University College London Hospitals NHS
NHS Foundation Trust

Demolition of the existing buildings and redevelopment for a building of 6 storeys in height including ground and 3 storeys basement, for use a specialist head and neck facility (Class D1)

Former University College London (UCL) Student Union and Royal Ear Hospital, Huntley Street, Bloomsbury

Energy Strategy

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University College London Hospitals NHS Trust

UCLH New Development

Energy Strategy

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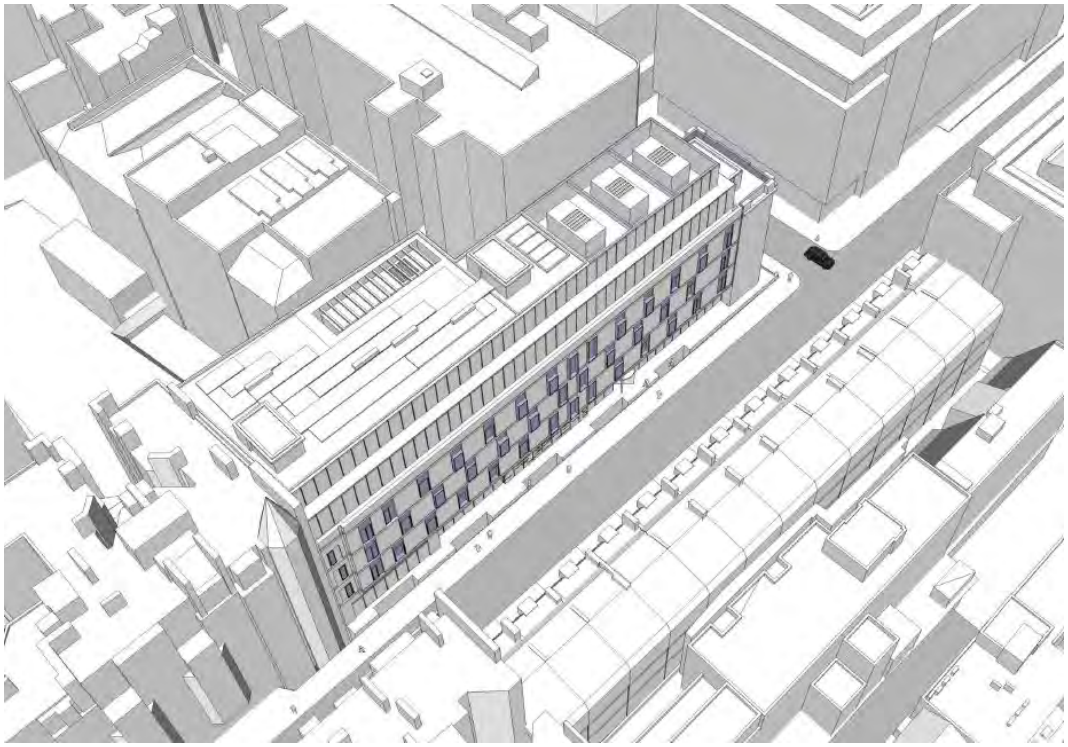
1 Introduction

The report is produced as part of planning and BREEAM requirements to identify and quantify the technical and commercial opportunities for Low and Zero Carbon (LZC) Technologies for the University College London Hospital new development - 'Demolition of the existing buildings and redevelopment for a building of 6 storeys in height including ground and 3 storeys basement, for use a specialist head and neck facility (Class D1)'. The site is located on the corner of Huntley Street and Capper Street.



The development originated from the proposal from UCLH to house both the Eastman Dental Hospital (EDH) clinical services and the Royal National Throat Nose & Ear (RNTNE) Hospital on the UCL Student Union/Royal Ear Hospital site on Huntley Street. The combined vision of this facility is that UCLH could achieve significant operational and clinical efficiencies to deliver interdisciplinary medical services on this site.

It is currently assumed that the following services will be co-located in the new development hospital building:

- EDH ambulatory services
- RNTNE ambulatory services

This report provides results of modelling undertaken and assessment of the feasibility of Low and Zero Carbon Technologies which could be used and their relative benefits.

The report sets out how the site layout, building design and active and passive measures have been chosen to minimise the CO_2 emissions.

The report also assesses the relevant planning and statutory regulations that apply to this facility. The targets that have been set for the new UCLH facility are as follows:

- Compliance with Part-L 2013 at As-Designed Stage
- Target compliance with Part-L 2013 at Post-Construction Stage
- BREEAM 2014 New Construction 'Excellent' – 5 credits under ENE01 and 1 credit under ENE02
- London Plan – 35% improvement over Part-L 2013 target

The Energy Assessment undertaken demonstrates that whilst the facility can achieve UK Building Regulation Part-L 2013 compliance and obtain the minimum requirements to reach BREEAM 2014 New Construction 'Excellent' rating, it is considered that achieving the full 35% improvement factor over Part-L 2013 is not feasible for this facility. As the building has a low base heat load, is located in central London with limitations on renewables and has a highly clinical need, there is very limited opportunity to improve on the measures proposed herein:

- **Passive Measures** – High Performance Building Fabric, Low emissivity glazing etc.
- **Low Energy Design** – Low Energy Lighting, Low Fan & Pumping Powers, Low Energy Ventilation, High Efficiency Heat Recovery on Ventilation Systems
- **Low Carbon Design** – Combined Heat & Power System, Connection to a Local District Heating
- **Renewables** – Photovoltaic Panels

The Energy Strategy Plan has concluded that alternative technologies such as wind power, biomass or ground source heat pumps are not the best solutions for this project and have been ruled out.

The challenge is to continue to develop a fully sustainable building that in no way hinders the healthcare endeavours within.

The report shows that with these key design features, the project should achieve:

Compliance with Part L 2013	✓
BREEAM New Construction 2014 – Excellent	✓
London Plan 35% Carbon Reduction Target	X 15.6%

2 Context

The energy performance and carbon dioxide emission for the development is considered against national, regional and local planning guidance.

2.1 National Policy

Under the Kyoto Protocol, the UK aims to reduce a basket of greenhouse gases to 12.5% below 1990 levels by 2008-2012.

This reduction may be achieved through a combination of strategies including reducing the need to use energy, using it more efficiently and increasing the proportion of energy from renewable sources.

The Energy White Paper 2007 sets out the Government's aspiration to supply 20% of its electricity from renewables by 2020 and put the UK on a path to delivering carbon dioxide reductions of around 60% by 2050.

The Climate Change Bill passed into law in November 2008 puts in place a framework to achieve a mandatory 80% cut in the UK's carbon emissions by 2050 (compared to 1990 levels), with an intermediate target of between 26% and 32% by 2020.

In summary, the government's proposed policy involves 5 components:

1) Establishing an international framework to tackle climate change, including the stabilisation of atmospheric greenhouse gas concentrations and a stronger European Union Emissions Trading Scheme (EU ETS).

2) Providing legally binding carbon targets for the whole UK economy, reducing emissions through the implementation of the Climate Change Bill.

3) Making further progress in achieving fully competitive and transparent international markets, including further liberalisation of the European Union energy market.

4) Encouraging more energy saving through better information, incentives and regulation.

5) Providing more support for low carbon technologies, including increased international and domestic public-private sector collaboration in the areas of research, development, demonstration and deployment – for example though the launch of the Energy Technologies Institute and the Environmental Transformation Fund.

The development of renewable energy resources on a commercial scale is a crucial element in meeting the UK Government's commitments on reducing emissions and combating climate change.

Given current renewable electricity production rates are around 3%, the scale of the challenge is clear. A 'step change' will be required if the targets are to be met, and this has been recognised by the Government in preparing:

Planning Policy Statement 22: Renewable Energy (PPS22)

The successful introduction of renewables in all parts of England will involve the installation of different kinds of schemes in different contexts, from rural areas to densely populated areas, market towns to suburban streets. Every local authority has something to offer in terms of renewable resources, and opportunities to contribute to meeting the targets and reducing overall demand for energy.

This document produced by the UK Government sets out the government's policies for renewable energy, which planning authorities should have regard to when preparing local development documents and when taking planning decisions.

2.2 Building Regulations 2013

The Building Regulations 2013 Approved Document L2A, 'Conservation of fuel and power in new buildings other than dwellings' came into force on 6th April 2014.

Part-L2A 2013 introduced five criteria for demonstrating that a building complies with the Regulations.

Criterion 1 – Achieving or outperforming the TER (Target Emission Rate)

Criterion 2 – Limit on design flexibility

Criterion 3 – Limiting effects of solar gains in summer

Criterion 4 – Building performance consistent with BER (Building Emission Rate)

Criterion 5 – Provisions for energy efficient operation

It is expected that compliance software will produce an output report that will assist BCBs (Building Control Bodies) check that compliance has been achieved. In general, compliance involves demonstrating that:

1) The CO_2 performance target has been met.
2) Elements of the design do not fall outside energy efficiency limits unless there are exceptional circumstances.
3) The building will not suffer from excessive solar gain.
4) The building, as constructed matches the design intent.
5) Information is provided to enable the building to be operated efficiently.

When carrying out the compliance check with Part-L 2013, energy and subsequent CO_2 emission from process-related activities can be excluded from the total when calculating the percentage reduction in CO_2 emissions, i.e. '*Regulated Energy*' CO_2 emissions only.

2.3 London Plan 2011 (2014 update)

The use of Decentralised energy (i.e. District Heating with combined heat and power) precedes Renewable Energy under the Major's Energy Hierarchy: paragraph 5.32 in the London Plan 2012 states – 'The Mayor supports the greater use of renewable and low carbon generation technologies and has set a target for London to generate 25% of its heat and power requirements through the use of local decentralised energy systems by 2025. These will potentially be based around the use of gas fired combined heat and power (CHP), district heating and cooling is the first preference'.

The key policies regarding energy efficiency and renewable energy in new developments are summarised below:

London Plan Policy 5.2 – Minimising CO_2 Emissions

Policy 5.2 of the London Plan sets out the methodology and targets for the journey towards zero carbon for both domestic and non-domestic buildings. Development proposals should meet the fullest contribution to minimising CO_2 emissions in accordance with the following energy hierarchy:

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

The CO_2 reduction targets are expressed as minimum improvements over the Target Emission Rate (TER) outlined in the national Building Regulations leading to zero carbon non-domestic buildings from 2019.

Currently, the London Plan requires all new major non-domestic developments to achieve improvement of 35 per cent over Building Regulations Part-L 2013.

Table 1: Part-L Compliance requirement from London Plan 2011

Non-Domestic Buildings	
Year	Improvement on 2010 Building Regulations
2010 – 2013	25 per cent
2013 – 2016	40 per cent (equivalent to 35 percent on 2013 Building Regulations)
2016 - 2019	As per Building Regulation requirements
2019 – 2031	Zero Carbon

Since 6 April 2014, the Mayor has applied a 35% carbon reduction target beyond Part-L 2013 of the Building Regulations; this is broadly equivalent to the 40% target beyond Part-L 2010.

The carbon dioxide reduction targets should be met onsite. Where the 35% target cannot be met on-site a commitment to ensure the shortfall is met off-site using the provision established by the borough must be provided. If the required target cannot be fully achieved onsite, any shortfall may be provided offsite or through a cash in lieu contribution to the relevant Borough to be ring fenced to secure delivery of CO_2 savings elsewhere.

London Plan Policy 5.6 – Decentralised Energy in Development Proposals

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

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

1) Connection to existing heating or cooling networks
2) Site wide CHP network
3) Communal heating and cooling

London Plan Policy 5.7 – Renewable Energy

There is a presumption that all major development proposals will seek to reduce CO_2 emissions by at least 20 per cent through the use of on-site renewable energy generation wherever feasible.

The use of a full range of renewable energy technologies is encouraged and should be incorporated wherever site conditions make them feasible and where they contribute to the highest overall and most cost effective CO_2 emissions savings.

London Plan Policy 5.8 – Overheating and Cooling

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

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

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

2.4 London Borough of Camden Local Development Framework

Camden's Core Strategy sets out the key elements of the Council's planning vision and strategy for the borough. It covers the physical aspects of location and land use but also addresses other factors that make places attractive, sustainable and successful, such as social and economic matters.

Under *Core Strategy Policy CS13* – Tackling climate change through promoting higher environmental standards and *Development Policy DP22* – Promoting sustainable design and construction:

- The Council will expect developments to achieve a reduction in carbon emissions of 20% from on-site renewable energy generation (which can include sources of site-related decentralised renewable energy) unless it can be demonstrated that such provision is not feasible.
- The Council expects non-domestic developments of 500 sqm of floorspace or above to achieve 'Very Good' in BREEAM assessments, with the aim of increasing the target to a rating of at least 'Excellent' in 2016, if feasible, and zero carbon from 2019.

The Council will require development to be resilient to climate change by ensuring schemes include appropriate climate change adaption measures, such as:

- Summer Shading and planting
- Limiting run-off
- Reducing water consumption
- Reducing air pollution
- Not locating vulnerable uses in basements in flood-prone areas.

2.5 BREEAM New Construction 2014

It is agreed with UCLH that the development is set out to achieve BREEAM 'Excellent' rating.

The minimum requirements for 'Excellent' within the Energy Section are as follows:

- To minimise the Carbon Emissions associated with building operational energy consumption, 5 credits out of a total of 12 required under ENE1 – Reduction of CO_2 emissions.
- To achieve minimum of 1 credit in order to comply with ENE2 – Energy Monitoring Criteria.
- To achieve minimum of 1 credit in order to comply with ENE4 – Low or Zero Carbon Technologies Criteria. This requires a feasibility study to be carried out for low and zero carbon technologies, and for the most appropriate technology to be provided for the development.

3 Energy Hierarchy

The performance of the redevelopment has been assessed following the procedure laid out by the document titled "*Energy Planning – Greater London Authority guidance on preparing energy assessments (April 2014)*", following the Mayor's Energy hierarchy:

- **Priority 1 – Energy Conservation & Energy Efficiency (Be Lean)**
- **Priority 2 – Exploitation of Low Carbon Technologies (Be Clean)**
- **Priority 3 – Exploitation of renewables, sustainable sources of energy (Be Green)**

The Energy Hierarchy offers an effective framework to guide energy policy and decision making. By prioritising demand-side activities to reduce wastage and improve efficiency, the hierarchy links closely to the principles of sustainable development and offers an integrated, easy to use approach to the management of energy demand and supply.

Priority 1 – Energy Conservation & Energy Efficiency (Be Lean)

The reduction or elimination of unnecessary energy use; Conservation is often achieved through behavioural changes such as switching appliances off when they are not being used, or the introduction of passive design features, an example of which would be to implement shading devices in order to reduce the need for cooling in summer etc.

Energy efficiency improvements are usually achieved through the application of engineering principles.

Priority 2 – Exploitation of low carbon technologies (Be Clean)

Finite natural resources such as oil, coal, gas and uranium provide the vast majority of global and UK energy supply. The current transport systems, buildings and power generation infrastructure have been built such that they are all largely dependent on the continued supply of these resources. Examples of low carbon technologies are Heat Pumps, Combined Heat & Power and District Heating/Cooling etc.

Priority 3 – Exploitation of Renewables, Sustainable Sources of Energy (Be Green)

Having taken all reasonable steps to minimise energy demand and improve efficiency, this next priority is to supply that demand from clean energy sources that are effectively infinite. Effective, sustainable energy provision, though, is not just about resource availability, it must also embrace wider issues such as affordability, societal acceptability and environmental impact.

4 Energy Consumption and Carbon Dioxide Emission Baseline

The baseline emissions for the UCLH development has been carried out following the assessment procedure and standards laid out by the document titled *"Energy Planning – Greater London Authority guidance on preparing energy assessments (April 2014)"*.

4.1 Software

Dynamic modelling software, Integrated Environmental Solutions Virtual Environment (IES VE) has been used to calculate the carbon dioxide emission rate. IES VE pro is accredited software for demonstrating UK Building Regulation Compliance. The version of the tool used for this analysis was 2014.2.0.0, which was the most recent release at the time of performing the calculations.

Calculations are based on first-principle models of heat transfer process and are driven by real weather data set. IES VE is an accredited and approved software and it can be used to demonstrate UK Building Regulation Part-L compliance and for producing Energy Performance Certificates.

4.2 Building Geometry

The Part-L energy model is based on SBA Architects plans and sections drawings for planning, received on 24/12/2014. Figure 1 shows a screenshot of the energy model:

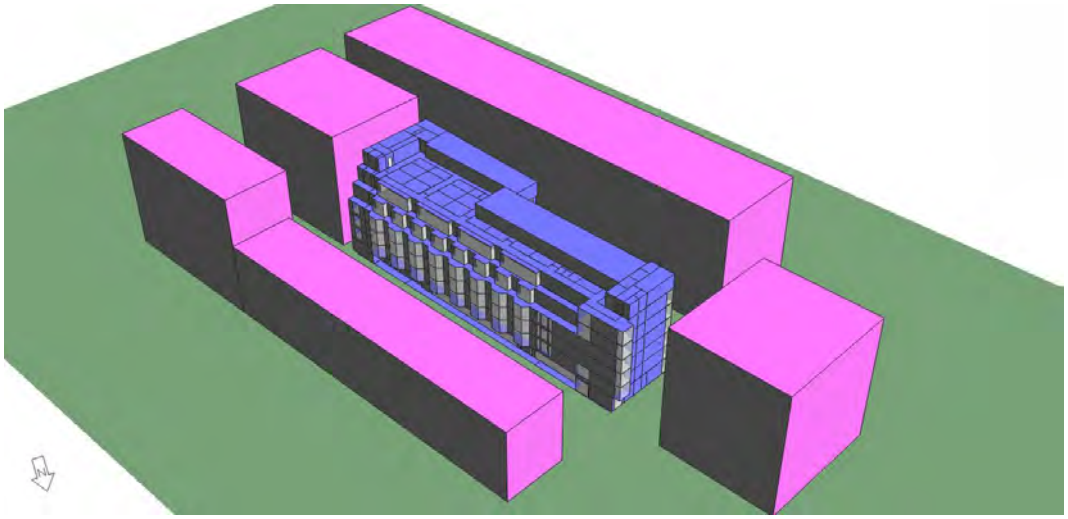


Figure 1: UCLH Development IES VE Model

4.3 Energy Consumption & Carbon Dioxide Emissions Baseline

The *Notional Baseline* represents the energy consumption and carbon dioxide emissions baseline associated with a typical Hospital that is built to 2013 standards. The performance metric of this 2013 standard hospital building is extracted from the Part-L energy model in the form of Target Emission Rate (TER). The target emission rate is the minimum energy performance requirement (required by UK Building Regulation) for a new non-domestic building ($kgCO_2/m^2/year$). The TER is calculated in accordance with the National Calculation Methodology (NCM).

