the building. Therefore, when identifying opportunities for operational energy reduction, it is important to consider the building's true energy profile in place of data obtained from compliance calculations.

7.0 BREEAM

The Planning Development Policy DP 22 identifies a minimum BREEAM rating of "Excellent" is achieved. It also identifies a requirement for minimum standards to be achieved in Water, Energy and Materials sections. They are 60%, 60% and 40% respectively. The design team have subsequently reviewed the energy strategy to assess whether an "Outstanding" rating is achievable, technically feasible or affordable. Additionally, a review into whether certain aspects of these additional credits would have an energy benefit (and therefore a payback) to the development during its operation lifespan.

The scheme has been identified as BREEAM Bespoke due to its various usage types and in the BREEAM Pre-Assessment (appendix 2); the current rated score is "Excellent" 74.32%, which also meets the aforementioned percentage requirements. Throughout the pre-assessment process, the design team have identified any additional opportunities that could improve the energy profile of the building through reduced operational energy consumption. This section of the report summarises the conclusions from each section of BREEAM, and highlights opportunities for further in-use energy reduction.

Management

Every credit within the Management section of BREEAM has been targeted. Effective commissioning, seasonal commissioning and aftercare are key areas where the energy consumption of the building can be monitored and improved. It is assumed that an independent Post Occupancy Evaluation (POE) process shall be carried out in years 1-3 following occupation to implement this.

Health & Wellbeing

Natural and artificial lighting form a key part of this section of BREEAM. Daylighting credits have been targeted, with sensor-controlled lighting systems to reduce the energy consumption of this system which is typically the greatest regulated energy consumer in new non-domestic buildings. BREEAM sets targets for the control strategy and luminaire efficacy of the lighting system which have all been met in the current design. However, the lighting system is typically one of the primary sources for capital cost savings or value engineering 'VE' exercises; therefore it is recommended to ensure the budget for the lighting system remains reflective of a best practice installation.

Natural ventilation, considered in this section of BREEAM, is not achievable in numerous areas due to either the lack of control of internal conditions (laboratories and healthcare areas) or noise (write-up and office areas), therefore a highly-efficient ventilation system has been pursued in its place. This is covered in the Energy section.

The energy demand of the fume cupboards and containment areas is expected to be significant and the credits for compliance with best performance equipment standards in these areas have been targeted within BREEAM.

Energy

Issue ENE01 awards credits for the building's predicted energy demand and CO_2 emissions performance based upon a combined assessment of three elements; fabric, systems and renewables. Of the 15 credits available, none would be awarded for merely complying with UK regulations whereas 15 would reflect a building whose overall energy performance demonstrates a 90% reduction beyond current new-build standards. This is not merely a comparison of CO_2 emissions from an EPC certificate, but a combined 'Energy Performance Ratio' of all three elements in line with the energy hierarchy discussed in section 3.

To achieve 6 of the 15 credits available is a mandatory requirement for a BREEAM Excellent building (and has therefore been targeted as a minimum), however early thermal modelling indications show that up to 14 credits may be achieved with the current building design.

Before energy consumption can be reduced, first it must be measured. A sufficient level of energy metering is key for benchmarking and identifying opportunities for improvement during operation. Whilst both credits have been targeted for the energy metering credits within BREEAM, there may be an opportunity to extend the detail to which the BMS system records the energy data for greater understanding of the building's in-use performance. This may be through additional metering or a more extensive software platform.

Finally, there are two credits that have not been taken as part of the baseline BREEAM assessment (but have been identified as 'opportunity' credits) relating to the procurement policy for equipment and white goods throughout the building. As previously discussed, unregulated loads can typically exceed regulated loads in non-domestic buildings, and ensuring that all new computer equipment has a high energy performance rating would reduce the energy performance of the building.

Transport

Maximum credits have been pursued in the Transport section of BREEAM, however none of the credits particularly relate to energy consumption of the building during operation.

Water

Leak detection systems and highly efficient sanitary fittings have achieved a high proportion of the credits within the Water section of BREEAM. A grey water recycling system would incur greater capital expenditure together with the requirement for additional space for distribution pipework and plant.

Materials

The incorporation of passive design measures such as thermal mass etc. are rewarded in the Energy section of BREEAM, whereas the Materials section concentrates on the embodied energy and carbon of the construction types and materials specified. Therefore none of the credits under this section have an impact on operational energy demand.

Waste

Similarly in the Waste section, the majority of credits concentrate on the construction phase of the building. There is limited opportunity to target energy saving measures in this section.

Land Use & Ecology

Improving the ecological value of the development is challenging in a dense urban setting, and has little impact on operational energy consumption. Green roofs and walls provide a benefit to the thermal performance of the building element onto which they are installed. When discounting the terrace areas, the plantroom roof (due to planning restrictions on building height) and the area designated for PV panels, there is limited opportunity to implement this design element.

Pollution

The only credit within the Pollution section of BREEAM that relates to energy is the control of external lighting. The current specification allows for a programmable time switch to control all non-emergency lighting systems in compliance with BREEAM criteria. There is therefore little opportunity to pursue energy saving measures in this section.

'Outstanding' Rating

BREEAM Excellent requires an overall score of 70% whereas outstanding requires 85%. Due to the weighting between categories, credits can be worth anywhere between 0.5% and 1.3% each, therefore this requirement for an additional 11% could require between 9 to 22 additional credits to be targeted.

Irrespective of the total score, BREEAM ratings also require certain credits to be achieved, designated 'Mandatory'. The table on the next page highlights (in yellow) that there are only 5 additional mandatory credits required for an Outstanding rating beyond the existing Excellent requirement.

Minimum standards by BREEAM rating level					
BREEAM issue	PASS	GOOD	VERY GOOD	EXCELLENT	OUTSTANDING
Man 01: Sustainable procurement	One credit	One credit	One credit	One credit	Two credits
Man 02: Responsible construction practices	None	None	None	One credit	Two credits
Man 04: Stakeholder participation	None	None	None	One credit (Building user information)	One credit (Building user information)
Hea 01: Visual comfort	Criterion 1 only	Criterion 1 only	Criterion 1 only	Criterion 1 only	Criterion 1 only
Hea 04: Water quality	Criterion 1 only	Criterion 1 only	Criterion 1 only	Criterion 1 only	Criterion 1 only
Ene 01: Reduction of CO_2 emissions	None	None	None	Six credits[1]	Ten credits[1]
Ene 02: Energy monitoring	None	None	One credit (First sub-metering credit)	One credit (First sub-metering credit)	One credit (First sub-metering credit)
Ene 04: Low or zero carbon technologies	None	None	None	One credit	One credit
Wat 01: Water consumption	None	One credit	One credit	One credit	Two credits
Wat 02: Water monitoring	None	Criterion 1 only	Criterion 1 only	Criterion 1 only	Criterion 1 only
Mat 03: Responsible Sourcing	Criterion 3 only	Criterion 3 only	Criterion 3 only	Criterion 3 only	Criterion 3 only
Wst 01: Construction waste management	None	None	None	None	One credit
Wst 03: Operational waste	None	None	None	One credit	One credit
LE03: Mitigating ecological impact	None	None	One credit	One credit	One credit

All of the mandatory credits for a BREEAM Outstanding rating have already been targeted for the existing Excellent rating. Most notable is the ENE01 Reduction of CO_2 emissions. As discussed in the Energy section of this report, the current design is superseding this requirement by a substantial margin.

Excluding the items already addressed under the BREEAM category headings, it has been agreed that to target an Outstanding rating would incur 'buying' credits to uplift the overall percentage score, that would have no benefit to the energy performance of the building during use. Therefore the design team aim to maintain the Excellent rating overall but with all mandatory credits for an Outstanding being achieved, especially with regards to energy and carbon emissions targets.

8.0 Appendix 1

LZC Feasibility Table

Technology	Maintenance	Security and reliability of supply	Risk of regulatory and planning issues	System cost per kW (peak)	Impact upon internal/external layout	To be considered further?
Small Scale Wind Turbines	Medium (Annual Checks)	Low (difficult to accurately pedict yield)	High (Visual impact is a concern, as is noise and flicker from the blades)	Medium	Low	**No - due to space requirements and noise impact**
Solar Photovoltaics (PV)	Low (Annual cleaning, inverter replacement every 15 years)	High (fairly stable yield)	Low	Medium but falling relatively quickly	Low - although roof location needs to be sensitive to height restrictions	**Yes - Particularly suitable for a building with a high electrical demand**
Solar Thermal (SHW)	Low (Annual cleaning, replacement of anti-freeze every 5-10 years)	High (fairly stable yield)	Low	Low	Low - although roof location needs to be sensitive to height restrictions	**No - as CHP is specified, both technologies would compete for the base heating load.**
Biomass Heating (Wood Fuelled)	High (Compared to gas boilers)	Low (Long term fuel supply arrangement recommended)	Medium (Air quality impact assesment may be required)	Low	High - Large weather-protected fuel storage area required.	**No - based upon maintenance burden, fuel supply security in central London, and space requirements for fuel storage**
Ground Source Heat Pumps (GSHP)	Low (Pumps and controls need maintenance as for general heating system)	High (Grid electricity required for operation)	Low	Medium	Low - Small external plant space required for heat pump	**Potentially - this would offer a low carbon heating solution but is likely to have a small impact on overall energy/CO2 performance in comparison to other LZC technologies.**
Air Source Heat Pumps (ASHP)	Medium (As for typical cooling system)	Medium - Grid electricity required for operation, however least efficient in peak winter conditions.	Low	Medium	High - Typically emit more noise and require more external plant space than the equivalent chiller.	**No - due to variation on potential performance. Air cooled chillers have been specified in place of ASHP.**
Combined Heat and Power (CHP)	High (Compared to gas boilers)	High (Mains gas required as fuel)	Medium (Air quality impact assesment may be required)	Medium	Low - Same size as domestic scale boiler	**Yes - As there will be a sufficient base heating and power load**

9.0 Appendix 2

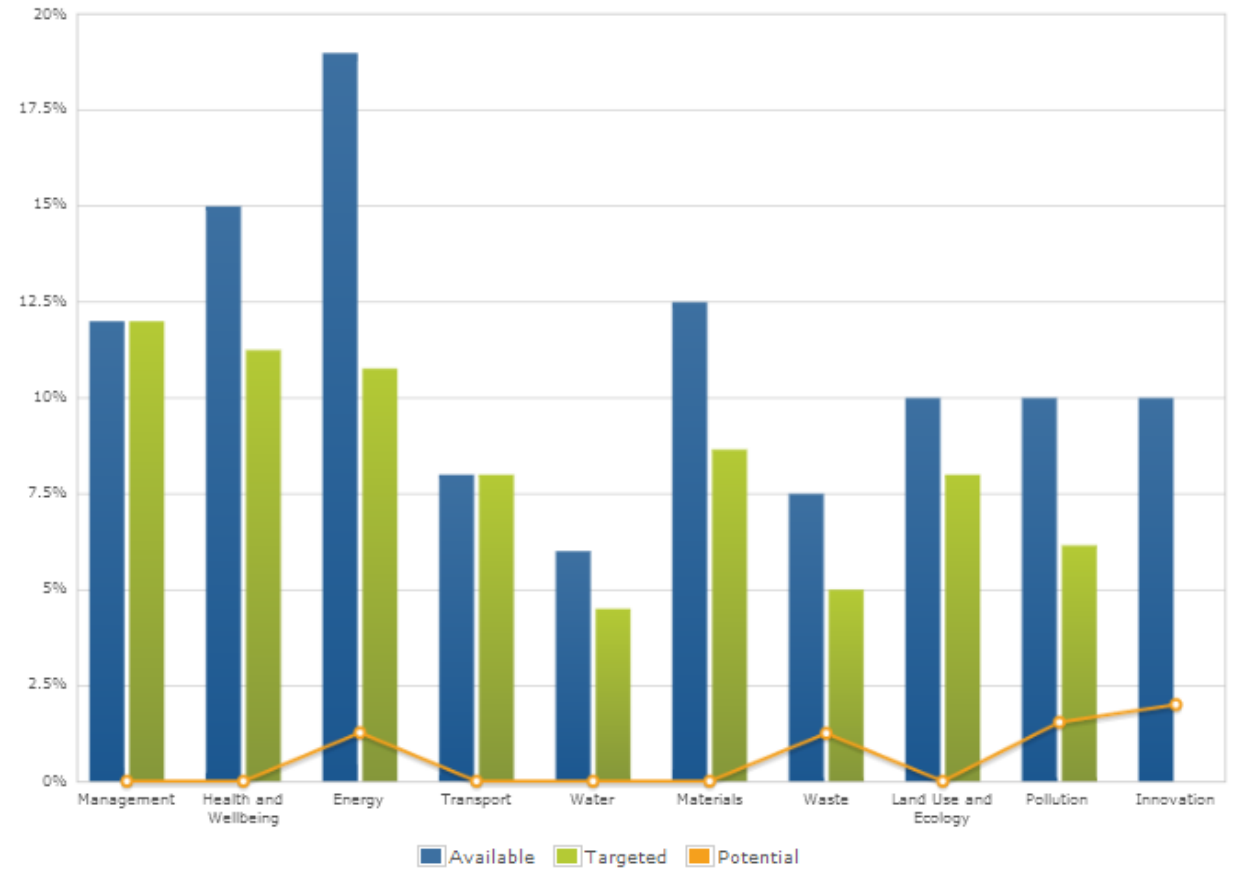
Full BREEAM Pre-assessment

Pre-Assessment Section Summary

Project:	15/20331 - The Centre for Research into Rare Disease in Children
Pre-Assessment:	Excellent - 74.32%
Potential Rating:	Excellent - 80.38%

