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King's House School

Energy and Sustainability Statement

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X T. Creswell-Wells	X Oliver Watts	X
Principal author	Checked by	Verified by
Signed by: Creswell-Wells, Tavis	Signed by: Watts, Oliver	Signed by: Kumari, Kavita

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Executive Summary

In accordance with the London Borough of Richmond upon Thames planning requirements and the Greater London Authority's (GLA) London Plan, the following Energy and Sustainability Statement has been developed for the proposed King's House School development.

The new build and refurbished aspects of the development have been assessed separately in relation to the energy requirements of the London Plan, following the GLA's energy hierarchy: Be Lean, Be Clean, and Be Green. In this way, compliance with the respective carbon reduction targets for new build and refurbished components of the development is demonstrated.

Energy and carbon figures presented in this report have been adjusted from the National Part L 2013 format to the GLA format which includes up-to-date carbon emissions factors (SAP10).

Passive design techniques have formed an integral part of the design for the proposed development. Passive and energy efficiency measures contributing to the energy strategy under the 'Be Lean' include:

- The envelope of all buildings will be designed to perform significantly better than the Building Regulation standards with low U-values, G-values and low air leakage rates.
- Analysis has been carried out to balance the façade design and optimise window sizing and placement so that heat losses are minimised whilst the access to natural light is improved.
- Natural ventilation has been included where possible. Where mechanical ventilation is necessary, high efficiency equipment has been specified beyond the minimum standards.
- Energy efficient services employed in the development include high efficacy LED lighting coupled with occupancy and daylight controls to significantly reduce the lighting energy use.
- Electrical and mechanical systems within the development will be tightly metered and controlled with a full Building Management System (BMS). This will enable energy use to be tracked and opportunities for efficiency improvements to be made.

At the 'Be Lean' Stage of the Energy Hierarchy, these features contribute to a 10.2% reduction in carbon dioxide emissions for the new aspects; and a 38.5% reduction for the refurbished aspects.

Following the 'Be Clean' step of the energy hierarchy, the feasibility of connecting to an existing or proposed district network has been investigated for the site in accordance with Policy 5.6 of the London Plan. The London Heat Map indicates that there are no existing or planned heat networks within a feasible connection distance of the development, therefore no connection is proposed.

Combined Heat and Power (CHP) is not considered appropriate for this development due to the air quality issues it will create in the school context and residential area; as well as the decarbonisation of the electrical grid which reduces the carbon emissions benefit of CHP.

For the 'Be Green' step of the energy hierarchy, heat pumps are introduced to drama and music rooms to complement the mechanical ventilation system. Variable refrigerant flow (VRF) air source heat pumps (ASHPs) provide heating and cooling at high efficiencies and benefit from the new GLA carbon factors for electricity.

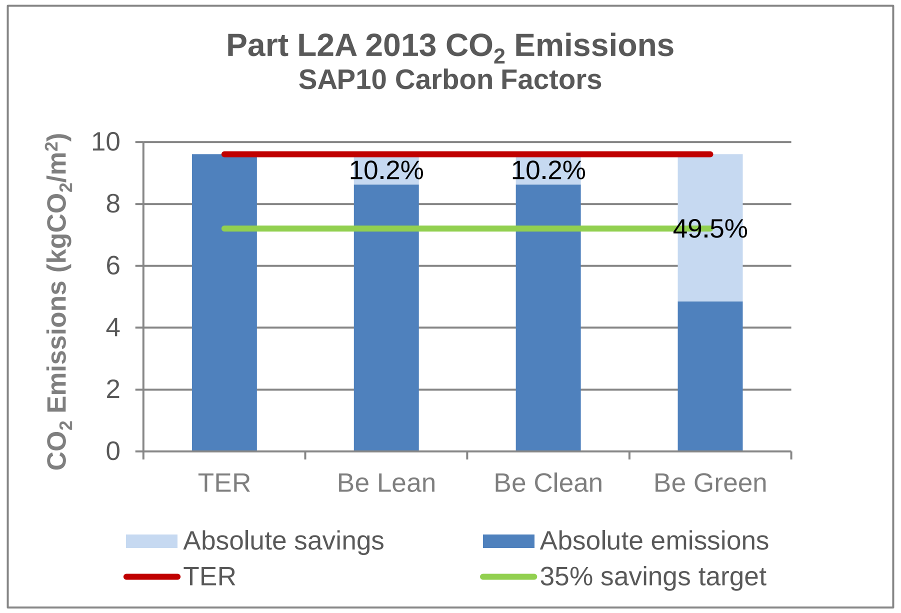
Photovoltaic panels are also included in the energy strategy. There is sufficient roof space within the development to incorporate a PV array. Initial analysis suggests an 14kWp PV array (approx. 80m^2 of panels), could be accommodated on the sports hall roof. This array could generate 11,700kWh of electricity (primarily for use in the new aspects of the development) reducing emissions by 2.9 tonnes annually.

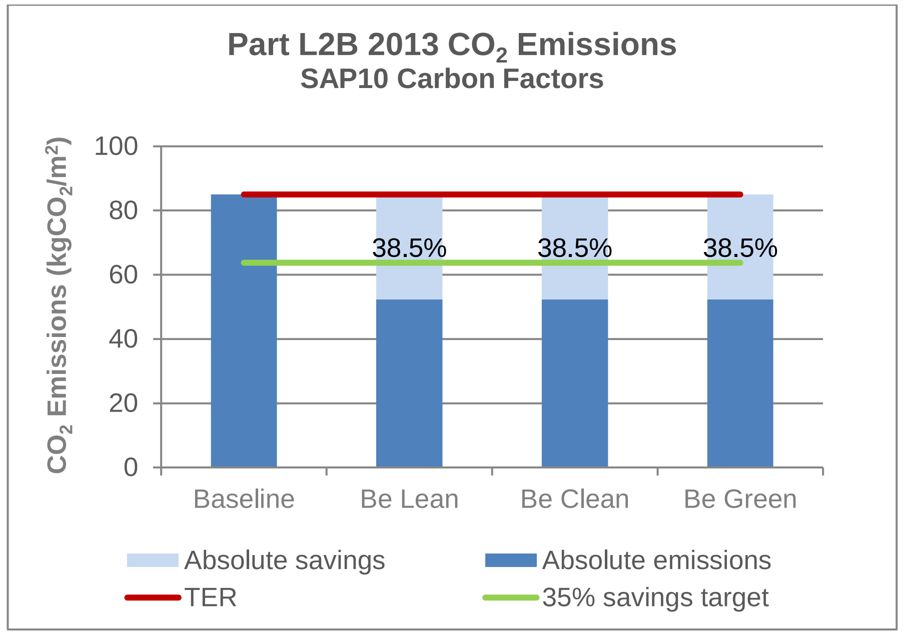
The results of the energy analysis show that the measures outlined above enabled the development to achieve an overall carbon emissions reduction of:

- 49.5% for the new aspects of the development,
- 38.5% for the refurbishment aspects of the development,

The new aspects component therefore meets the 35% emissions reduction planning requirements and will not be subject to a carbon offset payment.

On a site-wide basis, the scheme is achieving an area weighted carbon emission saving of 41.1% over Part L minimum standards.





A copy of the London Borough of Richmond upon Thames' 'Sustainable Construction Checklist' has been completed and included. This indicates the development will achieve a B rating on the scoring matrix.

A preliminary BREEAM assessment has also been undertaken for the indicating that an "Excellent" rating is able to be achieved, thus complying with the London Borough of Richmond's planning policy.

In accordance with the BREEAM assessment and planning policy, the following sustainable features have been considered for the development:

- Building materials, where possible, will be sourced locally to reduce transportation pollution and support the local economy;
- All timber will be procured from responsible forest sources;
- Recycling facilities will be provided on site for construction and operational waste;
- Water use will be minimised by the specification of water efficient taps, dual flush toilets and low water use appliances;
- Water metering will be installed to monitor and minimise wastage;
- The construction site will be managed in an environmentally sound manner in terms of resource use, storage, waste management, pollution. A Site Waste Management Plan (SWMP) will be produced for the works;
- Secure bicycle storage and changing facilities will be provided to incentivise building users to cycle.

A full 'BREEAM Summary' report (1018236-SU-002 – BREEAM Summary) has been submitted separately in support of the planning application. Please refer to this for further details.

Contents

1.0

Introduction

1.0 Introduction

This Energy and Sustainability Statement has been prepared for the King's House School planning application, in the London Borough of Richmond upon Thames. It aims to meet the energy and climate change requirements of the London Borough of Richmond upon Thames and the Greater London Authority (GLA).

The format of the statement is intended to reflect and respond to the issues raised in the GLA's 'Spatial Development Strategy for Greater London' - the 'London Plan'. The principal objectives are to reduce the site's contribution to the causes of climate change by reducing the site's needs for energy, by minimising the emissions of CO_2 by providing some of the requirement by renewable/sustainable means. The format of this report is based on the GLA's 'Guidance on Preparing Energy Statements', October 2018 document. The report also responds to the wider sustainability issues highlighted in the Richmond Core Strategy 2009.

The Building Research Establishment's Environmental Assessment Method (BREEAM) New Construction 2018 scheme has also been used to assess the development. A preliminary assessment indicates that an "Excellent" rating can be achieved, a standalone BREEAM report supports this application.

1.1 Existing Development

King's House School is located at the northwest corner of Richmond Park in southwest London. The site is within a low-density residential area, on Kings Rd. Richmond over ground station is a 15 minute-walk to the northwest.

The school currently consists of a number of older existing buildings. As such, the thermal envelope and fixed building services are poor with low efficiencies.

1.2 Proposed Development

The planning application proposal compromises three main aspects:

- Demolition of a number of existing school buildings, which have been added since the original Victorian and Edwardian houses.
- The erection of a two and three storey new build teaching block, linking to the existing sports hall, which will be extended to the north. This new teaching facility consists of music and drama classrooms, music practice rooms and general teaching classrooms. There are associated areas for staff, storage and services, which support the running of the building.
- To accommodate and connect to the new classrooms wing, part of the existing sports hall envelope will be replaced and upgraded. The building services employed in the sports hall will be upgraded and integrated with the new high efficiency systems included in the new build elements.

Development Area Schedule	
Area schedule	**GIA (m^2)**
New aspects	763
General hall refurbishment	191
Total	**954**

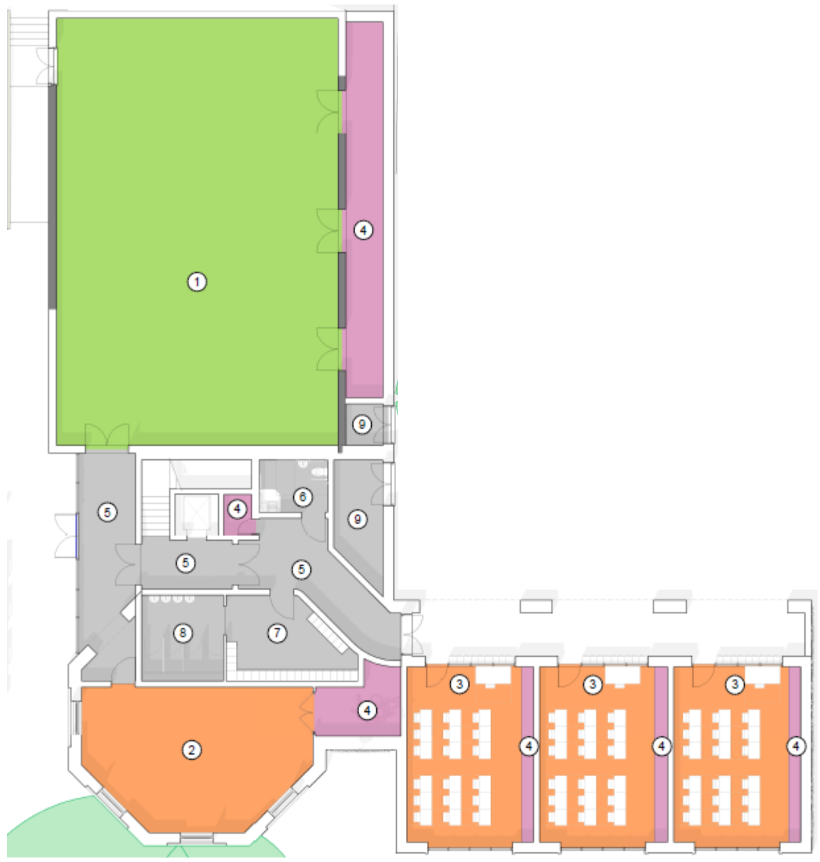


Figure 1-1 – Proposed development – Ground floor.

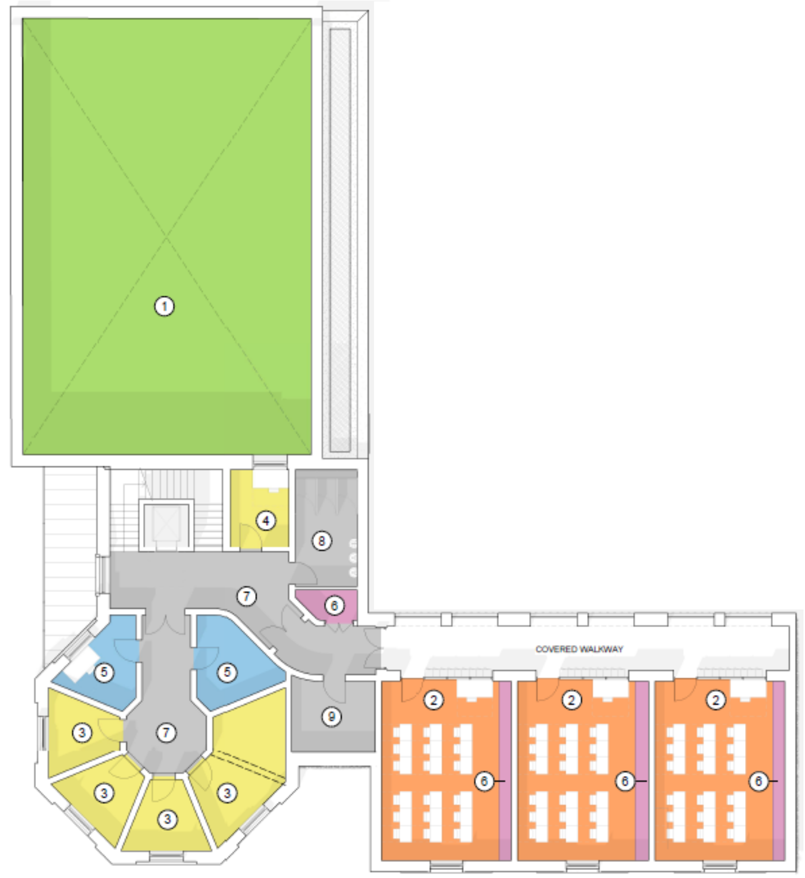


Figure 1-2 – Proposed development – First floor.