According to the Part-L energy model, the *Notional Baseline* has been estimated as follows:

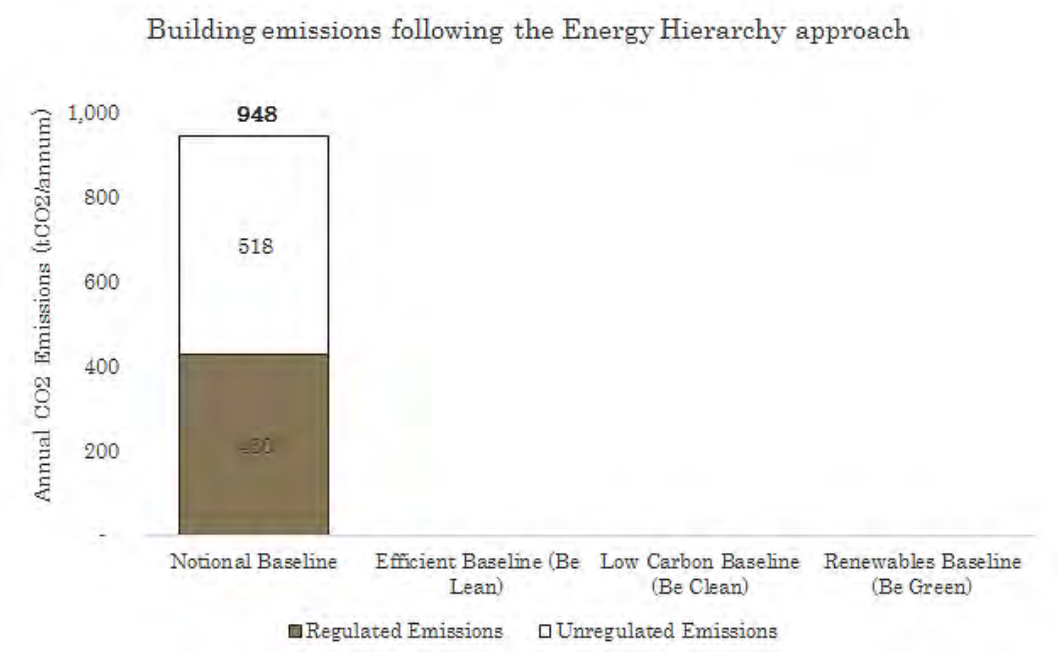


Figure 2: Energy Hierarchy chart demonstrating performance target to meet3

The results indicate that the entire UCLH development would exhibit a *Regulated Energy* baseline carbon dioxide emission of **430 tCO_2/annum**, based on a Part-L 2013 Target Emission Rate (TER) of **46.8 $KgCO_2/m^2$/annum**.

5 Energy Conservation & Energy Efficiency (Be Lean)

The second stage of the Mayor's Energy Hierarchy approach focus on Energy Efficiency, to reduce energy losses and eliminate waste, the following measures have been undertaken:

5.1 Passive Design

All construction was modelled based on assumptions that the build standard should be equal or better to the Part-L 2013 notional building. The figures below summarise the area-weighted average building fabric performance:

	Part-L 2013 limiting factors	Design Targets
External Wall	0.35	0.26
Roof	0.25	0.25
Ground/Exposed Floors	0.25	0.25
Windows	2.2	1.80
Air Tightness	10 m3/h.m2 @ 50Pa	5 m3/h.m2 @ 50Pa
Construction details	-	Standards of Robust Construction Details defined in IP 17/01

5.2 Daylighting

Effective use of day lighting can reduce the need for artificial lighting in the development. This is particularly appropriate because the building is generally occupied during the day when good levels of natural light are available. Daylighting is achieved through careful sitting of windows and other glazed elements. When considering the admission of daylight, it is important to bear in mind that solar overheating can be an unwanted consequential impact and external shading is often required to mitigate this.

To maximise the energy savings that good natural daylighting can provide it is important that it is complemented by a good performing lighting control system to allow artificial lighting to be dimmed or turned off when natural daylight levels are suitable.

5.3 Minimising Solar Gain

Internal blinds are to be employed to reduce the amount of solar penetration and to mitigate glare.

5.4 Efficient HVAC systems

The outpatient facility has a wide range of rooms with multiple functions and service requirements. The HVAC philosophy is therefore based on the functionality of the space.

Process and treatment rooms will be heated and cooled via air handling units located in the basement (all air system). All non-clinical spaces will be served with minimum fresh air based on the levels of occupancy within, served from air handling units in the basement. If the space requires heating and cooling this will be provided via local terminal units such as fan coil units. The atrium space will be heated by underfloor heating. This approach minimises the energy usage of the HVAC system whilst still providing patient comfort.

The air handling units and LTHW boilers will be located at basement level 3. The chillers will be located on the roof at level 6.

Main Heating system:	Gas Fired LTHW Boilers seasonal efficiency 91%
Cooling nominal efficiency:	Turbocor Chillers, high efficiency SEER 5.80
Circulation pumps:	Variable speed pumps with multiple pressure sensors
DHW heat source:	From Gas fired boilers with system losses (storage + distribution) of <10%

5.5 Low Energy Lighting and Lighting Control

The development is assumed to be built with low energy light fittings to achieve an average target luminaire efficacy value of 64 lumens per circuit watt, while the Part-L 2013 minimum requirement is around 60 lumens per circuit watt. PIR sensors and photoelectric options would also be implemented where feasible.

Other measures include:

- Implement intelligent switching and lighting system and other equipment
- Automatic switch-off of desktop PCs and other equipment via software and smart socket outlets
- Constant Illuminance Control where applicable
- Daylight harvesting control
- PIR occupancy sensing control

5.6 High Efficiency Cooling System

Turbocor Chillers are proposed for the UCLH development. Turbocor Chillers are a new type of “Ultra Efficient” chiller that delivers exceptional energy savings and reduction in carbon dioxide emissions, while ensuring high quality comfort for building occupants.

Turbocor Chillers are generally more compact and lightweight compared to screw and scroll chillers and they have excellent part load efficiency. The use of a variable speed drive enable the chiller output to be finely controlled between 15% and 100% of capacity, enable cooling to be matched precisely to load. Given that in the UK chillers operate at part load the bulk of the time, this helps significantly reduce energy consumption and ensure effective cooling.

5.7 Heat Recovery Ventilation

As building efficiency is improved with insulation and weather-stripping, buildings are intentionally made more airtight and consequently less well ventilated. While opening a window does provide ventilation, the building's heat and humidity will then be lost in the winter and gained in the summer, both of which are undesirable for the indoor climate and for energy efficiency, since the building's HVAC system must compensate, Heat Recovery Ventilation technology offers an optimal solution.

The efficient heat recovery efficiency in central ventilation plant is assumed to exhibit an overall heat recovery efficiency of 60%.

5.8 Minimising Specific Fan Power

Ducts shall be sized to minimise specific fan power. All non-process air handling systems are being sized to meet and exceed the limiting specific fan power requirements stated in Part-L 2013. The 2013 limiting SFP figure is 1.8W/l/s, although depending on the components within the air handling system – for example heat recovery devices and HEPA filters.

The UCLH development shall target overall supply & extract SFP figure of 1.80W/l/s at the Air Handling Units (AHUs) level. Energy efficient local fan coil units are to be selected to minimise fan power at local zone level.

5.9 Variable Flow for Pumps

Most existing pumping systems requiring flow control make use of bypass lines, throttling valves, or pump speed adjustments. The most efficient of these is pump speed control. When a pump's speed is reduced, less energy is imparted to the fluid and less energy needs to be throttled or bypassed. Speed can be controlled in a number of ways, with the most popular type of variable speed drive (VSD) being the variable frequency drive (VFD)

The saving from Variable Speed Pumps may go well beyond energy, and may include improved performance, improved reliability and reduced life cycle cost.

5.10 BEMS

Building (Energy) Management System is a central computer controlling, monitoring and optimising building services and systems such as heating, air-conditioning, lighting and security. To achieve BREEAM 'Excellent', the following major energy consuming systems (where present) are monitored using either a BEMS on:

- Space Heating
- Domestic Hot Water
- Fans (Major)
- Lighting
- Small Power
- Other major energy-consuming items where appropriate

The end energy consuming use is identifiable to the building user through labelling or data outputs.

5.11 Automatic Monitoring & Intelligent Controls

Installation of end use sub-meters and an automatic monitoring and targeting system has been shown to achieve significant operating energy savings. The system allows FM teams to pinpoint areas of excessive energy consumption and address the causes.

Night set-back will be employed as appropriate on the 24/7 ventilation systems to maintain containment but reduce energy usage, intelligent controls shall load match and load shed as appropriate to minimise energy use.

5.12 Establish Efficient Baseline

Following the Energy Hierarchy approach, by implementing Energy Conservation and Energy Efficiency measures, an *Efficient Baseline* carbon dioxide emission for the UCLH Development has been estimated.

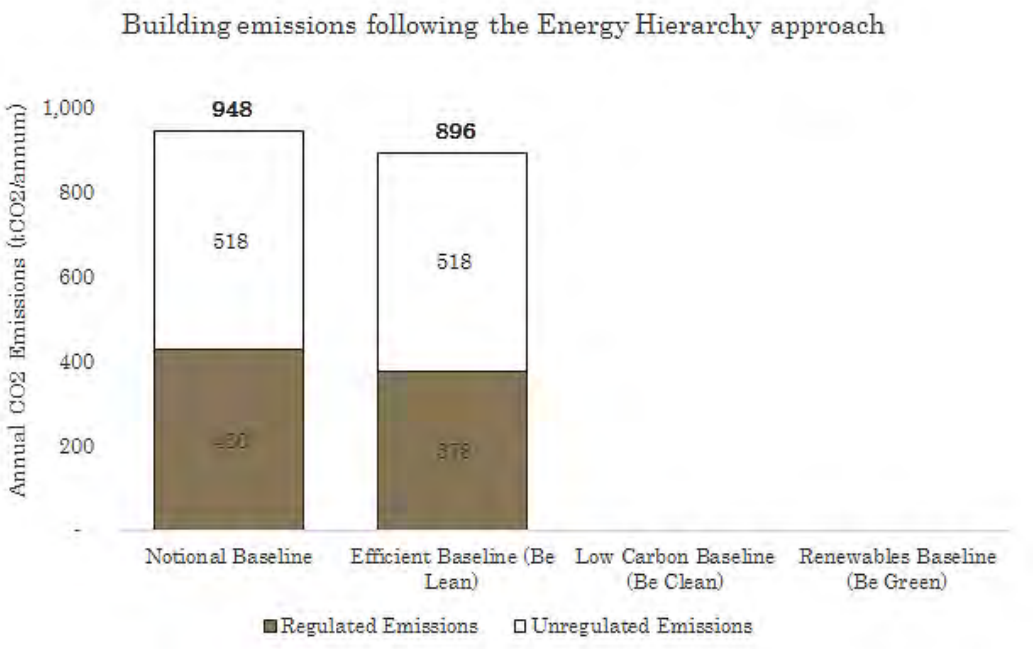


Figure 3: Energy Hierarchy chart demonstrating performance of Energy Conservation and Energy Efficiency measures

The results indicate that subsequent to Energy Conservation & Energy Efficiency measures, the UCLH Development would exhibit a '*Regulated Energy'* carbon dioxide emission of **378 tCO_2/annum**, based on a Part-L 2013 Building Emission Rate (BER) of **41.2 $KgCO_2/m^2$/annum**, an improvement of 12.1%.

6 Exploitation of Low Carbon Technologies (Be Clean)

The successful integration of low carbon technologies with buildings depends on a number of technical, economic and social factors.

6.1 Combined Heat and Power

Combined Heat & Power (CHP) Plants, also known as cogeneration, uses conventional stationary internal combustion engines or turbines to generate both electricity and heat. A generator is coupled directly to the output shaft of the engine in order to generate electricity. Heat is recovered from the engine via the water jacket, and from the exhaust gas. Assuming the CHP plant is well-designed and as such will be able to utilise large proportions of waste heat on an annual basis, this leads to an overall increase in the CHP plant efficiency to figures significantly greater than those of a conventional internal combustion engine, and is the basic advantage of a CHP plant.

CHP plants (up to a peak electrical output of around 5MW), are generally gas-fired, using conventional spark ignition engines. Above this range, gas turbines engines are more common, as they are capable of achieving 20+ MW electrical output.

Although they can provide energy with very high efficiency, CHP plants rely on matched building electrical and heat demands. If these do not follow a similar trend over the course of the day, and throughout the year, then the CHP plant may frequently be generating large proportions of heat when it is not required. If there is no demand then this heat is essentially wasted, or 'dumped'. This is a key factor which much be considered, as dumping heat will reduce the seasonal efficiency of a CHP system and in turn will reduce the reductions in carbon emissions that are achieved.

In addition, CHP plants are typically only economically feasible if they operate for at least 3,000 hours per year. To ensure steady operation of the CHP plant, and to prevent heat being dumped, it is recommended that CHP plants are designed to meet the building's base heating demand, exporting electricity to the grid when electrical demand is lower than the CHP electrical output.

Figure 4: Example CHP Engine

Packaged CHP engines usually come with a maintenance contract, the heat output of the CHP engine is likely to be monitored and managed so that heat dumping is minimised through the year.

Preliminary calculations suggest that a CHP engine of around 70kW(e) is appropriate for the UCLH Development (exact size of engine to be confirmed). The CHP engine overall heat efficiency for this scale of engine would be around 48% and electrical efficiency would be close to 31% (on LHV fuel input).

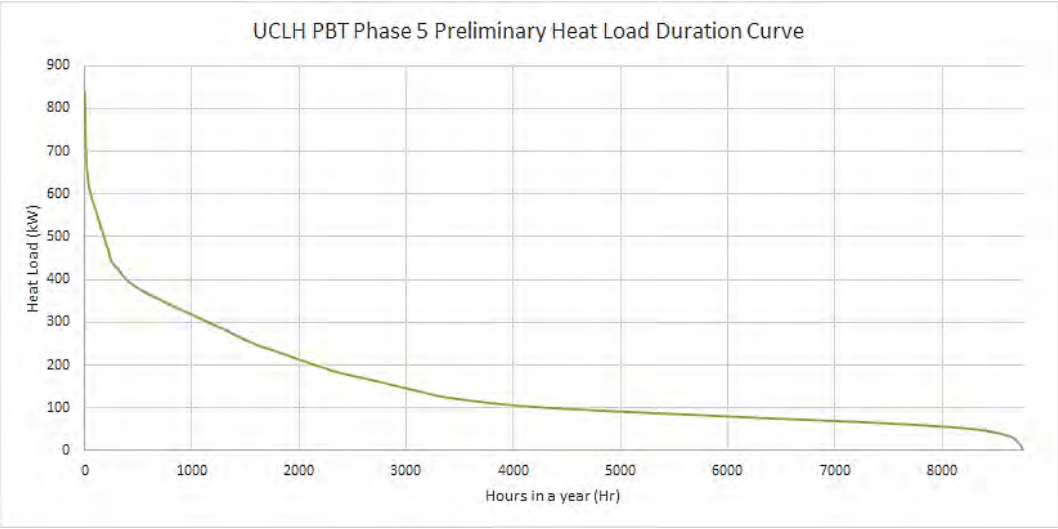


Figure 5: Estimated Development heat load duration curve

Calculations at this stage shows that the mini CHP engine should be able to operate at around 24 hours/day during winter as well as summer with minimal heat dump. It is expected for the engine to operate up to 7,980 hours per annum with an 8% (28 days) down time for maintenance etc.

6.2 Low Carbon Technology Contribution

Follow the Energy Hierarchy approach, subsequent of applying energy conservation and efficiency measures and low carbon technology in the form of CHP, a *Low Carbon Baseline* carbon dioxide emission for the UCLH Development has been established.

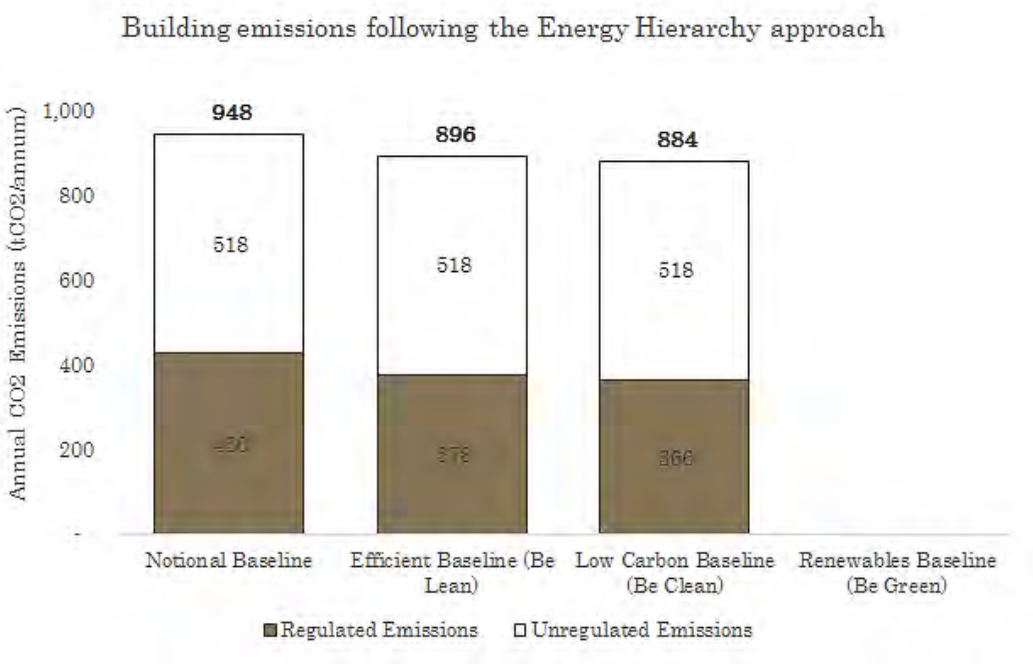


Figure 6: Energy Hierarchy chart demonstrating performance of CHP plant

The results indicate that subsequent to Low Carbon Technology (CHP engine), the UCLH Development would exhibit a *Regulated Energy* emissions of **366 tCO_2/annum**, based on a Part-L 2013 Building Emission Rate (BER) of **39.9 $KgCO_2/m^2$/annum**, a total improvement of 15.3% from the *Notional Baseline*.

6.3 Decentralised Heating, Cooling and Power

The most common form of local area energy network is community or district heating. This is where space heating and hot water is delivered to multiple occupants from a local plant via a network of insulated pipes buried in the ground. The pipe network can be installed at the same time as other services (water, drainage and other below ground services) to minimise costs in new development.

District heating can also be combined with electricity production if a CHP plant is used, leading to the production and delivery of more than one service and associated prime energy efficiency gains. This uses the inevitable waste heat from the electricity generation process to heat buildings, rather than requiring additional gas, oil or electricity to generate that heat. The CHP unit can be linked to buildings by a local district heat distribution network. The electricity produced could be exported to the national grid or transported to other user over the local electricity distribution network or over a new, community owned or part owned network.

Connecting to a local area energy network is also preferable to the London Borough of Camden, eligibility of a scheme to connect into a heat network are to be assessed as part of planning requirement. This forms part of GLA's Energy Hierarchy of 'Lean', 'Clean' and 'Green'. The 'Clean' requirements suggests forming or making future provision for connection into a local district heat network or CHP network, or if not suitable, install a local standalone CHP system.