Section	Available		Targeted		Potential	
	Credits	Percent	Credits	Percent	Credits	Percent
Management	22	12.00%	22	12.00%	0	0.00%
Health and Wellbeing	16	15.00%	12	11.25%	0	0.00%
Energy	30	19.00%	17	10.77%	2	1.27%
Transport	12	8.00%	12	8.00%	0	0.00%
Water	8	6.00%	6	4.50%	0	0.00%
Materials	13	12.50%	9	8.65%	0	0.00%
Waste	6	7.50%	4	5.00%	1	1.25%
Land Use and Ecology	10	10.00%	8	8.00%	0	0.00%
Pollution	13	10.00%	8	6.15%	2	1.54%
Innovation	10	10.00%	0	0.00%	2	2.00%
Total	**140**	**110.00%**	**98**	**74.32%**	**7**	**6.06%**

Performance by Section



Pre-Assessment Criteria Summary

Project:	15/20331 - The Centre for Research into Rare Disease in Children
Pre-Assessment:	Excellent - 74.32%
Potential Rating:	Excellent - 80.38%

Management	**Available**		**Targeted**		**Potential**	
	Credits	**Percent**	**Credits**	**Percent**	**Credits**	**Percent**
Man 01.1: Sustainable procurement : Project brief and design	4	2.18%	4	2.18%	0	0.00%
Man 01.2: Sustainable procurement : Construction and handover	2	1.09%	2	1.09%	0	0.00%
Man 01.3: Sustainable procurement : Aftercare	2	1.09%	2	1.09%	0	0.00%
Man 02: Responsible construction practices	2	1.09%	2	1.09%	0	0.00%
Man 03: Construction site impacts	5	2.73%	5	2.73%	0	0.00%
Man 04.1: Stakeholder participation : Consultation	1	0.55%	1	0.55%	0	0.00%
Man 04.2: Stakeholder participation : Inclusive and accessible design	1	0.55%	1	0.55%	0	0.00%
Man 04.3: Stakeholder participation : Building user information	1	0.55%	1	0.55%	0	0.00%
Man 04.4: Stakeholder participation : Post Occupancy Evaluation (POE) and information dissemination	1	0.55%	1	0.55%	0	0.00%
Man 05: Life cycle cost and service life planning	3	1.64%	3	1.64%	0	0.00%
Management Totals	**22**	**12.00%**	**22**	**12.00%**	**0**	**0.00%**

Health and Wellbeing	**Available**		**Targeted**		**Potential**	
	Credits	**Percent**	**Credits**	**Percent**	**Credits**	**Percent**
Hea 01.1: Visual comfort : Pre-requisite	N/A	0.00%	0	0.00%	0	0.00%
Hea 01.2: Visual comfort : Daylighting	1	0.94%	0	0.00%	0	0.00%
Hea 01.3: Visual comfort : Glare control and view out	1	0.94%	0	0.00%	0	0.00%
Hea 01.4: Visual comfort : Internal and external lighting	1	0.94%	1	0.94%	0	0.00%
Hea 02.1: Indoor air quality : Minimising sources of air pollution	3	2.81%	2	1.88%	0	0.00%
Hea 02.2: Indoor air quality : Potential for natural ventilation	1	0.94%	0	0.00%	0	0.00%
Hea 02.3: Indoor air quality : Laboratory fume cupboard and containment areas	2	1.88%	2	1.88%	0	0.00%
Hea 03: Thermal comfort	2	1.88%	2	1.88%	0	0.00%
Hea 04: Water quality	1	0.94%	1	0.94%	0	0.00%
Hea 05.5: Acoustic performance : Office, Industrial, Retail, Prisons, Courts and other (non residential) building types	2	1.88%	2	1.88%	0	0.00%
Hea 06.1: Safety and security : Safe access	1	0.94%	1	0.94%	0	0.00%
Hea 06.2: Safety and security : Security of site and building	1	0.94%	1	0.94%	0	0.00%
Health and Wellbeing Totals	**16**	**15.00%**	**12**	**11.25%**	**0**	**0.00%**

Energy	Available		Targeted		Potential	
	Credits	Percent	Credits	Percent	Credits	Percent
Ene 01: Reduction of CO2 emissions	15	9.50%	6	3.80%	0	0.00%
Ene 02: Energy monitoring	2	1.27%	2	1.27%	0	0.00%
Ene 03: External lighting	1	0.63%	1	0.63%	0	0.00%
Ene 04.1: Low and zero carbon technologies : Feasibility study OR renewable energy supply contract	1	0.63%	1	0.63%	0	0.00%
Ene 04.2: Low and zero carbon technologies : Low or zero carbon technology specification and installation	3	1.90%	3	1.90%	0	0.00%
Ene 04.3: Low and zero carbon technologies : Free cooling	1	0.63%	0	0.00%	0	0.00%
Ene 05: Energy efficient cold storage	2	1.27%	2	1.27%	0	0.00%
Ene 06: Energy efficient transportation systems	2	1.27%	2	1.27%	0	0.00%
Ene 07: Energy efficient laboratory systems	1	0.63%	0	0.00%	0	0.00%
Ene 08: Energy efficient equipment	2	1.27%	0	0.00%	2	1.27%
Energy Totals	**30**	**19.00%**	**17**	**10.77%**	**2**	**1.27%**

Transport	Available		Targeted		Potential	
	Credits	Percent	Credits	Percent	Credits	Percent
Tra 01.1: Public transport accessibility : Accessibility index	5	3.33%	5	3.33%	0	0.00%
Tra 02: Proximity to amenities	2	1.33%	2	1.33%	0	0.00%
Tra 03: Cyclist facilities	2	1.33%	2	1.33%	0	0.00%
Tra 04: Maximum car parking capacity	2	1.33%	2	1.33%	0	0.00%
Tra 05: Travel plan	1	0.67%	1	0.67%	0	0.00%
Transport Totals	**12**	**8.00%**	**12**	**8.00%**	**0**	**0.00%**

Water	Available		Targeted		Potential	
	Credits	Percent	Credits	Percent	Credits	Percent
Wat 01: Water consumption	5	3.75%	3	2.25%	0	0.00%
Wat 02: Water monitoring	1	0.75%	1	0.75%	0	0.00%
Wat 03: Water leak detection and prevention	2	1.50%	2	1.50%	0	0.00%
Water Totals	**8**	**6.00%**	**6**	**4.50%**	**0**	**0.00%**

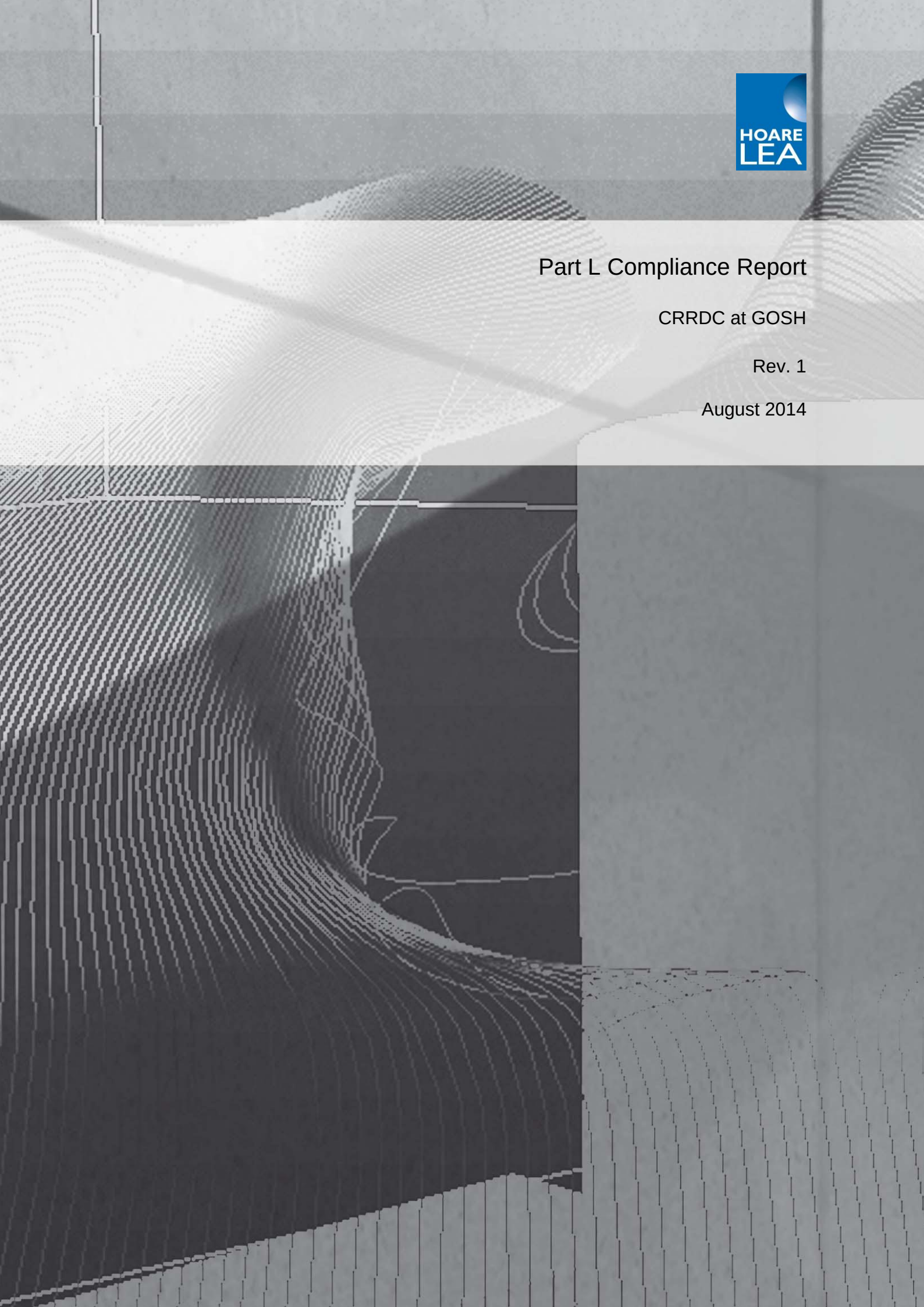
Materials	Available		Targeted		Potential	
	Credits	Percent	Credits	Percent	Credits	Percent
Mat 01: Life cycle impacts	6	5.77%	3	2.88%	0	0.00%
Mat 02: Hard landscaping and boundary	1	0.96%	1	0.96%	0	0.00%
Mat 03: Responsible sourcing of materials	3	2.88%	2	1.92%	0	0.00%
Mat 04.1: Insulation : Embodied impact	1	0.96%	1	0.96%	0	0.00%
Mat 04.2: Insulation : Responsible sourcing	1	0.96%	1	0.96%	0	0.00%
Mat 05: Designing for robustness	1	0.96%	1	0.96%	0	0.00%
Materials Totals	**13**	**12.50%**	**9**	**8.65%**	**0**	**0.00%**

Waste	Available		Targeted		Potential	
	Credits	Percent	Credits	Percent	Credits	Percent
Wst 01.1: Construction waste management : Construction resource efficiency	3	3.75%	2	2.50%	0	0.00%
Wst 01.2: Construction waste management : Diversion of resources from landfill	1	1.25%	1	1.25%	0	0.00%
Wst 02: Recycled aggregates	1	1.25%	0	0.00%	1	1.25%
Wst 03: Operational waste	1	1.25%	1	1.25%	0	0.00%
Waste Totals	**6**	**7.50%**	**4**	**5.00%**	**1**	**1.25%**

Land Use and Ecology	Available		Targeted		Potential	
	Credits	Percent	Credits	Percent	Credits	Percent
LE 01.1: Site selection : Previously developed land	1	1.00%	1	1.00%	0	0.00%
LE 01.2: Site selection : Contaminated land	1	1.00%	0	0.00%	0	0.00%
LE 02: Ecological value of site and protection of ecological features	1	1.00%	1	1.00%	0	0.00%
LE 03: Mitigating ecological impact	2	2.00%	2	2.00%	0	0.00%
LE 04: Enhancing site ecology	3	3.00%	2	2.00%	0	0.00%
LE 05: Long term impact on biodiversity	2	2.00%	2	2.00%	0	0.00%
Land Use and Ecology Totals	**10**	**10.00%**	**8**	**8.00%**	**0**	**0.00%**

Pollution	Available		Targeted		Potential	
	Credits	Percent	Credits	Percent	Credits	Percent
Pol 01: Impact of refrigerants	3	2.31%	0	0.00%	0	0.00%
Pol 02: NOx emissions	3	2.31%	1	0.77%	2	1.54%
Pol 03.1: Surface water run off : Flood risk	2	1.54%	2	1.54%	0	0.00%
Pol 03.2: Surface water run off : Surface water run off	2	1.54%	2	1.54%	0	0.00%
Pol 03.3: Surface water run off : Minimising water course pollution	1	0.77%	1	0.77%	0	0.00%
Pol 04: Reduction of night time light pollution	1	0.77%	1	0.77%	0	0.00%
Pol 05: Noise attenuation	1	0.77%	1	0.77%	0	0.00%
Pollution Totals	**13**	**10.00%**	**8**	**6.15%**	**2**	**1.54%**

Innovation	Available		Targeted		Potential	
	Credits	Percent	Credits	Percent	Credits	Percent
Inn 01: Innovation	10	10.00%	0	0.00%	0	0.00%
Man 01: Sustainable procurement	1	1.00%	0	0.00%	1	1.00%
Man 02: Responsible construction practices	1	1.00%	0	0.00%	1	1.00%
Hea 01: Visual comfort	1	1.00%	0	0.00%	0	0.00%
Ene 01: Reduction of CO2 emissions	5	5.00%	0	0.00%	0	0.00%
Ene 04: Low and zero carbon technologies	1	1.00%	0	0.00%	0	0.00%
Ene 05: Energy efficient cold storage	1	1.00%	0	0.00%	0	0.00%
Wat 01: Water consumption	1	1.00%	0	0.00%	0	0.00%
Mat 01: Life cycle impacts	3	3.00%	0	0.00%	0	0.00%
Mat 03: Responsible sourcing of materials	1	1.00%	0	0.00%	0	0.00%
Wst 01: Construction waste management	1	1.00%	0	0.00%	0	0.00%
Wst 02: Recycled aggregates	1	1.00%	0	0.00%	0	0.00%
Innovation Totals (Up to a maximum of 10 credits)	**10**	**10.00%**	**0**	**0.00%**	**2**	**2.00%**
Overall Totals	**140**	**110.00%**	**98**	**74.32%**	**7**	**6.06%**



Part L Compliance Report

CRRDC at GOSH

Rev. 1

August 2014

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Audit Sheet

Revision	Description	Date	Prepared by	Reviewed by
Draft	For Comment	30/07/2014	RG	VS
1	Stage D Issue	27/08/2014	RG	VS, PK

CONTENTS

1 Executive Summary

The Centre for Research into Rare Disease in Children (CRRDC) at Great Ormond Street Hospital, located in the London Borough of Camden, Central London, is a new building that will accommodate GMP, laboratory, outpatient and office spaces. This document reviews the thermal modelling simulations carried out in order to demonstrate compliance with Part L of Building Regulations (2013) as well as a 35% carbon emission reduction over Part L 2013 of the Building Regulations to meet London Plan requirements.