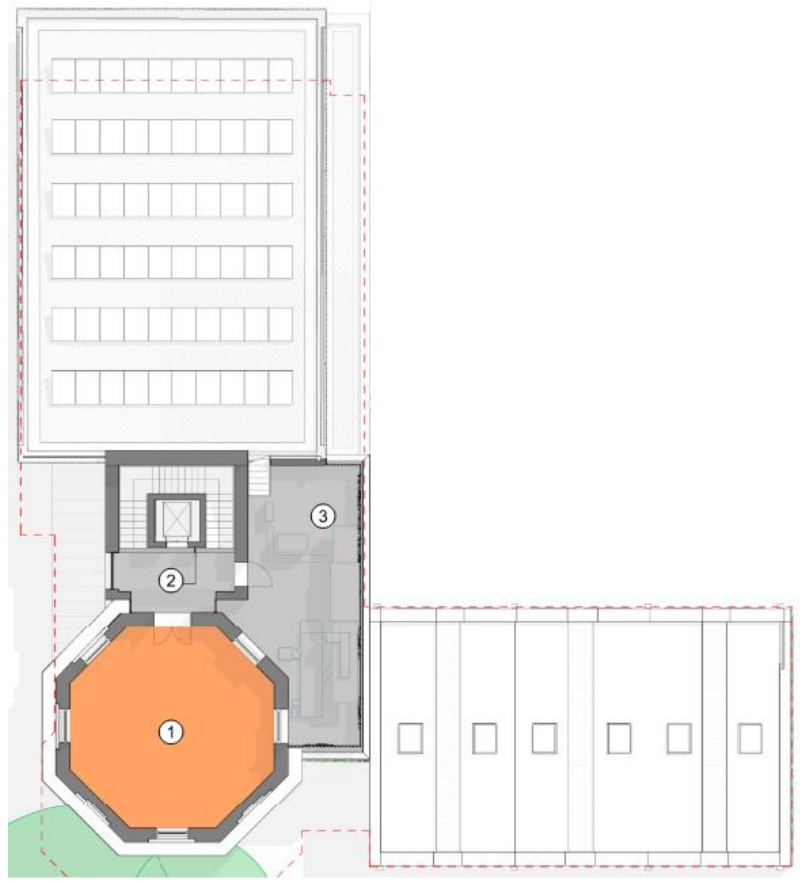


Figure 1-3 Proposed development – Second floor / roof.

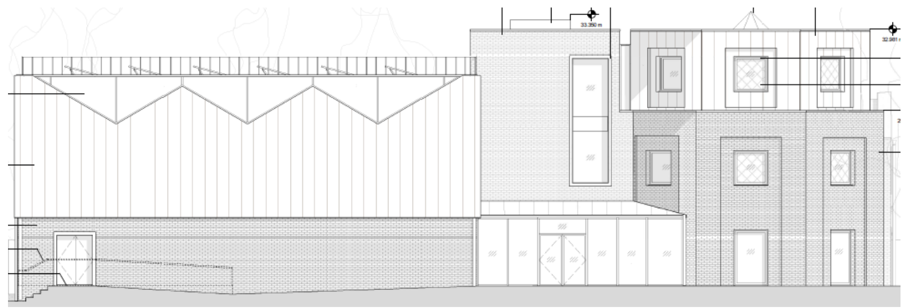


Figure 1-4 Proposed development – West elevation.

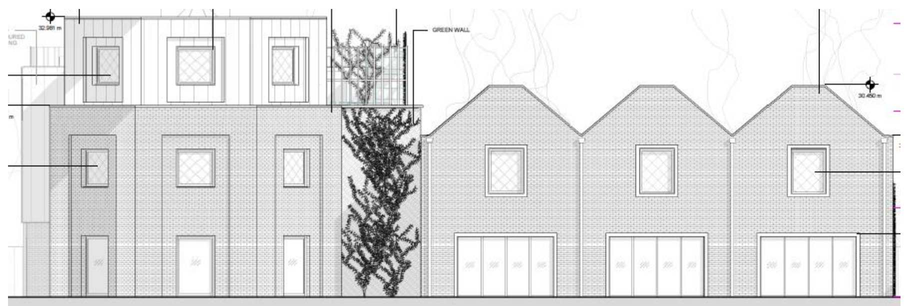


Figure 1-5 Proposed development – South elevation.

2.0

Planning Policy

2.0 Planning Policy

2.1 National Policy Requirements

The revised National Planning Policy Framework (NPPF) was published in February 2019 and sets out the government's planning policies for England and states a clear presumption in favour of sustainable development. The revised Framework replaces the previous NPPF published in March 2012.

The NPPF supports the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change, and encourages the reuse of existing resources, including conversion of existing buildings, and encourages the use of renewable resources.

The NPPF, Section 9 outlines the transport issues that should be considered from the earliest stages of plan-making and development proposals.

The NPPF, Section 14 outlines its energy and climate change policies. New development should be planned for in ways that:

- Avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure;
- Can help to reduce greenhouse gas emissions through its design. Any local requirements for the sustainability of buildings should reflect the Government's policy for national technical standards.

To support the move to a low carbon future, local planning authorities should:

- Plan for development in ways which reduce greenhouse gas emissions;
- Actively support energy efficiency improvements to existing buildings; and
- When setting any local requirement for a building's sustainability, do so in a way consistent with the Government's zero carbon buildings policy and adopt nationally described standards.

The NPPF states that in determining planning applications, local planning authorities should expect new development to:

- Comply with any development plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and
- Take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.

When determining planning applications for renewable and low carbon development, local planning authorities should:

- Not require applicants to demonstrate the overall need for renewable or low carbon energy, and recognise that even small-scale projects provide a valuable contribution to cutting greenhouse gas emissions; and
- Approve the application if its impacts are (or can be made) acceptable. Once suitable areas for renewable and low carbon energy have been identified in plans, local planning authorities should expect subsequent applications for commercial scale projects outside these areas to demonstrate that the proposed location meets the criteria used in identifying suitable areas.

The key focus of the NPPF is to support local and regional planning authorities.

2.2 Regional Policy Requirements

The Greater London Authority (GLA) London Plan 2016 and the GLA's Guidance on Preparing Energy Assessments October 2018 document are the benchmark for London planning regulation. Together they provide a useful tool to undertake energy and sustainability assessments.

GLA London Plan 2016

Policy 5.2: Minimizing Carbon Dioxide Emissions - requires that major developments achieve a 35% improvement over the 2013 Building Regulation CO_2 Emission Target. Development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy:

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

Failure to achieve the 35% target may result in the shortfall incurring a one-off contribution to the Carbon Offsetting Fund. The price for offsetting carbon will be determined by each individual borough unless a price has not been set, whereby it defers to the GLA's guidance of £60 per tonne of CO_2 for a period of 30 years.

Policy 5.3: Sustainable Design and Construction – requires the highest standards of sustainable design and construction to improve the environmental performance of new developments and to adapt to the effects of climate change over their lifetime. Development proposals should meet the minimum standards outlined in the Mayor's supplementary planning guidance.

Policy 5.6: Decentralised Energy - requires all major developments to evaluate the feasibility of connecting to existing or proposed district heating networks and where no opportunity existing consider a site wide Combined Heat and Power (CHP) system.

Policy 5.7: Renewable Energy - requires that all major developments seek to reduce their CO_2 emissions by at least 20% through the use of onsite renewable energy generation wherever feasible. Individual development proposals will also help to achieve these targets by applying the energy hierarchy in Policy 5.2.

Policy 5.9: Cooling and Overheating - requires all major developments to reduce demand for cooling based on the cooling hierarchy and overheating risk.

GLA Energy Assessment Guidance (October 2018)

The GLA Energy Assessment Guidance (October 2018) looks to standardise how energy assessments for developments within London are presented and reported. As part of the this process the guidance from January 2019 referable developments are encouraged to use the updated SAP 10 emissions factors while continuing to use the current Building Regulation methodology.

Draft New London Plan

In Dec 2017 the Mayor released a draft new London Plan, which has since been through a gradual process to formal adoption, which is expected in Q1 2021.

In relation to energy and sustainability the draft Plan looks to further push the requirements on referable developments. This includes the following:

- Requirement to undertake and report on the whole life cycle assessment, including embodied carbon.
- Address an additional stage in the energy hierarchy 'Be Seen'.
- The expansion of the 'zero-carbon' requirement to also cover non-residential aspects of developments.

This project was designed predominantly during the early stages of the draft New London Plan's development, to the requirements of the current 2016 London Plan. To transfer to the draft Plan policies late in the design process would incur significant rework and associated costs. As this project is neither a major development nor a referable development it is not subject to the more stringent policies proposed under the draft Plan. However, to demonstrate a commitment to sustainable development, and to reflect the intentions of the upgraded aspirations of the draft Plan, this energy strategy seeks to drive the sustainability credentials as far as reasonably possible within the limitations of the existing policy and project scope.

2.3 Local Policy – Richmond Borough

The London Borough of Richmond upon Thames Local Plan (adopted July 2018) sets out local policy requirements as follows:

Policy LP 22: Sustainable Design and Construction

A. Developments will be required to achieve the highest standards of sustainable design and construction to mitigate the likely effects of climate change. Applicants will be required to complete the following:

- Development of 1 dwelling unit or more, or 100sqm or more of non-residential floor space (including extensions) will be required to complete the Sustainable Construction Checklist SPD. A completed Checklist has to be submitted as part of the planning application.
- New non-residential buildings over 100sqm will be required to meet BREEAM 'Excellent' standard.

B. Developers are required to incorporate measures to improve energy conservation and efficiency as well as contributions to renewable and low carbon energy generation. Proposed developments are required to meet the following minimum reductions in carbon dioxide emissions:

- All non-residential buildings over 100sqm should achieve a 35% reduction. From 2019 all major non-residential buildings should achieve zero carbon standards in line with London Plan policy. As the development does not exceed 1000m^2 of new floor area it is not classified as a 'major' development and therefore the zero carbon target is not mandatory.

Targets are expressed as a percentage improvement over the target emission rate (TER) based on Part L of the 2013 Building Regulations.

C. This should be achieved by following the Energy Hierarchy:

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

Policy CP2: Reducing Carbon Emissions

The London Borough of Richmond upon Thames Core Strategy (adopted April 2009) sets out further policy requirements as follows:

- The Council will increase the use of renewable energy by requiring all new development to achieve a reduction in carbon dioxide emissions of 20% from on-site renewable energy generation unless it can be demonstrated that such provision is not feasible, and by promoting its use in existing development.

3.0

New Aspects – 'TER' & 'Be Lean'

3.0 New Aspects – 'TER' & 'Be Lean'

This section outlines the notional building Target Emissions Rate' (TER) (which represents the Part L minimum standard) and the actual base building (Be Lean) 'Building Emissions Rate' (BER) for the new aspects of the development, which are assessed under Part L2A of the Building Regulations.

The design of the new proposed King's House School aspects has been developed to reduce its annual energy consumption, provide energy in an environmentally friendly way, and to minimise its annual CO_2 footprint. In order to achieve this, a "Steps to low carbon" methodology has been applied.

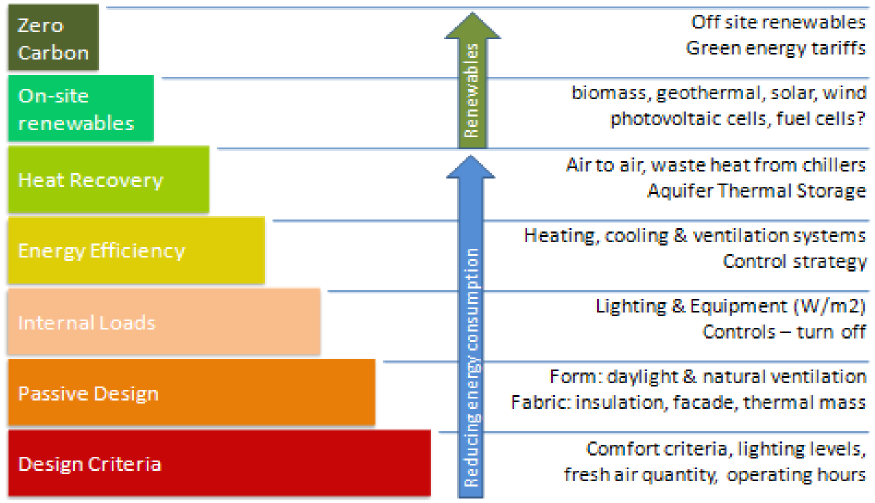


Figure 3-1 Steps to low carbon methodology.

3.1 Passive Design

Substantial reductions in energy usage for the scheme, together with improved occupancy comfort, will be achieved through consideration of the passive elements of the design. The design team have looked to implement passive design measures through optimising the passive solar design and building envelope performance as described in the following sections.

3.1.1 Passive Solar Design

Consideration of the development's façades and window areas and placement has been made so that low angle winter solar gains and sun light are able to enter the spaces providing 'free' heating and lighting in winter but are limited in summer to reduce the demand for cooling and limit the risk of 'overheating'.

3.1.2 Building Fabric

Improving the thermal insulation standards beyond the Building Regulation standards will help to reduce the annual CO_2 emissions associated with the building's heating and cooling systems, by limiting the heat loss though the building's fabric. Improvements over the Building Regulation minimum standards are being sought for the development, with target building fabric performance as summarised in the Table 3.1. These values exceed the minimum efficiency standards of Part L Criterion 2.

3.1.3 Air Permeability

An improved air leakage rate of 3.0 $m^3/(hr.m^2)$ is being targeted for the proposed development, in comparison with the Building Regulation minimum standards of 10 $m^3/(hr.m^2)$ at 50Pa. Good air tightness could be achieved by prefabrication of several key building components under factory conditions, robust detailing of junctions and good building practices on site.

Table 3.1 – Fabric Performance – New Aspects

Fabric Parameter	Part L Minimum	Design
Ground floor average U-value (W/m^2K)	0.25	0.20
Roof average U-value (W/m^2K)	0.25	0.16
External wall average U-value (W/m^2K)	0.35	0.18
External door U-value (W/m^2K)	2.20	1.60
Window/skylight U-value (inc. frame) (W/m^2K)	2.20	1.60
Window/skylight glazing G-value	-	0.40
Window/skylight glazing VLT	-	0.70
Air permeability @ 50 Pa ($m^3/hr/m^2$)	10.0	3.0

3.2 Energy Efficient Systems

After assessing the contribution of the passive elements to the overall energy balance, the aim is to further reduce CO_2 emissions by selecting efficient mechanical, electrical and control systems to manage the energy use during operation.