6.3.1 Networks in Central London

One of the Mayor's top priorities for reducing London's carbon dioxide emissions is to reduce the capital's reliance on centralised power stations. This means increasing the use of local, low-carbon energy supplies through decentralised energy systems.

The London Development Agency has developed a Heat Map of London which shows the current and proposed local energy area networks in Central London.

Currently known networks in the local area are:

- Gower Street Heat and Power – owned by UCL. This scheme covers large areas within Bloomsbury to the east of Tottenham Court Road.
- Euston Road Scheme – proposed scheme that will have its central plant located in Somerstown near King's Cross. The scheme has not been installed yet.

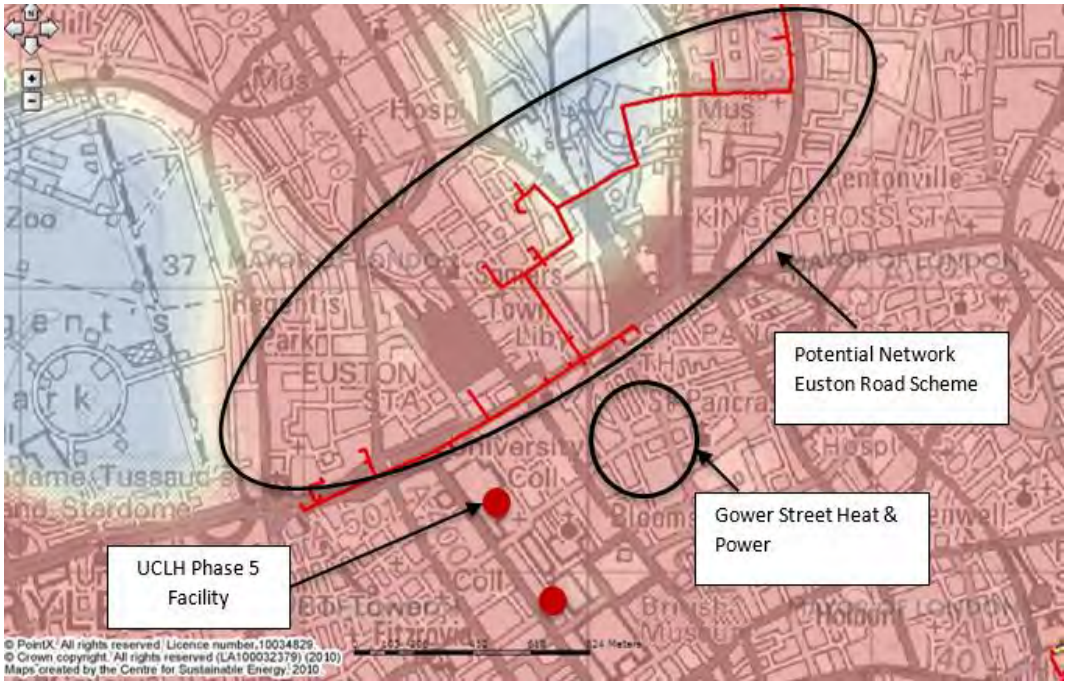


Figure 7: Euston Road Scheme and Gower Street Heat & Power

6.3.1.1 Gower Street Heat & Power

Medium Temperature Hot Water (MTHW), Steam and 11,000V distribution systems, 2x15MW CAT 3516 gas-fired CHP engine generators and back-up MTHW and steam boilers in 4 boiler houses are located around the campus.

The current UCLH Phase 3 Cancer Centre on Huntley Street is connected into this system using steam as a primary heat source. There are plans to upgrade the MTHW plant within this scheme to reduce the carbon intensity so the steam can be phased out. The UCLH design includes future flexibility for connecting into the MTHW system once the MTHW carbon intensity has been improved.

Following a meeting on 16th July 2014 between UCL, UCLH, Arup (MEP Consultants for both UCL & UCLH Phases 3, 4 & 5) and Riley (Project Managers for UCLH Phase 5), it was agreed that UCL would make their CHP District Heating Scheme (Gower Street Heat & Power) available for connection by UCLH for both Phases 4 (Cancer Care & Proton Beam Therapy) and 5 (Dental & Ear, Nose and Throat).

It was stated that the UCL District Heating Scheme is currently at full capacity and therefore cannot guarantee to provide heating to the UCLH properties under all operating conditions (ie peak winter conditions) as it will prioritise UCL demands first. However there may be portions of time, where UCLH can benefit from the spare heat and UCL can benefit from running their scheme at a more stable load.

In order to protect UCLH's business continuity, both Phases 4 & 5 will install a fully resilient heating plant within their buildings such that they can satisfy their demands at all times.

6.3.1.2 Euston Road Scheme

The London Development Agency state:

> *…There is a proposal for an area wide district heating scheme to supply low carbon heat to new and existing buildings in the immediate vicinity of Euston Road. This scheme could interconnect existing Local Authority community heating schemes with existing CHP schemes serving University of London campuses and with new centralised low carbon schemes planned for Kings Cross and Euston Stations. The analysis of the potential for this larger scheme to deliver marginal CO_2 savings at low cost will determine whether the scheme goes ahead. The area under consideration extends from Regent's Park to Caledonian Road with the 'core' of the scheme between Kings Cross and Euston Station. The proposal has been prompted by the planned developments around these two major transport interchanges. But there is clearly potential to supply low carbon heat to other major developments planned in the area and to existing buildings.*

Barriers to this scheme are:

- The system is not yet operational and may not even go ahead.
- The costs are predicted to be prohibitive.
- Currently there is no data on the carbon factors associate with the heat supply, hence uncertainty on UCLH's development's renewable credentials.

6.3.1.3 District Heat Network conclusion

This site will connect into the current Gower Street Heat and Power district heating system.

7 Exploitation of renewable, sustainable resource (Be Green)

The successful integration of renewable energy technologies with buildings depends on a number of technical, economic and social factors. The report to follow by Arup titled '*UCLH - LZC Technology Feasibility Study'* investigated the feasibility of each renewable energy technology and for each; a qualitative view of the feasibility was taken.

The key technologies are summarised below and show the findings from this feasibility study that only photovoltaic panels are suitable technology for the Development.

Table 2: Summary of Renewable Energy Technologies investigated

Technology	Feasible?	Practical Solution?	Comments
Small Scale Hydro	×	×	No hydro source
Tidal/ Wave Power	×	×	No tidal/ wave source
Solar Water Heating	✓	×	Not compatible with district heating, compete with technology such as CHP plant for base load
Wind Turbines	✓	×	Insufficient capacity or contribution
Biomass Boilers	✓	×	High NOx emissions, delivery issues, larger plant space than CHP
Heat Pumps	✓	×	Low effectiveness compare to CHP plant, high fuel cost
Photovoltaics	✓	✓	Complimentary to other technologies

7.1 Unviable Technologies

The following technologies have been analysed, and have been determined to be unfeasible or unviable. They are, therefore, NOT recommended to be implemented for this development.

7.1.1 Hydro and wave power

This site is not located near the coast or any rivers which could provide a source of moving water for hydro power generation, and therefore these technologies are not considered.

7.1.2 Solar Water Heating

Solar Thermal technology can provide hot water to buildings by pumping incoming cold water supply through collectors, typically located on the building roof or façade.

Solar Thermal technology is a proven technology, is silent in operation (does not cause any noise pollution) and does not require frequent access or maintenance. It is therefore considered to be a feasible option on technical and practical grounds.

However, it is difficult to implement solar water heating in conjunction with CHP plant; due to the fact that the Solar Thermal Collectors compete with the CHP plant for base thermal loads of the building and would adversely affect the running hours of the CHP engine, thereby reduces the amount of power production on site and hence reducing the carbon dioxide offset from the CHP engine.

Base on the reason stated above, it is determined that Solar Water Heating is not a suitable option for the UCLH Development. Refer to Arup report titled '*UCLH Phase 5 - LZC Technology Feasibility Study*' for further details.

7.1.3 Wind Turbines

Wind turbines can be divided into large scale and small scale generation. Large scale wind turbines are generally used where large areas of space area available, either in a windy coastal environment or large open countryside.

There is no simple method of estimating the energy yield at a particular site, so wind speeds should ideally be measured for up to a year at the actual position the turbine would be installed.

In addition, the dense, urban nature of the site is likely to give rise to a turbulent flow or air around the building which is unsuitable for effective operation of turbines. This turbulence can have a significant impact on the output of the wind turbine therefore determining a suitable location to mount the turbine can be a tricky task. It would be difficult to quantify without complex and expensive Wind and computational fluid dynamics (CFD) studies.

Turbines can potentially cause noise pollution from the turbine blades passing through the air as the hub rotates, and from the gearbox and generator in the nacelle. Noise from the blades can be minimised by careful attention to the design and manufacturer of the blades. The noise from the gearbox and generator is contained within the nacelle by sound insulation and isolation materials. A dedicated study of the likely noise levels should be carried out at a detailed design stage if wind turbines are specified.

In terms of power generation, as an example, an 8.5kW wind turbine, the QuietRevolution QR5, has been modelled. Based on a rotor diameter of 3.1m and installed hub height of 15m (ground mounted) above ground level. Using annual wind speed data for London combined with the manufacturers stated power curve to determine the annual electricity that can be generated with the turbine.

Figure 8: QuietRevolution QR5 Wind Turbine

The total annual output from a QuietRevolution QR5 wind turbine is estimated to be around 1.6MWh/annum, the total carbon dioxide saving is estimated to be around 0.84tCO_2/annum, equivalent to a 0.23% '*Regulated Energy'* carbon dioxide reduction from the *Low Carbon Baseline*.

In order to achieve further carbon dioxide mitigation, more turbines are required but this is not possible due to the space constraint at the site. Hence, wind turbine(s) are considered not to be an appropriate solution. Refer to Arup report titled '*UCLH - LZC Technology Feasibility Study'* for further details.

7.1.4 Biomass Heating

Biomass boilers could be used to provide hot water heating to the buildings. Carbon emissions associated with biomass boilers are low compared to a gas, oil or electric heating system. However, they present significant technical challenges and also require many additional components, such as a storage facility, handling, delivery access, ash removal, thermal storage etc. Biomass systems also generate high NOx emissions, typically around 200kg/kWh of delivered heating energy. As such, they have a negative impact to the BREEAM rating.

The implantation of biomass heating would have to be combined with district heating option with Energy Centre; the biomass boiler(s) will be put in place instead of power generation equipment such as a CHP engine, the reason being that they would compete for the same heat load of the redevelopment campus. Biomass gasification to power CHP plant is possible but this generally involves very complex systems and specialist management personnel so are more suited to large industrial scale projects.

Biomass boilers can typically be modulated down to 30% of their peak output. They are rarely sized for the peak heating demand as this will increase the number of times the boiler much start and stop, which generates thermal stress on the boiler and reduces its life. It is typical to size the boilers for 25 – 50% of the peak heat demand. They also have a slower response time than gas fired boilers. As such, thermal storage would be required to flatten the heat demand profile.

Figure 9: Showing a typical Biomass Boiler

Typical wood fuels for Biomass Boilers are in the form of wood chips or wood pellets. Wood pellets are recommended as they are highly processed to exhibit low moisture content, compact, higher calorific value due to higher density and moveable like a fluid. They can be moved very reliably with simple mechanical equipment such as augers.

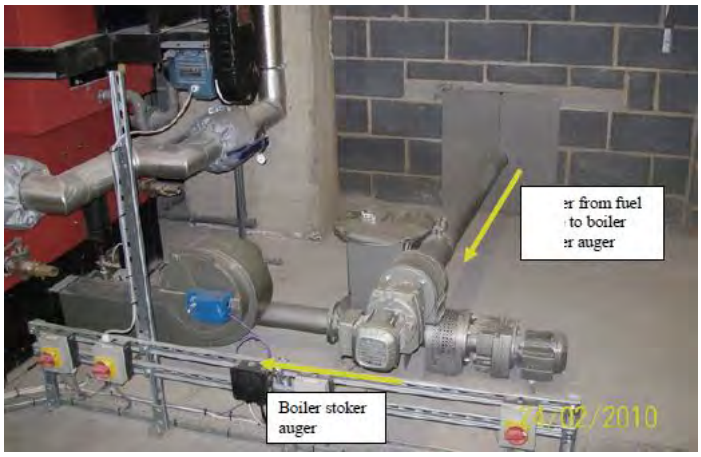


Figure 10: Wood Pellet Boiler with auger system

The figure above shows the type of system commonly proposed for handling wood pellets. The pellets are moved from the fuel store to the boiler with a screw auger. Within the silo itself a 'spring arm agitator' is connected to the end of the auger, which rotates to stir up the wood pellets, directing it to the entry channel of the screw auger then into the boiler.

Figure 11: Biomass delivery truck pumping wood fuel into a storage facility

Fuel can be delivered via trucks; the wood pellets can be pumped directly into the Storage facility via blowers as illustrated in the figure above. Careful consideration must be given to space requirements on site, vehicle turning radius and location of fuel store.

Wood chips/pellets will unlikely be housed outdoor therefore storage facility would have to be built inside the energy centre thereby increasing the cost and reducing the building footprint.

Whilst Biomass Heating can result in a significant carbon mitigation, they can produce a large amount of NOx and so may cause problems with obtaining planning consent and Code for Sustainable Home credits. However they can score highly in the Energy section of the Code.

In addition to air quality issues, in an urban environment, logistics and security of fuel delivery can also be an issue, as well as fuel storage.

Base on the reasons outlined above, it is considered that Biomass Heating is not a suitable renewable energy option for the UCLH Development, refer to Arup report titled '*UCLH - LZC Technology Feasibility Study'* for further details.

7.1.5 Heat Pumps

A heat pump is a refrigerant based system which uses a medium such as air, water, or the ground as an energy source for heating (or/and cooling). In many instances, they are considered a 'Low Carbon' technology, as the heat supplied to the buildings comes from a renewable source and not from combustion of non-renewable energy sources such as gas or oil. However, this heat is only being 'moved' from one space (outdoor) to another (indoor) and to do so requires a compressor in the refrigerant circuit, which consumes electricity, and therefore leads to carbon emission based on the carbon emission factor of the electricity supplied.

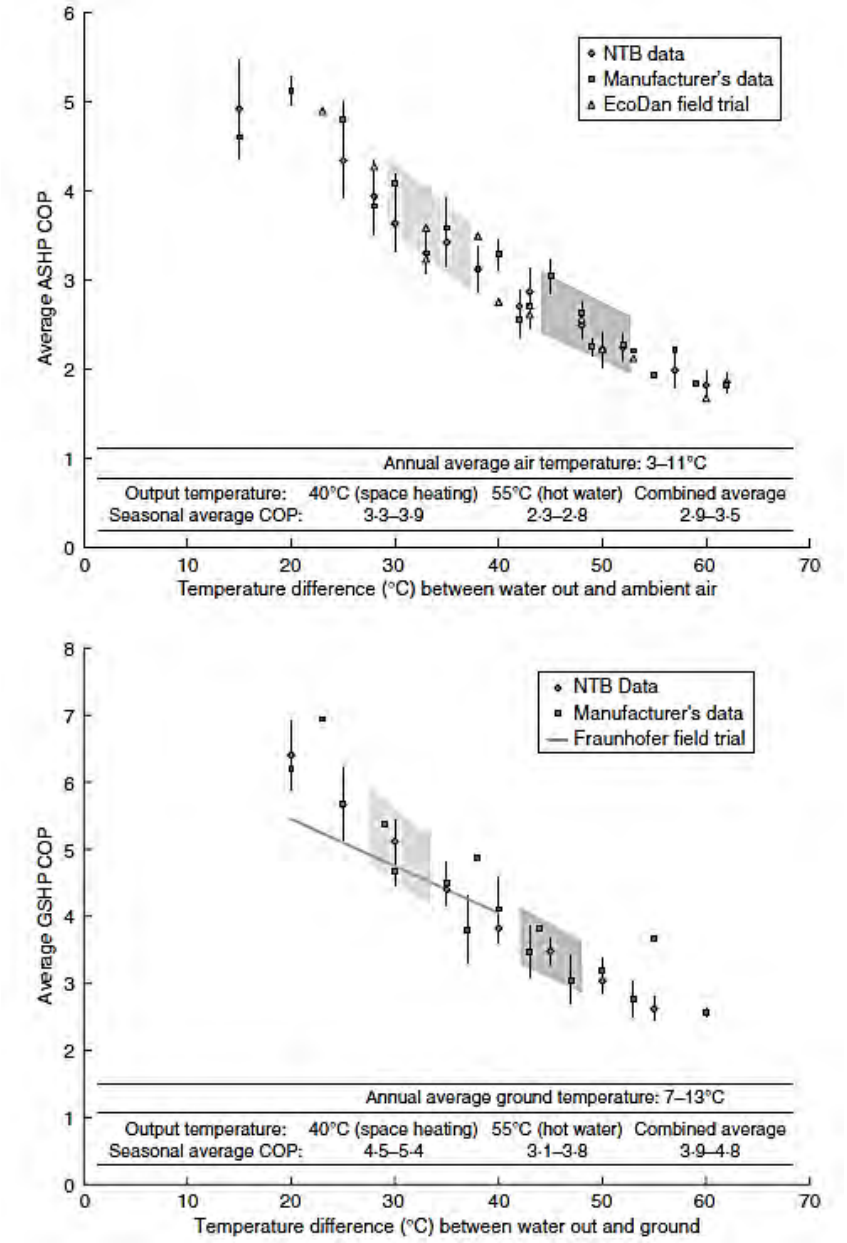


Figure 12: Typical CoP chart for ASHP/GSHP system

Air Source Heat Pumps (ASHPs)

ASHPs system use the ambient air as the medium from which heat is extracted, in general, ASHPs have a lower seasonal coefficient of performance than ground source heat pumps (GSHPs) as they are affected by significant variations in the temperature of the ambient air. At peak heating conditions, the ambient air is at its coldest. This leads to more energy input being required from the compressor, reducing the CoP and increasing carbon emissions for the ASHPs system.

Figure 13: Typical commercial air source heat pump condenser units positioned on the roof of a building

As with everything involving moving parts will make sound, the fans associated with external condensing units may cause noise pollution; considerations will have to be put in for positioning of the external condensing units, in the case of UCLH Development, the most logical location would be to place them on the roof. Both noise and external condensing unit's placement would need to be investigated further.

Ground Source Heat Pumps (GSHPs)

Similar to ASHPs system, a GSHPs system is a low carbon technology rather than a renewable energy technology as GSHPs do not generate any electrical power such solar PVs or Wind Turbines would. The system consumes electrical energy in pumping fluids through the building and the ground and in compressing refrigerant in the heat pumps vapour compression cycle.

The ground is a very effective heat sink because it has a high thermal mass. Soil temperature is mainly influenced by the temperature of the atmosphere at ground level and solar radiation. At around 5m below ground level, the soil temperature varies very little over the course of a year for a given location and will typically be roughly equal to the average annual ambient air temperature at that location. The relatively constant temperature of the ground can be exploited to provide heating and cooling using GSHPs.