A 36.8% carbon reduction over Part L (2013) has been demonstrated with the application of renewable technologies i.e. photovoltaic (PV) panels.

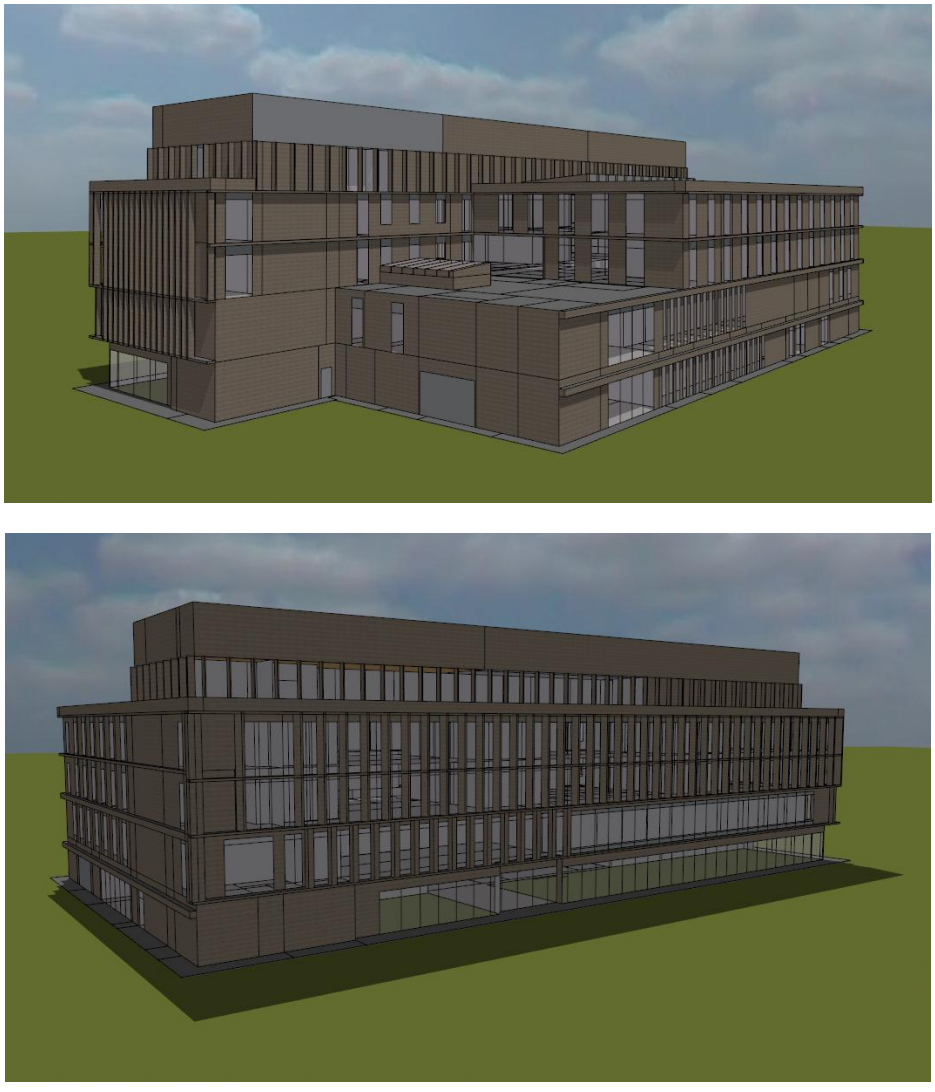


Figure 1: IES model of the CRRDC

Figure 1 shows the thermal model of the building. Appendix A includes full details of the input parameters and compliance results. The proposed system specifications (and resulting energy & carbon breakdown) in Appendix A outlines the engineers' aim to then reduce the energy consumption through active and passive design measures (lighting sensors, heat recovery etc.). Combined Heat and Power (CHP) and Photovoltaic (PV) panels are then used to achieve the renewable targets of the development. The conclusions from each section of this study are discussed below:

Criterion 3 Results

1. A high performance glazing specification (low g-value) has been pursued throughout the building to reduce solar gains, and enables most areas to pass criterion 3 of UK Building Regulations.

2. Eight areas currently exceed this criterion in the absence of internal blinds. Introducing internal blinds to these areas achieves compliance.

Passive Design Measures

3. The design team are pursuing best practice fabric performance standards as shown in Table 2. These are universally a substantial improvement upon the 'worst acceptable limits' in 2013 Building Regulations which are not representative of good practice.

4. The target air permeability of $3m^3/hr.m^2$ is a 70% improvement upon the limit in 2013 Building Regulations.

Active Design Measures

5. Lighting is a significant proportion of the building's overall energy demand, and is an even greater percentage of the annual regulated carbon emissions. It is recommended to utilise daylight and occupancy sensors extensively where appropriate. Occupancy sensing has been assumed in WCs, exam rooms, GMP, circulation and office areas as well as daylight sensing to the perimeter areas.

6. The target lighting densities (W/m^2) used in the notional building are challenging but achievable. These figures should be targeted in order to reduce the requirement of LZC technologies to meet the CO_2 targets of the building.

Low Carbon Technology

7. The majority of the DHW demand is expected to be served by the CHP, with the remainder supplemented by the gas boilers. Thermal stores have been included to extend the annual hours of operation and optimise the performance of the CHP unit.

Zero Carbon Technology

8. Whilst not required purely for Part L compliance, the design team are aiming to achieve compliance with London Plan 2011 using a provision of PV panels. The current design includes a PV array with an annual generation of approximately 33,700kWh/yr (estimated at $30kW_{peak}$ or $250m^2$ dependent upon the manufacturer's specification and panel's orientation).

9. Camden Planning Guidance requires a 20% reduction in carbon dioxide emission from on-site renewable energy generation. It is proposed to pursue an alternative, more beneficial strategy in line with the energy hierarchy to building design, reducing demand rather than simply installing renewables. This is in the form of 10 points under BREEAM 2014 Ene01 credit which has been achieved (as shown in Appendix C), exceeding the minimum requirements for BREEAM Outstanding rating.

Overall

10. The current building design passes the CO_2 emissions Criterion 1 target of Part L by 33.4% using a 40kWt CHP alone, and by 36.8% using PV and CHP. This achieves the London Plan target, as shown in Figure 5.

2 Introduction

Part L of UK Building Regulations consists of 5 criteria (listed below). This report considers the first three criteria in the design stage of a project;

- Criterion 1 – Achieving an acceptable Building CO_2 Emission Rate (BER)
- Criterion 2 – Limits on design flexibility
- Criterion 3 – Limiting the effects of solar gain in summer

} Design Stage

- Criterion 4 – Building performance consistent with BER
- Criterion 5 – Providing information

} Post Construction Stage

Four scenarios are to be investigated:

1. Part L (2013) compliance
2. The energy hierarchy (London Plan)
3. 35% carbon emission reduction over Part L 2013 (London Plan 2011 – 2014 amendments)
4. 20% reduction in carbon emissions from on-site renewable energy generation (Camden Planning Guidance)

2.1 Criterion 1 – BER<TER

Criterion 1 requires the actual Building's CO_2 Emissions Rate (BER) to be less than the Target CO_2 Emissions Rate (TER). The TER is calculated by an approved thermal modelling software (such as IES Virtual Environment) which requires the input of an extensive list of information including location, orientation, fabric constructions, room types, M&E system details and control parameters. The calculated annual energy demand is converted into carbon emissions using conversion factors shown in Table 1.

Fuel	Embodied Carbon ($kgCO_2/kWh$)
Electricity – grid consumed	0.519
Electricity – displaced (PV/CHP)	0.519
Gas - mains	0.216
Gas - LPG	0.241
Oil	0.319
Biomass	0.031

Table 1: Fuel conversion factors

Table 1 also highlights that if an electric heat pump is chosen as a heat source, it must be more than 2.4 times as efficient as the equivalent gas boiler to realise a carbon emission saving due to the comparative embodied carbon of the differing fuels.

2.2 Criterion 2 – Limits on design flexibility

Criterion 2 governs the acceptable limits on fabric, construction quality & thermal bridging, and performance of fixed building services provisions. For the M&E system parameters, it refers to the *Non-Domestic Building Services compliance guide 2010*.

Element	U Values (W/m^2.K)		
	Acceptable Limit	Notional Building	Proposed Design
Roof	0.25	0.18	0.15
Walls	0.35	0.26	0.15
Floors	0.25	0.22	0.17
Windows	2.2	1.6	1.3
Air Permeability (m^3/m^2.hr)	10	3	3

Table 2: Fabric and construction targets

The U-values used in the notional target building (which governs the TER for the building) are a significant improvement upon the worst acceptable limits under 2013 Part L of UK Building Regulations, as shown in Table 2. At this early design stage, the proposed building aims to improve upon the notional values, which will assist in reducing the requirement of LZC technologies for compliance. These can then be reviewed at a later design stage.

Similarly, the worst acceptable air permeability is 10m^3/m^2.hr however the 2013 notional building uses 3m^3/m^2.hr. CRRDC's target of 3m^3/m^2.hr matches the notional value, which is a 70% improvement on the acceptable limit figure of Part L.

2.3 Criterion 3 – Limiting the effects of solar gain in summer

Criterion 3 has seen the greatest change from the 2006 building regulations. Air conditioned spaces are no longer exempt from this requirement, and the method of simply ensuring temperatures within the space remain below 28^{o}C for less than 1% of occupied time is no longer relevant. As such, this criterion is not referred to as the 'overheating criterion' as it is independent of the HVAC strategy within the assessed rooms.

The current methodology compares the solar gain from the actual building to that of a reference facade within the notional building, based on the area and specification of glazing. The target level of solar gain (measured in W/m^2) is calculated using building design and parameters in the notional building shown in Figure 4. The images below demonstrate the difference between the actual (Figure 2) and notional (Figure 3) facades.

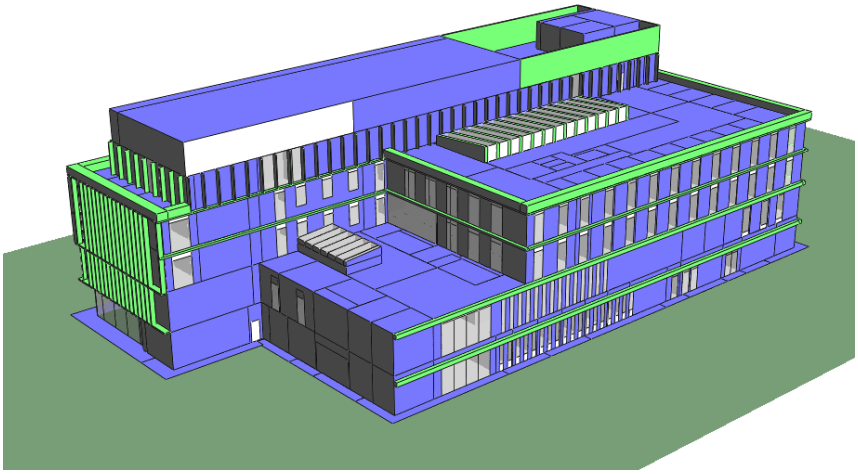


Figure 2: Actual building facade

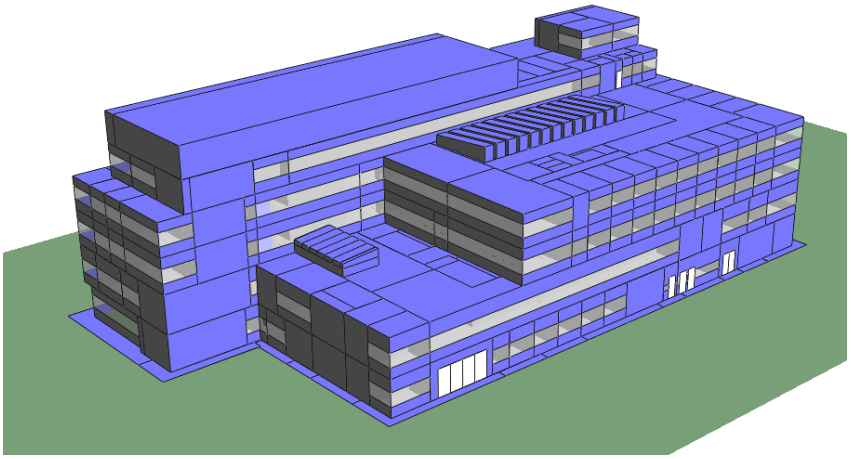


Figure 3: Notional building facade

Reference Facade	Area of Glazing	Frame factor	Eff. G-Value
East	~40%	10%	0.68

Figure 4: Notional building design and glazing specifications

For example, any occupied room which is designated as predominantly side lit (regardless of orientation) will have to achieve solar gain values less than a typical eastern facade with around 40% glazing (with a 10% frame area) with an effective G-Value of 0.68. The effective G-Value is the fraction of the sun's thermal radiation that is allowed to pass through the window and takes into account the G-value of the glass and also any solar shading treatment devices (i.e. film or brise soleil).