3.2.1 Low-energy Lighting

Teaching spaces have been designed to maximise daylight reducing the need for artificial lighting. To reduce the energy consumption associated with artificial lighting, high efficacy LED lighting will be specified along with passive infrared (PIR) occupancy sensors and daylight dimming controls where appropriate.

3.2.2 HVAC Plant Efficiencies

The design team will specify all equipment and plant to exceed the minimum requirements of the non-domestic building services compliance guide. This document provides guidance on the means of complying with the requirements of the Building Regulations for conventional space heating/cooling systems, hot water systems, ventilation and lighting systems.

3.2.3 Ventilation

Natural ventilation via windows for purge, with natural ventilation heat recovery units (NVHR) for minimum fresh air rates will be used in general classrooms, where noise egress issues are minimal. In music and drama spaces, where the noise generated has been identified as a potential nuisance for neighbouring properties, windows will be sealed shut and mechanical heating, ventilation and air-conditioning (HVAC) systems will be employed. A low specific fan power (SFP) central air handling unit (AHU) will provide fresh air to these spaces. This supply air will be heated or cooled to maintain thermal comfort. Mechanical ventilation heat recovery (MVHR) will be included in the AHU to minimise heat losses due to ventilation and maximize thermal efficiency.

3.2.4 Domestic Hot Water

Domestic hot water (DHW) will be a low temperature hot water (LTHW) system, with heat generated by the same boilers used for space heating. A small hot water storage vessel will be included to utilise the spare heat generated when space heating demands drop.

3.2.5 Variable Speed Pumps and Drives

All fans and pumps will be specified with variable-speed drives, which will reduce their energy consumption by more than two-thirds compared with equivalent constant speed alternatives, by only supplying the required flow rate to meet the demand. Multiple pressure sensors will control the speed of the systems.

3.2.6 Controls

The heating/cooling systems shall be appropriately zoned, with local fast responding controls. Appropriate lighting controls, including timers, occupancy controls, and daylight sensors and dimming shall be specified where applicable for all internal and external lighting.

3.2.7 Building Energy Management System (BEMS)

Where appropriate Building Energy Management System (BEMS) will be used to promote and facilitate a system that supports the energy demand management for non-domestic buildings (e.g. a system that recognises real-time room conditions in buildings by temperature sensors and/or the optimal operation of lighting and air-conditioning responding to the room condition). A combination of energy saving control techniques, such as optimum start with communication and information systems will allow active management of the building services and the capability to achieve and maintain a high level of energy efficiency. The systems will be easily accessible by the onsite team with automatic monitoring, targeting and automatic alarms for out of range values.

3.2.8 Commissioning

Commissioning is a systematic process, which configures a building's HVAC system and integrated control systems to operate at peak performance. Commissioning building systems can provide significant benefits such as improving occupant comfort, reducing energy cost, improving indoor air quality, enhancing building operations and extending equipment life. Hence, an extensive commissioning exercise will be incorporated in the programme for all buildings, with time allowed for reconfiguring plant and equipment if needed.

3.2.9 Energy Metering

Metering systems of the energy uses within the development will help the user to identify areas of excessive consumption and potential energy and emissions saving opportunities.

3.2.10 Fixed Building Services – Be Lean

The fixed building services modelled within the Be Lean scenario are presented in Table 3.2 below.

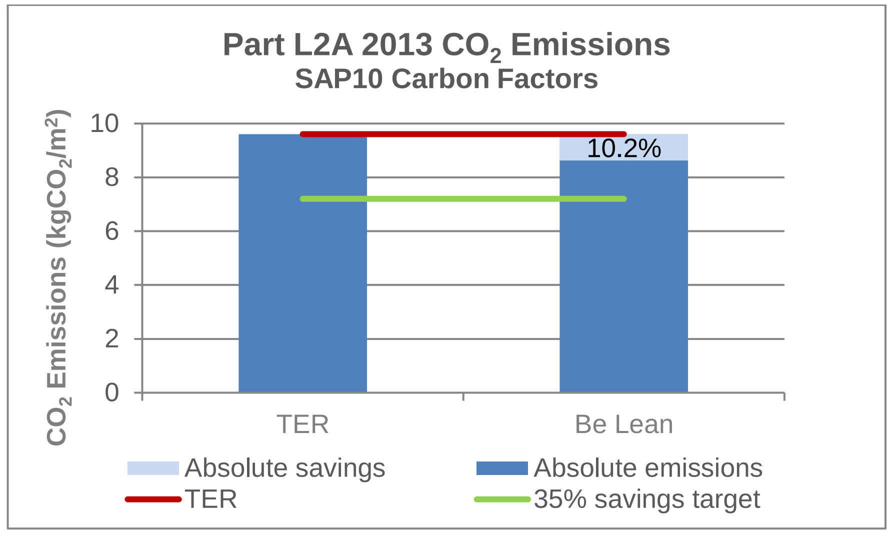
Table 3.2 – System Efficiencies – New Aspects	
System Parameter	**Be Lean**
Heating type	Central boilers
Heating fuel	Natural gas
Heating emitters	FCUs & Radiators
Boiler efficiency	95.0%
Chiller efficiency (SEER / EER)	2.6 / 2.6
Ventilation – general classes	Natural w NVHR
Ventilation SFP – general classes (W/l/s)	0.13
Ventilation – music/drama classes	AHU
Ventilation SFP – music/drama (W/l/s)	1.80
AHU heat recovery efficiency	0.74
Ventilation – bathrooms	Mech extract
Ventilation SFP – bathrooms (W/l/s)	0.40
HVAC systems provision for metering	Yes
HVAC systems out of range values	Yes
DHW source	Same as heating
DHW storage volume (L)	150
DHW storage losses (kWh/L.day)	0.014
DHW secondary circulation losses (W/m)	10
DHW secondary circulation loop length (m)	28
DHW secondary circulation pump power (kW)	0.1
DHW time switch	Yes
Pump speeds	Variable
Lighting efficacies – classes, offices, hall, plant, stores (lm/W)	120
Lighting efficacies – circ, WCs (lm/W)	100
PIR controls – classes, offices	Absence detection
PIR controls – circulation, WCs,	Presence detection
Daylight sensing – classes, offices	Yes
Lighting parasitic powers (W/m^2)	0.05
Lighting systems provision for metering	Yes
Lighting systems out of range values	Yes
Power factor correction	>0.95

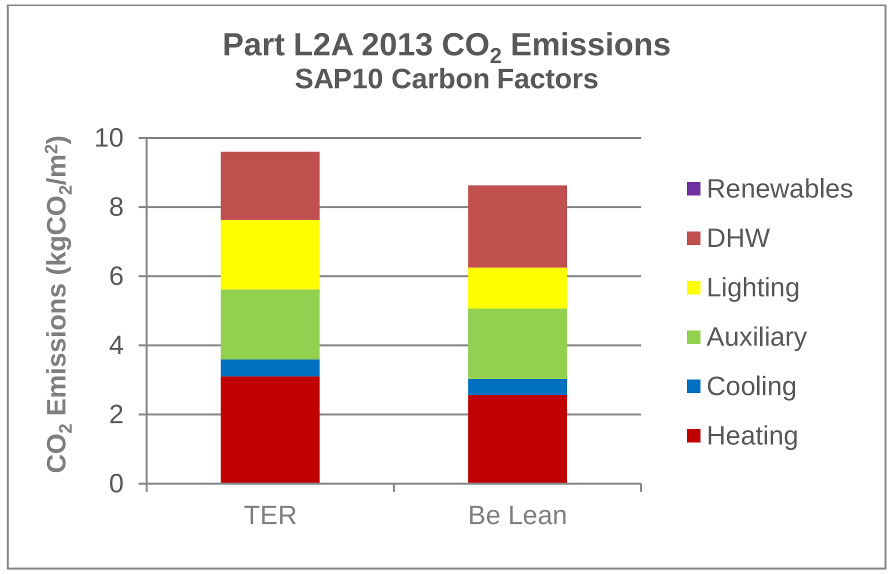
3.3 'Be Lean' Part L2A Performance Results

In accordance with the London Borough of Richmond and the Mayor's Energy Hierarchy the estimated energy consumption for the development has been based on the National Calculation Methodology (NCM). An energy assessment has been carried out for the entire development, with the aforementioned passive design and energy efficiency measures. The preliminary energy assessment is based on the requirements of Part L2A (2013) and uses approved dynamic simulation software IES Virtual Environment 2020. Calculations are based on the SAP10 carbon factors.

Improved building fabric performance coupled with energy efficient building services contribute to a 10.2% reduction on the Building Regulations emissions rate for the new development. The 'Be Lean' scenario therefore satisfies minimum national standards but is not sufficient to meet the local 35% target.

Regulated Emissions Summary – New Aspects	
Target Emission Rate (TER) (kgCO_2/m^2)	9.6
Building Emission Rate (BER) (kgCO_2/m^2) – Be Lean	8.6
Improvement (%) – Be Lean	**10.2%**





4.0

Existing Aspects – 'Baseline' & 'Be Lean'

4.0 Existing Aspects – 'Baseline' & 'Be Lean'

4.1 Part L2B

This section outlines the refurbishment aspects of the development which will be assessed under Part L2B of the Building Regulations. This includes the hall and adjoining plant and storage spaces which connect to the new build classrooms wing. The 'Baseline' notional building emissions benchmark, which replaces the TER used for new builds and represents the Part L minimum standard for refurbishments. This section also outlines the actual base building Be Lean BER for the refurbished aspects, which are assessed under Part L2B.

As the refurbishment aspects do not exceed 1000m² it will not need to comply with Consequential Improvements. Similarly, because the proposed extension is less than 100m², it cannot be assessed as a new build under Part L2A

Part L2B states that where renovation or replacement of a thermal element amounts to more than 50% of that element it must be specified to comply with the fabric standards set out in Table 4.

Table 4 **Standards for new *thermal elements***	
Element[1]	**Standard W/(m².K)**
Wall	0.28[2]
Pitched roof – insulation at ceiling level	0.16
Pitched roof – insulation at rafter level	0.18
Flat roof or roof with integral insulation	0.18
Floors[3]	0.22[4]
Swimming pool basin	0.25[5]

Figure 2. Table 4 excerpt from Part L2B Approved Document.

In terms of overall performance, the refurbished elements of the project are not required to meet the GLA carbon emissions savings targets, because they do not constitute a major development. Instead, the proposed works only need to demonstrate an improvement in comparison with the existing building. To do this, a 'Baseline' model will be created to represent the existing building and will form the 'benchmark against which the proposed refurbished design will be assessed. The following sections outline the inputs used in both of these models.

4.2 Fabric

As part of the project works, the existing sports hall will undergo upgrades to elements of its thermal envelope. Specifically, the roof and two external walls will be replaced. The thermal performance of the new elements will be specified to meet or exceed the minimum performance values required under Part L2B, as seen in the table below:

Table 4.1 – Fabric Performance – Refurbished Aspects		
Fabric Parameter	**Existing**	**Proposed**
Ground floor average U-value (W/m²K)	3.60	3.60
Roof average U-value (W/m²K)	0.78	0.16
External wall average U-value (W/m²K)	1.46	0.18
External door U-value (W/m²K)	2.20	1.60
Window U-value (inc. frame) (W/m²K)	-	0.18
Glazing G-value	-	0.40
Glazing VLT	-	0.40
Air permeability @ 50 Pa (m³/hr/m²)	25.0	7.0

Due to the refurbishment nature, it will not be feasible to achieve the same low air permeability as the new aspects. Therefore 7.0m³/hr/m² represents a significant and achievable improvement over the existing situation.

4.3 Fixed Building Services

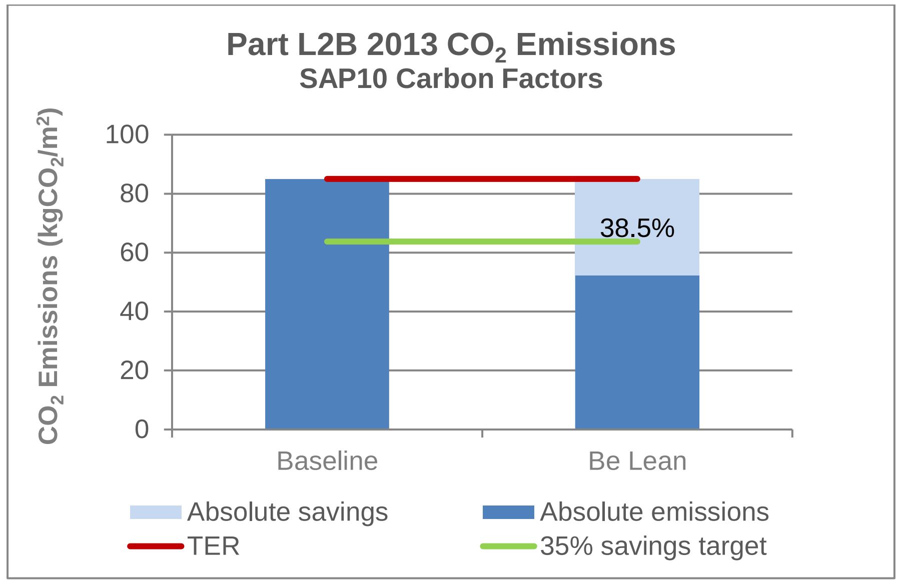
The following table presents the building services and associated efficiencies for both the Baseline and Be Lean cases of the refurbished aspects of the project.