Table 3: Practical heat pump extraction rates per m2 ground (horizontal loops)

Operation period / year	1800h	2400h
Soil Type:		
Dry, non-cohesive soil	10W/m2	8W/m2
Moist cohesive soil	20-30W/m2	16-24W/m2
Water saturated sand or gravel	40W/m2	32W/m2

Table 4: Practical heat pump extraction rates per metre run of vertical bore hole

Operation period / year	1800h	2400h
Ground Type:		
Poor underground and dry sediment	25W/m	20W/m
Normal underground and water-saturated sediment	60W/m	50W/m
Consolidated rock	84W/m	70W/m

GSHPs incorporate loops of High or Medium Density Polyethylene (HDPE or MDPE) tube buried in ground. Systems can be either closed loop or open loop. Open loop systems draw naturally occurring water straight from the ground, either for direct use in building systems or for use via a heat pump. Closed loop systems do not draw water directly, but operate based on pumping water through the ground, where heat is transferred through the walls of the ground loop and the temperature of the water is either increased or decreased due to the temperature of the surrounding soil compared to the fluid. In cooling mode, the primary fluid circuit dissipates heat into the ground. In heating mode, the heat stored in the ground is transferred to the secondary circuit.

Figure 14: Typical horizontal loop (left) and vertical loop (right) GSHP system

GSHPs should operate much quieter than ASHPs as they do not involve any fans. GSHPs can achieve CoP of 3 – 4 in heating and 4 – 5 in cooling model. The CoP of a GSHPS system is inversely related to the temperature difference required by the heating and cooling system hence low temperature large surface area distribution technologies such as underfloor heating/cooling, chilled beams, displacement ventilation etc. are preferred.

The drawback in using GSHPs is that it can be very expensive to install, with an indicative cost of £1,400 to £2,000 per installed KW of GSHP capacity. However, the sum of the trenching, pipework, electrofusion welded couplings, pressure testing, flushing, fluids, biocides etc. can easily add £1,000 to £1,500 per borehole to the cost of the total system, depending on borehole spacing, pipe runs, distance to heat pump etc.

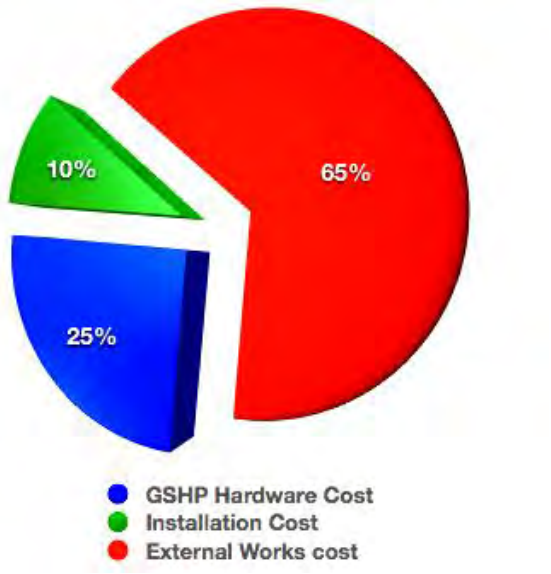


Figure 15: GSHP project cost breakdown with GSHPs

In terms of performance, a model has been produced with an assumption that the GSHPs would provide water up to a temperature of 50°C for space heating only, with a conservative estimate of a seasonal CoP of 4.0.

Heat Pumps Conclusion

Overall, analysis conclude that the performance of ASHPs and GSHPs system are not as effective in comparison to a CHP plant in terms of carbon abatement. In addition, operational cost of heat pump system tend to be high as electricity replaces natural gas as fuel source. In addition, there are implementation issues with ASHPs system and significant cost involved with installation of GSHPs system.

Due to the reasons outlined above, it is determined that heat pump systems are not suitable for the UCLH Development. Refer to Arup report titled '*UCLH Phase 5 - LZC Technology Feasibility Study*' for further details.

7.2 Feasible Technology – Photovoltaic

Photovoltaic (PV) systems work by converting solar energy directly into electricity. PV panels generate DC (Direct Current) electricity and are arranged in modules that include inverters to convert electricity into AC (Alternating Current) that can be used by the building systems. The panels should be mounted in a location that receives good access to the sun and is not overshadowed by surrounding parts of the building, adjacent buildings or other PV Panels. As such, they are typically either installed on the roof or integrated into the building facade.

PV arrays can also be installed at ground level if space is available, but will be more susceptible to reduced output due to overshadowing, and will also be a greater risk of damage due to increased activity at ground level.

PV panels can generate electricity by either direct or diffuse radiation (i.e. sunlight that has been scattered/ reflected by the atmosphere or surrounding objects). The amount of power that can be generated varies depending on a number of factors; include type of cell, orientation, sunlight conditions, etc.

Typically, peak outputs in the UK may be achieved by panels which are orientated around 30 degrees above the horizontal southerly direction. Alternate orientations are possible, but relative output of the PV arrays will decrease.

PV panels are proven technology, are silent in operation (do not cause any noise pollution) and do not require frequent access or maintenance. However they are still a relatively expensive renewable technology.

Figure 16: Example of PV Panels flat roof installation, taken from SolarCentury website

A preliminary assessment indicate that a 7.0kWp PV system size can be implemented based on the indicative campus layout diagram. This system size, equates to 30 panels of 19.4% efficiency, when coupled with energy efficiency measures and the CHP plant, can deliver a total of 15.6% improvement over Part-L 2013 target.

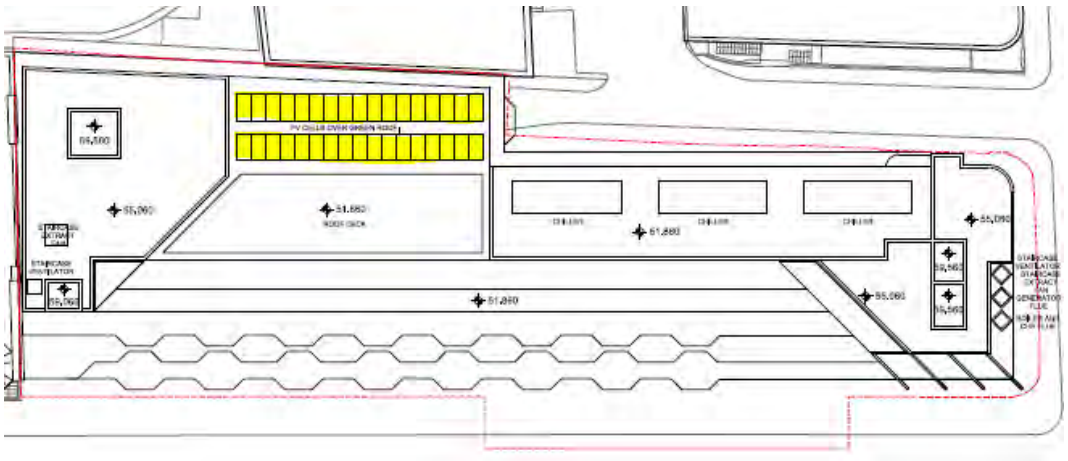


Figure 17: Indicative position of roof mounted PV Panels (30 no.) in yellow highlight

7.3 Photovoltaic Renewables Contribution

Following the Energy Hierarchy approach, after applying Energy Conservation & Efficiency measures, Low Carbon Technology in the form of a CHP plant, and Renewable Energy Technology in the form of Photovoltaic panels, a *Renewables Baseline* for the Development has been estimated:

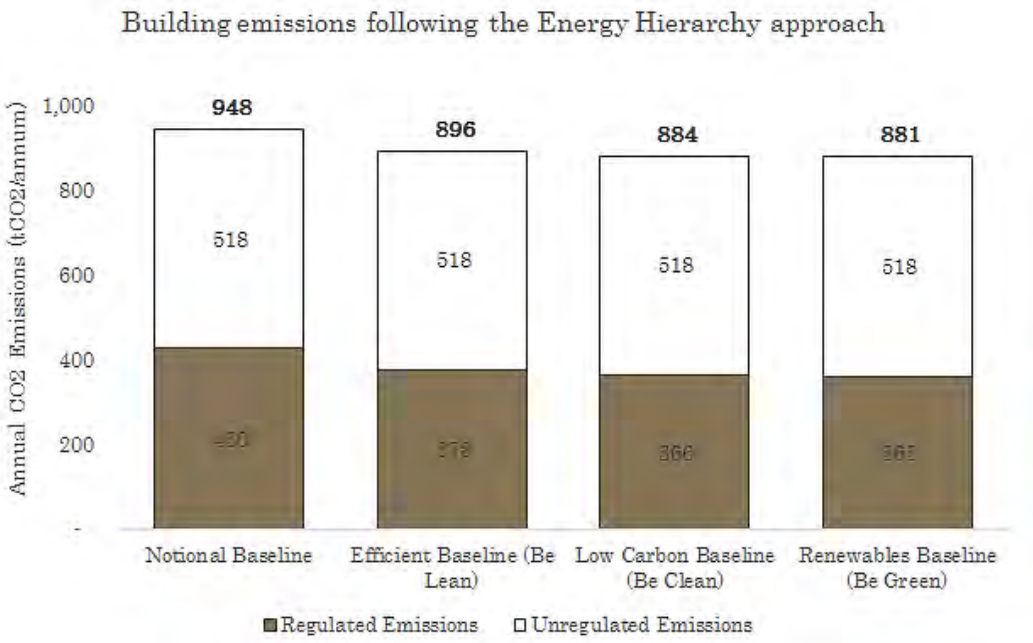


Figure 18: Energy Hierarchy chart demonstrating performance of Photovoltaic panels

8 Summary

An assessment has been undertaken for UCLH Development following the approach from the GLA guidance document on preparing energy assessments: *Energy Planning - GLA guidance on preparing energy assessments (April 2014).*

The emission baselines for the proposed redevelopment (Be Lean, Be Clean & Be Green) have been estimated on a '*Regulated Energy*' approach.

Following the Energy Hierarchy approach:

Priority 1 – Energy conservation & efficiency
Priority 2 – Exploitation of non-sustainable resources using low carbon technologies
Priority 3 – Exploitation of renewable, sustainable resources & technologies

The implementation of Energy Efficiency measures in the form of further fabric performance improvements, energy efficient building services and intelligent monitoring & controls etc. can result in a 12.1% reduction in '*Regulated Energy'* carbon dioxide emissions, from 430tCO_2/annum down to 378tCO_2/annum.

A preliminary assessment indicates that a 70kW(e) CHP engine should be sufficient to cover the base load of the facility. The building will be connected up to the Gower Street Heat and Power district heating system located locally.

The incorporation of a CHP engine reduces the '*Regulated Energy*' carbon dioxide emissions further from the *Efficient Baseline* 378tCO_2/annum down to 366tCO_2/annum, a total reduction of 15.3% from the *Notional Baseline.*

Finally, renewable energy technology such as Photovoltaic is determined to be feasible for the scheme and an initial assessment determined that a total of 7.0kWp PV system can be deployed on the roof of the bulling, which brings the '*Regulated Energy'* carbon dioxide emissions down from 366tCO_2/annum to 363tCO_2/annum, a further saving of 0.9%. Ultimately, results in an overall carbon dioxide reduction of 15.6%.

Table 5: Carbon dioxide emissions after each stage of the Energy Hierarchy

	Carbon dioxide emissions (Tonnes CO2 per	
	Regulated Emissions	Unregulated Emissions
Baseline: Part-L 2013 of the Building Regulations Compliant Development	430	518
After energy demand reduction	378	518
After CHP	366	518
After renewable energy	363	518

Table 6: *Regulated Energy* carbon dioxide savings from each of the Energy Hierarchy

	Regulated Carbon dioxide savings	
	(Tonnes CO2 per annum)	(%)
Savings from energy demand reduction	52	12.1%
Savings from CHP	12	3.2%
Savings from renewables	3	0.9%
Total Cumulative Savings	**67**	**15.6%**
Total Target Savings	**150**	**35.0%**
Annual Surplus	-	

Assessment indicate that the overall 15.6% is 19.4% short of the 35% from London Plan. The total annual and 30 years cumulative carbon emissions shortfall are shown in Table 7 below. An estimated 2,497tCO_2 is to be multiplied by the carbon offset price (set by Camden Council) in order to determine the required cash-in-lieu contribution.

Table 7: Short fall in *Regulated Energy* carbon dioxide savings:

	Annual Shortfall (Tonnes CO2)	Cumulative Shortfall (Tonnes CO2)
Total Target Savings	**83**	**2,497**

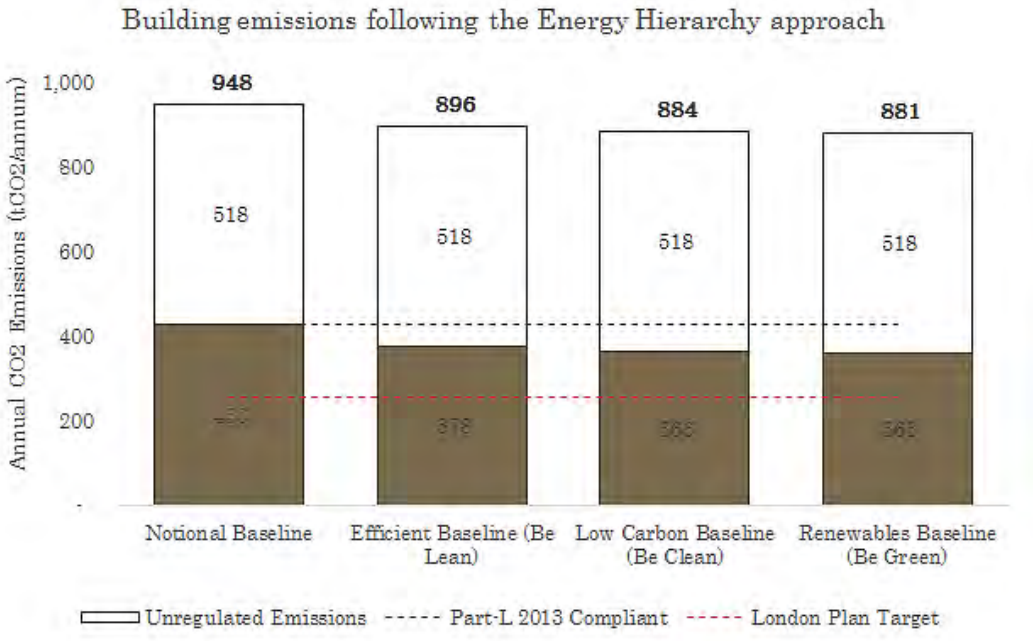


Figure 19: Summary chart following the Energy Hierarchy

The final renewable baseline is expected to be achieve an EPC Asset Rating of 48 (Band B).

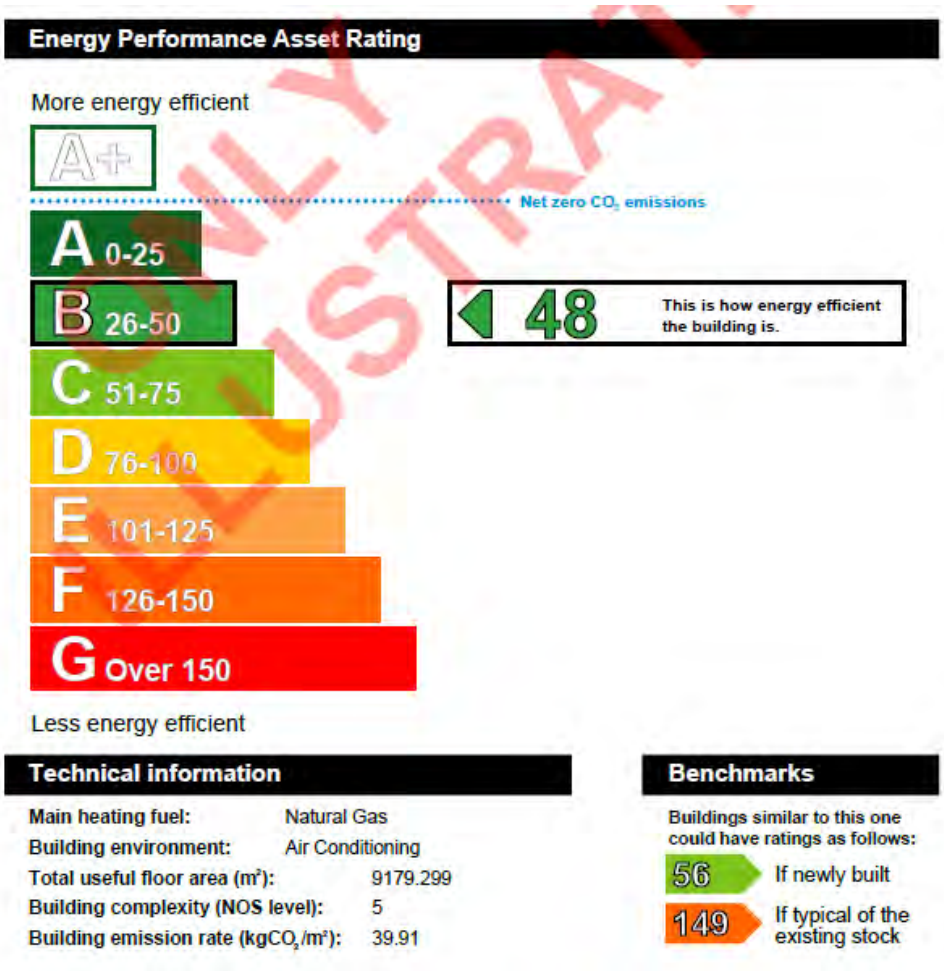
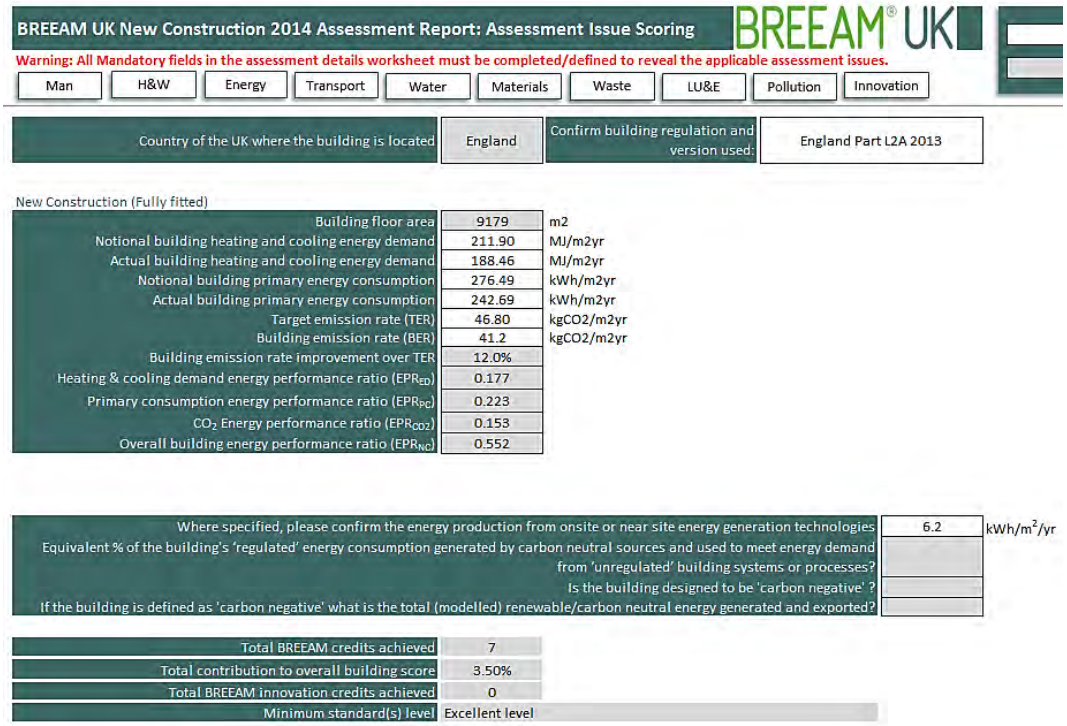


Figure 20: Renewables Baseline EPC Rating

8.1 BREEAM New Construction 2014

In relation to BREEAM 2014, pre-assessment calculation indicates that, based on the output of the sample building, it is expected that the new buildings would achieve the minimum ENE01 credits for "Excellent" level.