3 Results

3.1 Criterion 1 – BER<TER

3.1.1 Part L Compliance

The current design, based on the drawings received from Stanton Williams on 3rd July 2014, is passing the Part L CO_2 emissions targets with the use of passive design measures, active design measures and low carbon technology, in the form of combined heat and power (CHP) and PV. The Part L building emissions rate (BER) is 24.6kgCO_2/m².yr against a target emissions rate (TER) of 38.9kgCO_2/m².yr, which equates to a pass of approximately 36.8%. The space heating and domestic hot water (DHW) is provided by natural gas LTHW boilers working in conjunction with CHP, assisting in reducing the overall loads on the LTHW boilers.

3.1.2 London Plan 2011

The energy hierarchy for the development has been developed in line with the London Plan principles:

- Step 1 (Be Lean) – Reduce energy demand by adopting a passive design and energy efficiency measures;
- Step 2 (Be Clean) – After CHP
- Step 3 (Be Green) – After renewable energy sources (PV).

Figure 5 shows the carbon emissions results of the energy hierarchy. Table 3 shows the carbon dioxides emissions (per annum) after each stage of the energy hierarchy and Table 4 demonstrates the regulated carbon dioxide savings from each stage of the energy hierarchy.

Figure 5: The energy hierarchy results

	Carbon Dioxide Emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Building Regulations 2013 Part L Compliant Development	519.9	981
After energy demand reduction	360.8	981
After CHP	346.1	981
After renewable energy	328.8	981

Table 3: Carbon dioxide emissions after each stage of the energy hierarchy

	Regulated Carbon Dioxide Savings	
	(Tonnes CO_2 per annum)	(%)
Savings from energy demand reductions	159.0	30.6
Savings from CHP	14.7	4.1
Savings from renewable energy	17.4	5.0
Total Cumulative Savings	191.1	36.8
Total Target Savings	182.0	35
Annual Surplus	9.2	-

Table 4: Regulated carbon dioxide savings from each stage of the energy hierarchy

The results demonstrate that energy efficiency measures alone exceed 2013 Building Regulations. However, passive design measures, active design measures and low carbon technology alone do not achieve the required 35% carbon emission reduction over Part L 2013 to meet London Planning (2011) requirements. In order to achieve this, renewable technologies must be used, in this case photovoltaic panels (PV).

To meet London Plan requirements, a 35% reduction in carbon emission must be achieved over Part L 2013, which equates to a BER of 25.285kgCO_2/m².yr. This requires a reduction of 0.615kgCO_2/m².yr from the previous BER of 25.9kgCO_2/m².yr (achieved with passive and active design measures and CHP).

Figures 6 and 7 outline the energy and carbon breakdown of the Part L compliance simulations. Although shown in the bar charts, equipment load is an unregulated load and is therefore not included by the simulation. It shows that lighting and auxiliary (pump & fan power) are the main energy consumers and sources of carbon emissions, however these are based upon Building Regulations templates for compliance only and are likely to differ from the actual building profile.

The full details of the parameters used in the compliance calculation can be found within Appendix A and the BRUKL compliance documents for each stage of the energy hierarchy (Be Lean, Be Clean and Be Green) are included within Appendix B.

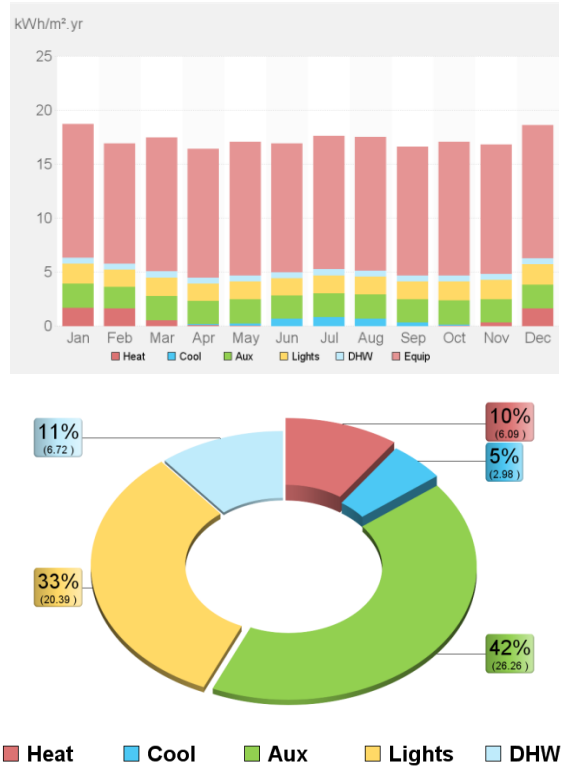


Figure 6: Energy consumption breakdown for Part L compliance figures

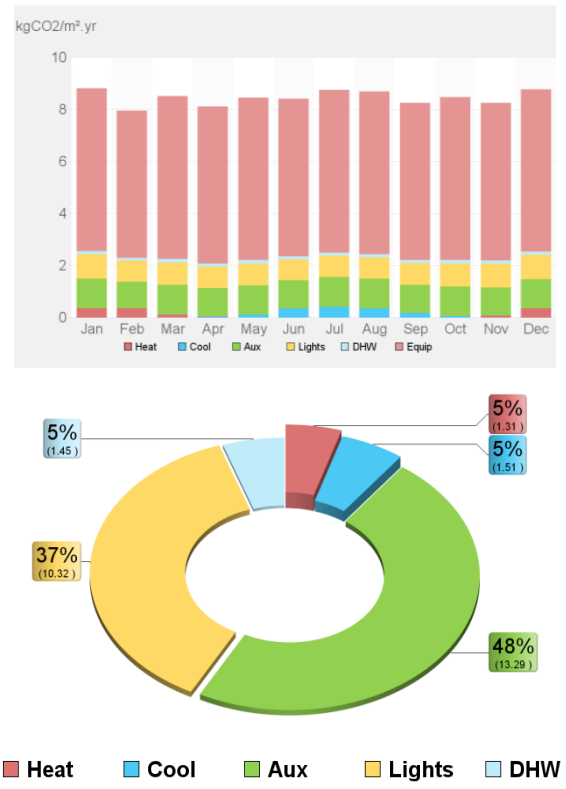


Figure 7: Carbon emissions breakdown for Part L compliance figures

3.1.2.1 Camden Planning Guidance
– 20% reduction in carbon dioxide emission from on-site renewable energy generation

Camden planning guidance, written in conjunction with The London Plan, states that the council expects the following:

All developments are to target at least a 20% reduction in carbon dioxide emissions through installation of on-site renewable energy technologies.

Suitable renewables technologies include:

- Solar thermal hot water panels
- Photovoltaic (PVs)
- Ground Source Heat Pumps (GSHP)
- Air Source Heat Pumps (ASHP)
- Biomass heating and power
- Wind turbines

The most viable renewable technology for use at the CRRDC building is PV.

The current PV array of 250m^2 accounts for a CO_2 emission reduction of approximately 5% over Step 2 (Be Clean) of the London Plan energy hierarchy, instead of the 20% required by Camden Planning Guidance.

A 20% carbon emission reduction over Step 2 would equate to a BER of 20.72kgCO_2/m^2.yr. This requires a reduction of 3.88kgCO_2/m^2.yr from the current BER of 24.6kgCO_2/m^2.yr (achieved with passive and active design measures, CHP and 250m^2 of PV). In order to achieve this carbon emission reduction, the PV array would need to produce an extra output of approximately 99,900kWh/yr which, depending on the specification of the panels, would equate to approximately 832m^2 (Table 5). These figures are additional to the PV array already included in the calculations.

	Emission reduction (kgCO2/m2.yr)	Building area (m2)
	3.88	13364.1
PV required	Output (kWh)	Estimated PV area (m2)
	99908.88	832.6

Table 5: PV required to meet Camden Planning Guidance

Due to the restrictions on available roof space, there is a limit to the area of PV that can be used and, as a result, achieving the 20% carbon emission reduction from on-site renewables is not feasible. Instead, pursuing the equivalent of a BREEAM Outstanding rating under BREEAM 2014 Ene01 credit (8 points) (Figure 8) is proposed as a suitable alternative, in line with the London Plan energy hierarchy of investing in fabric performance and system efficiencies to reduce energy demand before considering renewables.

As it can be seen in the BREEAM Ene01 Compliance Checker enclosed in Appendix C, the building has achieved 10 credits and an EPR_{NC} of 0.8020, thus exceeding the minimum requirements for BREEAM Outstanding rating.

BREEAM credits	EPR_{NC}	Minimum standards: Rating	Minimum standards: Minimum requirements
1	0.075	Pass Good Very Good	Requires a performance improvement progressively better than the relevant national building regulations compliant standard (see Other information).
2	0.15		
3	0.225		
4	0.30		
5	0.375	Excellent	Requires 5 credits to be achieved (equivalent to an EPR of at least 0.375).
6	0.45		
7	0.525		
8	0.60	Outstanding	Requires 8 credits to be achieved (equivalent to an EPR of at least 0.6).
9	0.675		
10	0.75		
11	0.825		
12	0.90 AND zero net regulated CO_2 emissions*.		

Figure 8: Ene01 EPR_{NC} benchmark scale from BREEAM 2014 Guide

3.2 Criterion 3 – Limiting the effects of solar gain in summer

The results of the preliminary Criterion 3 calculations demonstrate that compliance can be achieved with the current façade design utilising high-performance glazing within all areas with a glass g-value of 0.4. Figure 9 shows an extract from the BRUKL report (attached in full in Appendix B) which demonstrates that the majority of areas comply with Criterion 3, with the exception of eight areas (shown in red in the BRUKL report). Due to the relatively large glazing content of the façade, these areas struggle to comply with the benchmarks. To improve on these results, the use of internal blinds is recommended.

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

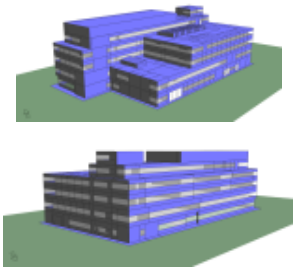
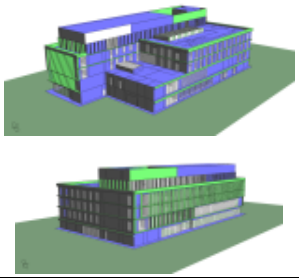
Zone	Solar gain limit exceeded? (%)	Internal blinds used?
X2044 COFFEE SHOP BOH	NO (-10.4%)	NO
X2046 COFFEE SHOP	NO (-42.2%)	NO
X2048 ENTRANCE ZONE HOT DESKS	YES (+10.6%)	NO
X2050 INTERVIEW	NO (-21.4%)	NO
X2052 CELLOFFICE3	YES (+18%)	NO
X2054 CELLOFFICE2	YES (+16%)	NO
X2056 CELLOFFICE1	NO (-6.7%)	NO
X2058 WORKSPACE1	NO (-32.6%)	NO
X2058 WORKSPACE1	NO (-80.4%)	NO

Figure 9: Extract from the BRUKL report

4 Appendix A List

1 – Building Specification

Appendix A: 1 – Building Specification

	2013 Notional Building	Proposed Design	Comments
Fabric: U-Values (W/m².K)			
Walls	0.26	0.15	
Ground Floor	0.22	0.17	
Internal ceiling/floor	1.09	N/A	
Internal partition	1.79	N/A	
Roof	0.18	0.15	
Fabric: Glazing			
Percentage of Façade	40%	(See design)	
Specification	Low Emissivity Double Glazing	Low Emissivity Double Glazing	
U-Value (W/m².K)	1.6	1.3	
G-Value (Solar Transmittance)	NCM	0.4	
Façade Design			
Fabric: Air Tightness			
Air Permeability (m³/m².hr)	3	3	
System Details: Heating/Cooling			
Primary System	Gas Boiler	Gas Boiler	
Heating Nominal Efficiency	91%	97.3%	
Heating Seasonal Efficiency	91%	97.3%	
Cooling Nominal Efficiency	N/A	372%	
Cooling Seasonal Efficiency	N/A	543%	
System Details: DHW			
DHW Delivered efficiency (%)	95%	N/A	Notional building imposes a target 95% delivered efficiency for DHW, whereas the actual building uses standing losses in the storage unit
Storage Volume (litres)	N/A	1500	
Storage Losses (kWh/(l.day))	N/A	0.004	
Secondary circulation losses (W/m)	N/A	7	
Pump Power (kW)	N/A	0.20	
System Details: Mechanical Ventilation			
Type (Natural / Mechanical / Mixed)	Mechanical	Mech	All areas are to be served by a number of centralised systems.
Ductwork leakage test rating	NCM	L2	
AHU's CEN Leakage Standards	NCM	None	
Specific Fan Power (W/l.s)	NCM	1.3	
HR Methodology	NCM	Recuperator	
HR Seasonal Efficiency (%)	NCM	50-70%	
System Details: Lighting			
Density W/m²/100lux	NCM	5.5/2.2/2.1 W/m²/100lux	
Occupancy Sensors Provision	Yes	PIR	
Daylight Dimming Provision	Yes	Perimeter spaces	
System Details: Renewables			
Solar PV	None	33,700kWh/yr	
Solar Thermal	None	None	
Wind Turbines	None	None	
CHP Engine	None	40kWt	1500 litre thermal store

5 Appendix B List

1 – BRUKL document extract (Be Lean)
2 – BRUKL document extract (Be Clean)
3 – BRUKL document (Be Green – London Plan and Camden Planning Guidance Compliance)

Appendix B: 1 – BRUKL document extract (Be Lean)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

CCRDR

As designed

Date: Thu Jul 31 12:02:38 2014

Administrative information

Building Details

Address: Great Ormond Street, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.0.1

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.0.1

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

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name:

Telephone number:

Address: , ,

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

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	38.9
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	38.9
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	27
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	Are as built details the same as used in the BER calculations?	Separate submission

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

Values which do not meet standards in the 2013 Non-Domestic Building Services Compliance Guide are displayed in red.