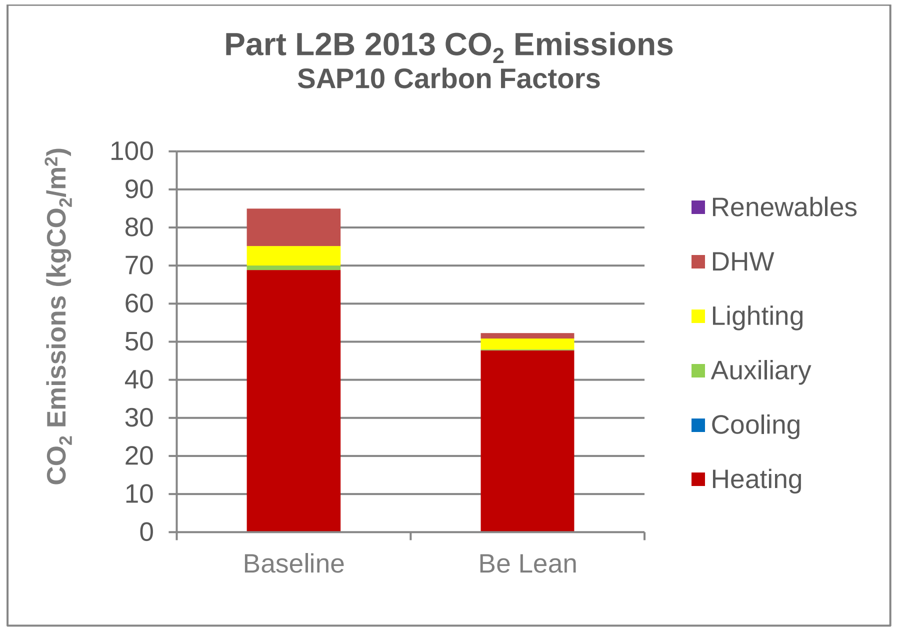
Table 4.2 – System Efficiencies – Refurbished Aspects		
System Parameter	**Existing**	**Be Lean**
Heating type	Central boilers	Central boilers
Heating fuel	Natural gas	Natural gas
Heating emitters	Radiant panels	Radiant panels
Boiler efficiency	91.0%	95.0%
Ventilation	Natural	Natural
DHW source	Same as heating	Same as heating
DHW storage volume (L)	150	150
DHW storage losses (kWh/L.day)	Uninsulated	0.014
DHW secondary circulation losses (W/m)	15	10
DHW secondary circulation loop length (m)	28	28
DHW secondary circulation pump power (kW)	0.15	0.1
DHW time switch	No	Yes
Pump speeds	Constant	Variable
Lighting efficacies (lm/W)	70	100
PIR controls and daylight sensing	None	None
Lighting parasitic powers (W/m²)	0.1	0.05
Lighting systems metering	No	Yes
Power factor correction	None	>0.95

4.4 'Be Lean' Part L2B Performance Results

Improved building fabric performance coupled with energy efficient building services contribute to a 38.5% reduction over the Baseline emissions rate. The 'Be Lean' scenario therefore satisfies the required Part L2B standards.

Regulated Emissions Summary – Refurbished Aspects	
Target Emission Rate (TER) ($kgCO_2/m^2$)	85.0
Building Emission Rate (DER) ($kgCO_2/m^2$) – Be Lean	52.3
Improvement (%) – Be Lean	**38.5%**





5.0

Decentralised Energy Systems – 'Be Clean'

5.0 Decentralised Energy Systems – 'Be Clean'

5.1 District Heating Networks

A heating network can be utilised to provide low carbon heat to both water-based systems: space heating and domestic hot water supplies. In a development with high heating and DHW loads – such as residential or leisure centre developments – a heating network can deliver significant CO_2 savings potential. In an office-based development, where heating requirements are relatively minimal, the heating network carbon savings potential is not as significant.

The feasibility of connecting to an existing district network has been investigated for the site in accordance with Policy 5.6 of the London Plan. An analysis of the London Heat Map (www.londonheatmap.org) has shown that there are no existing or planned district heating networks in the Borough of Richmond. The nearest district heating network is several kilometres away in Pimlico.

Therefore, there is no potential to connect to an existing network. The low heating demand of the development also does not justify its use as an anchor load, to build out a new heat network.

However, the development will build in the necessary connection plant should a local heating network be realized in the future.

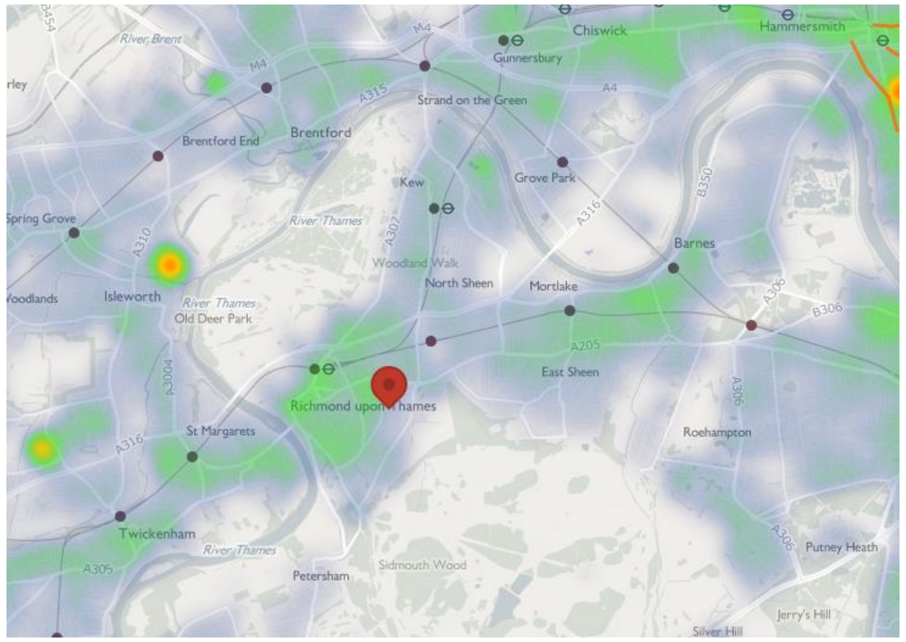


Figure 5-1. London Heat Map for Richmond, showing the nearest district heat network (yellow lines, none) and potential networks (red lines, none)

5.2 Combined Heat and Power (CHP)

In accordance with the Decentralised Energy Hierarchy in Policy 5.6 the feasibility of a site wide CHP network has been investigated. The efficient use of CHP typically depends on finding a use for the heat generated by the process. Issues to consider include:

- If heat is not used, then the system is effectively just an electricity generator and electricity will be greener and cheaper if sourced from the national grid.
- If excess electricity is generated on site this can be exported (sold) back to the grid whereas excess heat needs to be rejected (wasted). Exported electricity can count towards reducing the site's CO_2 emissions.
- Exported electricity will typically not be financially attractive as exports tend to coincide with low demand periods on the national grid so the cost of producing the electricity on site can be less than the prices received for the exported electricity.

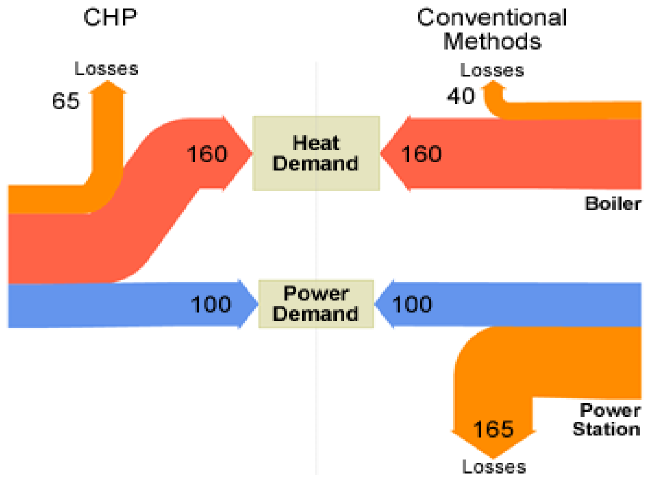


Figure 5-2. Sankey diagram illustrating the energy flows and benefits of CHP vs boiler heating.

The proposed King's House School development is characterised by a relatively high base load heat demand. However, heating loads in schools are only intermittent, occurring for less than 10 hours a day. In addition to the small scale of the school, the heating load would be inconsistent and insufficient to enable an efficient CHP system.

Due to the combustion processes of combined heat and power technology, they generate NOx and SOx emissions. This causes air quality issues which can be hazardous for building occupants and pedestrians around the site. As the development accommodates young children whose lungs are more vulnerable and is located in a suburban area with significant resident population, the impact a CHP would have on air quality in the area would be detrimental.

Further to the potential local air quality issues, the ongoing deployment of renewables within the national electricity grid means the carbon emissions of the electricity grid are now comparable to gas and therefore gas-fired CHP system will no longer offer the CO_2 savings now the SAP10 emission factors have been adopted in the GLA's guidance.

As such, CHP is not considered a feasible technology for this development and will not be incorporated into the energy strategy.

5.3 Be Clean Part L Performance Results

No decentralised energy networks are included in the 'Be Clean' case, therefore there is no change in the emissions results.

6.0

Low and Zero Carbon Technologies – 'Be Green'

6.0 Low and Zero Carbon Technologies – 'Be Green'

Within the framework of the energy hierarchy, Policy 5.7 of the London Plan and the Richmond Borough Core Strategy 20018 requires that all major developments seek to reduce their CO_2 emissions using onsite renewable energy generation, by 20%, wherever feasible. The following technologies have been considered for supplying a portion of the development's energy demand. The feasibility of each of the energy sources listed has been assessed regarding the potential contribution each could make to supply a proportion of the development's delivered energy requirement, whilst considering the technical, planning, land use and financial issues.

6.1 Biomass Heating

Biomass in the form of logs, wood chips and wood pellets are classified as a renewable source of energy since the carbon dioxide emitted when the biomass is burned has been taken out of the atmosphere by the growing plants. Even allowing for emissions of carbon dioxide in planting, harvesting, processing and transporting the fuel they will typically reduce net CO_2 emissions by over 90%.

Biomass boilers and their associated NOx emissions would impact local air quality. The London Borough of Richmond requires significant NOx abatement measures to be implemented before a biomass boiler would be considered suitable. The Borough has also targeted minimising emissions from local transport. As biomass relies on regular deliveries of fuel, specifying a boiler would increase local traffic and negatively impact air quality.

Biomass boilers are therefore not considered to be appropriate for the King's House School development.

6.2 Solar Hot Water Collectors (SHWC)

Solar thermal collectors utilise solar radiation to heat water for use in buildings. The optimum orientation for a solar collector in the UK is a south-facing surface, tilted at an angle of 30º from the horizontal.

Solar collectors are typically designed to meet a development's base heat load, associated with its domestic hot water requirements. For non-residential developments, the hot water demand is usually a lower proportion of the overall heating demand, unless there are comprehensive changing facilities with showers. As there are only two showers proposed for the new development the hot water demand will be low. Solar hot water collectors therefore will not be able to address a significant portion of the building's energy consumption. As such, SHWCs are not considered feasible for the development.

6.3 Air Source Heat Pumps (ASHP)

Air source heat pumps exchange heat between the outside air and a building to provide space heating in winter and cooling in the summer months. The efficiency of these systems is inherently linked to the ambient air temperatures.

Heat pumps supply more energy than they consume, by extracting heat from their surroundings. Heat pump systems can supply as much as 4kW of heat output for just 1kW of electrical energy input.

Typically, there are two main types of air sourced heat pump systems, one which is refrigerant-based system (VRF) and one which is water-based system (air to water heat pumps).

VRF systems transfer heat from one location to another using refrigerant. The volume or flow rate of refrigerant is accurately matched to the required heating or cooling loads, thereby saving energy and providing more accurate control of temperatures and energy consumption.

The drama and music classrooms have a requirement to be sealed to limit noise egress. The resulting mechanical ventilation system and need for cooling to mitigate overheating means that ASHPs are a suitable option for integration. They can provide cooling and heating directly into the fresh air supply. Additionally, their high efficiencies in combination with the new GLA carbon factors for electricity result in an effective low carbon system

An initial feasibility study has revealed that a system of this type is appropriate for this development; allowance has been made within plant spaces for a system which will supply 100% of the thermal energy required for space heating and cooling for the new music and drama aspects of the development.

It was calculated that an approximately 40kW VRF ASHP system would meet 100% of both the heating and cooling loads for the music and drama spaces. This technology has been predicted to save 0.4 tonnes of CO_2 per year, which is equal to 4.7% saving compared to conventional chiller and boiler system.

6.4 Ground Source Heat Pumps (GHSP)

Ground source heat pumps differ from air source heat pumps in that they extract heat from the ground to provide space heating and to pre-heat domestic hot water. In the summer months, this process can be reversed, rejecting heat to the ground, to meet the cooling requirements of a building.

GSHPs rely on the stable temperature of the ground of between 10-14°C. In winter when the ambient air temperatures are below this ground source heat pumps have higher CoPs than air source heat pumps (as there is more thermal energy in the ground).

As the heating demand for the site is larger than the cooling demand, over a period a ground source heat pump would begin to extract heat from the ground, cooling it down and reducing the seasonal efficiency. For these reasons, ground source heat pumps are not viable for the King's House School development.

6.5 Wind Turbines

The output from wind turbines is highly sensitive to wind speed. Hence it is essential that turbines should be sited away from obstructions, with a clear exposure, or fetch, for the prevailing wind.

In urban environments, it is difficult to achieve high wind speeds that would make the operation of turbines viable. Turbines would need to be located at a site where wind is channelled and is of a consistently high speed and laminar flow. The most likely option for this in London is on top of a tall building, clear of the urban canopy layer, where obstructions and surrounding buildings would not interfere with the wind flow.

The location of the King's House School site amongst a built-up suburban environment would result in a turbulent flow regime across the site, which would reduce the potential electrical output from wind turbines. It is also unlikely to be acceptable in townscape terms and as such it is not proposed to include wind turbines as part of the development.

6.6 Photovoltaics (PV)

Photovoltaic solar cells convert solar energy directly into electricity. The cells consist of two layers of silicon with a chemical layer between. The incoming solar energy charges the electrons held within the chemical. The energised electrons move through the cell into a wire creating an electrical current.

The roofs of the development are suited to hosting a photovoltaic array. Analysis indicates that panels orientated south could meet a proportion of the development's electrical demand, reducing dependence on the National Grid.

Initial analysis suggests a 14kW_p PV array (approximately 80m^2 of panels), could be accommodated across the roofs of the building, which could generate 11,700kWh of electricity, reducing CO_2 emissions by 2.9 tonnes annually.

Appendix C includes a mark-up of the roof layout showing the PV panels.

6.7 LZCs Summary

It is proposed that air source heat pumps are used to provide the thermal energy for the music and drama spaces of the development.

A PV array, approximately 80m^2, will also be included to provide clean electrical energy to the building to achieve the various sustainability targets.

The Be Green Part L results are presented in the following section.

7.0

Proposed Energy Strategy

7.0 Proposed Energy Strategy

In accordance with the London Borough of Richmond upon Thames and the Mayor's Energy Hierarchy, the estimated energy consumption and resulting carbon emissions for the King's House School development are based on the National Calculation Methodology (NCM).

Policy 5.2 of the London Plan requires for major developments that non-residential developments achieve a carbon dioxide reduction of 35% over the current 2013 Building Regulations target. The GLA carbon emissions factors have been applied for the calculations.

An energy assessment has been carried out for the proposed development based on the following energy strategies.

7.1 Be Lean Summary

Passive solar considerations have formed an integral part of the design for the proposed development. Analysis has been carried out to optimise the façade design so that heat losses are minimised whilst the size and position of openings has been optimised to maximise the use of natural light into teaching spaces.