BREEAM UK New Construction 2014 Assessment Report: Assessment Issue Scoring

BREEAM UK

Warning: All Mandatory fields in the assessment details worksheet must be completed/defined to reveal the applicable assessment issues.

Man | H&W | Energy | Transport | Water | Materials | Waste | LU&E | Pollution | Innovation

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	9179	m2
Notional building heating and cooling energy demand	211.90	MJ/m2yr
Actual building heating and cooling energy demand	188.46	MJ/m2yr
Notional building primary energy consumption	276.49	kWh/m2yr
Actual building primary energy consumption	242.69	kWh/m2yr
Target emission rate (TER)	46.80	kgCO2/m2yr
Building emission rate (BER)	41.2	kgCO2/m2yr
Building emission rate improvement over TER	12.0%	
Heating & cooling demand energy performance ratio (EPR_{ED})	0.177	
Primary consumption energy performance ratio (EPR_{PC})	0.223	
CO_2 Energy performance ratio (EPR_{CO2})	0.153	
Overall building energy performance ratio (EPR_{NC})	0.552	

Where specified, please confirm the energy production from onsite or near site energy generation technologies	6.2	$kWh/m^2/yr$
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	7
Total contribution to overall building score	3.50%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	Excellent level

Figure 21: BREEAM NC 2014 Pre-assessment Tool – ENE1 credits estimation

Appendix A

Glossary

A1 Glossary

Building Emission Rate (BER) – The building CO_2 emission rate expressed as $kgCO_2/m^2$/year. The BER is calculated in accordance with the National Calculation Methodology (NCM) and the Simplified Buildings Energy Model (SBEM)

Combined heat and power (CHP) – CHP integrates the production of usable heat and power (electricity), in a single, highly efficient process. CHP engine generates electricity whist also capturing usable heat that is produced in this process. This contracts with conventional ways of generating electricity where vast amounts of heat is simply wasted.

District Heating Network (DHN) – DHN is a distribution network of heat generated in a centralised location for residential and commercial heating requirements such as space heating and water heating. The heat is often obtained forma cogeneration plant burning fossil fuels but increasingly biofuel. DHN can provide higher efficiencies and better pollution control than heat generated by localised boilers.

Near-site LZC – a low or zero carbon source of energy generation located near to the site of the assessed building. The source is most likely to be providing energy for all or part of a local community of buildings, including the assessed building e.g. decentralised energy generation linked to a community heat network or renewable connected via private wire.

NOx – a generic term for mono-nitrogen oxides NO and NO2. They are produced from the reaction of nitrogen and oxygen gases in the air during combustion, especially at high temperature in an engine etc.

On-site LZC – a low or zero carbon source of energy generation which is located on the same site as the assessed building.

'Regulated Energy' – Building energy consumption resulting from the specification of a 'controlled', fixed building service' i.e. space heating and cooling, water heating, ventilation and lighting, as a result of requirements imposed by Building Regulations.

Target Emission Rate (TER) – The target emission rate is the minimum energy performance requirement (required by Building Regulation) for a new non domestic building ($kgCO_2/m^2$/year). The TER is calculated in accordance with the National Calculation Methodology (NCM) and the Simplified Buildings Energy Model (SBEM).

'Unregulated Energy' – Building energy consumption resulting from a system or process that is not 'controlled' i.e. energy consumption from systems in the building on which the Building Regulations do not impose a requirement. For example, this may include energy consumption from systems integral to the building and its operation e.g. lifts, escalators, refrigeration systems, ducted fume cupboards; or energy consumption from operational related equipment e.g. servers, printers, desktops, mobile fume cupboards, cooking and other appliances etc.

'Whole Energy' – energy consumption covered by the Building Regulation as well as energy consumption from any other part of the development, including plant or equipment that is not covered by the Building Regulations.

Appendix B

BRUKL Report - Efficient Baseline

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

UCLH Phase 5

As designed

Date: Fri Feb 20 15:19:35 2015

Administrative information

Building Details

Address: Huntley Street, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

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

Owner Details

Name: University College London Hospital NHS Foundation Trust

Telephone number: 020 3447 9897

Address: Communications Unit, 2nd floor central, 250 Euston Road., NW1 2PG, London, NW1 2PG

Certifier details

Name: Hans Chao

Telephone number: 020 7636 1531

Address: Arup, 13 Fitzroy Street, London, W1T 4BQ

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, $kgCO_2/m^2.annum$	46.8
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	46.8
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	41.2
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	0.3	0.3	L00000C7:Surf[0]
Floor	0.25	0.22	0.22	L00002B1:Surf[0]
Roof	0.25	0.22	0.52	L000023A:Surf[7]
Windows***, roof windows, and rooflights	2.2	2.01	2.01	L0000009:Surf[0]
Personnel doors	2.2	2.16	2.2	L0000233:Surf[1]
Vehicle access & similar large doors	1.5	1.49	1.49	L0000001:Surf[2]
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$] $U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

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

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

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- CAV (Clinical)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	5	0	1.8	0.6
Standard value	0.91*	4.7	N/A	1.6	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for 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- Fan Coil (Min Fresh Air)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	5	0	1.8	0.6
Standard value	0.91*	4.7	N/A	1.6	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for 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- Store Rooms (Ancilliary)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	5	0	1.8	0.6
Standard value	0.91*	4.7	N/A	1.6	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for 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- Plantroom vent

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	-	0	0.7	-
Standard value	0.91	N/A	N/A	1.5	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

5- Dirty Extract

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	-	0	0.7	-
Standard value	0.91	N/A	N/A	1.5	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

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

Local mechanical ventilation, exhaust, and terminal units

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

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
AVR	-	-	-	0.4	-	-	-	1.8	-	-	N/A
AVR	-	-	-	0.4	-	-	-	1.8	-	-	N/A
AVR	-	-	-	0.4	-	-	-	1.8	-	-	N/A
AVR	-	-	-	0.4	-	-	-	1.8	-	-	N/A
AVR	-	-	-	0.4	-	-	-	1.8	-	-	N/A
BCH	-	-	-	0.4	-	-	-	1.8	-	-	N/A
BCH & BF	-	-	-	0.4	-	-	-	1.8	-	-	N/A
BF	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CH	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CH	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CH	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	1.1	-	0.4	1.6	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Clinical Admin	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CM	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CM	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CM	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CM	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
EXTRA	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Extra	-	-	-	0.4	-	-	-	1.8	-	-	N/A
EXTRA	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Extra	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Extra	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Food Preparation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
LOC	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Meeting Room 1	-	-	-	0.4	-	-	-	1.8	-	-	N/A
OPG	-	-	-	0.4	-	-	-	1.8	-	-	N/A
OPG	-	-	-	0.4	-	-	-	1.8	-	-	N/A
OPG	-	-	-	0.4	-	-	-	1.8	-	-	N/A

Zone name	**SFP [W/(l/s)]**									**HR efficiency**	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
OPG	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Photo Studio	-	-	-	0.4	-	-	-	1.8	-	-	N/A
RC	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Reception	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Base	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Base	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Bay	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Bay	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Bay	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Bay	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Change	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
US	-	-	-	0.4	-	-	-	1.8	-	-	N/A
US	-	-	-	0.4	-	-	-	1.8	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Waiting	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting and CAFE	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Room	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Room	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
AVR 01	-	75	-	200
AVR 04	-	75	-	199
AVR 03	-	75	-	201
AVR	-	75	-	131
AVR B 7	-	75	-	132
AVR	-	75	-	128
AVR B 5	-	75	-	133
AVR	-	75	-	200
AVR	-	75	-	123
AVR 02	-	75	-	201
AVR B 1	-	75	-	131
AVR B 10	-	75	-	133
AVR B 9	-	75	-	130
AVR B 8	-	75	-	133
AVR B 2	-	75	-	128
AVR B 4	-	75	-	131
AVR B 3	-	75	-	123
AVR	-	75	-	131
AVR B 6	-	75	-	131
BCH	-	75	-	24
BCH & BF	-	75	-	22
BF	-	75	-	18
Bike Store	75	-	-	97
AVR Booths	-	75	15	278
AVR Booths	-	75	15	159
C/E	-	75	-	196

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
C/E	-	75	-	196
C/E	-	75	-	195
C/E	-	75	-	199
C/E	-	75	-	200
C/E	-	75	-	195
C/E	-	75	-	199
C/E	-	75	-	201
C/E	-	75	-	200
C/E	-	75	-	196
C/E	-	75	-	199
C/E	-	75	-	201
C/E	-	75	-	200
C/E	-	75	-	200
C/E	-	75	-	201
C/E	-	75	-	201
C/E	-	75	-	202
C/E	-	75	-	195
C/E	-	75	-	201
C/E	-	75	-	199
C/E	-	75	-	201
C/E	-	75	-	200
C/E	-	75	-	199
C/E	-	75	-	196
C/E	-	75	-	201
C/E	-	75	-	196
C/E	-	75	-	192
C/E	-	75	-	196
C/E	-	75	-	200
C/E	-	75	-	185
C/E	-	75	-	191
C/E	-	75	-	197
C/E	-	75	-	196
C/E	-	75	-	196
C/E	-	75	-	195
C/E	-	75	-	200
C/E	-	75	-	201
C/E	-	75	-	200
C/E	-	75	-	201
C/E	-	75	-	199
C/E	-	75	-	200
C/E	-	75	-	201
C/E	-	75	-	183
C/E	-	75	-	195

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Cafe Store	75	-	-	44
Central Housekeeping Store	75	-	-	107
Central Waste Store	75	-	-	87
CH	-	75	-	17
CH	-	75	-	17
CH	-	75	-	17
Changing Room	-	75	-	35
Circulation	-	75	-	17
Circulation	-	75	-	377
Circulation	-	75	-	414
Circulation	-	75	-	243
Circulation	-	75	-	243
Circulation	-	75	-	144
Circulation	-	75	-	303
Circulation	-	75	-	469
Circulation	-	75	-	42
Circulation	-	75	-	275
Circulation	-	75	-	42
Circulation	-	75	-	36
Circulation	-	75	-	26
Circulation	-	75	-	45
Circulation	-	75	-	52
Circulation	-	75	-	63
Circulation	-	75	-	31
Circulation	-	75	-	42
Circulation	-	75	-	243
Circulation	-	75	-	334
Circulation	-	75	-	75
Circulation	-	75	-	282
Circulation	-	75	-	75
Circulation	-	75	-	75
Circulation	-	75	-	66
Circulation	-	75	-	415
Circulation	-	75	-	351
Circulation	-	75	-	21
Circulation	-	75	-	20
Circulation	-	75	-	18
Circulation	-	75	-	42
Circulation	-	75	-	333
Circulation	-	75	-	27
Circulation	-	75	-	44
Circulation	-	75	-	45
Circulation	-	75	-	404

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Circulation	-	75	-	32
Circulation	-	75	-	171
Circulation	-	75	-	42
Circulation	-	75	-	58
Circulation	-	75	-	194
Circulation	-	75	-	300
Clean Store	75	-	-	63
Clinical Admin	-	75	-	175
CM	-	75	-	101
CM	-	75	-	99
CM	-	75	-	149
CM	-	75	-	150
Cone CT	-	75	-	201
Corridor	-	75	-	27
Corridor	-	75	-	36
Corridor	-	75	-	27
Corridor	-	75	-	27
Corridor	-	75	-	77
Corridor	-	75	-	27
Corridor	-	75	-	42
Corridor	-	75	-	31
Corridor	-	75	-	36
Corridor	-	75	-	27
Corridor	-	75	-	27
Corridor	-	75	-	52
Corridor	-	75	-	47
Corridor	-	75	-	64
Corridor	-	75	-	20
Corridor	-	75	-	17
CU	75	-	-	50
CU	75	-	-	22
CU	75	-	-	22
CU	75	-	-	37
CU	75	-	-	44
CU	75	-	-	37
Cytology	75	-	-	113
DI	-	75	-	57
Disp Hold Store	75	-	-	63
Disp Hold Store	75	-	-	69
Disp Hold Store	75	-	-	88
Disp Hold Store	75	-	-	69
Disp Hold + FM Store	75	-	-	130
Disp Hold Store	75	-	-	68

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Disp Hold Store	75	-	-	86
Disp Hold Store	75	-	-	86
Disp Hold Store	75	-	-	68
Disp Hold Store	75	-	-	86
DU	-	75	-	40
DU	-	75	-	50
DU	-	75	-	59
DU	-	75	-	50
DU	-	75	-	67
DU + CU	-	75	-	72
DU + DI	-	75	-	41
DU + DI	-	75	-	60
EXTRA	-	75	-	181
Extra	-	75	-	196
EXTRA	-	75	-	185
Extra	-	75	-	200
Extra	-	75	-	200
FM Store	75	-	-	39
FM Store	75	-	-	38
FM Store	75	-	-	40
FM Store	75	-	-	38
Food Preparation	-	75	-	126
Gas Cyling Store	75	-	-	56
Gas Meter	75	-	-	33
Interview Room	75	-	-	103
IT HUB	75	-	-	36
IT HUB	75	-	-	35
IT Hub	75	-	-	35
IT HUB	75	-	-	35
IT HUB	75	-	-	35
IT HUB	75	-	-	35
IT HUB	75	-	-	35
IT HUB	75	-	-	35
LOC	-	75	-	17
Medical Gas	75	-	-	88
Meeting Room 1	75	-	-	249
OPG	-	75	-	292
OPG	-	75	-	400
OPG	-	75	-	292
OPG	-	75	-	406
Phleb	-	75	-	30
Phleb	-	75	-	45
Phleb	-	75	-	31

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Photo Studio	-	75	-	614
Plant	75	-	-	56
Plant	75	-	-	58
Plant	75	-	-	58
Plant Room	75	-	-	652
Plant Room	75	-	-	202
Procedure	-	75	-	639
Procedure	-	75	-	631
Procedure	-	75	-	634
Procedure	-	75	-	630
Procedure	-	75	-	633
Procedure	-	75	-	630
Prone CT	-	75	-	282
RC	-	75	-	141
Reception	-	75	15	312
Recovery Area	-	75	-	356
Recovery R	-	75	-	53
Recovery Room	-	75	-	52
Staff	75	-	-	128
Staff	-	75	15	68
Staff	-	75	15	67
Staff Base	-	75	15	72
Staff Base	-	75	15	69
Staff Bay	-	75	15	79
Staff Bay	-	75	15	79
Staff Bay	-	75	15	79
Staff Bay	-	75	15	68
Staff Breakout	75	-	-	115
Staff Breakout	75	-	-	132
Staff Breakout	75	-	-	132
Staff Breakout	75	-	-	161
Staff Breakout	75	-	-	161
Staff Breakout	75	-	-	161
Staff Change	-	75	-	128
Stairway	-	75	-	54
Stairway	-	75	-	53
Stairway	-	75	-	53
Stairway	-	75	-	77
Stairway	-	75	-	53
Stairway	-	75	-	56
Stairway	-	75	-	56
Stairway	-	75	-	53
Stairway	-	75	-	53

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Stairway	-	75	-	54
Stairway	-	75	-	50
Stairway	-	75	-	53
Stairway	-	75	-	54
Stairway	-	75	-	79
Stairway	-	75	-	54
Stairway	-	75	-	53
Stairway	-	75	-	52
Stairway	-	75	-	53
Stairway	-	75	-	41
Stairway	-	75	-	60
Stairway	-	75	-	54
Store	75	-	-	45
Store	75	-	-	44
Store	75	-	-	25
Store	75	-	-	44
Store	75	-	-	30
Store	75	-	-	45
Store	75	-	-	24
Store	75	-	-	41
Store	75	-	-	38
Store	75	-	-	42
Store	75	-	-	44
Store	75	-	-	35
Store	75	-	-	42
Store	75	-	-	43
Store	75	-	-	44
Store	75	-	-	42
Store	75	-	-	41
Store	75	-	-	44
Store	75	-	-	40
Store	75	-	-	40
Store	75	-	-	44
Store	75	-	-	47
Store	75	-	-	38
Store	75	-	-	45
Store	75	-	-	49
Store	52	-	-	96
Tech + Mould Room	75	-	-	243
Treatment	-	75	-	209
Treatment	-	75	-	201
Treatment	-	75	-	189
Treatment	-	75	-	201

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Treatment	-	75	-	183
Treatment	-	75	-	200
Treatment	-	75	-	201
Treatment	-	75	-	200
Treatment	-	75	-	191
Treatment	-	75	-	201
Treatment	-	75	-	191
Treatment	-	75	-	199
Treatment	-	75	-	197
Treatment	-	75	-	201
Treatment	-	75	-	203
Treatment	-	75	-	203
Treatment	-	75	-	202
Treatment	-	75	-	200
Treatment	-	75	-	200
Treatment	-	75	-	198
Treatment	-	75	-	514
Treatment	-	75	-	513
Treatment	-	75	-	404
Treatment	-	75	-	386
Treatment	-	75	-	200
Treatment	-	75	-	388
Treatment	-	75	-	385
Treatment	-	75	-	378
Treatment	-	75	-	200
Treatment	-	75	-	404
Treatment	-	75	-	171
Treatment	-	75	-	481
Treatment	-	75	-	491
Treatment Bays	-	75	-	470
Treatment Bays	-	75	-	487
Treatment Bays	-	75	-	491
Treatment Bays	-	75	-	163
UKPN Substation	75	-	-	90
UKPN Switchroom	75	-	-	89
US	-	75	-	195
US	-	75	-	199
Vac and Air	-	75	-	219
Vehicle Loading Bay	75	-	-	230
WC	-	75	-	37
WC	-	75	-	42
WC	-	75	-	47
WC	-	75	-	30