2.a Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.15	0.15	0DMN0001:Surf[0]
Floor	0.25	0.17	0.35	1CL_0002:Surf[0]
Roof	0.25	0.15	0.15	1L000000:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.26	1.3	0XMR0002:Surf[0]
Personnel doors	2.2	1.28	1.3	0GDS0000:Surf[0]
Vehicle access & similar large doors	1.5	1.5	1.5	0GDS0001:Surf[0]
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

Appendix B: 2 – BRUKL document extract (Be Clean)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

CCRDR

As designed

Date: Thu Jul 31 11:26:00 2014

Administrative information

Building Details

Address: Great Ormond Street, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.0.1

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.0.1

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

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name:

Telephone number:

Address: , ,

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

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	38.9
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	38.9
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	25.9
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	Are as built details the same as used in the BER calculations?	Separate submission

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

Values which do not meet standards in the 2013 Non-Domestic Building Services Compliance Guide are displayed in red.

2.a Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.15	0.15	0DMN0001:Surf[0]
Floor	0.25	0.17	0.35	1CL_0002:Surf[0]
Roof	0.25	0.15	0.15	1L000000:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.26	1.3	0XMR0002:Surf[0]
Personnel doors	2.2	1.28	1.3	0GDS0000:Surf[0]
Vehicle access & similar large doors	1.5	1.5	1.5	0GDS0001:Surf[0]
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

Appendix B: 3 – BRUKL document (Be Green – London Plan and Camden Planning Guidance Compliance)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

CCRDR

As designed

Date: Thu Jul 31 10:34:57 2014

Administrative information

Building Details

Address: Great Ormond Street, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.0.1

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.0.1

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

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name:

Telephone number:

Address: , ,

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

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	38.9
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	38.9
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	24.6
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	Are as built details the same as used in the BER calculations?	Separate submission

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

Values which do not meet standards in the 2013 Non-Domestic Building Services Compliance Guide are displayed in red.

2.a Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.15	0.15	0DMN0001:Surf[0]
Floor	0.25	0.17	0.35	1CL_0002:Surf[0]
Roof	0.25	0.15	0.15	1L000000:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.26	1.3	0XMR0002:Surf[0]
Personnel doors	2.2	1.28	1.3	0GDS0000:Surf[0]
Vehicle access & similar large doors	1.5	1.5	1.5	0GDS0001:Surf[0]
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

2.b Building services

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

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

1- LG, Ground and First Floor System: FCUs

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.97	3.72	0	1.4	0.7
Standard value	0.91*	2.55	N/A	1.6	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

2- Basement system: MV and Rads

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.97	-	0.2	0	0.5
Standard value	0.91*	N/A	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

3- 2nd and 3rd Floor System: Displacement Vent and Chilled Beams

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.97	3.72	0	1.4	0.7
Standard value	0.91*	2.7	N/A	1.6	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

4- GMP system: VAV

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.97	3.72	0	1.6	0.5
Standard value	0.91*	2.55	N/A	1.6	0.45
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

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

1- CHECK2-CHP

	CHPQA quality index	**CHP electrical efficiency**
This building	0	0.3
Standard value	Not provided	N/A

Local mechanical ventilation, exhaust, and terminal units

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

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
-1 CORE 4	-	-	-	1.4	-	-	-	1.4	-	-	N/A
-1 WC LOBBY	-	-	-	1.4	-	-	-	1.4	-	-	N/A
-1 WC1	-	-	-	0.3	-	-	-	-	-	-	N/A
-1 WC2	-	-	-	0.3	-	-	-	-	-	-	N/A
-1CENTRALCORRIDOR	-	-	-	1.4	-	-	-	1.4	-	-	N/A
-1STAIRS1	-	-	-	1.4	-	-	-	1.4	-	-	N/A
-1STAIRS2	-	-	-	1.4	-	-	-	1.4	-	-	N/A
-1STAIRS3	-	-	-	1.4	-	-	-	1.4	-	-	N/A
-1TISSUECULTUREGENERAL1	-	-	-	1.4	-	-	-	1.4	-	-	N/A
-1TISSUECULTUREGENERAL4	-	-	-	1.4	-	-	-	1.4	-	-	N/A
-2 CORE 2	-	-	-	0.4	-	-	-	-	-	-	N/A
-2 CORE2	-	-	-	0.4	-	-	-	-	-	-	N/A
-2 LAB	-	-	-	0.4	-	-	-	-	-	-	N/A
-2CORRIDOR	-	-	-	0.4	-	-	-	-	-	-	N/A
-2STAIRS1	-	-	-	0.4	-	-	-	-	-	-	N/A
-2STAIRS2	-	-	-	0.4	-	-	-	-	-	-	N/A
-2STAIRS3	-	-	-	0.4	-	-	-	-	-	-	N/A
0ADMINANDBASE	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0ADMINANDBASELOBBY	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0AWC	-	-	-	0.3	-	-	-	-	-	-	N/A
0BOTTLESTORE	-	-	-	0.4	-	-	-	-	-	-	N/A
0CENTRALATRIUMSPACE	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0CENTRALATRIUMSPACE	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0CHANGELOBBY	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0CL1	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0CL2	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0CLEANUTILITY	-	-	-	0.4	-	-	-	-	-	-	N/A
0CLINICALSUPPORT	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0EQSTORE	-	-	-	0.4	-	-	-	-	-	-	N/A
0EXAMROOM1	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0EXAMROOM2	-	-	-	1.4	-	-	-	1.4	-	-	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
0EXAMROOM3	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0EXAMROOM4	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0EXAMROOM5	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0EXAMROOM6	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0EXAMROOM7	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0FCHANGE	-	-	-	0.3	-	-	-	-	-	-	N/A
0FEEDANDCHANGE	-	-	-	0.3	-	-	-	-	-	-	N/A
0GMPGSTORE	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0GMPQSTORE	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0GMPSTORE	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0GOODSCORRIDOR	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0GOODSRECEIPT	-	-	-	0.4	-	-	-	-	-	-	N/A
0HANDW	-	-	-	0.3	-	-	-	-	-	-	N/A
0HANDW2	-	-	-	0.3	-	-	-	-	-	-	N/A
0HVSWITCH	-	-	-	0.4	-	-	-	-	-	-	N/A
0INTROOM1	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0KIOSK	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0LINEN	-	-	-	0.4	-	-	-	-	-	-	N/A
0MAINCORRIDOR	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0MAINWORKSHOP	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0MCHANGE	-	-	-	0.3	-	-	-	-	-	-	N/A
0OFFICEANDCOPY	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0OUTPATIENTSCOMMUNAL	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0QUIETWAITING	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0RECEPTIONOP	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0SEMINARROOM	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0SEMINARROOM	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0SLUICE	-	-	-	0.4	-	-	-	-	-	-	N/A
0STAFFFACILITIES	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0STAIRS1	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0STAIRS2	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0STAIRS3	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0STAIRS4	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0STORE	-	-	-	0.4	-	-	-	-	-	-	N/A
0STORE	-	-	-	0.4	-	-	-	-	-	-	N/A
0TISSUECULTURECAT3AUTOCLAVE	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0TREATMENT	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0TREATMENTCORRIDOR	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0VP	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0WC	-	-	-	0.3	-	-	-	-	-	-	N/A
0WCCHANGING	-	-	-	0.3	-	-	-	-	-	-	N/A
0WCCORRIDOR	-	-	-	1.4	-	-	-	1.4	-	-	N/A
0WCLOBBY	-	-	-	1.4	-	-	-	1.4	-	-	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
1AWC	-	-	-	0.3	-	-	-	-	-	-	N/A
1BULKSTORE	-	-	-	0.4	-	-	-	-	-	-	N/A
1CL1	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1CL2	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1CL3	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1CL4	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1CL5	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1CL6	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1CL7	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1CLCORRIDOR	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1CLEANUTILITY	-	-	-	0.4	-	-	-	-	-	-	N/A
1CLINICALSUPPORT	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1CLSUPPORT	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1DISPOSALHOLD	-	-	-	0.4	-	-	-	-	-	-	N/A
1EQSTORE	-	-	-	0.4	-	-	-	-	-	-	N/A
1EXAMROOM10	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1EXAMROOM11	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1EXAMROOM12	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1EXAMROOM13	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1EXAMROOM14	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1EXAMROOM15	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1EXAMROOM16	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1EXAMROOM17	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1EXAMROOM18	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1EXAMROOM19	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1EXAMROOM20	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1EXAMROOM21	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1EXAMROOM22	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1EXAMROOM23	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1EXAMROOM24	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1EXAMROOM9	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1HOTDESK1	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1HOTDESK2	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1HOTDESK3	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1INTROOM3	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1LINEN	-	-	-	0.4	-	-	-	-	-	-	N/A
1MEETINGROOM	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1MEETINGROOM1	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1MEETINGROOM2	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1MEETINGROOM3	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1MEETINGROOM4	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1MEETINGROOM5	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1OUTPATIENTSCOMMUNAL	-	-	-	1.4	-	-	-	1.4	-	-	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
1OUTPATIENTSCOMMUNAL	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1SAROOM2	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1STAFFOFFICE1	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1STAFFOFFICE2	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1STAFFOFFICE3	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1STAFFOFFICE4	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1STAFFOFFICE5	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1STAFFOFFICE6	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1STAFFOFFICE7	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1STAIRS2	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1STAIRS3	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1STAIRS4	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1STORE	-	-	-	0.4	-	-	-	-	-	-	N/A
1SUBWAITING1	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1SUBWAITING2	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1TREATMENT	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1WC	-	-	-	0.3	-	-	-	-	-	-	N/A
1WCCHANGING	-	-	-	0.3	-	-	-	-	-	-	N/A
1WCLOBBY	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1WORKSPACE	-	-	-	1.4	-	-	-	1.4	-	-	N/A
1WORKSPACE	-	-	-	1.4	-	-	-	1.4	-	-	N/A
4 CORE1	-	-	-	1.4	-	-	-	1.4	-	-	N/A
4 DNA EXTRACT ROOM	-	-	-	1.4	-	-	-	1.4	-	-	N/A
4 LOBBY	-	-	-	1.4	-	-	-	1.4	-	-	N/A
4 MASTER MIX	-	-	-	1.4	-	-	-	1.4	-	-	N/A
4 PCR	-	-	-	1.4	-	-	-	1.4	-	-	N/A
4CIRCULATION	-	-	-	1.4	-	-	-	1.4	-	-	N/A
4STAIRS2	-	-	-	1.4	-	-	-	1.4	-	-	N/A
4STAIRS3	-	-	-	1.4	-	-	-	1.4	-	-	N/A
5 CORE1	-	-	-	0.4	-	-	-	-	-	-	N/A
5 STAIRS 2	-	-	-	0.4	-	-	-	-	-	-	N/A
ATRIUM	-	-	-	1.4	-	-	-	1.4	-	-	N/A
GFRAISEDCIRCULATIONAREA	-	-	-	1.4	-	-	-	1.4	-	-	N/A
PLANT	-	-	-	0.4	-	-	-	-	-	-	N/A
STORX0036	-	-	-	0.4	-	-	-	-	-	-	N/A
X-1002 CENTRALATRIUMSPACE	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1004 LABORATORY A	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1006 CARDIOLOGY BENCH TESTING ROOM	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1006 CORRIDOR	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1006 CORRIDOR	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1008 CARDIOLOGY RAPID PROTOTYPING1	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1010 CARDIOLOGY RAPID PROTOTYPING2	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1012 CORE1	-	-	-	1.4	-	-	-	1.4	-	-	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
X-1014 LABORATORY B	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1016 GOWNING3	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1018 PCR	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1020 CTG	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1022 GENERALEQUIPMENT4	-	-	-	0.4	-	-	-	-	-	-	N/A
X-1024 CARDIOMORPHROOM	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1026 WC	-	-	-	0.3	-	-	-	-	-	-	N/A
X-1028 CARDIOMORPHLOBBY	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1032 GOWNING	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1034 TISSUE CULTURE GENERAL	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1036 STORE	-	-	-	0.4	-	-	-	-	-	-	N/A
X-1038	-	-	-	0.4	-	-	-	-	-	-	N/A
X-1040 LOBBY	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1042 TISSUE CULTURE GENERAL	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1044 GOWNING	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1046 GOWNING	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1048 TISSUE CULTURE GENERAL	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1052 TISSUE CULTURE STEM CELLS	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1054 GOWNING	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1056 TISSUE CULTURE GENERAL	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1060 TISSUE CULTURE STEM CELLS	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1062 GOWNING	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1064 TISSUECULTUREGENERAL2	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1066 GENERAL EQUIP 5	-	-	-	0.4	-	-	-	-	-	-	N/A
X-1070 TISSUE CULTURE STEM CELLS	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1082 AWC	-	-	-	0.3	-	-	-	-	-	-	N/A
X-1084 TISSUE CULTURE BANK	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1086 MICROSCOPE ROOM	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1088 GENERAL EQUIP 3	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1090 GOWNING1	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1092 GENERAL EQUIP 1	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1092 GENERAL EQUIP 2	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1094 AUTOCLAVE	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1100 GENERAL EQUIP 4	-	-	-	0.4	-	-	-	-	-	-	N/A
X-1102 FACS FACILITY	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1108 GOWNING	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1110 CARDIOLOGY NITINOL	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-1112 MICROCTSUITE	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X-2004 AWC	-	-	-	0.3	-	-	-	-	-	-	N/A
X-2006 PLANT 2	-	-	-	0.4	-	-	-	-	-	-	N/A
X-2008 GMP DISPOSAL HOLD	-	-	-	0.4	-	-	-	-	-	-	N/A
X-2010 CO2 GAS CYLINDER	-	-	-	0.4	-	-	-	-	-	-	N/A
X-2012 WASTE STORE	-	-	-	0.4	-	-	-	-	-	-	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
X-2014 SER	-	-	-	0.4	-	-	-	-	-	-	N/A
X-2016 TELECOM INTAKE	-	-	-	0.4	-	-	-	-	-	-	N/A
X-2018 GAS/WATER INTAKE	-	-	-	0.4	-	-	-	-	-	-	N/A
X-2020 PLANT	-	-	-	0.4	-	-	-	-	-	-	N/A
X-2022 LIQUID NITROGEN	-	-	-	0.4	-	-	-	-	-	-	N/A
X-2024 GMP GENERAL STORE	-	-	-	0.4	-	-	-	-	-	-	N/A
X-2026 GENERAL EQUIPMENT	-	-	-	0.4	-	-	-	-	-	-	N/A
X-2028 STORE	-	-	-	0.4	-	-	-	-	-	-	N/A
X-2030 GE STORE/FREEZERS	-	-	-	0.4	-	-	-	-	-	-	N/A
X-2032 RADIO-ISOTOPE LAB	-	-	-	0.4	-	-	-	-	-	-	N/A
X-2034 DARK ROOM	-	-	-	0.4	-	-	-	-	-	-	N/A
X-2036 ZEBRAFISH LAB	-	-	-	0.4	-	-	-	-	-	-	N/A
X2004 STORE	-	-	-	0.4	-	-	-	-	-	-	N/A
X2032 AWC2	-	-	-	0.3	-	-	-	-	-	-	N/A
X2034 WC4	-	-	-	0.3	-	-	-	-	-	-	N/A
X2036 WC4	-	-	-	0.3	-	-	-	-	-	-	N/A
X2038 WC3	-	-	-	0.3	-	-	-	-	-	-	N/A
X2086 WC1	-	-	-	0.3	-	-	-	-	-	-	N/A
X2088 WC2	-	-	-	0.3	-	-	-	-	-	-	N/A
X2090 AWC	-	-	-	0.3	-	-	-	-	-	-	N/A
X3004 STORE	-	-	-	0.4	-	-	-	-	-	-	N/A
X3036 STORE	-	-	-	0.4	-	-	-	-	-	-	N/A
X3046 WC4	-	-	-	0.3	-	-	-	-	-	-	N/A
X3048 WC4	-	-	-	0.3	-	-	-	-	-	-	N/A
X3050 WC3	-	-	-	0.3	-	-	-	-	-	-	N/A
X3054 AWC2	-	-	-	0.3	-	-	-	-	-	-	N/A
X3098 WC1	-	-	-	0.3	-	-	-	-	-	-	N/A
X3100 WC2	-	-	-	0.3	-	-	-	-	-	-	N/A
X3102 AWC	-	-	-	0.3	-	-	-	-	-	-	N/A
X4002 QUIET ROOM	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X4004 AWC	-	-	-	0.3	-	-	-	-	-	-	N/A
X4006 WC 2	-	-	-	0.3	-	-	-	-	-	-	N/A
X4008 WC 1	-	-	-	0.3	-	-	-	-	-	-	N/A
X4010 WC LOBBY	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X4012 DISPOSAL HOLD	-	-	-	0.4	-	-	-	-	-	-	N/A
X4018 LIQUID NITROGEN	-	-	-	0.4	-	-	-	-	-	-	N/A
X4020 GENERAL STORE	-	-	-	0.4	-	-	-	-	-	-	N/A
X4022 CHANGE	-	-	-	0.3	-	-	-	-	-	-	N/A
X4072 EQUIPMENT ROOM	-	-	-	0.4	-	-	-	-	-	-	N/A
X4076 CIRCULATION2	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X4078 SIMULATION/TRAINING LAB	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X4082 FLOW CYTOMERTRY LAB	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X4084 BEVERAGE BAY	-	-	-	0.4	-	-	-	-	-	-	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
X4086 SER	-	-	-	1.4	-	-	-	1.4	-	-	N/A
X4092 WRITE UP AREA	-	-	-	1.4	-	-	-	1.4	-	-	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	
-1 CORE 4	-	410	-	12
-1 WC LOBBY	-	239	-	16
-1 WC1	-	164	-	56
-1 WC2	-	164	-	56
-1CENTRALCORRIDOR	-	268	-	299
-1STAIRS1	-	195	-	55
-1STAIRS2	-	180	-	76
-1STAIRS3	-	216	-	46
-1TISSUECULTUREGENERAL1	87	-	-	214
-1TISSUECULTUREGENERAL4	94	-	-	280
-2 CORE 2	-	240	-	65
-2 CORE2	-	223	-	50
-2 LAB	101	-	-	201
-2CORRIDOR	-	216	-	274
-2STAIRS1	-	188	-	60
-2STAIRS2	-	178	-	76
-2STAIRS3	-	212	-	46
0ADMINANDBASE	136	-	-	75
0ADMINANDBASELOBBY	-	277	-	30
0AWC	-	149	-	54
0BOTTLESTORE	106	-	-	45
0CENTRALATRIUMSPACE	-	150	-	52
0CENTRALATRIUMSPACE	-	430	-	18
0CHANGELOBBY	-	363	-	11
0CL1	99	-	-	143
0CL2	98	-	-	150
0CLEANUTILITY	139	-	-	26
0CLINICALSUPPORT	152	-	-	54
0EQSTORE	115	-	-	37
0EXAMROOM1	103	-	-	130
0EXAMROOM2	101	-	-	132
0EXAMROOM3	102	-	-	140
0EXAMROOM4	102	-	-	140
0EXAMROOM5	102	-	-	140
0EXAMROOM6	102	-	-	140
0EXAMROOM7	102	-	-	141
0FCHANGE	-	79	-	91