By prioritising natural ventilation and MVHR where possible, demand for active services is reduced. To service the remaining demand, energy efficient mechanical ventilation, heating and cooling systems will be specified.

In terms of lighting, high efficiency LED luminaires coupled with occupancy and daylight controls will be employed to significantly reduce the lighting energy use.

Improved building fabric performance coupled with energy efficient building services result in a 10.2% reduction in emissions for the new build aspect when compared with the Building Regulations benchmark.

7.2 Be Clean Summary

The feasibility of connecting to an existing or proposed district network has been investigated for the site in accordance with Policy 5.6 of the London Plan.

The London Heat Map indicates that there are no existing or planned heat networks within a feasible connection distance of the development.

CHP would cause air quality issues and does not provide the same level of carbon emissions savings as alternative technologies.

As such, no decentralised energy networks are recommended for the energy strategy, and no changes are seen at the Be Clean stage.

7.3 Be Green Summary

For sealed drama and music spaces, a full mechanical system will be employed. This will include high efficiency ASHPs to provide heating and cooling.

Additional to the heat pumps will be roof-mounted photovoltaics. Initial analysis suggests an 14kW$_p$ PV array (approx. 80m^2 array), could be accommodated across the roof of the hall, which could generate approx. 11,700kWh of clean electricity, reducing CO_2 emissions by 2.9 tonnes annually.

The following tables and graphs present the CO_2 emissions of the site at each stage of the energy hierarchy according to the GLA methodology. Proposed Fixed Building Services Strategy.

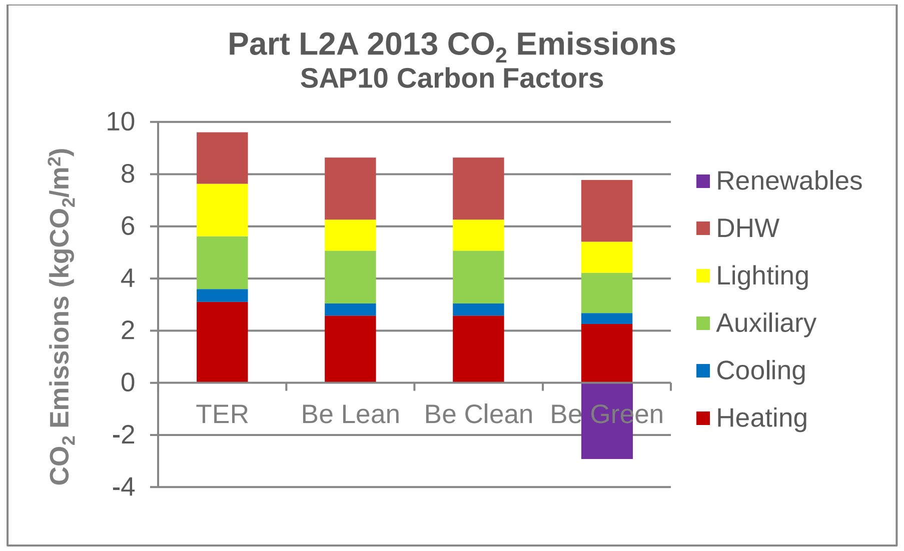
Table 7.1 – System Efficiencies

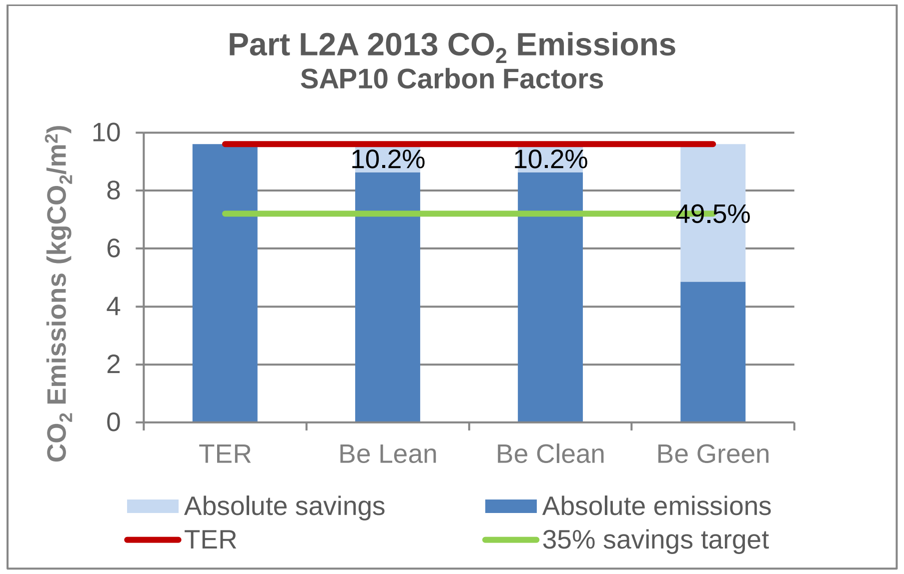
System Parameter	Design
Heating type – general classes	Central boilers
Heating fuel – general classes	Natural gas
Heating emitters – general classes	Radiators
Boiler efficiency	95.0%
Heating type – drama/music spaces	ASHP
Heating fuel – drama/music spaces	Electricity
Emitters – drama/music spaces	FCUs
ASHP heating efficiency (SCoP / COP)	4.0 / 4.0
ASHP cooling efficiency (SEER / EER)	3.5 / 4.0
Ventilation – general classes	Natural w NVHR
Ventilation SFP – general classes (W/l/s)	0.13
Ventilation – music/drama classes	AHU
Ventilation SFP – music/drama (W/l/s)	1.80
AHU heat recovery efficiency	0.74
Ventilation – bathrooms	Mech extract
Ventilation SFP – bathrooms (W/l/s)	0.40
HVAC systems provision for metering	Yes
HVAC systems out of range values	Yes
DHW source	Same as heating
DHW storage volume (L)	150
DHW storage losses (kWh/L.day)	0.014
DHW secondary circulation losses (W/m)	10
DHW secondary circulation loop length (m)	28
DHW secondary circulation pump power (kW)	0.1
DHW time switch	Yes
Pump speeds	Variable
Lighting efficacies – classes, offices, hall, plant, stores (lm/W)	120
Lighting efficacies – circ, WCs (lm/W)	100
PIR controls – classes, offices	Absence detection
PIR controls – circulation, WCs,	Presence detection
Daylight sensing – classes, offices	Yes
Lighting parasitic powers (W/m²)	0.05
Lighting systems provision for metering	Yes
Lighting systems out of range values	Yes
Power factor correction	>0.95
PV array size (m²)	80
PV module efficiency	17%
PV module orientation	South
PV module incline from horizontal	30º

7.4 Part L Results

7.4.1 New Aspects

The new aspects of the development achieve an overall reduction of 49.5% over the Part L2A (2013) TER. This comfortably exceeds the 35% carbon emissions savings target. Therefore, no carbon offset payment is applicable.



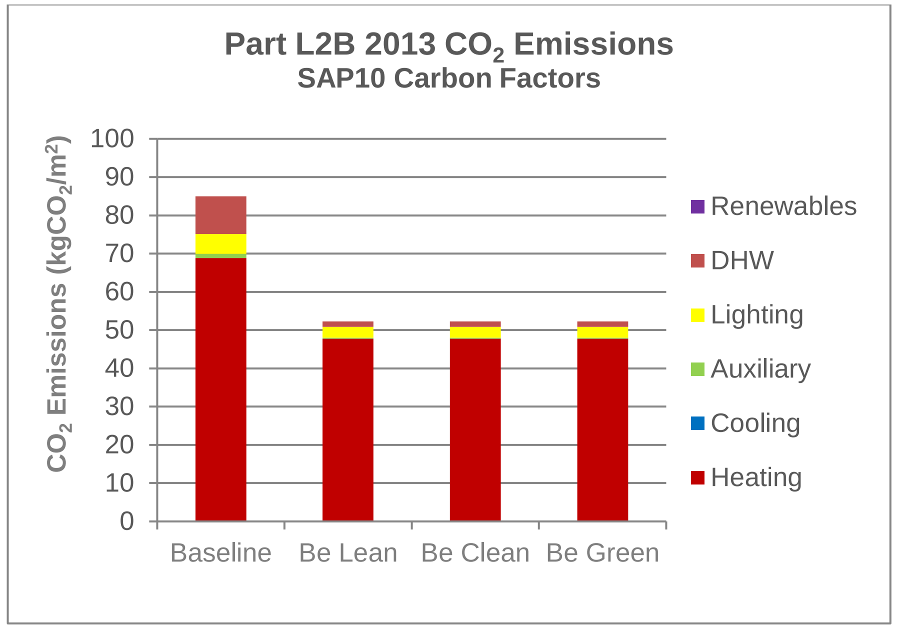


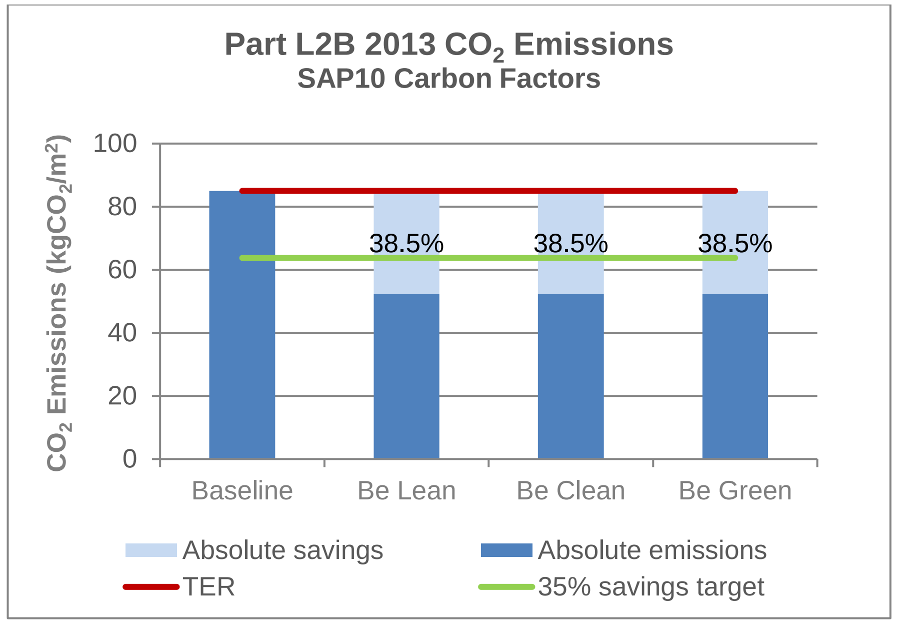
Carbon Dioxide Emissions after each stage of the Energy Hierarchy for non-domestic buildings	Carbon dioxide emissions for non- domestic buildings (Tonnes CO_2 per annum)	
Carbon dioxide emissions for non-domestic buildings	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	6.8	6.8
After energy demand reduction	6.1	6.8
After heat network / CHP	6.1	6.8
After renewable energy	3.4	6.8

*Unregulated emissions remain the same throughout each stage of the hierarchy, as savings from energy efficiency measures and renewables are applied to the regulated emissions only.

Regulated CO_2 savings from stages of Energy Hierarchy for non-domestic buildings	Tonnes CO_2 per annum	%
Savings from energy demand reduction	0.7	10.2
Savings from heat network / CHP	0.0	0.0
Savings from renewable energy	2.7	39.3
Total cumulative savings	3.4	49.5

Shortfall in regulated carbon dioxide savings	Annual Shortfall (Tonnes CO_2)	Cumulative Shortfall (Tonnes CO_2)
Total Target Savings	2.4	
Shortfall	-1.0	-29.4
Shortfall payment	None	





7.4.2 Refurbished Aspects

The refurbished aspects of the development achieved an overall reduction of 38.5% over the Part L2B (2013) baseline. As such it meets the carbon emissions requirements for the refurbishment.

As the hall's roof area will be entirely dedicated to photovoltaics for the new building, there is no remaining space for PV to be added for the sports hall. Therefore, no further measures are proposed for the refurbished elements at Be Clean or Be Green Stages.

The graphs below illustrate the significant improvements that will be made to the base building, which will enable a substantial reduction in carbon emissions due to the refurbishment works.

8.0

Overheating and Cooling

8.0 Overheating and Cooling

The proposed development has been designed to minimise its use of energy intensive cooling systems through passive and energy efficient measures.

8.1 GLA Cooling Hierarchy

To reduce the need for cooling and reduce the risk of overheating, the following measures have been taken in accordance with Policy 5.9 of the GLA's Cooling Hierarchy:

8.1.1 Minimising internal heat generation

Low energy, high efficacy lighting luminaires, along with occupancy and daylight sensing where appropriate, will be used throughout the development to minimize internal heat gains due to lighting systems.

8.1.2 Reducing the amount of heat entering the building

The façade and building envelope of the building has been developed to reduce the risk of overheating:

- The ratio of opaque fabric to transparent fabric means that solar gain will be limited into the spaces.
- Choice of a low g-value glazing similarly assists in reducing solar gain into the space.

8.1.3 Use of thermal mass and high ceiling to manage heat

Exposed thermal mass is used wherever the acoustic and daylighting requirements permit. Thermal mass enables heat gains to be absorbed by the building, limiting peak temperatures during the day, releasing the thermal energy at night when the spaces are unoccupied.

8.1.4 Passive ventilation

General classrooms and the sports hall will have openable windows and doors to provide access to fresh and breezes via natural ventilation. This will be the primary means of ventilating the space and mitigating overheating during warm periods.

8.1.5 Mechanical ventilation and active cooling systems

Each of the general classrooms will include Natural Ventilation Heat Recovery (NVHR) units. These will ensure minimum rates of fresh air are delivered to the spaces at all times. They will also minimise the impact of cold breezes during winter as they mix warm indoor air with cold incoming air before its introduced to the spaces.

Music and drama spaces will be provided with fresh air via a central AHU with heat recovery. This mechanical ventilation solution is necessary due to the noise egress issues associated with these space types, meaning windows need to be sealed shut precluding natural ventilation as an option.

Comfort cooling will be included in these spaces to mitigate overheating issues.

All mechanical equipment will be highly efficient, exceeding the minimum standards of the non-domestic building services compliance guide.

8.2 Part L Criterion 3 – Limiting Solar Gains

Under Part L2 of the building regulations, non-domestic developments must demonstrate solar gains have been reduced to a sufficient level under 'Criterion 3 – Limiting the effects of heat gains in summer'. The assessment has shown that all spaces comply with the Requirements of Criterion 3. Full Criterion 3 results can be found in the Be Lean BRUKL document in Appendix A.