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
WC	-	75	-	28
Waiting	-	75	15	1340
Waiting and CAFE	-	75	-	258
Waiting Area	-	75	15	1094
Waiting Area	-	75	15	122
Waiting Area	-	75	15	122
Waiting Area	-	75	15	123
Waiting Area	-	75	15	121
Waiting Area	-	75	15	1340
Waiting Area	-	75	15	367
Waiting Room	-	75	15	296
Waiting Room	-	75	15	1340
WC	-	75	-	45
WC	-	75	-	37
WC	-	75	-	38
WC	-	75	-	27
WC	-	75	-	38
WC	-	75	-	42
WC	-	75	-	28
WC	-	75	-	37
WC	-	75	-	37
WC	-	75	-	45
WC	-	75	-	45
WC	-	75	-	28
WC	-	75	-	48
WC	-	75	-	28
WC	-	75	-	28
WC	-	75	-	26
WC	-	75	-	48
WC	-	75	-	28
WC	-	75	-	28
WC	-	75	-	37
WC	-	75	-	46
WC	-	75	-	37
WC	-	75	-	34
WC	-	75	-	28
WC	-	75	-	26
WC	-	75	-	44
WC	-	75	-	37
WC	-	75	-	30
WC	-	75	-	45
WC	-	75	-	28
WC	-	75	-	28

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
WC	-	75	-	37
WC	-	75	-	45
WC	-	75	-	53
WC	-	75	-	28
WC	-	75	-	30
WC	-	75	-	37
WC	-	75	-	28
WC	-	75	-	37
WC	-	75	-	45
WC	-	75	-	28
WC	-	75	-	28
WC	-	75	-	39
WC	-	75	-	28
WC	-	75	-	29
WC	-	75	-	34
WC	-	75	-	36
WC	-	75	-	30
WC	-	75	-	28
WC	-	75	-	28
WC	-	75	-	37
WC	-	75	-	45
WC	-	75	-	34
WC	-	75	-	28
WC	-	75	-	46
WC	-	75	-	28
WC	-	75	-	27
WC	-	75	-	30
WC	-	75	-	28
WC	-	75	-	29
WC	-	75	-	29
WC	-	75	-	34
WC	-	75	-	34
WC	-	75	-	34
WC	-	75	-	53
WHC Store	75	-	-	25
X Ray	-	75	-	699
Circulation	-	75	-	633
Plant Room	75	-	-	2274
Circulation	-	75	-	147

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?
AVR 01	N/A	N/A
AVR 04	N/A	N/A
AVR 03	N/A	N/A
AVR	N/A	N/A
AVR B 7	N/A	N/A
AVR	N/A	N/A
AVR B 5	N/A	N/A
AVR	N/A	N/A
AVR	N/A	N/A
AVR 02	N/A	N/A
AVR B 1	N/A	N/A
AVR B 10	N/A	N/A
AVR B 9	N/A	N/A
AVR B 8	N/A	N/A
AVR B 2	N/A	N/A
AVR B 4	N/A	N/A
AVR B 3	N/A	N/A
AVR	N/A	N/A
AVR B 6	N/A	N/A
BCH	N/A	N/A
BCH & BF	N/A	N/A
BF	N/A	N/A
Bike Store	N/A	N/A
AVR Booths	N/A	N/A
AVR Booths	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	NO (-92.2%)	YES
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
Cafe Store	N/A	N/A
CH	N/A	N/A
CH	N/A	N/A
CH	N/A	N/A
Changing Room	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-61.3%)	YES
Circulation	NO (-85.9%)	YES
Circulation	NO (-17.5%)	YES
Circulation	YES (+1.1%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-87.8%)	YES
Circulation	NO (-45.6%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-46.4%)	YES
Circulation	NO (-10.1%)	YES

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-85.2%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-84%)	YES
Circulation	NO (-59.9%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-33%)	YES
Circulation	NO (-69.3%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-67.3%)	YES
Circulation	NO (-75.9%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-50.4%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Clean Store	N/A	N/A
Clinical Admin	N/A	N/A
CM	N/A	N/A
CM	N/A	N/A
CM	N/A	N/A
CM	N/A	N/A
Cone CT	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
CU	N/A	N/A
CU	N/A	N/A
CU	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
CU	N/A	N/A
CU	N/A	N/A
CU	N/A	N/A
Cytology	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
EXTRA	N/A	N/A
Extra	N/A	N/A
EXTRA	N/A	N/A
Extra	N/A	N/A
Extra	N/A	N/A
FM Store	N/A	N/A
FM Store	N/A	N/A
FM Store	N/A	N/A
FM Store	N/A	N/A
Food Preparation	N/A	N/A
Interview Room	N/A	N/A
LOC	N/A	N/A
Meeting Room 1	N/A	N/A
OPG	N/A	N/A
OPG	N/A	N/A
OPG	N/A	N/A
OPG	N/A	N/A
Phleb	N/A	N/A
Phleb	N/A	N/A
Phleb	N/A	N/A
Photo Studio	N/A	N/A
Plant Room	N/A	N/A
Procedure	N/A	N/A
Procedure	N/A	N/A
Procedure	N/A	N/A
Procedure	N/A	N/A
Procedure	N/A	N/A
Procedure	N/A	N/A
Prone CT	N/A	N/A
RC	N/A	N/A
Reception	NO (-71.8%)	YES
Recovery Area	N/A	N/A
Recovery R	N/A	N/A
Recovery Room	N/A	N/A
Staff	NO (-86.6%)	YES
Staff	NO (-96.9%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Staff	NO (-96.9%)	NO
Staff Base	NO (-92.5%)	NO
Staff Base	NO (-91.7%)	NO
Staff Bay	NO (-99%)	NO
Staff Bay	NO (-98.7%)	NO
Staff Bay	NO (-99%)	NO
Staff Bay	NO (-96.9%)	NO
Staff Breakout	NO (-84.5%)	YES
Staff Breakout	N/A	N/A
Staff Breakout	N/A	N/A
Staff Breakout	NO (-91.1%)	YES
Staff Breakout	NO (-90.4%)	YES
Staff Breakout	NO (-91.6%)	YES
Staff Change	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	NO (-80.5%)	YES
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	NO (-82.8%)	YES
Stairway	NO (-83.7%)	YES
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	NO (-79.1%)	YES
Stairway	NO (-82.1%)	YES
Stairway	NO (-80.3%)	YES
Stairway	N/A	N/A
Stairway	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A

Zone	**Solar gain limit exceeded? (%)**	**Internal blinds used?**
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Tech + Mould Room	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	NO (-91.2%)	YES
Treatment	N/A	N/A
Treatment	NO (-90.2%)	YES
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment Bays	NO (-99.9%)	NO
Treatment Bays	N/A	N/A
Treatment Bays	NO (-99.8%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Treatment Bays	NO (-100%)	NO
US	N/A	N/A
US	N/A	N/A
Vac and Air	N/A	N/A
Waiting	NO (-79.4%)	YES
Waiting and CAFE	NO (-75.6%)	YES
Waiting Area	NO (-60.6%)	YES
Waiting Area	NO (-25.8%)	YES
Waiting Area	NO (-23.5%)	YES
Waiting Area	NO (-32.7%)	YES
Waiting Area	NO (-24.2%)	YES
Waiting Area	NO (-75.1%)	YES
Waiting Area	N/A	N/A
Waiting Room	NO (-97.4%)	NO
Waiting Room	NO (-80.7%)	YES
WHC Store	NO (-96%)	NO
X Ray	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-92.6%)	YES

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 [m²]	9179.3	9179.3
External area [m²]	8968.9	8968.9
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	5	3
Average conductance [W/K]	4638.89	3782.97
Average U-value [W/m²K]	0.52	0.42
Alpha value* [%]	11.13	10

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

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
99	**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
1	**Others: Miscellaneous 24hr activities**
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	6.23	2.61
Cooling	8.08	14.94
Auxiliary	31.88	27.89
Lighting	34.89	45.7
Hot water	9.04	6.84
Equipment*	111.62	111.62
TOTAL**	**90.13**	**97.97**

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

Energy Production by Technology [kWh/m²]

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

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	188.46	211.9
Primary energy* [kWh/m²]	242.69	276.49
Total emissions [kg/m²]	41.2	46.8

* 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] Constant volume system (fixed fresh air rate), [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	13.2	358.9	3.3	17.2	82.3	1.12	5.8	0.91	6
	Notional	4	461.4	1.3	33.8	56.5	0.86	3.79	----	----
[ST] Central heating using air distribution, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	1.8	0	0.6	0	6.4	0.87	0	0.91	0
	Notional	0.2	0	0.1	0	15.9	0.86	0	----	----
[ST] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	28.3	174.5	9.2	8.4	27.3	0.85	5.8	0.91	6
	Notional	12.3	203.5	4	14.9	27.3	0.86	3.79	----	----
[ST] Central heating using air distribution, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	5	0	1.6	0	3.5	0.87	0	0.91	0
	Notional	0	0	0	0	7.4	0.86	0	----	----
[ST] Constant volume system (variable fresh air rate), [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	4.4	90.2	1.1	4.3	16.4	1.12	5.8	0.91	6
	Notional	2.9	104.7	0.9	7.7	12.5	0.86	3.79	----	----

Key to terms

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

Key Features

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

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.3	L00000C7:Surf[0]
Floor	0.2	0.22	L00002B1:Surf[0]
Roof	0.15	0.18	L00001FE:Surf[0]
Windows, roof windows, and rooflights	1.5	2.01	L0000009:Surf[0]
Personnel doors	1.5	0.64	L0000228:Surf[7]
Vehicle access & similar large doors	1.5	1.49	L0000001:Surf[2]
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	5

Appendix C

BRUKL Report - Low Carbon Baseline

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

UCLH Phase 5

As designed

Date: Fri Feb 20 16:39:29 2015

Administrative information

Building Details

Address: Huntley Street, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

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

Owner Details

Name: University College London Hospital NHS Foundation Trust

Telephone number: 020 3447 9897

Address: Communications Unit, 2nd floor central, 250 Euston Road., NW1 2PG, London, NW1 2PG

Certifier details

Name: Hans Chao

Telephone number: 020 7636 1531

Address: Arup, 13 Fitzroy Street, London, W1T 4BQ

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, $kgCO_2/m^2.annum$	46.8
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	46.8
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	39.9
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	0.3	0.3	L00000C7:Surf[0]
Floor	0.25	0.22	0.22	L00002B1:Surf[0]
Roof	0.25	0.22	0.52	L000023A:Surf[7]
Windows***, roof windows, and rooflights	2.2	2.01	2.01	L0000009:Surf[0]
Personnel doors	2.2	2.16	2.2	L0000233:Surf[1]
Vehicle access & similar large doors	1.5	1.49	1.49	L0000001:Surf[2]
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$] $U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

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

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

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- CAV (Clinical)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	5	0	1.8	0.6
Standard value	0.91*	4.7	N/A	1.6	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for 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- Fan Coil (Min Fresh Air)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	5	0	1.8	0.6
Standard value	0.91*	4.7	N/A	1.6	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for 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- Store Rooms (Ancilliary)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	5	0	1.8	0.6
Standard value	0.91*	4.7	N/A	1.6	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for 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- Plantroom vent

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	-	0	0.7	-
Standard value	0.91	N/A	N/A	1.5	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

5- Dirty Extract

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	-	0	0.7	-
Standard value	0.91	N/A	N/A	1.5	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

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

1- CHECK2-CHP

	CHPQA quality index	**CHP electrical efficiency**
This building	133	0.31
Standard value	105	0.2

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**
AVR	-	-	-	0.4	-	-	-	1.8	-	-	N/A
AVR	-	-	-	0.4	-	-	-	1.8	-	-	N/A
AVR	-	-	-	0.4	-	-	-	1.8	-	-	N/A
AVR	-	-	-	0.4	-	-	-	1.8	-	-	N/A
AVR	-	-	-	0.4	-	-	-	1.8	-	-	N/A
BCH	-	-	-	0.4	-	-	-	1.8	-	-	N/A
BCH & BF	-	-	-	0.4	-	-	-	1.8	-	-	N/A
BF	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CH	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CH	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CH	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A

Zone name	**SFP [W/(l/s)]**									**HR efficiency**	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Clinical Admin	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CM	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CM	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CM	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CM	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A

Zone name	**SFP [W/(l/s)]**									**HR efficiency**	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
EXTRA	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Extra	-	-	-	0.4	-	-	-	1.8	-	-	N/A
EXTRA	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Extra	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Extra	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Food Preparation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
LOC	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Meeting Room 1	-	-	-	0.4	-	-	-	1.8	-	-	N/A
OPG	-	-	-	0.4	-	-	-	1.8	-	-	N/A
OPG	-	-	-	0.4	-	-	-	1.8	-	-	N/A
OPG	-	-	-	0.4	-	-	-	1.8	-	-	N/A
OPG	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Photo Studio	-	-	-	0.4	-	-	-	1.8	-	-	N/A
RC	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Reception	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Base	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Base	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Bay	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Bay	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Bay	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Bay	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Change	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
US	-	-	-	0.4	-	-	-	1.8	-	-	N/A
US	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting and CAFE	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Room	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Room	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
AVR 01	-	75	-	200
AVR 04	-	75	-	199
AVR 03	-	75	-	201
AVR	-	75	-	131
AVR B 7	-	75	-	132
AVR	-	75	-	128
AVR B 5	-	75	-	133
AVR	-	75	-	200
AVR	-	75	-	123
AVR 02	-	75	-	201
AVR B 1	-	75	-	131
AVR B 10	-	75	-	133
AVR B 9	-	75	-	130
AVR B 8	-	75	-	133

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
AVR B 2	-	75	-	128
AVR B 4	-	75	-	131
AVR B 3	-	75	-	123
AVR	-	75	-	131
AVR B 6	-	75	-	131
BCH	-	75	-	24
BCH & BF	-	75	-	22
BF	-	75	-	18
Bike Store	75	-	-	97
AVR Booths	-	75	15	278
AVR Booths	-	75	15	159
C/E	-	75	-	196
C/E	-	75	-	196
C/E	-	75	-	195
C/E	-	75	-	199
C/E	-	75	-	200
C/E	-	75	-	195
C/E	-	75	-	199
C/E	-	75	-	201
C/E	-	75	-	200
C/E	-	75	-	196
C/E	-	75	-	199
C/E	-	75	-	201
C/E	-	75	-	200
C/E	-	75	-	200
C/E	-	75	-	201
C/E	-	75	-	201
C/E	-	75	-	202
C/E	-	75	-	195
C/E	-	75	-	201
C/E	-	75	-	199
C/E	-	75	-	201
C/E	-	75	-	200
C/E	-	75	-	199
C/E	-	75	-	196
C/E	-	75	-	201
C/E	-	75	-	196
C/E	-	75	-	192
C/E	-	75	-	196
C/E	-	75	-	200
C/E	-	75	-	185
C/E	-	75	-	191
C/E	-	75	-	197

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
C/E	-	75	-	196
C/E	-	75	-	196
C/E	-	75	-	195
C/E	-	75	-	200
C/E	-	75	-	201
C/E	-	75	-	200
C/E	-	75	-	201
C/E	-	75	-	199
C/E	-	75	-	200
C/E	-	75	-	201
C/E	-	75	-	183
C/E	-	75	-	195
Cafe Store	75	-	-	44
Central Housekeeping Store	75	-	-	107
Central Waste Store	75	-	-	87
CH	-	75	-	17
CH	-	75	-	17
CH	-	75	-	17
Changing Room	-	75	-	35
Circulation	-	75	-	17
Circulation	-	75	-	377
Circulation	-	75	-	414
Circulation	-	75	-	243
Circulation	-	75	-	243
Circulation	-	75	-	144
Circulation	-	75	-	303
Circulation	-	75	-	469
Circulation	-	75	-	42
Circulation	-	75	-	275
Circulation	-	75	-	42
Circulation	-	75	-	36
Circulation	-	75	-	26
Circulation	-	75	-	45
Circulation	-	75	-	52
Circulation	-	75	-	63
Circulation	-	75	-	31
Circulation	-	75	-	42
Circulation	-	75	-	243
Circulation	-	75	-	334
Circulation	-	75	-	75
Circulation	-	75	-	282
Circulation	-	75	-	75
Circulation	-	75	-	75

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Circulation	-	75	-	66
Circulation	-	75	-	415
Circulation	-	75	-	351
Circulation	-	75	-	21
Circulation	-	75	-	20
Circulation	-	75	-	18
Circulation	-	75	-	42
Circulation	-	75	-	333
Circulation	-	75	-	27
Circulation	-	75	-	44
Circulation	-	75	-	45
Circulation	-	75	-	404
Circulation	-	75	-	32
Circulation	-	75	-	171
Circulation	-	75	-	42
Circulation	-	75	-	58
Circulation	-	75	-	194
Circulation	-	75	-	300
Clean Store	75	-	-	63
Clinical Admin	-	75	-	175
CM	-	75	-	101
CM	-	75	-	99
CM	-	75	-	149
CM	-	75	-	150
Cone CT	-	75	-	201
Corridor	-	75	-	27
Corridor	-	75	-	36
Corridor	-	75	-	27
Corridor	-	75	-	27
Corridor	-	75	-	77
Corridor	-	75	-	27
Corridor	-	75	-	42
Corridor	-	75	-	31
Corridor	-	75	-	36
Corridor	-	75	-	27
Corridor	-	75	-	27
Corridor	-	75	-	52
Corridor	-	75	-	47
Corridor	-	75	-	64
Corridor	-	75	-	20
Corridor	-	75	-	17
CU	75	-	-	50
CU	75	-	-	22

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
CU	75	-	-	22
CU	75	-	-	37
CU	75	-	-	44
CU	75	-	-	37
Cytology	75	-	-	113
DI	-	75	-	57
Disp Hold Store	75	-	-	63
Disp Hold Store	75	-	-	69
Disp Hold Store	75	-	-	88
Disp Hold Store	75	-	-	69
Disp Hold + FM Store	75	-	-	130
Disp Hold Store	75	-	-	68
Disp Hold Store	75	-	-	86
Disp Hold Store	75	-	-	86
Disp Hold Store	75	-	-	68
Disp Hold Store	75	-	-	86
DU	-	75	-	40
DU	-	75	-	50
DU	-	75	-	59
DU	-	75	-	50
DU	-	75	-	67
DU + CU	-	75	-	72
DU + DI	-	75	-	41
DU + DI	-	75	-	60
EXTRA	-	75	-	181
Extra	-	75	-	196
EXTRA	-	75	-	185
Extra	-	75	-	200
Extra	-	75	-	200
FM Store	75	-	-	39
FM Store	75	-	-	38
FM Store	75	-	-	40
FM Store	75	-	-	38
Food Preparation	-	75	-	126
Gas Cyling Store	75	-	-	56
Gas Meter	75	-	-	33
Interview Room	75	-	-	103
IT HUB	75	-	-	36
IT HUB	75	-	-	35
IT Hub	75	-	-	35
IT HUB	75	-	-	35
IT HUB	75	-	-	35
IT HUB	75	-	-	35

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
IT HUB	75	-	-	35
IT HUB	75	-	-	35
LOC	-	75	-	17
Medical Gas	75	-	-	88
Meeting Room 1	75	-	-	249
OPG	-	75	-	292
OPG	-	75	-	400
OPG	-	75	-	292
OPG	-	75	-	406
Phleb	-	75	-	30
Phleb	-	75	-	45
Phleb	-	75	-	31
Photo Studio	-	75	-	614
Plant	75	-	-	56
Plant	75	-	-	58
Plant	75	-	-	58
Plant Room	75	-	-	652
Plant Room	75	-	-	202
Procedure	-	75	-	639
Procedure	-	75	-	631
Procedure	-	75	-	634
Procedure	-	75	-	630
Procedure	-	75	-	633
Procedure	-	75	-	630
Prone CT	-	75	-	282
RC	-	75	-	141
Reception	-	75	15	312
Recovery Area	-	75	-	356
Recovery R	-	75	-	53
Recovery Room	-	75	-	52
Staff	75	-	-	128
Staff	-	75	15	68
Staff	-	75	15	67
Staff Base	-	75	15	72
Staff Base	-	75	15	69
Staff Bay	-	75	15	79
Staff Bay	-	75	15	79
Staff Bay	-	75	15	79
Staff Bay	-	75	15	68
Staff Breakout	75	-	-	115
Staff Breakout	75	-	-	132
Staff Breakout	75	-	-	132
Staff Breakout	75	-	-	161

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Staff Breakout	75	-	-	161
Staff Breakout	75	-	-	161
Staff Change	-	75	-	128
Stairway	-	75	-	54
Stairway	-	75	-	53
Stairway	-	75	-	53
Stairway	-	75	-	77
Stairway	-	75	-	53
Stairway	-	75	-	56
Stairway	-	75	-	56
Stairway	-	75	-	53
Stairway	-	75	-	53
Stairway	-	75	-	54
Stairway	-	75	-	50
Stairway	-	75	-	53
Stairway	-	75	-	54
Stairway	-	75	-	79
Stairway	-	75	-	54
Stairway	-	75	-	53
Stairway	-	75	-	52
Stairway	-	75	-	53
Stairway	-	75	-	41
Stairway	-	75	-	60
Stairway	-	75	-	54
Store	75	-	-	45
Store	75	-	-	44
Store	75	-	-	25
Store	75	-	-	44
Store	75	-	-	30
Store	75	-	-	45
Store	75	-	-	24
Store	75	-	-	41
Store	75	-	-	38
Store	75	-	-	42
Store	75	-	-	44
Store	75	-	-	35
Store	75	-	-	42
Store	75	-	-	43
Store	75	-	-	44
Store	75	-	-	42
Store	75	-	-	41
Store	75	-	-	44
Store	75	-	-	40

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Store	75	-	-	40
Store	75	-	-	44
Store	75	-	-	47
Store	75	-	-	38
Store	75	-	-	45
Store	75	-	-	49
Store	52	-	-	96
Tech + Mould Room	75	-	-	243
Treatment	-	75	-	209
Treatment	-	75	-	201
Treatment	-	75	-	189
Treatment	-	75	-	201
Treatment	-	75	-	183
Treatment	-	75	-	200
Treatment	-	75	-	201
Treatment	-	75	-	200
Treatment	-	75	-	191
Treatment	-	75	-	201
Treatment	-	75	-	191
Treatment	-	75	-	199
Treatment	-	75	-	197
Treatment	-	75	-	201
Treatment	-	75	-	203
Treatment	-	75	-	203
Treatment	-	75	-	202
Treatment	-	75	-	200
Treatment	-	75	-	200
Treatment	-	75	-	198
Treatment	-	75	-	514
Treatment	-	75	-	513
Treatment	-	75	-	404
Treatment	-	75	-	386
Treatment	-	75	-	200
Treatment	-	75	-	388
Treatment	-	75	-	385
Treatment	-	75	-	378
Treatment	-	75	-	200
Treatment	-	75	-	404
Treatment	-	75	-	171
Treatment	-	75	-	481
Treatment	-	75	-	491
Treatment Bays	-	75	-	470
Treatment Bays	-	75	-	487

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Treatment Bays	-	75	-	491
Treatment Bays	-	75	-	163
UKPN Substation	75	-	-	90
UKPN Switchroom	75	-	-	89
US	-	75	-	195
US	-	75	-	199
Vac and Air	-	75	-	219
Vehicle Loading Bay	75	-	-	230
WC	-	75	-	37
WC	-	75	-	42
WC	-	75	-	47
WC	-	75	-	30
WC	-	75	-	28
Waiting	-	75	15	1340
Waiting and CAFE	-	75	-	258
Waiting Area	-	75	15	1094
Waiting Area	-	75	15	122
Waiting Area	-	75	15	122
Waiting Area	-	75	15	123
Waiting Area	-	75	15	121
Waiting Area	-	75	15	1340
Waiting Area	-	75	15	367
Waiting Room	-	75	15	296
Waiting Room	-	75	15	1340
WC	-	75	-	45
WC	-	75	-	37
WC	-	75	-	38
WC	-	75	-	27
WC	-	75	-	38
WC	-	75	-	42
WC	-	75	-	28
WC	-	75	-	37
WC	-	75	-	37
WC	-	75	-	45
WC	-	75	-	45
WC	-	75	-	28
WC	-	75	-	48
WC	-	75	-	28
WC	-	75	-	28
WC	-	75	-	26
WC	-	75	-	48
WC	-	75	-	28
WC	-	75	-	28

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
WC	-	75	-	37
WC	-	75	-	46
WC	-	75	-	37
WC	-	75	-	34
WC	-	75	-	28
WC	-	75	-	26
WC	-	75	-	44
WC	-	75	-	37
WC	-	75	-	30
WC	-	75	-	45
WC	-	75	-	28
WC	-	75	-	28
WC	-	75	-	37
WC	-	75	-	45
WC	-	75	-	53
WC	-	75	-	28
WC	-	75	-	30
WC	-	75	-	37
WC	-	75	-	28
WC	-	75	-	37
WC	-	75	-	45
WC	-	75	-	28
WC	-	75	-	28
WC	-	75	-	39
WC	-	75	-	28
WC	-	75	-	29
WC	-	75	-	34
WC	-	75	-	36
WC	-	75	-	30
WC	-	75	-	28
WC	-	75	-	28
WC	-	75	-	37
WC	-	75	-	45
WC	-	75	-	34
WC	-	75	-	28
WC	-	75	-	46
WC	-	75	-	28
WC	-	75	-	27
WC	-	75	-	30
WC	-	75	-	28
WC	-	75	-	29
WC	-	75	-	29
WC	-	75	-	34

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
WC	-	75	-	34
WC	-	75	-	34
WC	-	75	-	53
WHC Store	75	-	-	25
X Ray	-	75	-	699
Circulation	-	75	-	633
Plant Room	75	-	-	2274
Circulation	-	75	-	147

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?
AVR 01	N/A	N/A
AVR 04	N/A	N/A
AVR 03	N/A	N/A
AVR	N/A	N/A
AVR B 7	N/A	N/A
AVR	N/A	N/A
AVR B 5	N/A	N/A
AVR	N/A	N/A
AVR	N/A	N/A
AVR 02	N/A	N/A
AVR B 1	N/A	N/A
AVR B 10	N/A	N/A
AVR B 9	N/A	N/A
AVR B 8	N/A	N/A
AVR B 2	N/A	N/A
AVR B 4	N/A	N/A
AVR B 3	N/A	N/A
AVR	N/A	N/A
AVR B 6	N/A	N/A
BCH	N/A	N/A
BCH & BF	N/A	N/A
BF	N/A	N/A
Bike Store	N/A	N/A
AVR Booths	N/A	N/A
AVR Booths	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	NO (-92.2%)	YES
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
Cafe Store	N/A	N/A
CH	N/A	N/A
CH	N/A	N/A
CH	N/A	N/A
Changing Room	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-61.3%)	YES
Circulation	NO (-85.9%)	YES
Circulation	NO (-17.5%)	YES
Circulation	YES (+1.1%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Circulation	NO (-87.8%)	YES
Circulation	NO (-45.6%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-46.4%)	YES
Circulation	NO (-10.1%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-85.2%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-84%)	YES
Circulation	NO (-59.9%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-33%)	YES
Circulation	NO (-69.3%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-67.3%)	YES
Circulation	NO (-75.9%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-50.4%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Clean Store	N/A	N/A
Clinical Admin	N/A	N/A
CM	N/A	N/A
CM	N/A	N/A
CM	N/A	N/A
CM	N/A	N/A
Cone CT	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
CU	N/A	N/A
CU	N/A	N/A
CU	N/A	N/A
CU	N/A	N/A
CU	N/A	N/A
CU	N/A	N/A
Cytology	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
EXTRA	N/A	N/A
Extra	N/A	N/A
EXTRA	N/A	N/A
Extra	N/A	N/A
Extra	N/A	N/A
FM Store	N/A	N/A
FM Store	N/A	N/A
FM Store	N/A	N/A
FM Store	N/A	N/A
Food Preparation	N/A	N/A
Interview Room	N/A	N/A
LOC	N/A	N/A
Meeting Room 1	N/A	N/A
OPG	N/A	N/A
OPG	N/A	N/A
OPG	N/A	N/A
OPG	N/A	N/A
Phleb	N/A	N/A
Phleb	N/A	N/A
Phleb	N/A	N/A
Photo Studio	N/A	N/A
Plant Room	N/A	N/A
Procedure	N/A	N/A
Procedure	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Procedure	N/A	N/A
Procedure	N/A	N/A
Procedure	N/A	N/A
Procedure	N/A	N/A
Prone CT	N/A	N/A
RC	N/A	N/A
Reception	NO (-71.8%)	YES
Recovery Area	N/A	N/A
Recovery R	N/A	N/A
Recovery Room	N/A	N/A
Staff	NO (-86.6%)	YES
Staff	NO (-96.9%)	NO
Staff	NO (-96.9%)	NO
Staff Base	NO (-92.5%)	NO
Staff Base	NO (-91.7%)	NO
Staff Bay	NO (-99%)	NO
Staff Bay	NO (-98.7%)	NO
Staff Bay	NO (-99%)	NO
Staff Bay	NO (-96.9%)	NO
Staff Breakout	NO (-84.5%)	YES
Staff Breakout	N/A	N/A
Staff Breakout	N/A	N/A
Staff Breakout	NO (-91.1%)	YES
Staff Breakout	NO (-90.4%)	YES
Staff Breakout	NO (-91.6%)	YES
Staff Change	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	NO (-80.5%)	YES
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	NO (-82.8%)	YES
Stairway	NO (-83.7%)	YES
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	NO (-79.1%)	YES
Stairway	NO (-82.1%)	YES
Stairway	NO (-80.3%)	YES
Stairway	N/A	N/A
Stairway	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Tech + Mould Room	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	NO (-91.2%)	YES
Treatment	N/A	N/A
Treatment	NO (-90.2%)	YES
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment Bays	NO (-99.9%)	NO
Treatment Bays	N/A	N/A
Treatment Bays	NO (-99.8%)	NO
Treatment Bays	NO (-100%)	NO
US	N/A	N/A
US	N/A	N/A
Vac and Air	N/A	N/A
Waiting	NO (-79.4%)	YES
Waiting and CAFE	NO (-75.6%)	YES
Waiting Area	NO (-60.6%)	YES
Waiting Area	NO (-25.8%)	YES
Waiting Area	NO (-23.5%)	YES
Waiting Area	NO (-32.7%)	YES
Waiting Area	NO (-24.2%)	YES
Waiting Area	NO (-75.1%)	YES
Waiting Area	N/A	N/A
Waiting Room	NO (-97.4%)	NO
Waiting Room	NO (-80.7%)	YES
WHC Store	NO (-96%)	NO
X Ray	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-92.6%)	YES

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 [m²]	9179.3	9179.3
External area [m²]	8968.9	8968.9
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	5	3
Average conductance [W/K]	4638.89	3782.97
Average U-value [W/m²K]	0.52	0.42
Alpha value* [%]	11.13	10

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

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
99	**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
1	**Others: Miscellaneous 24hr activities**
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	8.56	2.61
Cooling	8.08	14.94
Auxiliary	31.88	27.89
Lighting	34.89	45.7
Hot water	14.2	6.84
Equipment*	111.62	111.62
TOTAL**	**92.09**	**97.97**

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

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	5.52	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	188.46	211.9
Primary energy* [kWh/m²]	234.87	276.49
Total emissions [kg/m²]	39.9	46.8

* 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] Constant volume system (fixed fresh air rate), [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	13.2	358.9	1.9	17.2	82.3	1.12	5.8	0.91	6
	Notional	4	461.4	1.3	33.8	56.5	0.86	3.79	----	----
[ST] Central heating using air distribution, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	1.8	0	0.3	0	6.4	0.87	0	0.91	0
	Notional	0.2	0	0.1	0	15.9	0.86	0	----	----
[ST] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	28.3	174.5	4.8	8.4	27.3	0.85	5.8	0.91	6
	Notional	12.3	203.5	4	14.9	27.3	0.86	3.79	----	----
[ST] Central heating using air distribution, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	5	0	0.8	0	3.5	0.87	0	0.91	0
	Notional	0	0	0	0	7.4	0.86	0	----	----
[ST] Constant volume system (variable fresh air rate), [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	4.4	90.2	0.7	4.3	16.4	1.12	5.8	0.91	6
	Notional	2.9	104.7	0.9	7.7	12.5	0.86	3.79	----	----

Key to terms

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

Key Features

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

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.3	L00000C7:Surf[0]
Floor	0.2	0.22	L00002B1:Surf[0]
Roof	0.15	0.18	L00001FE:Surf[0]
Windows, roof windows, and rooflights	1.5	2.01	L0000009:Surf[0]
Personnel doors	1.5	0.64	L0000228:Surf[7]
Vehicle access & similar large doors	1.5	1.49	L0000001:Surf[2]
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	5

Appendix D

BRUKL Report - Renewables Baseline

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

UCLH Phase 5

As designed

Date: Tue Feb 24 12:38:09 2015

Administrative information

Building Details

Address: Huntley Street, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

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

Owner Details

Name: University College London Hospital NHS Foundation Trust

Telephone number: 020 3447 9897

Address: Communications Unit, 2nd floor central, 250 Euston Road., NW1 2PG, London, NW1 2PG

Certifier details

Name: Hans Chao

Telephone number: 020 7636 1531

Address: Arup, 13 Fitzroy Street, London, W1T 4BQ

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, $kgCO_2/m^2.annum$	46.8
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	46.8
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	39.6
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	0.3	0.3	L00000C7:Surf[0]
Floor	0.25	0.22	0.22	L00002B1:Surf[0]
Roof	0.25	0.22	0.52	L000023A:Surf[7]
Windows***, roof windows, and rooflights	2.2	2.01	2.01	L0000009:Surf[0]
Personnel doors	2.2	2.16	2.2	L0000233:Surf[1]
Vehicle access & similar large doors	1.5	1.49	1.49	L0000001:Surf[2]
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$] $U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

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

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

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- CAV (Clinical)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	5	0	1.8	0.6
Standard value	0.91*	4.7	N/A	1.6	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for 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- Fan Coil (Min Fresh Air)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	5	0	1.8	0.6
Standard value	0.91*	4.7	N/A	1.6	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for 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- Store Rooms (Ancilliary)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	5	0	1.8	0.6
Standard value	0.91*	4.7	N/A	1.6	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for 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- Plantroom vent

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	-	0	0.7	-
Standard value	0.91	N/A	N/A	1.5	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

5- Dirty Extract

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	-	0	0.7	-
Standard value	0.91	N/A	N/A	1.5	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

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

1- CHECK2-CHP

	CHPQA quality index	**CHP electrical efficiency**
This building	133	0.31
Standard value	105	0.2

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
AVR	-	-	-	0.4	-	-	-	1.8	-	-	N/A
AVR	-	-	-	0.4	-	-	-	1.8	-	-	N/A
AVR	-	-	-	0.4	-	-	-	1.8	-	-	N/A
AVR	-	-	-	0.4	-	-	-	1.8	-	-	N/A
AVR	-	-	-	0.4	-	-	-	1.8	-	-	N/A
BCH	-	-	-	0.4	-	-	-	1.8	-	-	N/A
BCH & BF	-	-	-	0.4	-	-	-	1.8	-	-	N/A
BF	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A

Zone name	**SFP [W/(l/s)]**									**HR efficiency**	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
C/E	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CH	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CH	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CH	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Clinical Admin	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CM	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CM	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CM	-	-	-	0.4	-	-	-	1.8	-	-	N/A
CM	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A

Zone name	**SFP [W/(l/s)]**									**HR efficiency**	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
Corridor	-	-	-	0.4	-	-	-	1.8	-	-	N/A
EXTRA	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Extra	-	-	-	0.4	-	-	-	1.8	-	-	N/A
EXTRA	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Extra	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Extra	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Food Preparation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
LOC	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Meeting Room 1	-	-	-	0.4	-	-	-	1.8	-	-	N/A
OPG	-	-	-	0.4	-	-	-	1.8	-	-	N/A
OPG	-	-	-	0.4	-	-	-	1.8	-	-	N/A
OPG	-	-	-	0.4	-	-	-	1.8	-	-	N/A
OPG	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Photo Studio	-	-	-	0.4	-	-	-	1.8	-	-	N/A
RC	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Reception	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Base	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Base	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Bay	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Bay	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Bay	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Bay	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Breakout	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Staff Change	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A

Zone name	**SFP [W/(l/s)]**									**HR efficiency**	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Stairway	-	-	-	0.4	-	-	-	1.8	-	-	N/A
US	-	-	-	0.4	-	-	-	1.8	-	-	N/A
US	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting and CAFE	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Area	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Room	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Waiting Room	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A
Circulation	-	-	-	0.4	-	-	-	1.8	-	-	N/A

General lighting and display lighting	**Luminous efficacy [lm/W]**			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
AVR 01	-	75	-	200
AVR 04	-	75	-	199
AVR 03	-	75	-	201
AVR	-	75	-	131
AVR B 7	-	75	-	132
AVR	-	75	-	128
AVR B 5	-	75	-	133
AVR	-	75	-	200
AVR	-	75	-	123
AVR 02	-	75	-	201
AVR B 1	-	75	-	131
AVR B 10	-	75	-	133
AVR B 9	-	75	-	130
AVR B 8	-	75	-	133

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
AVR B 2	-	75	-	128
AVR B 4	-	75	-	131
AVR B 3	-	75	-	123
AVR	-	75	-	131
AVR B 6	-	75	-	131
BCH	-	75	-	24
BCH & BF	-	75	-	22
BF	-	75	-	18
Bike Store	75	-	-	97
AVR Booths	-	75	15	278
AVR Booths	-	75	15	159
C/E	-	75	-	196
C/E	-	75	-	196
C/E	-	75	-	195
C/E	-	75	-	199
C/E	-	75	-	200
C/E	-	75	-	195
C/E	-	75	-	199
C/E	-	75	-	201
C/E	-	75	-	200
C/E	-	75	-	196
C/E	-	75	-	199
C/E	-	75	-	201
C/E	-	75	-	200
C/E	-	75	-	200
C/E	-	75	-	201
C/E	-	75	-	201
C/E	-	75	-	202
C/E	-	75	-	195
C/E	-	75	-	201
C/E	-	75	-	199
C/E	-	75	-	201
C/E	-	75	-	200
C/E	-	75	-	199
C/E	-	75	-	196
C/E	-	75	-	201
C/E	-	75	-	196
C/E	-	75	-	192
C/E	-	75	-	196
C/E	-	75	-	200
C/E	-	75	-	185
C/E	-	75	-	191
C/E	-	75	-	197

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
C/E	-	75	-	196
C/E	-	75	-	196
C/E	-	75	-	195
C/E	-	75	-	200
C/E	-	75	-	201
C/E	-	75	-	200
C/E	-	75	-	201
C/E	-	75	-	199
C/E	-	75	-	200
C/E	-	75	-	201
C/E	-	75	-	183
C/E	-	75	-	195
Cafe Store	75	-	-	44
Central Housekeeping Store	75	-	-	107
Central Waste Store	75	-	-	87
CH	-	75	-	17
CH	-	75	-	17
CH	-	75	-	17
Changing Room	-	75	-	35
Circulation	-	75	-	17
Circulation	-	75	-	377
Circulation	-	75	-	414
Circulation	-	75	-	243
Circulation	-	75	-	243
Circulation	-	75	-	144
Circulation	-	75	-	303
Circulation	-	75	-	469
Circulation	-	75	-	42
Circulation	-	75	-	275
Circulation	-	75	-	42
Circulation	-	75	-	36
Circulation	-	75	-	26
Circulation	-	75	-	45
Circulation	-	75	-	52
Circulation	-	75	-	63
Circulation	-	75	-	31
Circulation	-	75	-	42
Circulation	-	75	-	243
Circulation	-	75	-	334
Circulation	-	75	-	75
Circulation	-	75	-	282
Circulation	-	75	-	75
Circulation	-	75	-	75

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Circulation	-	75	-	66
Circulation	-	75	-	415
Circulation	-	75	-	351
Circulation	-	75	-	21
Circulation	-	75	-	20
Circulation	-	75	-	18
Circulation	-	75	-	42
Circulation	-	75	-	333
Circulation	-	75	-	27
Circulation	-	75	-	44
Circulation	-	75	-	45
Circulation	-	75	-	404
Circulation	-	75	-	32
Circulation	-	75	-	171
Circulation	-	75	-	42
Circulation	-	75	-	58
Circulation	-	75	-	194
Circulation	-	75	-	300
Clean Store	75	-	-	63
Clinical Admin	-	75	-	175
CM	-	75	-	101
CM	-	75	-	99
CM	-	75	-	149
CM	-	75	-	150
Cone CT	-	75	-	201
Corridor	-	75	-	27
Corridor	-	75	-	36
Corridor	-	75	-	27
Corridor	-	75	-	27
Corridor	-	75	-	77
Corridor	-	75	-	27
Corridor	-	75	-	42
Corridor	-	75	-	31
Corridor	-	75	-	36
Corridor	-	75	-	27
Corridor	-	75	-	27
Corridor	-	75	-	52
Corridor	-	75	-	47
Corridor	-	75	-	64
Corridor	-	75	-	20
Corridor	-	75	-	17
CU	75	-	-	50
CU	75	-	-	22

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
CU	75	-	-	22
CU	75	-	-	37
CU	75	-	-	44
CU	75	-	-	37
Cytology	75	-	-	113
DI	-	75	-	57
Disp Hold Store	75	-	-	63
Disp Hold Store	75	-	-	69
Disp Hold Store	75	-	-	88
Disp Hold Store	75	-	-	69
Disp Hold + FM Store	75	-	-	130
Disp Hold Store	75	-	-	68
Disp Hold Store	75	-	-	86
Disp Hold Store	75	-	-	86
Disp Hold Store	75	-	-	68
Disp Hold Store	75	-	-	86
DU	-	75	-	40
DU	-	75	-	50
DU	-	75	-	59
DU	-	75	-	50
DU	-	75	-	67
DU + CU	-	75	-	72
DU + DI	-	75	-	41
DU + DI	-	75	-	60
EXTRA	-	75	-	181
Extra	-	75	-	196
EXTRA	-	75	-	185
Extra	-	75	-	200
Extra	-	75	-	200
FM Store	75	-	-	39
FM Store	75	-	-	38
FM Store	75	-	-	40
FM Store	75	-	-	38
Food Preparation	-	75	-	126
Gas Cyling Store	75	-	-	56
Gas Meter	75	-	-	33
Interview Room	75	-	-	103
IT HUB	75	-	-	36
IT HUB	75	-	-	35
IT Hub	75	-	-	35
IT HUB	75	-	-	35
IT HUB	75	-	-	35
IT HUB	75	-	-	35

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
IT HUB	75	-	-	35
IT HUB	75	-	-	35
LOC	-	75	-	17
Medical Gas	75	-	-	88
Meeting Room 1	75	-	-	249
OPG	-	75	-	292
OPG	-	75	-	400
OPG	-	75	-	292
OPG	-	75	-	406
Phleb	-	75	-	30
Phleb	-	75	-	45
Phleb	-	75	-	31
Photo Studio	-	75	-	614
Plant	75	-	-	56
Plant	75	-	-	58
Plant	75	-	-	58
Plant Room	75	-	-	652
Plant Room	75	-	-	202
Procedure	-	75	-	639
Procedure	-	75	-	631
Procedure	-	75	-	634
Procedure	-	75	-	630
Procedure	-	75	-	633
Procedure	-	75	-	630
Prone CT	-	75	-	282
RC	-	75	-	141
Reception	-	75	15	312
Recovery Area	-	75	-	356
Recovery R	-	75	-	53
Recovery Room	-	75	-	52
Staff	75	-	-	128
Staff	-	75	15	68
Staff	-	75	15	67
Staff Base	-	75	15	72
Staff Base	-	75	15	69
Staff Bay	-	75	15	79
Staff Bay	-	75	15	79
Staff Bay	-	75	15	79
Staff Bay	-	75	15	68
Staff Breakout	75	-	-	115
Staff Breakout	75	-	-	132
Staff Breakout	75	-	-	132
Staff Breakout	75	-	-	161

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Staff Breakout	75	-	-	161
Staff Breakout	75	-	-	161
Staff Change	-	75	-	128
Stairway	-	75	-	54
Stairway	-	75	-	53
Stairway	-	75	-	53
Stairway	-	75	-	77
Stairway	-	75	-	53
Stairway	-	75	-	56
Stairway	-	75	-	56
Stairway	-	75	-	53
Stairway	-	75	-	53
Stairway	-	75	-	54
Stairway	-	75	-	50
Stairway	-	75	-	53
Stairway	-	75	-	54
Stairway	-	75	-	79
Stairway	-	75	-	54
Stairway	-	75	-	53
Stairway	-	75	-	52
Stairway	-	75	-	53
Stairway	-	75	-	41
Stairway	-	75	-	60
Stairway	-	75	-	54
Store	75	-	-	45
Store	75	-	-	44
Store	75	-	-	25
Store	75	-	-	44
Store	75	-	-	30
Store	75	-	-	45
Store	75	-	-	24
Store	75	-	-	41
Store	75	-	-	38
Store	75	-	-	42
Store	75	-	-	44
Store	75	-	-	35
Store	75	-	-	42
Store	75	-	-	43
Store	75	-	-	44
Store	75	-	-	42
Store	75	-	-	41
Store	75	-	-	44
Store	75	-	-	40

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Store	75	-	-	40
Store	75	-	-	44
Store	75	-	-	47
Store	75	-	-	38
Store	75	-	-	45
Store	75	-	-	49
Store	52	-	-	96
Tech + Mould Room	75	-	-	243
Treatment	-	75	-	209
Treatment	-	75	-	201
Treatment	-	75	-	189
Treatment	-	75	-	201
Treatment	-	75	-	183
Treatment	-	75	-	200
Treatment	-	75	-	201
Treatment	-	75	-	200
Treatment	-	75	-	191
Treatment	-	75	-	201
Treatment	-	75	-	191
Treatment	-	75	-	199
Treatment	-	75	-	197
Treatment	-	75	-	201
Treatment	-	75	-	203
Treatment	-	75	-	203
Treatment	-	75	-	202
Treatment	-	75	-	200
Treatment	-	75	-	200
Treatment	-	75	-	198
Treatment	-	75	-	514
Treatment	-	75	-	513
Treatment	-	75	-	404
Treatment	-	75	-	386
Treatment	-	75	-	200
Treatment	-	75	-	388
Treatment	-	75	-	385
Treatment	-	75	-	378
Treatment	-	75	-	200
Treatment	-	75	-	404
Treatment	-	75	-	171
Treatment	-	75	-	481
Treatment	-	75	-	491
Treatment Bays	-	75	-	470
Treatment Bays	-	75	-	487

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Treatment Bays	-	75	-	491
Treatment Bays	-	75	-	163
UKPN Substation	75	-	-	90
UKPN Switchroom	75	-	-	89
US	-	75	-	195
US	-	75	-	199
Vac and Air	-	75	-	219
Vehicle Loading Bay	75	-	-	230
WC	-	75	-	37
WC	-	75	-	42
WC	-	75	-	47
WC	-	75	-	30
WC	-	75	-	28
Waiting	-	75	15	1340
Waiting and CAFE	-	75	-	258
Waiting Area	-	75	15	1094
Waiting Area	-	75	15	122
Waiting Area	-	75	15	122
Waiting Area	-	75	15	123
Waiting Area	-	75	15	121
Waiting Area	-	75	15	1340
Waiting Area	-	75	15	367
Waiting Room	-	75	15	296
Waiting Room	-	75	15	1340
WC	-	75	-	45
WC	-	75	-	37
WC	-	75	-	38
WC	-	75	-	27
WC	-	75	-	38
WC	-	75	-	42
WC	-	75	-	28
WC	-	75	-	37
WC	-	75	-	37
WC	-	75	-	45
WC	-	75	-	45
WC	-	75	-	28
WC	-	75	-	48
WC	-	75	-	28
WC	-	75	-	28
WC	-	75	-	26
WC	-	75	-	48
WC	-	75	-	28
WC	-	75	-	28

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
WC	-	75	-	37
WC	-	75	-	46
WC	-	75	-	37
WC	-	75	-	34
WC	-	75	-	28
WC	-	75	-	26
WC	-	75	-	44
WC	-	75	-	37
WC	-	75	-	30
WC	-	75	-	45
WC	-	75	-	28
WC	-	75	-	28
WC	-	75	-	37
WC	-	75	-	45
WC	-	75	-	53
WC	-	75	-	28
WC	-	75	-	30
WC	-	75	-	37
WC	-	75	-	28
WC	-	75	-	37
WC	-	75	-	45
WC	-	75	-	28
WC	-	75	-	28
WC	-	75	-	39
WC	-	75	-	28
WC	-	75	-	29
WC	-	75	-	34
WC	-	75	-	36
WC	-	75	-	30
WC	-	75	-	28
WC	-	75	-	28
WC	-	75	-	37
WC	-	75	-	45
WC	-	75	-	34
WC	-	75	-	28
WC	-	75	-	46
WC	-	75	-	28
WC	-	75	-	27
WC	-	75	-	30
WC	-	75	-	28
WC	-	75	-	29
WC	-	75	-	29
WC	-	75	-	34

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
WC	-	75	-	34
WC	-	75	-	34
WC	-	75	-	53
WHC Store	75	-	-	25
X Ray	-	75	-	699
Circulation	-	75	-	633
Plant Room	75	-	-	2274
Circulation	-	75	-	147

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?
AVR 01	N/A	N/A
AVR 04	N/A	N/A
AVR 03	N/A	N/A
AVR	N/A	N/A
AVR B 7	N/A	N/A
AVR	N/A	N/A
AVR B 5	N/A	N/A
AVR	N/A	N/A
AVR	N/A	N/A
AVR 02	N/A	N/A
AVR B 1	N/A	N/A
AVR B 10	N/A	N/A
AVR B 9	N/A	N/A
AVR B 8	N/A	N/A
AVR B 2	N/A	N/A
AVR B 4	N/A	N/A
AVR B 3	N/A	N/A
AVR	N/A	N/A
AVR B 6	N/A	N/A
BCH	N/A	N/A
BCH & BF	N/A	N/A
BF	N/A	N/A
Bike Store	N/A	N/A
AVR Booths	N/A	N/A
AVR Booths	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	NO (-92.2%)	YES
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
C/E	N/A	N/A
Cafe Store	N/A	N/A
CH	N/A	N/A
CH	N/A	N/A
CH	N/A	N/A
Changing Room	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-61.3%)	YES
Circulation	NO (-85.9%)	YES
Circulation	NO (-17.5%)	YES
Circulation	YES (+1.1%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Circulation	NO (-87.8%)	YES
Circulation	NO (-45.6%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-46.4%)	YES
Circulation	NO (-10.1%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-85.2%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-84%)	YES
Circulation	NO (-59.9%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-33%)	YES
Circulation	NO (-69.3%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-67.3%)	YES
Circulation	NO (-75.9%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-50.4%)	YES
Circulation	N/A	N/A
Circulation	N/A	N/A
Circulation	N/A	N/A
Clean Store	N/A	N/A
Clinical Admin	N/A	N/A
CM	N/A	N/A
CM	N/A	N/A
CM	N/A	N/A
CM	N/A	N/A
Cone CT	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
Corridor	N/A	N/A
CU	N/A	N/A
CU	N/A	N/A
CU	N/A	N/A
CU	N/A	N/A
CU	N/A	N/A
CU	N/A	N/A
Cytology	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
Disp Hold Store	N/A	N/A
EXTRA	N/A	N/A
Extra	N/A	N/A
EXTRA	N/A	N/A
Extra	N/A	N/A
Extra	N/A	N/A
FM Store	N/A	N/A
FM Store	N/A	N/A
FM Store	N/A	N/A
FM Store	N/A	N/A
Food Preparation	N/A	N/A
Interview Room	N/A	N/A
LOC	N/A	N/A
Meeting Room 1	N/A	N/A
OPG	N/A	N/A
OPG	N/A	N/A
OPG	N/A	N/A
OPG	N/A	N/A
Phleb	N/A	N/A
Phleb	N/A	N/A
Phleb	N/A	N/A
Photo Studio	N/A	N/A
Plant Room	N/A	N/A
Procedure	N/A	N/A
Procedure	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Procedure	N/A	N/A
Procedure	N/A	N/A
Procedure	N/A	N/A
Procedure	N/A	N/A
Prone CT	N/A	N/A
RC	N/A	N/A
Reception	NO (-71.8%)	YES
Recovery Area	N/A	N/A
Recovery R	N/A	N/A
Recovery Room	N/A	N/A
Staff	NO (-86.6%)	YES
Staff	NO (-96.9%)	NO
Staff	NO (-96.9%)	NO
Staff Base	NO (-92.5%)	NO
Staff Base	NO (-91.7%)	NO
Staff Bay	NO (-99%)	NO
Staff Bay	NO (-98.7%)	NO
Staff Bay	NO (-99%)	NO
Staff Bay	NO (-96.9%)	NO
Staff Breakout	NO (-84.5%)	YES
Staff Breakout	N/A	N/A
Staff Breakout	N/A	N/A
Staff Breakout	NO (-91.1%)	YES
Staff Breakout	NO (-90.4%)	YES
Staff Breakout	NO (-91.6%)	YES
Staff Change	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	NO (-80.5%)	YES
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	NO (-82.8%)	YES
Stairway	NO (-83.7%)	YES
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	N/A	N/A
Stairway	NO (-79.1%)	YES
Stairway	NO (-82.1%)	YES
Stairway	NO (-80.3%)	YES
Stairway	N/A	N/A
Stairway	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Store	N/A	N/A
Tech + Mould Room	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	NO (-91.2%)	YES
Treatment	N/A	N/A
Treatment	NO (-90.2%)	YES
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment	N/A	N/A
Treatment Bays	NO (-99.9%)	NO
Treatment Bays	N/A	N/A
Treatment Bays	NO (-99.8%)	NO
Treatment Bays	NO (-100%)	NO
US	N/A	N/A
US	N/A	N/A
Vac and Air	N/A	N/A
Waiting	NO (-79.4%)	YES
Waiting and CAFE	NO (-75.6%)	YES
Waiting Area	NO (-60.6%)	YES
Waiting Area	NO (-25.8%)	YES
Waiting Area	NO (-23.5%)	YES
Waiting Area	NO (-32.7%)	YES
Waiting Area	NO (-24.2%)	YES
Waiting Area	NO (-75.1%)	YES
Waiting Area	N/A	N/A
Waiting Room	NO (-97.4%)	NO
Waiting Room	NO (-80.7%)	YES
WHC Store	NO (-96%)	NO
X Ray	N/A	N/A
Circulation	N/A	N/A
Circulation	NO (-92.6%)	YES

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

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

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	9179.3	9179.3
External area [m²]	8968.9	8968.9
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	5	3
Average conductance [W/K]	4638.89	3782.97
Average U-value [W/m²K]	0.52	0.42
Alpha value* [%]	11.13	10

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

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
99	**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
1	**Others: Miscellaneous 24hr activities**
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	8.56	2.61
Cooling	8.08	14.94
Auxiliary	31.88	27.89
Lighting	34.89	45.7
Hot water	14.2	6.84
Equipment*	111.62	111.62
TOTAL**	**92.09**	**97.97**

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

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0.68	0
Wind turbines	0	0
CHP generators	5.52	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	188.46	211.9
Primary energy* [kWh/m²]	234.87	276.49
Total emissions [kg/m²]	39.6	46.8

* 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] Constant volume system (fixed fresh air rate), [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	13.2	358.9	1.9	17.2	82.3	1.12	5.8	0.91	6
	Notional	4	461.4	1.3	33.8	56.5	0.86	3.79	----	----
[ST] Central heating using air distribution, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	1.8	0	0.3	0	6.4	0.87	0	0.91	0
	Notional	0.2	0	0.1	0	15.9	0.86	0	----	----
[ST] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	28.3	174.5	4.8	8.4	27.3	0.85	5.8	0.91	6
	Notional	12.3	203.5	4	14.9	27.3	0.86	3.79	----	----
[ST] Central heating using air distribution, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	5	0	0.8	0	3.5	0.87	0	0.91	0
	Notional	0	0	0	0	7.4	0.86	0	----	----
[ST] Constant volume system (variable fresh air rate), [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	4.4	90.2	0.7	4.3	16.4	1.12	5.8	0.91	6
	Notional	2.9	104.7	0.9	7.7	12.5	0.86	3.79	----	----

Key to terms

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

Key Features

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

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.3	L00000C7:Surf[0]
Floor	0.2	0.22	L00002B1:Surf[0]
Roof	0.15	0.18	L00001FE:Surf[0]
Windows, roof windows, and rooflights	1.5	2.01	L0000009:Surf[0]
Personnel doors	1.5	0.64	L0000228:Surf[7]
Vehicle access & similar large doors	1.5	1.49	L0000001:Surf[2]
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	5