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
0FEEDANDCHANGE	-	74	-	111
0GMPGSTORE	139	-	-	29
0GMPQSTORE	113	-	-	42
0GMPSTORE	107	-	-	51
0GOODSCORRIDOR	-	201	-	102
0GOODSRECEIPT	80	-	-	162
0HANDW	-	86	-	179
0HANDW2	-	85	-	181
0HVSWITCH	89	-	-	81
0INTROOM1	127	-	-	106
0KIOSK	110	-	-	121
0LINEN	-	410	-	40
0MAINCORRIDOR	-	250	-	91
0MAINWORKSHOP	96	-	-	145
0MCHANGE	-	83	-	86
0OFFICEANDCOPY	85	-	-	315
0OUTPATIENTSCOMMUNAL	-	147	-	349
0QUIETWAITING	-	212	22	157
0RECEPTIONOP	-	167	22	376
0SEMINARROOM	-	151	-	290
0SEMINARROOM	-	148	-	367
0SLUICE	173	-	-	19
0STAFFFACILITIES	80	-	-	430
0STAIRS1	-	243	-	28
0STAIRS2	-	189	-	53
0STAIRS3	-	196	-	54
0STAIRS4	-	199	-	43
0STORE	161	-	-	20
0STORE	184	-	-	17
0TISSUECULTURECAT3AUTOCLAVE	107	-	-	144
0TREATMENT	-	204	-	185
0TREATMENTCORRIDOR	-	214	-	47
0VP	112	-	-	138
0WC	-	104	-	116
0WCCHANGING	-	81	-	87
0WCCORRIDOR	-	214	-	56
0WCLOBBY	-	309	-	29
1AWC	-	159	-	54
1BULKSTORE	112	-	-	47
1CL1	101	-	-	169
1CL2	100	-	-	170
1CL3	100	-	-	170
1CL4	94	-	-	187

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
1CL5	101	-	-	170
1CL6	215	-	-	36
1CL7	86	-	-	279
1CLCORRIDOR	-	181	-	103
1CLEANUTILITY	171	-	-	21
1CLINICALSUPPORT	89	-	-	405
1CLSUPPORT	113	-	-	253
1DISPOSALHOLD	161	-	-	34
1EQSTORE	103	-	-	55
1EXAMROOM10	106	-	-	129
1EXAMROOM11	106	-	-	129
1EXAMROOM12	108	-	-	129
1EXAMROOM13	108	-	-	129
1EXAMROOM14	108	-	-	129
1EXAMROOM15	108	-	-	129
1EXAMROOM16	108	-	-	129
1EXAMROOM17	108	-	-	129
1EXAMROOM18	105	-	-	143
1EXAMROOM19	106	-	-	141
1EXAMROOM20	108	-	-	129
1EXAMROOM21	108	-	-	129
1EXAMROOM22	108	-	-	129
1EXAMROOM23	108	-	-	129
1EXAMROOM24	108	-	-	129
1EXAMROOM9	102	-	-	144
1HOTDESK1	71	-	-	1738
1HOTDESK2	98	-	-	287
1HOTDESK3	113	-	-	111
1INTROOM3	115	-	-	120
1LINEN	-	325	-	66
1MEETINGROOM	87	-	-	241
1MEETINGROOM1	99	-	-	142
1MEETINGROOM2	99	-	-	142
1MEETINGROOM3	99	-	-	142
1MEETINGROOM4	99	-	-	145
1MEETINGROOM5	95	-	-	158
1OUTPATIENTSCOMMUNAL	-	430	-	0
1OUTPATIENTSCOMMUNAL	-	153	-	361
1SAROOM2	141	-	-	81
1STAFFOFFICE1	95	-	-	207
1STAFFOFFICE2	121	-	-	107
1STAFFOFFICE3	121	-	-	107
1STAFFOFFICE4	121	-	-	107

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
1STAFFOFFICE5	121	-	-	107
1STAFFOFFICE6	121	-	-	107
1STAFFOFFICE7	119	-	-	111
1STAIRS2	-	195	-	53
1STAIRS3	-	227	-	62
1STAIRS4	-	206	-	43
1STORE	121	-	-	36
1SUBWAITING1	-	171	22	1268
1SUBWAITING2	-	154	22	1566
1TREATMENT	-	213	-	183
1WC	-	87	-	252
1WCCHANGING	-	84	-	87
1WCLOBBY	-	222	-	56
1WORKSPACE	73	-	-	938
1WORKSPACE	74	-	-	768
2 CIRCULATION2	-	217	-	45
2 CIRCULATION2	-	207	-	45
2 CORE1	-	168	-	62
2 WC LOBBY 1	-	299	-	16
2 WC LOBBY 2	-	322	-	13
2CELLOFFICE16	103	-	-	132
2CELLOFFICE17	104	-	-	131
2CELLOFFICE18	104	-	-	131
2CELLOFFICE19	104	-	-	131
2CELLOFFICE20	104	-	-	131
2CENTRALATRIUMSPACE	-	430	-	0
2CIRCULATION	-	171	-	65
2STAIRS2	-	176	-	53
2STAIRS3	-	196	-	51
3 CORE1	-	164	-	62
3 HOT DESK 2	70	-	-	477
3 WC LOBBY 1	-	280	-	16
3 WC LOBBY 2	-	301	-	13
3 WORKSPACE	73	-	-	503
3CENTRALATRIUMSPACE	-	430	-	0
3CIRCULATION1	-	166	-	65
3STAIRS2	-	171	-	53
3STAIRS3	-	188	-	51
4 CORE1	-	162	-	74
4 DNA EXTRACT ROOM	102	-	-	111
4 LOBBY	-	410	-	8
4 MASTER MIX	123	-	-	75
4 PCR	90	-	-	178

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
4CIRCULATION	-	208	-	70
4STAIRS2	-	160	-	69
4STAIRS3	-	179	-	46
5 CORE1	-	173	-	43
5 STAIRS 2	-	158	-	69
ATRIUM	-	141	-	214
GFRAISEDCIRCULATIONAREA	-	171	-	403
PLANT	67	-	-	1654
STORX0036	205	-	-	21
X-1002 CENTRALATRIUMSPACE	-	150	-	331
X-1004 LABORATORY A	71	-	-	6393
X-1006 CARDIOLOGY BENCH TESTING ROOM	107	-	-	196
X-1006 CORRIDOR	-	218	-	70
X-1006 CORRIDOR	-	294	-	20
X-1008 CARDIOLOGY RAPID PROTOTYPING1	97	-	-	290
X-1010 CARDIOLOGY RAPID PROTOTYPING2	125	-	-	129
X-1012 CORE1	-	241	-	78
X-1014 LABORATORY B	77	-	-	841
X-1016 GOWNING3	-	326	-	17
X-1018 PCR	160	-	-	72
X-1020 CTG	85	-	-	427
X-1022 GENERALEQUIPMENT4	126	-	-	45
X-1024 CARDIOMORPHROOM	84	-	-	460
X-1026 WC	-	125	-	101
X-1028 CARDIOMORPHLOBBY	202	-	-	60
X-1032 GOWNING	-	361	-	12
X-1034 TISSUE CULTURE GENERAL	77	-	-	464
X-1036 STORE	113	-	-	52
X-1038	205	-	-	9
X-1040 LOBBY	-	410	-	7
X-1042 TISSUE CULTURE GENERAL	88	-	-	449
X-1044 GOWNING	-	400	-	12
X-1046 GOWNING	-	273	-	12
X-1048 TISSUE CULTURE GENERAL	79	-	-	598
X-1052 TISSUE CULTURE STEM CELLS	90	-	-	320
X-1054 GOWNING	-	272	-	12
X-1056 TISSUE CULTURE GENERAL	76	-	-	480
X-1060 TISSUE CULTURE STEM CELLS	90	-	-	321
X-1062 GOWNING	-	400	-	12
X-1064 TISSUECULTUREGENERAL2	83	-	-	673
X-1066 GENERAL EQUIP 5	125	-	-	52
X-1070 TISSUE CULTURE STEM CELLS	88	-	-	270
X-1082 AWC	-	164	-	81