Table 8.1 – Criterion 3 Status

Space Name	Solar Gain Benchmark	Solar Gain Total (kWh)	Criterion 3 Status
L0_Hall	10800	1307	Pass
L0_Class_DramaStudio	4960	1689	Pass
L0_Class_Gen_1	4814	1458	Pass
L0_Class_Gen_2	2794	1464	Pass
L0_Class_Gen_3	3866	1435	Pass
L1_Class_AV-Recording	355	0	Pass
L1_Class_Gen_1	4814	911	Pass
L1_Class_Gen_2	2794	908	Pass
L1_Class_Gen_3	3866	884	Pass
L1_Class_MusicAdmin	1067	193	Pass
L1_Class_MusicAdmin	1067	193	Pass
L1_Class_MusicRm_1	1348	256	Pass
L1_Class_MusicRm_2	1122	259	Pass
L1_Class_MusicRm_3	1111	276	Pass
L1_Class_MusicRm_4	1122	267	Pass
L2_Class_MusicRm	7713	1774	Pass

9.0

Sustainability Strategy

9.0 Sustainability Strategy

9.1 Materials

Building and construction activities worldwide consume 3 billion tonnes of raw material each year, which account for approximately 50% of total global consumption. Using sustainable building materials and products promotes conservation of dwindling non-renewable resources. In addition, integrating sustainable building materials into building projects can help reduce the environmental impacts associated with the extraction, transport, processing, fabrication, installation, reuse, recycling, and disposal of these source materials.

9.1.1 Environmental Impact of Materials - Life Cycle Assessment (LCA)

The use of construction materials leads to a wide range of environmental and social impacts across the life cycle through procurement, wastage, maintenance and replacement. In order to reduce the environmental impacts of materials, a building Life Cycle Assessment (LCA) appraisal will be carried out with 2 to 4 significantly different superstructure design options. The LCA options appraisal will be integrated within the wider design decision-making process. The design option selected by the client to be progressed beyond Concept Design with the reasons for and reasons for not selecting the other design options.

9.1.2 Sustainable Timber

All the timber and timber-based products used on the project shall be 'Legal' and 'Sustainable' as per the UK Government's Timber Procurement Policy (TPP). All timber used for basic or finishing building elements in the scheme will be sourced from responsibly managed and sustainable forests or plantations. Such timber products are the only truly renewable construction material in common use and the responsible management of forests for timber helps to lock in CO_2. By maximising the use of timber for structural or finishing purposes the embodied carbon impact of the development can be reduced.

9.1.3 Locally Sourced Materials

A building that is truly sustainable must be constructed using locally sourced, sustainable materials i.e. materials that can be supplied without any adverse effect on the environment. Therefore, where practical, materials should be sourced from local suppliers, reducing the environment impacts and CO_2 emissions associated with transportation to the site.

9.1.4 Recycled Materials

Scope for increased recycling will be incorporated by specifying recycled materials where possible and ensuring that even where new materials are used, as much as possible can be recycled at the end of the building's life.

Specifying materials with a high-recycled content is also another method of saving processing or manufacturing energy. The recycled content of a material can be described as either post-consumer or post-industrial to indicate at what point in the life cycle a material is reclaimed.

9.2 Water Conservation

Water consumption in the UK has risen by 70% over the last 30 years. Trying to meet the increasing demand by locating new sources of water supply is both expensive and damaging to the environment. Therefore, the design team have focused on reducing the demand for water and managing the existing resources.

9.2.1 Water Demand Reduction and Water Efficiency

In accordance with London Plan policy 5.15 and draft London Plan policy SI5 the project will incorporate measures in order to reduce the water consumption. At least one point in the BREEAM Wat-01 calculator must be achieved, consistent with the minimum standards of BREEAM Excellent.

To meet water efficiency targets the following water saving measures are being considered for a range of areas in line with the BREEAM requirements:

Dual Flush Cisterns on WC's - These units have the ability to provide a single flush of 4L and/or a dual flush of 6/3 L with an effective flush volume of 3.75 Litres. It is proposed that these are used throughout the development in order to minimise water consumption

Flow Restrictors to Taps - Flow restrictors reduce the volume of water discharging from the tap. Maximum 5 Litres/min is recommended on the taps. Spray taps have a similar effect and are recommended to reduce both hot and cold-water consumption. Low flow taps in one of the above forms will be installed in all of areas so as to comply with the BREEAM mandatory requirements.

Low Flow Showers - The average shower uses 15 litres of water a minute, by restricting the output of the showers in the development to a maximum of 9 litres/min a 40% water saving can be achieved. Flow rate can be reduced down to 8litres/ minute without compromising on water pressure and hence will be considered as the design develops.

Water Meters - In 1995 approximately 33,200 million litres of water a day were extracted in England and Wales, this increased to 44,130 million litres/day in 2001, and much of this was for domestic water supply. To reduce this figure, accurate information on usage is required for management of a building's consumption. Water meters will be specified on the main supply and sub-metering in line with the BREEAM requirements. Metering will look to include features such as smart metering that can improve user ability to manage consumption in accordance with policy SI5 of the draft London Plan.

9.3 Sustainable Urban Drainage

The site's drainage strategy will aim to reduce the impact of development on the natural drainage patterns, by retaining water on site through the incorporation of Sustainable Urban Drainage systems (SUDs).

The Environment Agency's Flood Map indicates that the site is in Flood Zone 1 – 'very low risk'. As such there is no requirement for specific flooding risk measures to be adopted. Despite this, a number of measures have been devised to safeguard the development. The bespoke Drainage Strategy and FRA reports produced by Elliot Wood, provides further details of these measures.

Figure 9-1. Flood Map of the site, showing the site is located within low risk flood zone 1.

9.4 Waste Management

Buildings and building sites produce a significant amount of waste per year. Most of the waste produced in the UK is disposed of in landfill sites and only a small percentage of it is recycled or reused.

9.4.1 Waste Targets

Under EU legislation the UK will have to ensure that less than a third of its waste is sent for burial in landfill sites by 2020 and the figure at present is approximately 80%. To achieve this target several measures are implemented, including landfill tax, aiming to discourage disposal of waste to landfill. Good waste management is a key component of sustainable development and is an important means of:

- Reducing unnecessary expenditure.
- Reducing the amount of natural resources for production of new materials.
- Reducing energy for waste disposal.
- Reducing levels of contamination and pollution arising from waste disposal.

9.4.2 Demolition and Construction

During the construction phase a large amount of waste material will be generated through construction, demolition and land clearing procedures. In building construction, the primary waste products in descending percentages are wood, asphalt/concrete/masonry, drywall, roofing, metals, and paper products.

Prior to commencement on site a Resource Management Plan (RMP) that complies with the requirements of current legislation and BREEAM will be prepared. This plan will identify the local waste haulers and recyclers, determine the local salvage material market, identify and clearly label site spaces for various waste material storage and require a reporting system that will quantify the results and set targets. As a minimum, the RMP will contain:

1. A target benchmark for resource efficiency, i.e. m^3 of waste per $100m^2$ or tonnes of waste per $100m^2$
2. Procedures and commitments to minimise non-hazardous waste in line with the target benchmark
3. Procedures to minimise hazardous waste
4. A waste-minimisation target and details of waste minimisation actions to be undertaken
5. Procedures to estimate, monitor, measures and report on hazardous and non-hazardous site waste and demolition waste, where relevant, arising from work carried out by the principal contractor and all subcontractors. Waste data obtained from licensed external waste contractors needs to be reliable and verifiable, e.g. using data from EA/SEPA/EA Wales/NIEA waste return forms or from a PAS402 compliant company
6. Monthly reporting of all construction waste data throughout the project checked against what would be expected based on the stage of the project, invoices, etc., to validate completeness of waste reporting data
7. Procedures to sort, reuse and recycle construction waste into defined waste groups, either on site or through a licensed external contractor
8. Procedures to review and update the plan
9. The name or job title of the individual responsible for implementing the above.

As the proposed King's House School development is on land that has previously been built upon, there is the potential for using waste materials from the existing buildings and hard paved areas. Bricks and concrete could possibly be reused as hard-core materials etc. Opportunities for introducing more reused or reusable materials/components will be explored during detailed design.

9.4.3 Waste Management and Reporting in Operation

The detailed design phases will identify the potential waste streams that the development will produce. As a minimum, plans will be formulated to handle the separation, collection, and storage of common recyclable materials such as paper, glass, plastics, and metals. The collection points will be easily accessible to all of the users.

The main aim will be to recycle as much waste as possible, this will be achieved by making sure that waste recycling facilities are strategically placed in convenient locations.

Dedicated storage space for recyclable materials generated by the site during occupation, will include the following:

- Be clearly labelled to assist with segregation, storage and collection of the recyclable waste streams
- Be placed within accessible reach to building occupants or facilities operators for the deposit of materials and collections by waste management contractors
- Of a capacity appropriate to the building type, size, number of units (if relevant) and predicted volumes of waste that will arise from daily or weekly operational activities and occupancy rates.

Facilities within the existing building can be used to assess compliance. These facilities must cater for the total volume of predicted recyclable waste arising from the new extension and the existing buildings.

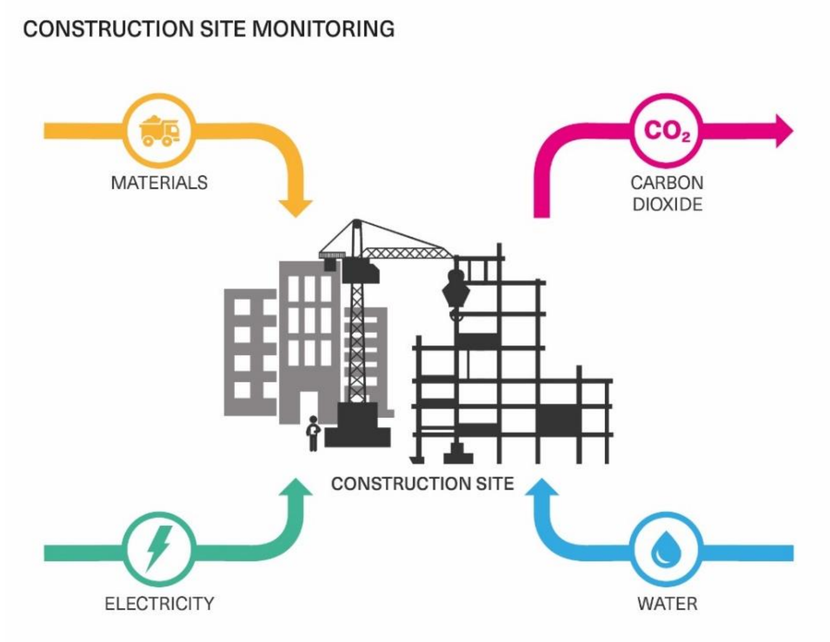
Waste collection points – at key ground floor location there will be waste recycling collection points, which will be emptied on a regular basis. The split recycling streams will then be directed to an accessible refuse area, where the separate streams can be stored until collected by the London Borough of Richmond.

A waste management strategy for the new school development will be developed based on Richmond Borough guidance, with the aim of supporting recycling of as much waste as possible. These facilities will be easily accessible to all users and sized according with BREEAM guidance.

9.5 Construction Environmental Management

Construction sites are responsible for significant impacts, especially at a local level. These arise from noise, potential sources of pollution, waste and other disturbances. Impacts such as increased energy and water use are also significant. Therefore, attention is being given to site-related parameters with the aim to protect and enhance the existing site & its ecology.

The aim is to have a construction site managed in an environmentally sound manner in terms of resource use, storage, waste management, pollution and good neighbourliness.



9.5.1 Considerate Construction Scheme

The principal contractor should report and monitor on the following items to achieve one credit for responsible construction management:

Vehicle movement

- Manage the construction site entrance to minimise the impacts (e.g. safety, disruption) arising from vehicles approaching and leaving the development footprint.

Pollution management

- Minimise the risks of air, land and water pollution.

Tidiness

- Practices ensure the development footprint is safe, clean and organised at all times. This includes, but is not limited to, facilities, materials and waste storage.
- Ensure clear and safe access in and around the buildings at the point of handover.

Health and wellbeing

- Provide processes and equipment required to respond to medical emergencies.
- Establish management practices and facilities encouraging equality, fair treatment and respect of all site operatives.

Security processes

- Ensure ongoing training is provided, and up to date, for personnel and visitors.
- The principal contractor ensures that site operatives are trained for the tasks they are undertaking (including any site-specific considerations).
- All visitor, workforce and community accidents, incidents and near misses are recorded, and action is taken to reduce the likelihood of them reoccurring.

One additional credit can be achieved by achieving six additional items from Table 4.1, BREEAM UK New Construction 2018.

When demonstrating compliance with the responsible construction management criteria it may be possible to use BREEAM recognised responsible construction management schemes to support in this process. The Considerate Constructors Scheme (CCS) monitor's report can be used as evidence to demonstrate that the relevant items in the criteria have been achieved. As a minimum, a score of greater than 35 is required.

To achieve this, there will be a commitment to comply with the Considerate Constructors Scheme and achieve formal certification under the scheme in line with the BREEAM requirements. As a minimum, a score of greater than 35 of out 50 will be achieved with an aspiration to exceed 40, with no individual section achieving a score of less than 7.

CONSIDERATE CONSTRUCTORS

Areas that can be taken into consideration in order to minimise the impact of the construction site on its surroundings and the global environment as outlined in the BREEAM methodology:

- Monitor, report and set targets for CO_2 or energy usage from site activities.
- Monitor, report and set targets for CO_2 or energy usage arising from transport to and from site.
- Monitor, report and set targets for water consumption from site activities.

- Monitor construction waste on site, sorting and recycling construction waste where applicable.
- Adopt best practice policies in respect of air and water pollution arising from site activities.
- Operate an Environmental Management System.
- Additionally, all timber used on site will be responsibly sourced.

9.6 Pollution

Global concern for environmental pollution has risen in recent years, as concentrations of harmful pollutants in the atmosphere are increasing. Buildings have the potential to create major pollution both from their construction and operation, largely through pollution to the air (dust emissions, NOx emissions, ozone depletion and global warming) but also through pollution to watercourses and ground water. The proposed development will aim to minimise the above impacts, both at the design stage and onsite.

9.6.1 Ozone Depletion

CFCs and HCFCs, compounds commonly used in insulation materials and refrigerants, can cause long-term damage to the Earth's stratospheric ozone layer, exposing living organisms to harmful radiation from the sun. They also significantly increase global warming if they leak into the atmosphere. Following the Montreal Protocol, production and use of CFCs is no longer permitted and EC regulations required phasing out of HCFCs by 2015. However, products that replaced these gases are often still potent global warming contributors. Where refrigerants are used, they will be CFC and HCFC-free.

9.6.2 Internal pollutants

Volatile organic compounds (VOCs) are emitted as gases (commonly referred to as off gassing) from certain solids or liquids. VOCs include a variety of chemicals, some of which are known to have short-term and long-term adverse health effects. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors.

VOCs are emitted by a wide array of products numbering in the thousands. Examples include: paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials, furnishings, adhesives, Urea-formaldehyde foam insulation (UFFI), pressed wood products (hardwood plywood wall panelling, particleboard, fibreboard) and furniture made with these pressed wood products.

'No' or 'low' VOC paints are available from most standard mainstream paint manufacturers. There 'eco-friendly' paints are made from organic plant sources and also powdered milk-based products.

The design team will select internal finishes and fittings with low or no emissions of VOCs and comply with European best practice levels as a minimum.

9.6.3 Night Sky Pollution

External lighting encompasses vehicle and pedestrian access lighting, security lighting, facility illumination and general feature lighting. A separate light pollution advice note is submitted as part of the planning application but in summary the lighting will be designed on a site wide basis to meet the mandatory requirements and aesthetic considerations. The strategy is to provide a balance between adequate external lighting for safe and secure operation of the site without unnecessary illumination or power consumption.

The intention is to be a good neighbour and not to introduce nuisance glare or light pollution of the night sky from miss directed or unnecessary lighting. Feature lighting, where required, will be focussed to the task/subject. Where necessary, luminaires will be further screened in cases where there may be an issue of close proximity and light spill to the adjacent neighbouring residential areas, although the intention is to avoid this situation arising wherever possible from the outset. The external lighting design will take into consideration the relevant guidance from the British Standards and other recommended documents including the following Standards and Design Guides:

- CIBSE Lighting Guide for the Outdoor Environment
- CIBSE Lighting Design Guides
- BS5489 Code of Practice for the Design of Road Lighting
- BS EN 13201-1 Road Lighting, Selection of Lighting Classes
- BSEN 13201-2 Road Lighting, Performance requirements
- Institute of Lighting Engineers Guidance Notes for the Reduction of Obtrusive Light

9.7 Land Use and Ecology

A site survey has been conducted identifying the existing ecological situation and opportunities for the development. The site currently comprises of a mix of existing buildings and hard and soft landscaping as well as opportunities for a range of species to roost. The aim of the landscaping strategy will be to improve the ecological value of the site. The bespoke report 'Kings House School – Preliminary Ecological Appraisal, Version 1', produced by The Ecology Consultancy provides details on the existing ecology as well as recommendations for the measures that should be adopted to improve the ecological value of the site.

9.8 Transport

The transport of people between buildings is the second largest source of CO_2 emissions in the UK after energy use in buildings and remains the main source of many local pollutants. Energy use and emissions from transport are growing at 4% per year, while the effects of climate change are becoming more severe.

9.8.1 Site Location

King's House School benefits from good public transport links. Richmond Station is located within a fifteen-minute walk of the site (900m away), providing both over-ground and underground services on the District Line.

There are several bus stops near King's House School within a ten-minute walk, serving routes 371, 33, 337, 493 and 969.

The London Public Transport Accessibility Level (PTAL) for the site is 2, indicating very poor transport links (see Figure 9-2.).

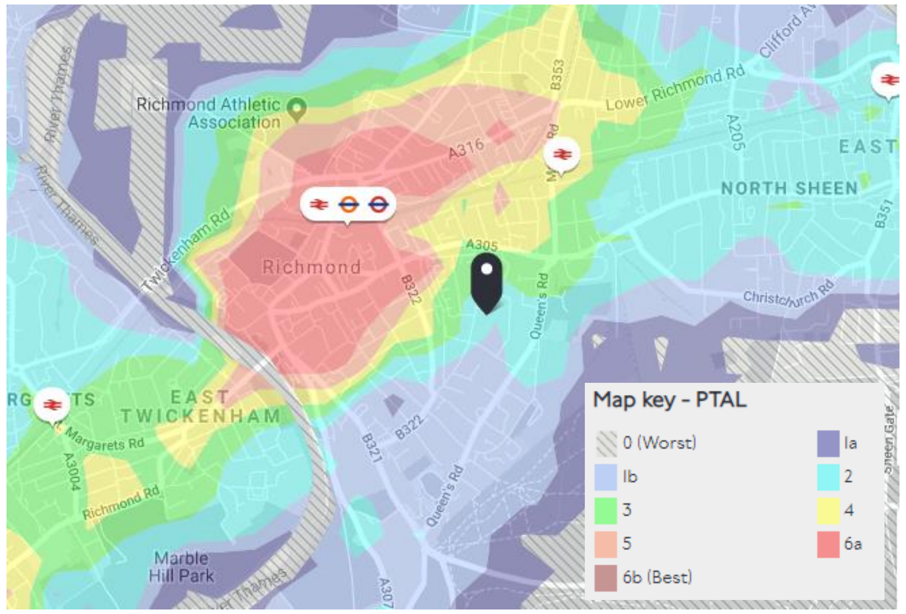


Figure 9-2 PTAL map illustrating public transport connectivity around the site.

9.8.2 Cycling Facilities

A small number of secure cycle storage racks are already existing on the site, along with showering facilities, to encourage the occupants to use this carbon-free mode of transport.

9.8.3 Travel Plan

The school has achieved a Silver level accreditation by the Sustainable Travel Active Responsible Safe (STARS) programme, reflecting their commitment to road safety and transport systems. Futher details can be found in that document.

Appendices

Appendix A – New Aspects BRUKLs

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Kings House School - Planning2 - New Aspects - Be Lean

As designed

Date: Fri Dec 11 15:23:11 2020

Administrative information

Building Details

Address: Kings House School - Planning2 - New Aspects - Be Lean, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.13

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.13

BRUKL compliance check version: v5.6.b.0

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	15.1
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	15.1
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	13.1
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

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

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

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	L000000C:Surf[0]
Floor	0.25	0.2	0.2	L000000C:Surf[3]
Roof	0.25	0.16	0.16	L0000014:Surf[4]
Windows***, roof windows, and rooflights	2.2	1.58	1.6	L000000C:Surf[1]
Personnel doors	2.2	1.6	1.6	L2000002:Surf[3]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	1.6	1.6	L000000C:Surf[5]

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)] $U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

*** Display windows and similar glazing are excluded from the U-value check.

N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

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

Building services

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

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

1- Lean - HTMs Nat vent - gen classes

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

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

2- Lean - Rads Nat vent - circ

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	-	0.2	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

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

3- Lean - Boilers Chillers AHU - music and drama spaces

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	3	0	1.8	0.74
Standard value	0.91*	3.9	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.

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

4- Lean - Rads Mech extract - WCs, showers

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	-	0.2	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

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

"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
L0_Class_Gen_1	-	-	-	-	-	0.1	-	-	-	-	N/A
L0_Class_Gen_2	-	-	-	-	-	0.1	-	-	-	-	N/A
L1_Class_Gen_1	-	-	-	-	-	0.1	-	-	-	-	N/A
L1_Class_Gen_2	-	-	-	-	-	0.1	-	-	-	-	N/A
L1_Class_MusicAdmin	-	-	-	-	-	-	-	0.2	-	-	N/A
L1_Class_MusicRm_4	-	-	-	-	-	-	-	0.2	-	-	N/A
L1_Class_MusicRm_3	-	-	-	-	-	-	-	0.2	-	-	N/A
L1_Class_MusicRm_2	-	-	-	-	-	-	-	0.2	-	-	N/A
L1_Class_AV-Recording	-	-	-	-	-	-	-	0.2	-	-	N/A
L2_Class_MusicRm	-	-	-	-	-	-	-	0.2	-	-	N/A
L0_Class_DramaStudio	-	-	-	-	-	-	-	0.2	-	-	N/A
L0_WC	-	-	0.4	-	-	-	-	-	-	-	N/A
L0_Changing	-	-	0.4	-	-	-	-	-	-	-	N/A
L1_Class_Gen_3	-	-	-	-	-	0.1	-	-	-	-	N/A
L1_Class_MusicAdmin	-	-	-	-	-	-	-	0.2	-	-	N/A
L1_Class_MusicRm_1	-	-	-	-	-	-	-	0.2	-	-	N/A
L0_Class_Gen_3	-	-	-	-	-	0.1	-	-	-	-	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	
L0_Class_Gen_1	120	-	-	183
L0_Class_Gen_2	120	-	-	176
L0_Circ_2	-	100	-	41
L1_Class_Gen_1	120	-	-	183
L1_Class_Gen_2	120	-	-	176
L1_Class_MusicAdmin	120	-	-	63
L1_Class_MusicRm_4	120	-	-	61
L1_Class_MusicRm_3	120	-	-	61
L1_Class_MusicRm_2	120	-	-	61
L1_Circ_2	-	100	-	37
L1_Plant	120	-	-	45
L1_Stair	-	100	-	38
L1_Class_AV-Recording	120	-	-	59
L2_Stair	-	100	-	38
L2_Circ_1	-	100	-	26
L2_Class_MusicRm	120	-	-	342
L0_Class_DramaStudio	120	-	-	252
L0_Store_Drama	120	-	-	11
L0_WC	-	100	-	58
L0_Changing	-	100	-	73
L0_ShowerWCacc	-	100	-	40
L0_Store_PE	120	-	-	6

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
L0_Stair	-	100	-	32
L0_Plant_Sprinkler	120	-	-	26
L0_Store_PE	120	-	-	30
L1_Class_Gen_3	120	-	-	173
L1_Class_MusicAdmin	120	-	-	60
L1_Class_MusicRm_1	120	-	-	95
L1_Circ_1	-	100	-	64
L1_WC	-	100	-	61
L1_Store	100	-	-	8
L0_Circ_1	-	100	-	64
L0_Plant_Sprinkler	120	-	-	51
L0_Class_Gen_3	120	-	-	173

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?
L0_Class_Gen_1	NO (-69.7%)	NO
L0_Class_Gen_2	NO (-47.6%)	NO
L1_Class_Gen_1	NO (-81.1%)	NO
L1_Class_Gen_2	NO (-67.5%)	NO
L1_Class_MusicAdmin	NO (-81.9%)	NO
L1_Class_MusicRm_4	NO (-76.2%)	NO
L1_Class_MusicRm_3	NO (-75.2%)	NO
L1_Class_MusicRm_2	NO (-77%)	NO
L1_Class_AV-Recording	N/A	N/A
L2_Class_MusicRm	NO (-77%)	NO
L0_Class_DramaStudio	NO (-65.9%)	NO
L1_Class_Gen_3	NO (-77.2%)	NO
L1_Class_MusicAdmin	N/A	N/A
L1_Class_MusicRm_1	NO (-81%)	NO
L0_Class_Gen_3	NO (-62.9%)	NO

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	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]	807.8	807.8
External area [m²]	1607.6	1607.6
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	561.19	808.59
Average U-value [W/m²K]	0.35	0.5
Alpha value* [%]	10.4	10

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

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
100	**D1 Non-residential Institutions: Education**
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	12.22	14.76
Cooling	2.01	2.13
Auxiliary	8.71	8.69
Lighting	5.11	8.63
Hot water	11.31	9.4
Equipment*	21.16	21.16
TOTAL**	**39.36**	**43.61**

* Energy used by equipment does not count towards the total for consumption or 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]	55.23	74.87
Primary energy* [kWh/m²]	76.09	87.68
Total emissions [kg/m²]	13.1	15.1

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

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	43.7	0	13.6	0	2	0.89	0	0.95	0
	Notional	54.6	0	17.6	0	1.2	0.86	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	64.3	0	20.9	0	2.1	0.85	0	0.91	0
	Notional	70.5	0	22.7	0	4.7	0.86	0	----	----
[ST] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	23	54.9	7.2	6.5	19.5	0.88	2.35	0.95	3
	Notional	32.5	93.6	10.5	6.9	17.7	0.86	3.79	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	18.7	0	5.8	0	17.4	0.89	0	0.95	0
	Notional	27	0	8.7	0	21.2	0.86	0	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

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

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	**$U_{i\text{-}Typ}$**	**$U_{i\text{-}Min}$**	**Surface where the minimum value occurs***
Wall	0.23	0.18	L000000C:Surf[0]
Floor	0.2	0.2	L000000C:Surf[3]
Roof	0.15	0.16	L0000014:Surf[4]
Windows, roof windows, and rooflights	1.5	1.3	DF000002:Surf[2]
Personnel doors	1.5	1.6	L2000002:Surf[3]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	1.6	L000000C:Surf[5]

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	**Typical value**	**This building**
$m^3/(h.m^2)$ at 50 Pa	5	3

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Kings House School - Planning2 - New Aspects - Be Green

As designed

Date: Fri Dec 11 17:13:28 2020

Administrative information

Building Details

Address: Kings House School - Planning2 - New Aspects - Be Green, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.13

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.13

BRUKL compliance check version: v5.6.b.0

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	12.8
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	12.8
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	5.2
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

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

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

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	L000000C:Surf[0]
Floor	0.25	0.2	0.2	L000000C:Surf[3]
Roof	0.25	0.16	0.16	L0000014:Surf[4]
Windows***, roof windows, and rooflights	2.2	1.58	1.6	L000000C:Surf[1]
Personnel doors	2.2	1.6	1.6	L2000002:Surf[3]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	1.6	1.6	L000000C:Surf[5]

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

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

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

Building services

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

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

1- Green - HTMs Nat vent - gen classes

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

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

2- Lean - Rads Nat vent - circ

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	-	0.2	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

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

3- Green - VRF AHU - music and drama spaces

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4	4	0	0	0.74
Standard value	2.5*	2.6	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

4- Lean - Rads Mech extract - WCs, showers

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	-	0.2	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

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

"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
L0_Class_Gen_1	-	-	-	-	-	0.1	-	-	-	-	N/A
L0_Class_Gen_2	-	-	-	-	-	0.1	-	-	-	-	N/A
L1_Class_Gen_1	-	-	-	-	-	0.1	-	-	-	-	N/A
L1_Class_Gen_2	-	-	-	-	-	0.1	-	-	-	-	N/A
L1_Class_MusicAdmin	-	-	-	1.8	-	-	-	-	-	-	N/A
L1_Class_MusicRm_4	-	-	-	1.8	-	-	-	-	-	-	N/A
L1_Class_MusicRm_3	-	-	-	1.8	-	-	-	-	-	-	N/A
L1_Class_MusicRm_2	-	-	-	1.8	-	-	-	-	-	-	N/A
L1_Class_AV-Recording	-	-	-	1.8	-	-	-	-	-	-	N/A
L2_Class_MusicRm	-	-	-	1.8	-	-	-	-	-	-	N/A
L0_Class_DramaStudio	-	-	-	1.8	-	-	-	-	-	-	N/A
L0_WC	-	-	0.4	-	-	-	-	-	-	-	N/A
L0_Changing	-	-	0.4	-	-	-	-	-	-	-	N/A
L1_Class_Gen_3	-	-	-	-	-	0.1	-	-	-	-	N/A
L1_Class_MusicAdmin	-	-	-	1.8	-	-	-	-	-	-	N/A
L1_Class_MusicRm_1	-	-	-	1.8	-	-	-	-	-	-	N/A
L0_Class_Gen_3	-	-	-	-	-	0.1	-	-	-	-	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	
L0_Class_Gen_1	120	-	-	183
L0_Class_Gen_2	120	-	-	176
L0_Circ_2	-	100	-	41
L1_Class_Gen_1	120	-	-	183
L1_Class_Gen_2	120	-	-	176
L1_Class_MusicAdmin	120	-	-	63
L1_Class_MusicRm_4	120	-	-	61
L1_Class_MusicRm_3	120	-	-	61
L1_Class_MusicRm_2	120	-	-	61
L1_Circ_2	-	100	-	37
L1_Plant	120	-	-	45
L1_Stair	-	100	-	38
L1_Class_AV-Recording	120	-	-	59
L2_Stair	-	100	-	38
L2_Circ_1	-	100	-	26
L2_Class_MusicRm	120	-	-	342
L0_Class_DramaStudio	120	-	-	252
L0_Store_Drama	120	-	-	11
L0_WC	-	100	-	58
L0_Changing	-	100	-	73
L0_ShowerWCacc	-	100	-	40
L0_Store_PE	120	-	-	6

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
L0_Stair	-	100	-	32
L0_Plant_Sprinkler	120	-	-	26
L0_Store_PE	120	-	-	30
L1_Class_Gen_3	120	-	-	173
L1_Class_MusicAdmin	120	-	-	60
L1_Class_MusicRm_1	120	-	-	95
L1_Circ_1	-	100	-	64
L1_WC	-	100	-	61
L1_Store	100	-	-	8
L0_Circ_1	-	100	-	64
L0_Plant_Sprinkler	120	-	-	51
L0_Class_Gen_3	120	-	-	173

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?
L0_Class_Gen_1	NO (-69.7%)	NO
L0_Class_Gen_2	NO (-47.6%)	NO
L1_Class_Gen_1	NO (-81.1%)	NO
L1_Class_Gen_2	NO (-67.5%)	NO
L1_Class_MusicAdmin	NO (-81.9%)	NO
L1_Class_MusicRm_4	NO (-76.2%)	NO
L1_Class_MusicRm_3	NO (-75.2%)	NO
L1_Class_MusicRm_2	NO (-77%)	NO
L1_Class_AV-Recording	N/A	N/A
L2_Class_MusicRm	NO (-77%)	NO
L0_Class_DramaStudio	NO (-65.9%)	NO
L1_Class_Gen_3	NO (-77.2%)	NO
L1_Class_MusicAdmin	N/A	N/A
L1_Class_MusicRm_1	NO (-81%)	NO
L0_Class_Gen_3	NO (-62.9%)	NO

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	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]	807.8	807.8
External area [m²]	1607.6	1607.6
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	561.19	808.59
Average U-value [W/m²K]	0.35	0.5
Alpha value* [%]	10.4	10

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

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
100	**D1 Non-residential Institutions: Education**
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	10.48	12.61
Cooling	1.81	2.13
Auxiliary	6.62	4.44
Lighting	5.11	8.63
Hot water	11.31	9.4
Equipment*	21.16	21.16
TOTAL**	**35.33**	**37.2**

* Energy used by equipment does not count towards the total for consumption or 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	12.56	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]	55.23	74.87
Primary energy* [kWh/m²]	68.01	74.26
Total emissions [kg/m²]	5.2	12.8

* 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] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	23	54.9	1.6	5.8	12.8	3.92	2.62	4	3.5
	Notional	32.5	93.6	3.5	6.9	4	2.56	3.79	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	43.7	0	13.6	0	2	0.89	0	0.95	0
	Notional	54.6	0	17.6	0	1.2	0.86	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	18.7	0	5.8	0	17.4	0.89	0	0.95	0
	Notional	27	0	8.7	0	21.2	0.86	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	64.3	0	20.9	0	2.1	0.85	0	0.91	0
	Notional	70.5	0	22.7	0	4.7	0.86	0	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

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

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	**$U_{i\text{-}Typ}$**	**$U_{i\text{-}Min}$**	**Surface where the minimum value occurs***
Wall	0.23	0.18	L000000C:Surf[0]
Floor	0.2	0.2	L000000C:Surf[3]
Roof	0.15	0.16	L0000014:Surf[4]
Windows, roof windows, and rooflights	1.5	1.3	DF000002:Surf[2]
Personnel doors	1.5	1.6	L2000002:Surf[3]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	1.6	L000000C:Surf[5]

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	**Typical value**	**This building**
$m^3/(h.m^2)$ at 50 Pa	5	3

Appendix B – Retained Aspects BRUKLs

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Kings House School - Planning2 - Retained Aspects - Baseline

As designed

Date: Fri Dec 11 14:16:32 2020

Administrative information

Building Details

Address: Kings House School - Planning2 - Retained Aspects - Baseline, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.13

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.13

BRUKL compliance check version: v5.6.b.0

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

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

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	11.8
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	11.8
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	95
Are emissions from the building less than or equal to the target?	BER > TER
Are as built details the same as used in the BER calculations?	Separate submission

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

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

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	1.46	1.46	L0000019:Surf[6]
Floor	0.25	3.63	3.63	L0000019:Surf[0]
Roof	0.25	0.78	0.78	L0000019:Surf[1]
Windows***, roof windows, and rooflights	2.2	0.18	0.18	L0000019:Surf[3]
Personnel doors	2.2	2.2	2.2	L0000019:Surf[2]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

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

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	15*

* Buildings with less than 500 m² total useful floor area may avoid the need for a pressure test provided that the air permeability is taken as 15 $m^3/(h.m^2)$ at 50 Pa.

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	NO
Whole building electric power factor achieved by power factor correction	<0.9

1- O1 - Radiant panels Nat vent - hall

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.9	0	-
Standard value	0.86	N/A	0.55	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system	NO				

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

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

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
L0_Hall	-	70	-	1659
L0_Plant	70	-	-	47
L0_Store_PE	70	-	-	51

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?
L0_Hall	NO (-89.2%)	NO

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	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]	267.6	267.6
External area [m²]	977.3	977.3
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	15	6
Average conductance [W/K]	1821.41	289.51
Average U-value [W/m²K]	1.86	0.3
Alpha value* [%]	10	10

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

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
100	**D1 Non-residential Institutions: Education**
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	327.72	36.62
Cooling	0	0
Auxiliary	4.91	0
Lighting	22.06	7.6
Hot water	47.14	0
Equipment*	11.64	11.64
TOTAL**	**401.83**	**44.21**

* Energy used by equipment does not count towards the total for consumption or 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]	1002.01	113.64
Primary energy* [kWh/m²]	540.11	67.41
Total emissions [kg/m²]	95	11.8

* 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] Unflued radiant heater, [HS] Unflued radiant heater, [HFT] Natural Gas, [CFT] Electricity										
	Actual	1169	0	382.3	0	0	0.85	0	0.91	0
	Notional	132.6	0	42.7	0	0	0.86	0	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

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

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	**$U_{i\text{-}Typ}$**	**$U_{i\text{-}Min}$**	**Surface where the minimum value occurs***
Wall	0.23	1.46	L0000019:Surf[6]
Floor	0.2	3.63	L0000019:Surf[0]
Roof	0.15	0.78	L0000019:Surf[1]
Windows, roof windows, and rooflights	1.5	0.18	L0000019:Surf[3]
Personnel doors	1.5	2.2	L0000019:Surf[2]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)]
$U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	**Typical value**	**This building**
$m^3/(h.m^2)$ at 50 Pa	5	15

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Kings House School - Planning2 - Retained Aspects - Be Lean

As designed

Date: Fri Dec 11 14:16:54 2020

Administrative information

Building Details

Address: Kings House School - Planning2 - Retained Aspects - Be Lean, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.13

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.13

BRUKL compliance check version: v5.6.b.0

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

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

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	11.7
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	11.7
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	57.3
Are emissions from the building less than or equal to the target?	BER > TER
Are as built details the same as used in the BER calculations?	Separate submission

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

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

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.95	1.46	L0000019:Surf[7]
Floor	0.25	3.14	3.63	L0000019:Surf[0]
Roof	0.25	0.16	0.16	L0000019:Surf[1]
Windows***, roof windows, and rooflights	2.2	0.18	0.18	L0000019:Surf[3]
Personnel doors	2.2	1.6	1.6	L0000019:Surf[2]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

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

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	7

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- O1 - Radiant panels Nat vent - hall

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	-	0.9	0	-
Standard value	0.86	N/A	0.55	N/A	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"

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

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
L0_Hall	-	120	-	968
L0_Plant	120	-	-	27
L0_Store_PE	120	-	-	30

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?
L0_Hall	NO (-89.2%)	NO

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	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]	267.6	267.6
External area [m²]	977.3	977.3
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	7	6
Average conductance [W/K]	1300.64	289.51
Average U-value [W/m²K]	1.33	0.3
Alpha value* [%]	10	10

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

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
100	**D1 Non-residential Institutions: Education**
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	226.65	36.57
Cooling	0	0
Auxiliary	1.24	0
Lighting	12.22	7.6
Hot water	6.87	0
Equipment*	11.64	11.64
TOTAL**	**246.98**	**44.17**

* Energy used by equipment does not count towards the total for consumption or 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]	761.5	113.51
Primary energy* [kWh/m²]	325.19	67.35
Total emissions [kg/m²]	57.3	11.7

* 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] Unflued radiant heater, [HS] Unflued radiant heater, [HFT] Natural Gas, [CFT] Electricity										
	Actual	888.4	0	264.4	0	0	0.93	0	0.95	0
	Notional	132.4	0	42.7	0	0	0.86	0	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

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

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

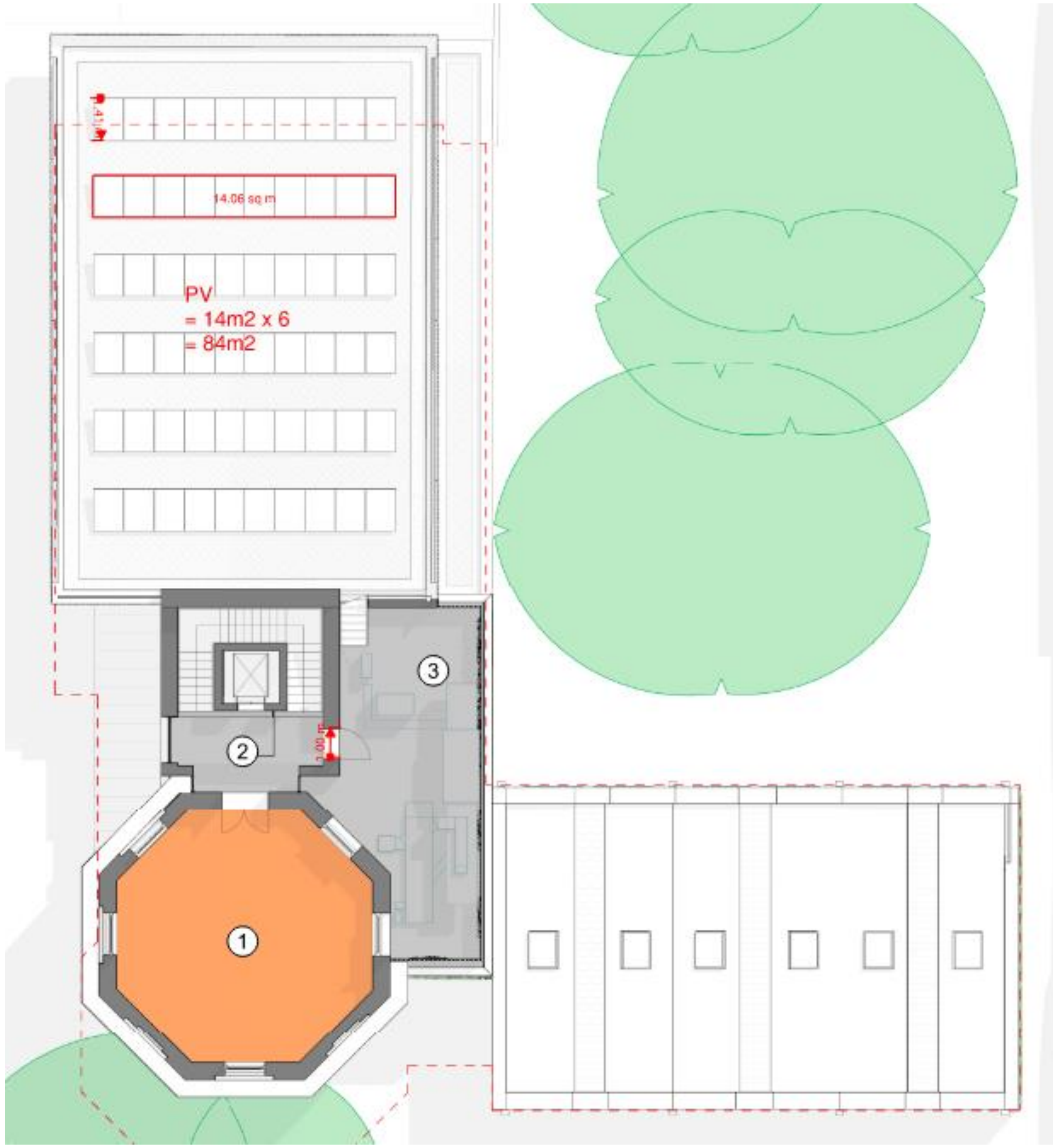
Element	**$U_{i\text{-}Typ}$**	**$U_{i\text{-}Min}$**	**Surface where the minimum value occurs***
Wall	0.23	0.18	L0000019:Surf[8]
Floor	0.2	0.2	L0000004:Surf[2]
Roof	0.15	0.16	L0000019:Surf[1]
Windows, roof windows, and rooflights	1.5	0.18	L0000019:Surf[3]
Personnel doors	1.5	1.6	L0000019:Surf[2]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	**Typical value**	**This building**
$m^3/(h.m^2)$ at 50 Pa	5	7

Appendix C – Roof Layout showing Solar PV



Cundall Johnston & Partners LLP
One Carter Lane London EC4V 5ER United Kingdom Tel:+44 (0)20 7438 1600

Asia Australia Europe MENA UK and Ireland
www.cundall.com

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