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
X-1084 TISSUE CULTURE BANK	99	-	-	241
X-1086 MICROSCOPE ROOM	88	-	-	351
X-1088 GENERAL EQUIP 3	163	-	-	70
X-1090 GOWNING1	-	268	-	24
X-1092 GENERAL EQUIP 1	125	-	-	118
X-1092 GENERAL EQUIP 2	125	-	-	118
X-1094 AUTOCLAVE	103	-	-	205
X-1100 GENERAL EQUIP 4	98	-	-	98
X-1102 FACS FACILITY	83	-	-	557
X-1108 GOWNING	-	271	-	23
X-1110 CARDIOLOGY NITINOL	102	-	-	252
X-1112 MICROCTSUITE	89	-	-	343
X-2004 AWC	-	149	-	82
X-2006 PLANT 2	72	-	-	396
X-2008 GMP DISPOSAL HOLD	101	-	-	68
X-2010 CO2 GAS CYLINDER	96	-	-	81
X-2012 WASTE STORE	77	-	-	280
X-2014 SER	112	-	-	145
X-2016 TELECOM INTAKE	122	-	-	42
X-2018 GAS/WATER INTAKE	96	-	-	82
X-2020 PLANT	67	-	-	5159
X-2022 LIQUID NITROGEN	93	-	-	86
X-2024 GMP GENERAL STORE	139	-	-	37
X-2026 GENERAL EQUIPMENT	83	-	-	141
X-2028 STORE	80	-	-	166
X-2030 GE STORE/FREEZERS	77	-	-	252
X-2032 RADIO-ISOTOPE LAB	105	-	-	183
X-2034 DARK ROOM	134	-	-	114
X-2036 ZEBRAFISH LAB	81	-	-	685
X2002 SEMINAR MEETING	-	180	-	196
X2004 STORE	189	-	-	14
X2006 HOT DESK	71	-	-	450
X2006 HOT DESK	69	-	-	234
X2008 WORKSPACE4	69	-	-	537
X2008 WORKSPACE4	72	-	-	733
X2010 SEMINAR MEETING	-	174	-	188
X2012 STAFFOFFICE9	104	-	-	118
X2014 STAFFOFFICE8	107	-	-	118
X2016 STAFFOFFICE7	103	-	-	118
X2018 STAFFOFFICE6	101	-	-	118
X2020 STAFFOFFICE5	99	-	-	119
X2022 STAFFOFFICE4	97	-	-	118
X2024 STAFFOFFICE3	97	-	-	118

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
X2026 STAFFOFFICE2	100	-	-	118
X2028 STAFFOFFICE1	107	-	-	118
X2030 COPY PRINT	136	-	-	40
X2032 AWC2	-	116	-	71
X2034 WC4	-	164	-	37
X2036 WC4	-	164	-	36
X2038 WC3	-	164	-	37
X2040 SER	107	-	-	100
X2044 COFFEE SHOP BOH	131	-	-	70
X2046 COFFEE SHOP	70	-	-	602
X2048 ENTRANCE ZONE HOT DESKS	70	-	-	988
X2050 INTERVIEW	88	-	-	192
X2052 CELLOFFICE3	120	-	-	87
X2054 CELLOFFICE2	119	-	-	87
X2056 CELLOFFICE1	112	-	-	101
X2058 WORKSPACE1	74	-	-	627
X2058 WORKSPACE1	75	-	-	509
X2060 CELLOFFICE6	108	-	-	113
X2062 CELLOFFICE5	109	-	-	110
X2064 CELLOFFICE4	108	-	-	111
X2066 CELLOFFICE7	108	-	-	111
X2068 CELLOFFICE8	109	-	-	110
X2070 CELLOFFICE9	108	-	-	113
X2072 WORKSPACE2	73	-	-	813
X2072 WORKSPACE2	72	-	-	296
X2072 WORKSPACE2	70	-	-	798
X2072 WORKSPACE3	70	-	-	889
X2072 WORKSPACE3	75	-	-	701
X2074 CELLOFFICE12	108	-	-	113
X2076 CELLOFFICE11	109	-	-	110
X2078 CELLOFFICE10	108	-	-	111
X2080 CELLOFFICE13	108	-	-	111
X2082 CELLOFFICE14	109	-	-	110
X2084 CELLOFFICE15	108	-	-	113
X2086 WC1	-	164	-	26
X2088 WC2	-	164	-	27
X2090 AWC	-	145	-	50
X3002 SEMINAR MEETING	-	175	-	196
X3004 STORE	175	-	-	14
X3006 HOT DESK	71	-	-	450
X3006 HOT DESK	69	-	-	234
X3008 CELLOFFICE16	99	-	-	132
X3010 CELLOFFICE17	100	-	-	131

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
X3012 CELLOFFICE18	100	-	-	131
X3014 WORKSPACE4	72	-	-	733
X3014 WORKSPACE4	70	-	-	663
X3016 SEMINAR MEETING	-	170	-	188
X3018 STAFFOFFICE9	100	-	-	118
X3020 STAFFOFFICE8	103	-	-	118
X3022 STAFFOFFICE7	99	-	-	118
X3024 STAFFOFFICE6	98	-	-	118
X3026 STAFFOFFICE5	95	-	-	119
X3028 STAFFOFFICE4	94	-	-	118
X3030 STAFFOFFICE3	94	-	-	118
X3032 STAFFOFFICE2	97	-	-	118
X3034 STAFFOFFICE1	102	-	-	118
X3036 STORE	118	-	-	31
X3042 COPY PRINT	128	-	-	40
X3046 WC4	-	164	-	37
X3048 WC4	-	164	-	36
X3050 WC3	-	164	-	37
X3052 SER	103	-	-	100
X3054 AWC2	-	109	-	71
X3062 INTERVIEW	85	-	-	192
X3064 CELLOFFICE3	114	-	-	87
X3066 CELLOFFICE2	114	-	-	87
X3068 CELLOFFICE1	107	-	-	101
X3070 WORKSPACE1	73	-	-	627
X3070 WORKSPACE1	73	-	-	509
X3072 CELLOFFICE6	103	-	-	113
X3074 CELLOFFICE5	104	-	-	110
X3076 CELLOFFICE4	104	-	-	111
X3078 CELLOFFICE7	104	-	-	111
X3080 CELLOFFICE8	104	-	-	110
X3082 CELLOFFICE9	103	-	-	113
X3084 WORKSPACE2	72	-	-	813
X3084 WORKSPACE2	70	-	-	798
X3084 WORKSPACE2	71	-	-	296
X3086 CELLOFFICE12	103	-	-	113
X3088 CELLOFFICE11	104	-	-	110
X3090 CELLOFFICE10	104	-	-	111
X3092 CELLOFFICE13	104	-	-	111
X3094 CELLOFFICE14	104	-	-	110
X3096 CELLOFFICE15	103	-	-	113
X3098 WC1	-	164	-	26
X3100 WC2	-	164	-	27

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
X3102 AWC	-	135	-	50
X3104 CELLOFFICE19	100	-	-	131
X3106 CELLOFFICE20	100	-	-	131
X3114 WORKSPACE3	74	-	-	701
X3114 WORKSPACE3	70	-	-	889
X4002 QUIET ROOM	-	199	22	150
X4004 AWC	-	97	-	83
X4006 WC 2	-	164	-	27
X4008 WC 1	-	164	-	27
X4010 WC LOBBY	-	295	-	13
X4012 DISPOSAL HOLD	144	-	-	17
X4014 AUTOCLAVE	110	-	-	81
X4018 LIQUID NITROGEN	97	-	-	53
X4020 GENERAL STORE	97	-	-	53
X4022 CHANGE	-	65	-	151
X4024 AIRLOCK8	-	353	-	84
X4026 CR8B	-	400	-	71
X4028 CR8	-	203	-	283
X4030 AIRLOCK7	-	353	-	84
X4032 CR7B	-	400	-	71
X4034 CR7	-	203	-	283
X4036 AIRLOCK6	-	374	-	78
X4038 CR6B	-	403	-	70
X4040 CR6	-	206	-	270
X4042 AIRLOCK5	-	264	-	149
X4044 CR5B	-	387	-	74
X4046 CR5	-	183	-	406
X4048 AIRLOCK4	-	262	-	151
X4050 CR4B	-	399	-	71
X4052 CR4	-	183	-	407
X4054 AIRLOCK3	-	377	-	77
X4056 CR3B	-	399	-	71
X4058 CR3	-	206	-	270
X4060 AIRLOCK2	-	374	-	77
X4062 CR2B	-	403	-	70
X4064 CR2	-	206	-	270
X4066 AIRLOCK1	-	373	-	78
X4068 CR1B	-	402	-	70
X4070 CR1	-	206	-	271
X4072 CIRCULATION 4	-	227	-	135
X4072 EQUIPMENT ROOM	89	-	-	66
X4074 CIRCULATION 3	-	299	-	13
X4076 CIRCULATION2	-	209	-	16

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
X4078 SIMULATION/TRAINING LAB	81	-	-	310
X4082 FLOW CYTOMERTRY LAB	84	-	-	252
X4084 BEVERAGE BAY	113	-	-	31
X4086 SER	102	-	-	98
X4092 WRITE UP AREA	74	-	-	1396

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

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
-1 CORE 4	N/A	N/A
-1 WC LOBBY	N/A	N/A
-1CENTRALCORRIDOR	N/A	N/A
-1STAIRS1	N/A	N/A
-1STAIRS2	N/A	N/A
-1STAIRS3	N/A	N/A
-1TISSUECULTUREGENERAL1	N/A	N/A
-1TISSUECULTUREGENERAL4	N/A	N/A
-2 LAB	N/A	N/A
0ADMINANDBASE	N/A	N/A
0ADMINANDBASELOBBY	N/A	N/A
0CENTRALATRIUMSPACE	NO (-91.4%)	NO
0CENTRALATRIUMSPACE	NO (-47.7%)	NO
0CHANGELOBBY	N/A	N/A
0CL1	N/A	N/A
0CL2	N/A	N/A
0CLINICALSUPPORT	N/A	N/A
0EXAMROOM1	N/A	N/A
0EXAMROOM2	N/A	N/A
0EXAMROOM3	NO (-47.8%)	NO
0EXAMROOM4	NO (-47.7%)	NO
0EXAMROOM5	NO (-47.8%)	NO
0EXAMROOM6	NO (-47.8%)	NO
0EXAMROOM7	NO (-48%)	NO
0GMPGSTORE	N/A	N/A
0GMPQSTORE	N/A	N/A
0GMPSTORE	N/A	N/A
0GOODSCORRIDOR	NO (-29.3%)	NO
0INTROOM1	NO (-47.5%)	NO
0KIOSK	N/A	N/A
0MAINCORRIDOR	N/A	N/A
0MAINWORKSHOP	N/A	N/A
0OFFICEANDCOPY	N/A	N/A
0OUTPATIENTSCOMMUNAL	NO (-0.8%)	NO
0QUIETWAITING	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
0RECEPTIONOP	N/A	N/A
0SEMINARROOM	NO (-62.5%)	NO
0SEMINARROOM	YES (+3.5%)	NO
0STAFFFACILITIES	NO (-97.2%)	NO
0STAIRS1	NO (-47.1%)	NO
0STAIRS2	NO (-82.6%)	NO
0STAIRS3	N/A	N/A
0STAIRS4	NO (-64.1%)	NO
0TISSUECULTURECAT3AUTOCLAVE	N/A	N/A
0TREATMENT	N/A	N/A
0TREATMENTCORRIDOR	N/A	N/A
0VP	N/A	N/A
0WCCORRIDOR	N/A	N/A
0WCLOBBY	N/A	N/A
1CL1	N/A	N/A
1CL2	N/A	N/A
1CL3	N/A	N/A
1CL4	NO (-69.9%)	NO
1CL5	YES (+18.1%)	NO
1CL6	N/A	N/A
1CL7	N/A	N/A
1CLCORRIDOR	N/A	N/A
1CLINICALSUPPORT	N/A	N/A
1CLSUPPORT	N/A	N/A
1EXAMROOM10	N/A	N/A
1EXAMROOM11	N/A	N/A
1EXAMROOM12	N/A	N/A
1EXAMROOM13	N/A	N/A
1EXAMROOM14	N/A	N/A
1EXAMROOM15	N/A	N/A
1EXAMROOM16	N/A	N/A
1EXAMROOM17	N/A	N/A
1EXAMROOM18	N/A	N/A
1EXAMROOM19	N/A	N/A
1EXAMROOM20	N/A	N/A
1EXAMROOM21	N/A	N/A
1EXAMROOM22	N/A	N/A
1EXAMROOM23	N/A	N/A
1EXAMROOM24	N/A	N/A
1EXAMROOM9	YES (+15.4%)	NO
1HOTDESK1	NO (-95.1%)	NO
1HOTDESK2	N/A	N/A
1HOTDESK3	NO (-43.9%)	NO
1INTROOM3	N/A	N/A
1MEETINGROOM	NO (-41.5%)	NO
1MEETINGROOM1	N/A	N/A
1MEETINGROOM2	N/A	N/A
1MEETINGROOM3	N/A	N/A
1MEETINGROOM4	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
1MEETINGROOM5	NO (-58.8%)	NO
1OUTPATIENTSCOMMUNAL	NO (-92.5%)	NO
1OUTPATIENTSCOMMUNAL	NO (-75.7%)	NO
1SAROOM2	N/A	N/A
1STAFFOFFICE1	NO (-65.4%)	NO
1STAFFOFFICE2	NO (-46.6%)	NO
1STAFFOFFICE3	NO (-45.7%)	NO
1STAFFOFFICE4	NO (-45%)	NO
1STAFFOFFICE5	NO (-44.3%)	NO
1STAFFOFFICE6	NO (-43.6%)	NO
1STAFFOFFICE7	NO (-44.6%)	NO
1STAIRS2	N/A	N/A
1STAIRS3	N/A	N/A
1STAIRS4	NO (-99.8%)	NO
1SUBWAITING1	NO (-18%)	NO
1SUBWAITING2	NO (-30.4%)	NO
1TREATMENT	N/A	N/A
1WCLOBBY	N/A	N/A
1WORKSPACE	NO (-48.6%)	NO
1WORKSPACE	NO (-79.4%)	NO
2 CIRCULATION2	NO (-95.1%)	NO
2 CIRCULATION2	NO (-95.3%)	NO
2 CORE1	N/A	N/A
2 WC LOBBY 1	N/A	N/A
2 WC LOBBY 2	N/A	N/A
2CELLOFFICE16	NO (-46.2%)	NO
2CELLOFFICE17	NO (-45.7%)	NO
2CELLOFFICE18	NO (-45.7%)	NO
2CELLOFFICE19	NO (-45.7%)	NO
2CELLOFFICE20	NO (-45.7%)	NO
2CENTRALATRIUMSPACE	NO (-94%)	NO
2CIRCULATION	NO (-67.8%)	NO
2STAIRS2	N/A	N/A
2STAIRS3	NO (-99%)	NO
3 CORE1	N/A	N/A
3 HOT DESK 2	NO (-46.2%)	NO
3 WC LOBBY 1	N/A	N/A
3 WC LOBBY 2	N/A	N/A
3 WORKSPACE	NO (-44.2%)	NO
3CENTRALATRIUMSPACE	NO (-70.2%)	NO
3CIRCULATION1	NO (-59.7%)	NO
3STAIRS2	N/A	N/A
3STAIRS3	NO (-97.9%)	NO
4 CORE1	N/A	N/A
4 DNA EXTRACT ROOM	N/A	N/A
4 LOBBY	N/A	N/A
4 MASTER MIX	N/A	N/A
4 PCR	N/A	N/A
4CIRCULATION	NO (-86.1%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
4STAIRS2	N/A	N/A
4STAIRS3	N/A	N/A
ATRIUM	NO (-86.7%)	NO
GFRAISEDCIRCULATIONAREA	NO (-44.4%)	NO
X-1002 CENTRALATRIUMSPACE	NO (-96.9%)	NO
X-1004 LABORATORY A	NO (-76.3%)	NO
X-1006 CARDIOLOGY BENCH TESTING ROOM	N/A	N/A
X-1006 CORRIDOR	N/A	N/A
X-1006 CORRIDOR	N/A	N/A
X-1008 CARDIOLOGY RAPID PROTOTYPING1	N/A	N/A
X-1010 CARDIOLOGY RAPID PROTOTYPING2	N/A	N/A
X-1012 CORE1	N/A	N/A
X-1014 LABORATORY B	N/A	N/A
X-1016 GOWNING3	N/A	N/A
X-1018 PCR	N/A	N/A
X-1020 CTG	N/A	N/A
X-1024 CARDIOMORPHROOM	N/A	N/A
X-1028 CARDIOMORPHLOBBY	N/A	N/A
X-1032 GOWNING	N/A	N/A
X-1034 TISSUE CULTURE GENERAL	N/A	N/A
X-1040 LOBBY	N/A	N/A
X-1042 TISSUE CULTURE GENERAL	N/A	N/A
X-1044 GOWNING	N/A	N/A
X-1046 GOWNING	N/A	N/A
X-1048 TISSUE CULTURE GENERAL	N/A	N/A
X-1052 TISSUE CULTURE STEM CELLS	N/A	N/A
X-1054 GOWNING	N/A	N/A
X-1056 TISSUE CULTURE GENERAL	N/A	N/A
X-1060 TISSUE CULTURE STEM CELLS	N/A	N/A
X-1062 GOWNING	N/A	N/A
X-1064 TISSUECULTUREGENERAL2	N/A	N/A
X-1070 TISSUE CULTURE STEM CELLS	N/A	N/A
X-1084 TISSUE CULTURE BANK	N/A	N/A
X-1086 MICROSCOPE ROOM	N/A	N/A
X-1088 GENERAL EQUIP 3	N/A	N/A
X-1090 GOWNING1	N/A	N/A
X-1092 GENERAL EQUIP 1	N/A	N/A
X-1092 GENERAL EQUIP 2	N/A	N/A
X-1094 AUTOCLAVE	N/A	N/A
X-1102 FACS FACILITY	N/A	N/A
X-1108 GOWNING	N/A	N/A
X-1110 CARDIOLOGY NITINOL	N/A	N/A
X-1112 MICROCTSUITE	NO (-95.2%)	NO
X-2014 SER	N/A	N/A
X-2032 RADIO-ISOTOPE LAB	N/A	N/A
X-2034 DARK ROOM	N/A	N/A
X-2036 ZEBRAFISH LAB	N/A	N/A
X2002 SEMINAR MEETING	NO (-55.6%)	NO
X2006 HOT DESK	NO (-95.1%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
X2006 HOT DESK	NO (-86.1%)	NO
X2008 WORKSPACE4	NO (-93.5%)	NO
X2008 WORKSPACE4	NO (-94%)	NO
X2010 SEMINAR MEETING	NO (-51.8%)	NO
X2012 STAFFOFFICE9	NO (-39.7%)	NO
X2014 STAFFOFFICE8	NO (-39.5%)	NO
X2016 STAFFOFFICE7	NO (-39.5%)	NO
X2018 STAFFOFFICE6	NO (-39.4%)	NO
X2020 STAFFOFFICE5	NO (-39.7%)	NO
X2022 STAFFOFFICE4	NO (-39.7%)	NO
X2024 STAFFOFFICE3	NO (-39.7%)	NO
X2026 STAFFOFFICE2	NO (-39.6%)	NO
X2028 STAFFOFFICE1	NO (-39.4%)	NO
X2030 COPY PRINT	NO (-97.2%)	NO
X2040 SER	N/A	N/A
X2044 COFFEE SHOP BOH	NO (-10.4%)	NO
X2046 COFFEE SHOP	NO (-42.2%)	NO
X2048 ENTRANCE ZONE HOT DESKS	YES (+10.6%)	NO
X2050 INTERVIEW	NO (-21.4%)	NO
X2052 CELLOFFICE3	YES (+18%)	NO
X2054 CELLOFFICE2	YES (+16%)	NO
X2056 CELLOFFICE1	NO (-6.7%)	NO
X2058 WORKSPACE1	NO (-32.6%)	NO
X2058 WORKSPACE1	NO (-80.4%)	NO
X2060 CELLOFFICE6	N/A	N/A
X2062 CELLOFFICE5	N/A	N/A
X2064 CELLOFFICE4	N/A	N/A
X2066 CELLOFFICE7	N/A	N/A
X2068 CELLOFFICE8	N/A	N/A
X2070 CELLOFFICE9	N/A	N/A
X2072 WORKSPACE2	NO (-35.3%)	NO
X2072 WORKSPACE2	YES (+7.3%)	NO
X2072 WORKSPACE2	NO (-77.3%)	NO
X2072 WORKSPACE3	NO (-69%)	NO
X2072 WORKSPACE3	NO (-33.6%)	NO
X2074 CELLOFFICE12	N/A	N/A
X2076 CELLOFFICE11	N/A	N/A
X2078 CELLOFFICE10	N/A	N/A
X2080 CELLOFFICE13	N/A	N/A
X2082 CELLOFFICE14	N/A	N/A
X2084 CELLOFFICE15	N/A	N/A
X3002 SEMINAR MEETING	NO (-59.4%)	NO
X3006 HOT DESK	NO (-93.9%)	NO
X3006 HOT DESK	NO (-79.4%)	NO
X3008 CELLOFFICE16	NO (-46.6%)	NO
X3010 CELLOFFICE17	NO (-46.1%)	NO
X3012 CELLOFFICE18	NO (-46.1%)	NO
X3014 WORKSPACE4	NO (-88.8%)	NO
X3014 WORKSPACE4	NO (-83.9%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
X3016 SEMINAR MEETING	NO (-52.4%)	NO
X3018 STAFFOFFICE9	NO (-40.8%)	NO
X3020 STAFFOFFICE8	NO (-40.5%)	NO
X3022 STAFFOFFICE7	NO (-40.6%)	NO
X3024 STAFFOFFICE6	NO (-40.5%)	NO
X3026 STAFFOFFICE5	NO (-40.7%)	NO
X3028 STAFFOFFICE4	NO (-40.7%)	NO
X3030 STAFFOFFICE3	NO (-40.7%)	NO
X3032 STAFFOFFICE2	NO (-40.7%)	NO
X3034 STAFFOFFICE1	NO (-40.5%)	NO
X3042 COPY PRINT	NO (-96.8%)	NO
X3052 SER	N/A	N/A
X3062 INTERVIEW	NO (-29.6%)	NO
X3064 CELLOFFICE3	NO (-1.6%)	NO
X3066 CELLOFFICE2	NO (-2.1%)	NO
X3068 CELLOFFICE1	NO (-21.7%)	NO
X3070 WORKSPACE1	NO (-45.8%)	NO
X3070 WORKSPACE1	NO (-80.6%)	NO
X3072 CELLOFFICE6	N/A	N/A
X3074 CELLOFFICE5	N/A	N/A
X3076 CELLOFFICE4	N/A	N/A
X3078 CELLOFFICE7	N/A	N/A
X3080 CELLOFFICE8	N/A	N/A
X3082 CELLOFFICE9	N/A	N/A
X3084 WORKSPACE2	NO (-45.9%)	NO
X3084 WORKSPACE2	NO (-82.1%)	NO
X3084 WORKSPACE2	NO (-3.9%)	NO
X3086 CELLOFFICE12	N/A	N/A
X3088 CELLOFFICE11	N/A	N/A
X3090 CELLOFFICE10	N/A	N/A
X3092 CELLOFFICE13	N/A	N/A
X3094 CELLOFFICE14	N/A	N/A
X3096 CELLOFFICE15	N/A	N/A
X3104 CELLOFFICE19	NO (-46.1%)	NO
X3106 CELLOFFICE20	NO (-46.1%)	NO
X3114 WORKSPACE3	NO (-44.1%)	NO
X3114 WORKSPACE3	NO (-73.2%)	NO
X4002 QUIET ROOM	NO (-43.7%)	NO
X4010 WC LOBBY	N/A	N/A
X4014 AUTOCLAVE	N/A	N/A
X4024 AIRLOCK8	N/A	N/A
X4026 CR8B	N/A	N/A
X4028 CR8	N/A	N/A
X4030 AIRLOCK7	N/A	N/A
X4032 CR7B	N/A	N/A
X4034 CR7	N/A	N/A
X4036 AIRLOCK6	N/A	N/A
X4038 CR6B	N/A	N/A
X4040 CR6	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
X4042 AIRLOCK5	N/A	N/A
X4044 CR5B	N/A	N/A
X4046 CR5	N/A	N/A
X4048 AIRLOCK4	N/A	N/A
X4050 CR4B	N/A	N/A
X4052 CR4	N/A	N/A
X4054 AIRLOCK3	N/A	N/A
X4056 CR3B	N/A	N/A
X4058 CR3	N/A	N/A
X4060 AIRLOCK2	N/A	N/A
X4062 CR2B	N/A	N/A
X4064 CR2	N/A	N/A
X4066 AIRLOCK1	N/A	N/A
X4068 CR1B	N/A	N/A
X4070 CR1	N/A	N/A
X4072 CIRCULATION 4	NO (-90.2%)	NO
X4074 CIRCULATION 3	YES (+31.4%)	NO
X4076 CIRCULATION2	N/A	N/A
X4078 SIMULATION/TRAINING LAB	N/A	N/A
X4082 FLOW CYTOMERTRY LAB	NO (-44.9%)	NO
X4086 SER	N/A	N/A
X4092 WRITE UP AREA	NO (-15.2%)	NO

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	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 [m^2]	13364.1	13364.1
External area [m^2]	12245.1	12245.1
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	3
Average conductance [W/K]	3899.27	4689.84
Average U-value [W/m^2K]	0.32	0.38
Alpha value* [%]	10.11	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
11	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
89	**C2 Residential Inst.: Hospitals and Care Homes**
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	6.09	5.41
Cooling	2.98	8.28
Auxiliary	26.26	33.4
Lighting	20.39	31.46
Hot water	6.72	3.51
Equipment*	145.13	145.13
TOTAL**	**58.58**	**82.06**

* 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	2.52	0
Wind turbines	0	0
CHP generators	3.85	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	94.19	101.51
Primary energy* [kWh/m^2]	152.35	229.81
Total emissions [kg/m^2]	24.6	38.9

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

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	11.3	0	0.3	0	1.6	0.91	0	0.97	0
	Notional	14.3	0	4.6	0	3.7	0.86	0	----	----
[ST] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	11.1	104.2	0.5	4	39.1	0.89	7.23	0.97	5.43
	Notional	15.3	102.7	4.9	10	44.8	0.86	2.84	----	----
[ST] Chilled ceilings or passive chilled beams and displacement ventilation, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Elect										
	Actual	18	115	1.2	3.8	16.7	0.87	8.31	0.97	5.43
	Notional	21.3	131.4	6.9	12.8	32.4	0.86	2.84	----	----
[ST] Single-duct VAV, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	34.3	234.7	2.5	10	200.9	0.85	6.53	0.97	5.43
	Notional	28.1	252.6	9	24.7	203.5	0.86	2.84	----	----

Key to terms

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

Key Features

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

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.15	0XMR0002:Surf[3]
Floor	0.2	0.17	2C00000E:Surf[0]
Roof	0.15	0.15	1L000000:Surf[0]
Windows, roof windows, and rooflights	1.5	0.85	RF000011:Surf[2]
Personnel doors	1.5	1	4WC_0000:Surf[1]
Vehicle access & similar large doors	1.5	1.5	0GDS0001:Surf[0]
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

6 Appendix C List

1 – BREEAM 2014 Ene01 Compliance Checker

ENERGY

Ene 01 Reduction of energy use and carbon emissions

No. of BREEAM credits available	12	Available contribution to overall score	7.20%
No. of BREEAM innovation credits available	5	Minimum standards applicable	Yes

Ene 01 Calculator

Country of the UK where the building is located	England	Confirm building regulation and version used:	England Part L2A 2013

New Construction (Fully fitted)

Building floor area	13364	m2
Notional building heating and cooling energy demand	101.51	MJ/m2yr
Actual building heating and cooling energy demand	94.19	MJ/m2yr
Notional building primary energy consumption	229.81	kWh/m2yr
Actual building primary energy consumption	152.35	kWh/m2yr
Target emission rate (TER)	38.90	kgCO2/m2yr
Building emission rate (BER)	24.60	kgCO2/m2yr
Building emission rate improvement over TER	36.76%	
Heating & cooling demand energy performance ratio (EPR_{ED})	0.1333	
Primary consumption energy performance ratio (EPR_{PC})	0.3365	
CO_2 Energy performance ratio (EPR_{CO2})	0.3322	
Overall building energy performance ratio (EPR_{NC})	0.8020	

Equivalent % of the building's 'regulated' energy consumption generated by carbon neutral sources and used to meet energy demand from 'unregulated' building systems or processes?	
Is the building designed to be 'carbon negative' ?	
If the building is defined as 'carbon negative' what is the total (modelled) renewable/carbon neutral energy generated and exported	

Total BREEAM credits achieved	10
Total contribution to overall building score	6.00%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	Outstanding level

Assessor comments/notes: