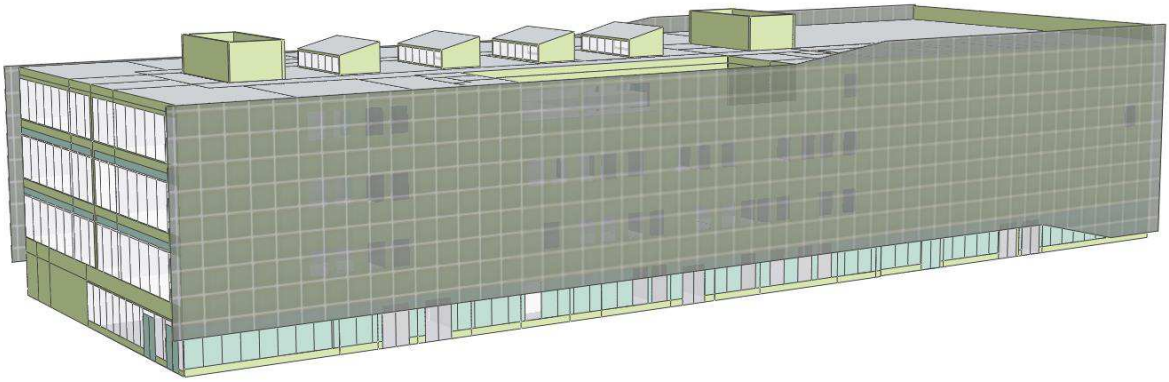
Global Academy UTC

THE OLD VINYL FACTORY,

BLYTH ROAD, HAYES, UB3 1HA



April 2015

Energy Strategy Report

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Executive Summary

Planning permission is being sought to construct a new University Technical College (UTC) on the 'Picturehouse' site within the wider master-planned regeneration area of The Old Vinyl Factory area.

The UTC is sponsored by Global Radio ('Global') working in conjunction with its University partner, the University of the Arts London, and will specialise in offering up to 800 14-19 year olds the vocational skills to work in the broadcast and media industry. UTCs are a relatively new concept in secondary school provision and provide students with the opportunity to take a full-time, technically orientated course of study alongside the core academic subjects of English, Mathematics, Science and ICT. The UTC is being procured by the Education Funding Agency (EFA) and under a standard framework agreement.

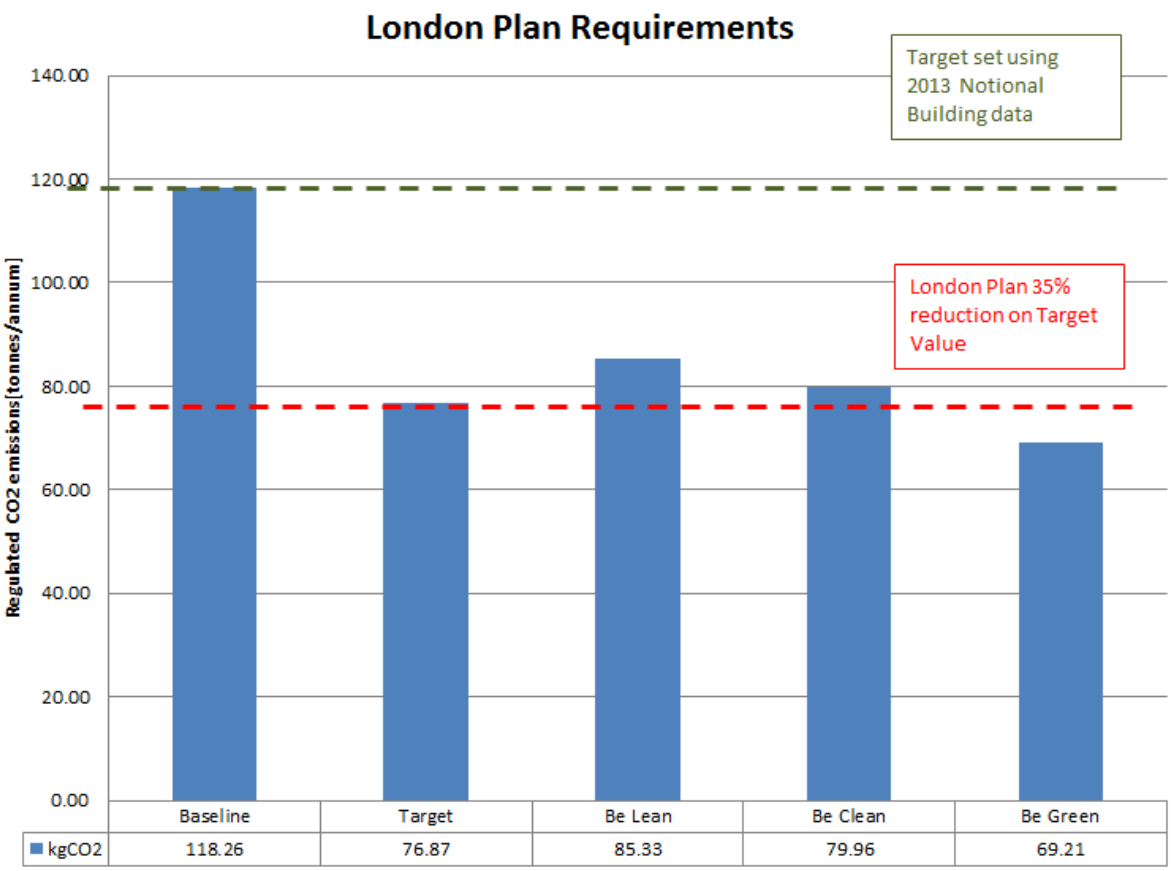
The Construction is of a proposed of a 4-storey largely modular building (arranged over ground and three upper floors).

The design team have considered all the available options and opportunities associated with the scheme and site constraints and believe they have a robust approach which will meet the planning conditions and the London Plan requirements delivering a 35% reduction in regulated carbon emissions [tonnes /annum] based on a ADL2A 2013 baseline model approach.

The design will incorporate the following with a fabric first approach:

- Improved U Values
- Design to Maximise Natural Daylight
- LED Lighting
- Mixed Mode ventilation
- Demand controlled Ventilation
- Mitigate the need for High Capacity Cooling Systems
- High efficiency Heat pumps
- Connection into a District Heating Network

The following Extract shows the Baseline, and savings for the Hierarchy actions to be implemented:



Technical data and Supporting BRUKL documents are included in the Appendix sections.

The carbon factor of the private district heating plant has been provided with the calculation detailed in appendix F and has been set at of 0.151 kgCO2/kWh.

The following table details the overall Carbon Target and reduction for the Baseline and H1 to H3 analysis reported in Table 1 and Table 2 formats.

Table 1.0 Carbon Dioxide Emissions after each stage of the energy Hierarchy

	Carbon Dioxide emissions [Tonnes CO2 per annum]	
	Regulated	Unregulated
Baseline: Part L 2013 of the building Regulations Compliant Development	118.26	
After energy Demand reduction	85.33	
After CHP/District Heating	79.96	
After renewable energy	69.21	

Table 2.0 Regulated Carbon Dioxide Emissions after each stage of the energy Hierarchy

	Regulated Carbon Dioxide Savings	
	[Tonnes CO2 per annum]	[%]
Savings from Energy Demand reduction	33	27.84%
Savings from CHP	5	4.55%
Savings from Renewable energy	11	9.09%
Total Cumulative Savings	49	41.48%
Total Target savings	41	35.00%
Annual Surplus	8	

The estimated savings anticipated from implementing this energy strategy on the baseline 2013 energy demand for the development can be seen in table 1 and 2 above. It is anticipated that these measures in combination would achieve a 41.48%, 49 tonnes of Carbon reduction in emissions compared to the baseline analysis with the use of renewable technologies and Private District heating network.

As requested within the London plan the cooling demand of the combined analysis is detailed below with clarity as to why the actual cooling demand exceeds the Notional building.

	Cooling Demand [Mj/m2]
Actual	1279.5
Notional	1132.8

The detailed analysis and consideration of offsite modular design and practical implications of physical size and structure as well as the need to provide meet the TM52 comfort criterion with these physical constraints is the primary reason for the cooling demands variance.

The team are committed to further investigate this design issue and solar performance of glazing and high performance blinds are to be further investigated.

1.0 Introduction

A number of regional and local policies exist which promote energy efficiency and the use of renewable technologies where appropriate.

The London Plan contains policies which set the following targets for new development within the London boroughs:

All development proposals should take the most appropriate action to minimising carbon emissions in accordance with the energy hierarchy: Be Lean- Be Clean- Be Green as well as consider the need to reduce cooling demand and asses impact of overheating.

The energy assessment is structured around the Energy Hierarchy which is generally accepted as the most effective way of reducing building carbon emissions. The three stage strategy targets energy use by consideration of the following actions:

Be Lean	Energy demand Reduction
Be Clean	Consideration of heating infrastructure including CHP
Be Green	Supply energy from renewable sources

The approach detailed in this document is based on and around the CIBSE methodology for Energy reports and follows 4 primary steps

Step 1	Identifying the Targets
Step 2	Assessing the Baseline
Step 3	Applying energy efficiency
Step 4	Applicability of Renewable and LZC's

2.0 Identifying the Targets

The scheme is a new build teaching facility with Part Modular building design.

The scheme and the target has been assessed based around applying the energy hierarchy in relation to Part L2A of the 2013 building regulations to the new build areas generally in accordance with the London Plan and the setting of a baseline energy target based around the existing building fabric and services.

The London Plan Target for 2013 to 2016 new build schemes is 35% beyond Part L2A 2013.

This is the target adopted in this report and used as the basis of comparison.

The planning conditions is as detailed below and uses the 35% improvements over ADL2A 2013. The 2013 notional building performance has been selected to set the Target Value as detailed below.

Table 5 Summary of concurrent notional building specification

Element	Side lit or unlit (where HVAC specification is heating only)	Side lit or unlit (where HVAC specification includes cooling)
Roof U-value (W/m².K)	0.18	0.18
Wall U-value (W/m².K)	0.26	0.26
Floor U-value (W/m².K)	0.22	0.22
Window U-value (W/m².K)	1.6 (10% FF)	1.6 (10% FF)
G-Value (%)	40%	40%
Light Transmittance (%)	71%	71%
Roof light U-value (W/m².K)	N/A	N/A
G-Value (%)	N/A	N/A
Light Transmittance (%)	N/A	N/A
Air-permeability (m³/m²/hour) Gross Internal Area less than or equal to 250m²	5	5
Air-permeability (m³/m²/hour) Gross Internal Area greater than 250m² and less than 3,500m²	3	3
Air-permeability (m³/m²/hour) Gross Internal Area greater than or equal to 3,500m² and less than 10,000m²	3	3
Air-permeability (m³/m²/hour) Gross Internal Area greater than or equal to 10,000m²	3	3
Lighting Luminaire (lm / circuit watt)	60	60
Occupancy control (Yes/No)	Yes	Yes
Daylight control (Yes/No)	Yes	Yes
Maintenance Factor	0.8	0.8
Constant illuminance control	No	No
Heating efficiency (Heating and hot water)	91%	91%
Central Ventilation SFP (W/l/s)	1.8	1.8
Terminal Unit SFP (W/l/s)	0.3	0.3
Cooling (air-conditioned) (SEER / SSEER)	N/A	4.5 / 3.6
Cooling (mixed mode) (SSEER)[1]	N/A	2.7
Heat recovery efficiency (%)	70%	70%
Variable speed control of fans and pumps, controlled via multiple sensors	Yes	Yes
Demand control (mechanical ventilation only). Variable speed control of fans via CO_2 sensors	Yes	Yes

FIg 1: ADL2A 2013 extract

3.0 Assessing Baseline Emissions

Using DSM modelling baseline energy consumption for the proposed development using the existing fabric and Services specification has been assessed using a primary DSM model [Baseline] taking account baseline data, results are as follows with the supporting BRUKL in Appendix A

Performance	TER	17.6	kgCO2/m2
	Model Floor Area	6719.1	m2
	Regulated Energy	59.66	Kwh/m2
	Total Energy	83.82	Kwh/m2
	Total Carbon	118.26	TCO2

Table 3: Baseline Emissions

Building Regulations take account of energy used to heat, cool, light, provide hot water and ventilate the building. This is detailed as the 'regulated' energy use. Unregulated Small power (other equipment etc.) is not considered within these figures. London Borough of Hillingdon does not require inclusion of these 'unregulated' energy loads in the calculation of energy consumption and associated emissions.

The baseline emissions are based on the building specification before the application of energy efficiency measures. The following assumptions have been made in the calculations and generally based on the notional building performance:

Drawings Provided	Ground floor Plan	Planning	
	First Floor Plan	Planning	
	Second Floor Plan	Planning	
	Third Floor Plan	Planning	
	Sections	Planning	
	Elevations	Planning	
New Build U Values	Walls	0.26	W/m2K
	Ground Floor	0.22	W/m2K
	Exposed Floor	0.22	W/m2K
	Windows and roof Lights	1.6	W/m2K
	Roof	0.18	W/m2K
Building Type	Modular Building		
Air Permeability	New Build	3.00	m3/hr/m2 @ 50Pa
Renewable	New Build	None	
Power Factor Correction	Not Installed	< 0.9	
Heating [ECA List]	Natural Gas	0.91	
Heat Recovery Eff	AHU and FCU	0.7	
Cooling	Air Cooled [ECA List]	4.5	SEER
	Air Cooled [ECA List]	3.125	EER
Lighting	Lighting Metering	Yes	
	Out of Range Values	No	
	Lamp Type	60 lm/cW	
	Control	PC and PIR	

Table 4: Baseline Building input Data

The baseline emissions are based on the Services specification before application of energy efficiency measures. The following assumptions have been made in the calculations and generally based generally on the notional building services performance:

HVAC System Details	HVAC system name	BL01 LTHW Radiators	BL02 LTHW Radiators Local Extract
	NCM System Type	Central Heating using water : radiators	Fan coil systems
Heating	Heat source	LTHW Boiler	LTHW Boiler
	Fuel	Natural Gas	Natural Gas
	Qualify for ECAs?	Yes	Yes
	Inst. On or after 1998?	Yes	Yes
	Does system use CHP?	No	No
	Heat Gen. SEER	0.91	0.91
Cooling	Pack chiller type	-	-
	Pack chiller power	-	-
	Chiller fuel type	-	-
	Qualify for ECAs?	-	-
	SEER		
	EER		
	Mixed Mode	Not a CMM system	Not a CMM system
	Heat rejection [Pump and Fan Power %]		
System adjustment	Ductwork Leakage tested	-	Class worse than A, or not tested
	AHU Leakage Tested	-	Class worse than L3, or not Compliant
	SFP (W/l/S)		1.10
	Variable speed pumps	variable speed differential sensor across pump	variable speed differential sensor across pump
Metering Provision	Met.	Yes	Yes
	Alarm for out of range	No	No
Ventilation	Cooling/vent Mechanism	Natural Ventilation	Mechanical Ventilation
	Air supply mechanism	-	Zonal extract with remote fan
	Heat recovery method	-	-
	Variable Heat recovery efficiency	-	-
	Heat recovery efficiency		
	Demand Control Ventlation		
System Controls (EPC only)	Central Time Control	Yes	Yes
	Optimum start/stop control	Yes	Yes
	Local time control	No	No
	Local temp control	Yes	Yes
	Weather Comp control	Yes	Yes
Bivalent systems	Heat source	-	-
	Fuel	-	-
	Gen Seff		
	% load		
HVAC System Details	**HVAC system name**	**BL03 LTHW_CHW FCU**	**BL05 LTHW_CHW Central AHU**
	NCM System Type	Fan coil systems	Fan coil systems
Heating	Heat source	LTHW Boiler	LTHW Boiler
	Fuel	Natural Gas	Natural Gas
	Qualify for ECAs?	Yes	No
	Inst. On or after 1998?	Yes	No
	Does system use CHP?	No	No
	Heat Gen. SEER	0.91	0.91
Cooling	Pack chiller type	Air Cooled	Air Cooled
	Pack chiller power	101 - 500 kW	101 - 500 kW
	Chiller fuel type	Grid supplied electricity	Grid supplied electricity
	Qualify for ECAs?	Yes	Yes
	SEER	4.50	4.50
	EER	3.125	3.125
	Mixed Mode	Not a CMM system	Not a CMM system
	Heat rejection [Pump and Fan Power %]		
System adjustment	Ductwork Leakage tested	Class worse than A, or not tested	Class worse than A, or not tested
	AHU Leakage Tested	Class worse than L3, or not Compliant	Class worse than L3, or not Compliant
	SFP (W/l/S)	1.8 and 0.3 [terminal unit]	1.80
	Variable speed pumps	variable speed differential sensor across pump	variable speed differential sensor across pump
Metering Provision	Met.	Yes	Yes
	Alarm for out of range	No	No
Ventilation	Cooling/vent Mechanism	Air Conditioning	Air Conditioning
	Air supply mechanism	Central balanced A/C or mech vent system	Central balanced A/C or mech vent system
	Heat recovery method	plate heat exchanger	plate heat exchanger
	Variable Heat recovery efficiency	No	No
	Heat recovery efficiency	0.7	0.7
	Demand Control Ventlation	Yes	Yes
System Controls (EPC only)	Central Time Control	Yes	Yes
	Optimum start/stop control	Yes	Yes
	Local time control	No	No
	Local temp control	Yes	Yes
	Weather Comp control	Yes	Yes
Bivalent systems	Heat source	-	-
	Fuel	-	-
	Gen Seff		
	% load		

Table 5: Baseline Building Services input Data

The following details the Baseline analysis full summary table:

Summary		Baseline rev 3 ADL2A Notional Building [2013]	
Drawings Provided	Ground floor Plan	Planning	
	First Floor Plan	Planning	
	Second Floor Plan	Planning	
	Third Floor	Planning	
	Sections	Planning	
	Elevations	Planning	
New Build U Values	Walls	0.26	W/m2K
	Ground Floor	0.22	W/m2K
	Exposed Floor	0.22	W/m2K
	Windows	1.6	W/m2K
	Roof	0.18	W/m2K
Building Type		Modular	
Air Permeability	New Build	3	m3/hr/m2 @ 50Pa
	Renewable	None	
Power Factor Correction	Not Installed	< 0.9	
Lighting	Lighting Metering	Yes	
	Out of Range Values	No	
	Lamp Type	T5 Inference Lamp Type	
	Luminarie Efficacy	60 ll/cW	
	Control	PIR and Daylight Control	
Performance	TER	17.6	kgCO2/m2
	Model Floor Area	6719.1	m2
	Regulated Energy	59.66	Kwh/m2
	Total Energy	83.82	Kwh/m2
	Total Carbon	118.26	TCO2

Table 6: Baseline summary

The Base line analysis sets a baseline Carbon emission based on the data used of 118.26 tonnes of carbon.

	Carbon Dioxide emissions [Tonnes CO2 per annum]	
	Regulated	Unregulated
Baseline: Part L 2013 of the building Regulations Compliant Development	118.26	

4.0 Demand Reduction [Be lean]

4.1 Passive Measures

A number of passive design measures have been considered and where applicable incorporated into the proposed scheme in order to reduce total energy demand.

The proposed development is new modular building design on an urban site in central London. There is very little opportunity to orientate the building to benefit from passive solar design as the site is restricted by adjacent buildings and physical constraints.

The internal layout has been designed to maximise the use of natural light and borrowed light between spaces and the central Atrium.

A natural ventilation strategy has been provided but its proximity to the adjacent roads means the use or natural ventilation can't be relied upon without impacting on the use of spaces and alternate ventilation systems are required. However, natural ventilation has been incorporated and user guide and training will explain and show the occupiers the best use of natural ventilation to reduce dependence on Mechanical ventilation and cooling systems.

User controlled blinds will be provided to all windows serving occupied spaces to control glare and reduce overheating. However, the external perforated screening will provide building generated shade and the design of the screen shall be developed to maximise natural light to the spaces that will benefit from natural light without impacting on the internal intended uses.

All external building elements; floors, walls, roof and openings, are proposed to be upgraded where possible and financially viable above the notional U Values detailed in Table 2 beyond those required by Part L. New glazing Units (improved solar g values to solar exposed windows where necessary) will reduce the energy required to heat the building during the heating season while also reducing overheating in the summer and therefore reducing cooling loads.

Building air tightness has been reviewed by the team and the designers feel a target air permeability rate of 5.0 m3/(h.m2)at 50Pa for the new build areas shall be achieved if not reduced further during detailed design and building junction detailing.

4.2 Active Measures

The new and existing building and communal areas will all be fitted with a low energy, lighting scheme. Lighting to communal spaces, circulation and stairwells will include adequate controls to maximise efficiency sensing, proximity control or timed control, whichever proves most suitable to a given area shall be reviewed and considered.

The proposed HVAC system will utilise highly efficient systems to provide space heating. The system will be fully controlled by a Building Management System (BMS) to maximise efficiency and ensure adequate levels of environmental control to

provide thermal comfort to building occupiers. Local control within the teaching spaces will be possible within limits set by the BMS.

Because of the proposed activities within the project emitting high casual loads and to meet the comfort requirements of the users cooling will be required and the team have considered that the most effective systems will be the incorporation of Air sourced heat pumps and heat recovery systems that shall allow heat and coolth to be recovered reducing the energy demands of the systems and that will also facilitate free cooling when possible.

Occupant presence and CO2 controls shall be incorporated into the design so systems operate in low speed and or off when spaces are unoccupied and systems shall have a night purge capability to maximise free cooling opportunities.

		Hierarchy 1	Hierarchy 1
HVAC System Details	**HVAC system name**	**01 VRF Ducted Units**	**02 VRF HRU Ducted Units**
	NCM System Type	Split or multi-split system	Split or multi-split system
Heating	Heat source	Heat pump [Electric]: air source	Heat pump [Electric]: air source
	Fuel	Grid supplied electricity	Grid supplied electricity
	Qualify for ECAs?	-	-
	Inst. On or after 1998?	Yes	Yes
	Does system use CHP?	No	No
	Heat Gen. SEER	4.00	4.00
Cooling	Pack chiller type	Heat pump [Electric]	Heat pump [Electric]
	Pack chiller power	Upto 100kW	Upto 100kW
	Chiller fuel type	Grid supplied electricity	Grid supplied electricity
	Qualify for ECAs?	Yes	Yes
	SEER	5.00	5.00
	EER	3.13	3.13
	Mixed Mode	Mechanical Ventilation	Mechanical Ventilation
	Heat rejection [Pump and Fan Power %]		
System adjustment	Ductwork Leakage tested	Class A	Class A
	AHU Leakage Tested	Class L3	Class L3
	SFP (W/l/S)	1.6 and 0.3 terminal SFP [CO2 Speed Control]	1.6 and 0.3 terminal SFP {CO2 Speed Control]
	Variable speed pumps	-	-
Metering Provision	Met.	Yes	Yes
	Alarm for out of range	Yes	Yes
Ventilation	Cooling/vent Mechanism	Air Conditioning	Air Conditioning
	Air supply mechanism	Local ventilation units	Local ventilation units
	Heat recovery method	plate heat exchanger	plate heat exchanger
	Variable Heat recovery efficiency	No	No
	Heat recovery efficiency	0.77	0.77
	Demand Control Ventlation	Yes	Yes
System Controls (EPC only)	Central Time Control	Yes	Yes
	Optimum start/stop control	Yes	Yes
	Local time control	Yes	Yes
	Local temp control	Yes	Yes
	Weather Comp control	No	No
Bivalent systems	Heat source	-	-
	Fuel	-	-
	Gen Seff		
	% load		

Table 7: Hierarchy 1 Building services improvements HVAC

		Hierarchy 1	Hierarchy 1
HVAC System Details	**HVAC system name**	**03 LTHW Radiators Nat Vent**	**04 LTHW Radiant Panels Nat Vent**
	NCM System Type	Central Heating using water : radiators	Central Heating using water : radiators
Heating	Heat source	LTHW Boiler	LTHW Boiler
	Fuel	Natural Gas	Natural Gas
	Qualify for ECAs?	Yes	Yes
	Inst. On or after 1998?	Yes	Yes
	Does system use CHP?	No	No
	Heat Gen. SEER	0.96	0.96
Cooling	Pack chiller type	-	-
	Pack chiller power	-	-
	Chiller fuel type	-	-
	Qualify for ECAs?	-	-
	SEER		
	EER		
	Mixed Mode	-	-
	Heat rejection [Pump and Fan Power %]		
System adjustment	Ductwork Leakage tested	-	-
	AHU Leakage Tested	-	-
	SFP (W/l/S)		
	Variable speed pumps	variable speed differential sensor across pump	variable speed differential sensor across pump
Metering Provision	Met.	Yes	Yes
	Alarm for out of range	Yes	Yes
Ventilation	Cooling/vent Mechanism	Natural Ventilation	Natural Ventilation
	Air supply mechanism	-	-
	Heat recovery method	-	-
	Variable Heat recovery efficiency	-	-
	Heat recovery efficiency		
	Demand Control Ventlation		
System Controls (EPC only)	Central Time Control	Yes	Yes
	Optimum start/stop control	Yes	Yes
	Local time control	No	No
	Local temp control	Yes	Yes
	Weather Comp control	Yes	Yes
Bivalent systems	Heat source	-	-
	Fuel	-	-
	Gen Seff		
	% load		

Table 8: Hierarchy 1 Building services improvements HVAC [cont]

		Hierarchy 1	Hierarchy 1
HVAC System Details	**HVAC system name**	**05 LTHW Radiant Panels Local Extract**	**06 LTHW UFH Natural vent**
	NCM System Type	Central Heating using water : radiators	Central Heating using water : Floor Heating
Heating	Heat source	LTHW Boiler	LTHW Boiler
	Fuel	Natural Gas	Natural Gas
	Qualify for ECAs?	Yes	Yes
	Inst. On or after 1998?	Yes	Yes
	Does system use CHP?	No	No
	Heat Gen. SEER	0.96	0.96
Cooling	Pack chiller type	-	
	Pack chiller power	-	
	Chiller fuel type	-	
	Qualify for ECAs?	-	
	SEER		
	EER		
	Mixed Mode	-	
	Heat rejection [Pump and Fan Power %]		
System adjustment	Ductwork Leakage tested	-	
	AHU Leakage Tested	-	
	SFP (W/l/S)	0.4 [Enhanced Control]	
	Variable speed pumps	variable speed differential sensor across pump	variable speed differential sensor across pump
Metering Provision	Met.	Yes	Yes
	Alarm for out of range	Yes	Yes
Ventilation	Cooling/vent Mechanism	Mechanical Ventilation	Natural Ventilation
	Air supply mechanism	Zonal extract with remote fan	-
	Heat recovery method	-	-
	Variable Heat recovery efficiency	-	-
	Heat recovery efficiency		
	Demand Control Ventlation	Yes	
System Controls (EPC only)	Central Time Control	Yes	Yes
	Optimum start/stop control	Yes	Yes
	Local time control	No	No
	Local temp control	Yes	Yes
	Weather Comp control	Yes	Yes
Bivalent systems	Heat source	-	
	Fuel	-	
	Gen Seff		
	% load		

Table 9: Hierarchy 1 Building services improvements HVAC [cont]

		Hierarchy 1	Hierarchy 1
HVAC System Details	**HVAC system name**	**07 Comms Room**	**08 Packaged AHU**
	NCM System Type	Split or multi-split system	Single-duct VAV
Heating	Heat source	Heat pump [Electric]: air source	Heat pump [Electric]: air source
	Fuel	Grid supplied electricity	Grid supplied electricity
	Qualify for ECAs?		No
	Inst. On or after 1998?	Yes	Yes
	Does system use CHP?	No	No
	Heat Gen. SEER	4.00	4.00
Cooling	Pack chiller type	Heat pump [Electric]	Heat pump [Electric]
	Pack chiller power	Upto 100kW	Upto 100kW
	Chiller fuel type	Grid supplied electricity	Grid supplied electricity
	Qualify for ECAs?	Yes	Yes
	SEER	3.50	5.00
	EER	3.13	3.13
	Mixed Mode	Not a CMM system	Mechanical Ventilation
	Heat rejection [Pump and Fan Power %]		
System adjustment	Ductwork Leakage tested	-	Class A
	AHU Leakage Tested	-	Class L3
	SFP (W/l/S)		1.6
	Variable speed pumps	-	-
Metering Provision	Met.	Yes	Yes
	Alarm for out of range	Yes	Yes
Ventilation	Cooling/vent Mechanism	Air Conditioning	Air Conditioning
	Air supply mechanism		Central balanced A/C or mech vent system
	Heat recovery method		Thermal Wheel
	Variable Heat recovery efficiency		Yes
	Heat recovery efficiency		0.77
	Demand Control Ventlation		Yes
System Controls (EPC only)	Central Time Control	No	Yes
	Optimum start/stop control	No	Yes
	Local time control	Yes	Yes
	Local temp control	Yes	Yes
	Weather Comp control	No	No
Bivalent systems	Heat source		-
	Fuel		-
	Gen Seff		
	% load		

Table 10: Hierarchy 1 Building services improvements HVAC [cont]

				Hierarchy 1	Hierarchy 2
System Details	**system name**	**System DHW01 Baseline New Build**	**System DHW02 Baseline Existing**	**System DHW03 Proposed**	**System DHW03 Proposed**
Domestic Hot Water	DHW Delivery Efficiency	1 [0.89]	0.8	1	1
	Generator Type	Same as Heating System	Same as Heating System	Same as Heating System	Same as Heating System
	Fuel Type	Gas	Gas	Gas	District heating
	Does the system have storage?	Yes	Yes	Yes	Yes
	Storage Volume (litres)	2000	1500	2000	2000
	Storage Losses (kWh/l day)	0.075	0.1	0.0045	0.0045
	Does the system have secondary circulation?	Yes	Yes	Yes	Yes
	Circulation Losses (W/m)	12.5	16	5	5
	Pump Power (kW)	0.1	0.1	0.1	0.1
	Loop Length (m)	400	400	400	400
	Time Switch?	Yes	No	Yes	Yes
	Does the system Use CHP	No	No	No	No
	Predicted CHP running Hours	0	0	0	0
Solar Water Heating		None	None	None	None
Solar Water Heating		None	None	None	None

Table 11: Hierarchy 1 Building services improvements DHWS

A second DSM model has been created [H1] taking account of passive and active improvements to establish the emission reductions possible through these actions. The results and input data are shown in the following tables.

The results and details of the H1 DSM modelling analysis are as follows:

	Carbon Dioxide emissions [Tonnes CO2 per annum]	
	Regulated	Unregulated
Baseline: Part L 2013 of the building Regulations Compliant Development	118.26	
After energy Demand reduction	85.33	
	Regulated Carbon Dioxide Savings	
	[Tonnes CO2 per annum]	[%]
Savings from Energy Demand reduction	33	27.84%

Table 12: Hierarchy 1 Emissions

Summary		Baseline rev 3 ADL2A Notional Building [2013]		Hierarchy 1 rev 3a Be Lean Reduce the Need for Energy	
Drawings Provided	Ground floor Plan	Planning		Planning	
	First Floor Plan	Planning		Planning	
	Second Floor Plan	Planning		Planning	
	Third Floor	Planning		Planning	
	Sections	Planning		Planning	
	Elevations	Planning		Planning	
New Build U Values	Walls	0.26	W/m2K	0.24	
	Ground Floor	0.22	W/m2K	0.20	
	Exposed Floor	0.22	W/m2K	0.21	
	Windows	1.6	W/m2K	1.6 [1.2 Punch windows]	
	Roof	0.18	W/m2K	0.14	
Building Type		Modular		Modular	
Air Permeability	New Build	3	m3/hr/m2 @ 50Pa	5	
	Renewable	None		None	
Power Factor Correction	Not Installed	< 0.9		>0.95	
Lighting	Lighting Metering	Yes		Yes	
	Out of Range Values	No		No	
	Lamp Type	T5 Inference Lamp Type		T5 Inference Lamp Type	
	Luminarie Efficacy	60 ll/cW		65 ll/cW	
	Control	PIR and Daylight Control		PIR and Daylight Control	
				H2 Services Upgrade	
Performance	TER	17.6	kgCO2/m2	12.7	kgCO2/m2
	Model Floor Area	6719.1	m2	6719.1	m2
	Regulated Energy	59.66	Kwh/m2	35.02	Kwh/m2
	Total Energy	83.82	Kwh/m2	59.18	Kwh/m2
	Total Carbon	118.26	TCO2	85.33	TCO2

Table 13: Hierarchy 1 Building improvements

It can be seen from the analysis the H1 [Be Lean] actions provide a 34.33% improvements over the baseline DSM compliance results.

This equates to a reduction in carbon emissions of 54 tonnes of Carbon.

The H1 supporting BRUKL output is provided ion Appendix B for Information.

5.0 Heating Infrastructure [Be Clean]

A Third DSM model has been created [H2] taking account of passive and active improvements to establish the emission reductions possible through these actions. The results and input data are shown in the following tables.

5.1 Decentralised energy

Planning guidance and the London Plan and ADL2A requests that all developments investigate the feasibility of

- Connecting to an existing or planned decentralised energy scheme.
- Installing combined heat on power (CHP) or combined cooling, heat and power (CCHP).
- Designing in the flexibility to connect to any future decentralised energy network.

District heating networks are considered to provide more efficient energy delivery as network losses are often considerably less than conventional energy supplies.

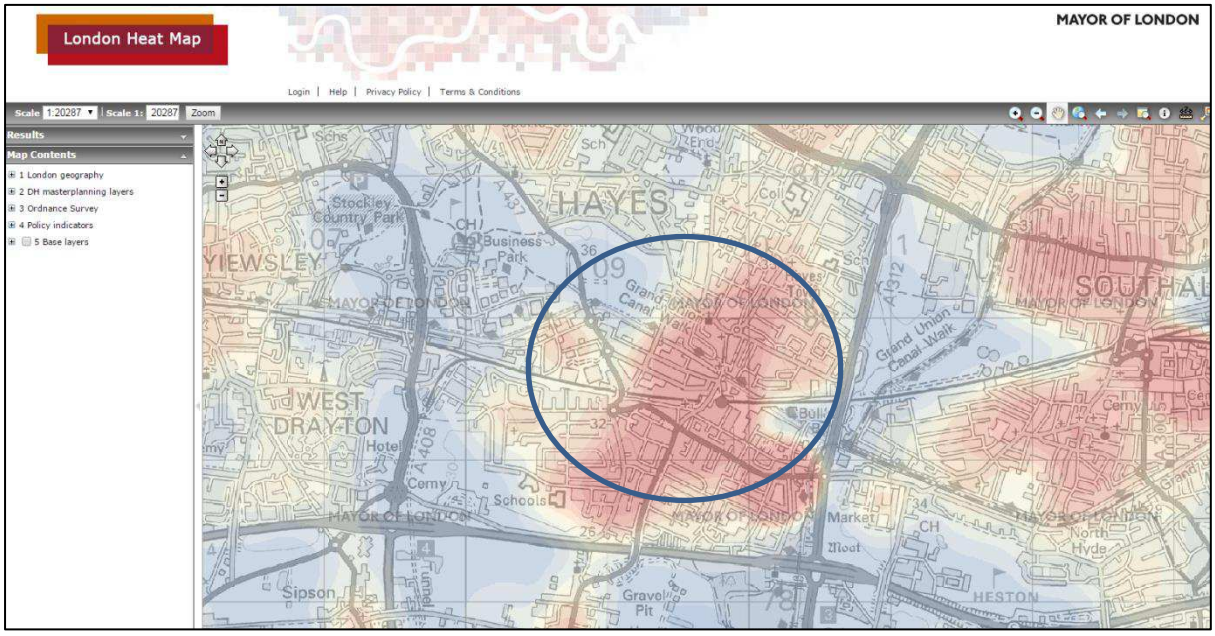


Figure 2: Extract from London Heat Map

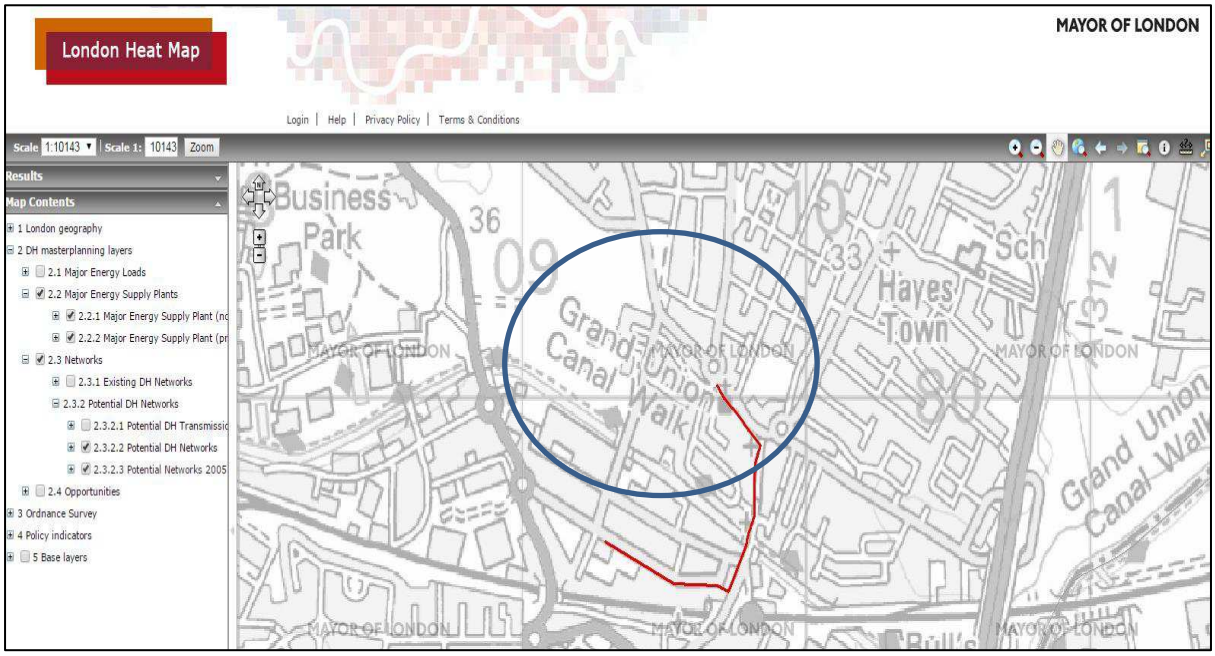


Figure 3: Extract from London Heat Map detailing available networks

There are no current large scale heating or cooling networks in economical proximity to the site However, the London heat mapping information details potential network and master planning information indicates that there will be a local network within the time scale of the scheme.

Although modelling has generally indicated the building is cooling lead with LTHW Under floor heating and DHWS heating needs the availability of a District heating network is of benefit and the scheme is committed to connecting into this network.

Based on this benefit the scheme intends to connect into a private adjacent Gas Fired CHP district heating network and this use of LTHW heating has been considered as the best approach, however, the actual carbon factor of the systems is unknown and this needs further consideration Appendix F details the selected BRE carbon conversion factor used by the team in the Carbon analysis.

5.2 Combined heat and power

CHP (combined heat and power) provides both heat and electricity locally for use in a single building or larger heating network. Providing heat and electricity in this way has an efficiency benefit over conventional systems due to the relative inefficiency of grid supplied power.

Small to medium scale CHP most often uses purpose built or converted reciprocating internal combustion engines to drive a generator supplying three phase electricity. The efficiency of IC engines is relatively low because of the amount of energy lost as heat. In a CHP unit this otherwise waste heat is used to heat water. This water is used to provide space heating and DHW, either directly or via a heat exchanger.

The scheme has a DHWS base load however the selection of a CHP unit that will operate above 4500 hours is not considered viable for the project and there is greater benefit in connecting into the adjacent private LTHW export network.

The results and details of the H3 'Be Clean' DSM modelling analysis are as follows:

	Carbon Dioxide emissions [Tonnes CO2 per annum]	
	Regulated	Unregulated
Baseline: Part L 2013 of the building Regulations Compliant Development	118.26	
After energy Demand reduction	85.33	
After CHP/District Heating	79.96	

	Regulated Carbon Dioxide Savings	
	[Tonnes CO2 per annum]	[%]
Savings from Energy Demand reduction	33	27.84%
Savings from CHP	5	4.55%

Table 14: Hierarchy 2 Building improvements

Summary		Baseline rev 3 ADL2A Notional Building [2013]		Hierarchy 2 rev 3a Be Clean Use energy More Efficiency	
Drawings Provided	Ground floor Plan	Planning		Planning	
	First Floor Plan	Planning		Planning	
	Second Floor Plan	Planning		Planning	
	Third Floor	Planning		Planning	
	Sections	Planning		Planning	
	Elevations	Planning		Planning	
New Build U Values	Walls	0.26	W/m2K	0.24	
	Ground Floor	0.22	W/m2K	0.20	
	Exposed Floor	0.22	W/m2K	0.21	
	Windows	1.6	W/m2K	1.6 [1.2 Punch windows]	
	Roof	0.18	W/m2K	0.14	
Building Type		Modular		Modular	
Air Permeability	New Build	3	m3/hr/m2 @ 50Pa	5	
	Renewable	None		None	
Power Factor Correction	Not Installed	< 0.9		> 0.95	
Lighting	Lighting Metering	Yes		Yes	
	Out of Range Values	No		Yes	
	Lamp Type	T5 Inference Lamp Type		T5 Inference Lamp Type	
	Luminarie Efficacy	60 ll/cW		65 ll/cW	
	Control	PIR and Daylight Control		PIR and Daylight Control	
				H2 Services Upgrade	
				District Carbon Factor 0.151	
Performance	TER	17.6	kgCO2/m2	11.9	kgCO2/m2
	Model Floor Area	6719.1	m2	6719.1	m2
	Regulated Energy	59.66	Kwh/m2	34.58	Kwh/m2
	Total Energy	83.82	Kwh/m2	58.74	Kwh/m2
	Total Carbon	118.26	TCO2	79.96	TCO2

Table 15: Hierarchy 2 summary

It can be seen from the analysis the H2 [Be Clean] actions provide a 0.86% reduction in carbon emissions of 1.0tonnes of Carbon improvements over the baseline DSM compliance results.

The H2 supporting BRUKL output is provided in Appendix C for Information.

6.0 Cooling Demand Reduction and Overheating mitigation

As a major development Policy 5.9 seeks to reduce impact of the urban heat island effect and encourages the design of developments to avoid overheating and excessive heat generation in order to reduce the demand for cooling.

The London Plan requires that measures are proposed to mitigate the demand for cooling under the following headings:

1. Minimise internal heat generation through energy efficient design
2. Reduce the amount of heat entering the building during in summer
3. Use of thermal mass and high ceiling to manage the heat within building's
4. Passive Ventilation
5. Mechanical Ventilation

It should be noted that the proposed development although a teaching facility, its is not a typical secondary type facility in that its projected internal casual loads are related to the curriculum and although this can be managed in terms of energy efficiency by the users its coupled with the modular approach to construction limit the physical adaptions to the building design.

The design team as a whole have considered and would provide the following statements under each of the above headings.

6.1 Minimise internal heat generation through energy efficient design

The design and distribution of services have been located into general circulation spaces reducing the implied casual load on the occupied zones.

The design team have considered spacial proximity of areas and located them to reduce circulation distances of Heating and Hot water services but also ductwork distribution and impact on auxiliary fan energy.

6.2 Reduce the amount of heat entering the building during in summer

As can be seen from the proposed planning drawings the building façade has been developed to provide solar screening to the large south elevation which provides effective solar screening.

6.3 Use of thermal mass and high ceiling to manage the heat within buildings

The use of the modular systems limits the amount of thermal mass that can be introduced into the building design and construction for practical reasons. However, the team have consider the holistic building design space adjacencies and have introduced open spaces off the large Atrium which we feel will absorb heat and propagate stack effect which is covered in the next section.

6.4 Passive Ventilation

As referenced in section 6.3 a fundamental design aspect of the scheme is a large Atrium with is used as part of a natural ventilation strategy which introduces air at low level through purposely design external louvers and ducts and exhausts naturally from the 4 glazed Atrium towers.

These Atrium towers also allow natural light to entre deep into the building maximising borrowed light into the occupied spaces at each level.

The atrium also allows the perimeter occupied spaces to benefit from cross ventilation with air entering the external opening windows, shaded via the external screen, and across the teaching area and then into the atrium where the stack effect in the atrium will assist in entraining the teaching zone stale air.

Section 6.7 reports thermal simulation results in detail.

6.5 Mechanical Ventilation

As indicated from outline analysis detailed in section 6.7 with the solar shading and passive ventilation measures there are still areas in the proposed development that do not meet the Adaptive comfort criterion and as part of the mitigation and developing design principles the team have considered the use of Mechanical mixed mode ventilation to further reduce the overheating potential and reduce any cooling demand.

The principle adopted by the team is a to ventilate and provide heat recovery via the use of local heat Recovery units [HRU] with temperature and CO2 speed control to each of the spaces controlled via an occupancy sensor so that the mode of control is generally as follows:

Mode 1; Natural Ventilation

The occupants can open windows to manage internal conditions

Mode 2: Mechanical ventialtion

The HRU will sense internal occupancy and start to monitor temperature and CO2 ramping up and down as necessary to maintain the preselected set point

The HRU will also facilitate pre occupancy Purge and Post occupancy Purge automatically as well as night time ventilation as necessary operating under the dictates of the Site BMS.

Section 6.7 reports thermal simulation results in detail.

6.6 ADL2A Criterion 3

Part L2013 Criterion 3 is a simple check to consider solar exposure and the potential for excessive solar gain that may influence the designer to consider the inclusion of cooling systems in mitigating overheating.

It is recognised that the building regulations 2013 Solar limit assessment in ADL2A and reported on the BRUKL output does not cover all the factors influencing overheating and the energy assessments guidance recommends that additional design assessments should be undertaken.

Criterion 3 output from the BRUKL documents is summarised below for thoroughness in this report to act as a comparator to Dynamic simulation analysis included in later sections.

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?
10 Music Tech Classroom	NO (-62.9%)	NO
103 Electronics Lab	NO (-89.1%)	NO
104 Learning Base 1	NO (-91.6%)	NO
105 Learning Base 2	NO (-91.6%)	NO
11 Recording Audio Control Room	N/A	N/A
111 Sports Hall	N/A	N/A
12 Light recording Room	N/A	N/A
123 Radio E	N/A	N/A
124 Meeting E	N/A	N/A
13 Recording teaching Space	NO (-66.3%)	NO
131 Internal Learning 6	NO (-29.7%)	NO
132 Media Hub	NO (-87.7%)	NO
133 SEN	N/A	N/A
134 SEN Resources	N/A	N/A
135 IAG Careers	N/A	N/A
136 Radio F	YES (+11.5%)	NO
137 Radio G	YES (+7.3%)	NO
138 Meeting F	N/A	N/A
139 Meeting G	N/A	N/A
14 Practice 1	NO (-81.5%)	NO
140 Internal Learning 7	NO (-19.6%)	NO
144 LRC	NO (-88.6%)	NO
146 Media Hub	NO (-91%)	NO

Figure 4: Extract from H3 BRUKL Document

It can be seen from the above extract there are a number of spaces that exceed the compliance solar gain limit and design development in terms of glazing solar performance and use of Blinds shall be considered as design development.

6.7 Adaptive Thermal Comfort

The development as a whole has been modelled with regards to occupant comfort. IES dynamic thermal modelling software has been used to undertake the modelling. IES Virtual Environment v2014.2.1.0 thermal modelling software is approved by 2013 Building Regulations and is also compliant with CIBSE AM11 requirements.

The Priority School Building Programme (PSPB) overheating assessment is to be undertaken for natural, mechanical and mixed mode ventilation environments which are not mechanically cooled. The assessment is now based on the adaptive comfort model, which follows the methodology and recommendations from EN 15251, and is outlined in CIBSE TM52.

The Proposed scheme has been developed with Air Sourced Heat pumps for teaching and other internally occupied spaces and as a feature of this approach cooling is available from the same system. It should be noted the design philosophy is not to provided close control of cooling and internal conditions with the cooling capacity but to select systems and equipment for heating mode and the resulting cooling capacity used to control upper summer time internal temperatures [Peak lopping]

As a result all teaching spaces weather naturally ventilated, mechanical ventilated or peak lopping have been assessed in line with CIBSE TM52 adaptive comfort criterion.

The three criteria applied for overheating use is:

Criteria 1: The number of hours that the predicted operative temperature exceeds the upper limit of the range of acceptable operative temperatures by 1K or more.

Criteria 2: The number of days that the weighted exceedance is >6

Criteria 3: The number of hours that the predicted operative temperature exceeds the θmax by 4K or more

The building will be deemed to have 'Overheated' if any two of the three criteria are exceeded.

The modelling process has considered the entire building so that thermal interactions and air transfer between spaces are taken into account as well as night time ventilation and the building thermal mass.

It's important when considering thermal comfort all aspects of the integrated design have been taken into account. The design team as a whole has had input into the building shape and form and the use of screening to reduce solar gain and glare is

a key feature to comfort assessments and has been considered in the modelling process.

Design developments and information on the high casual load of internal equipment has identified that the building will need an elements of cooling to maintain adaptive comfort conditions.

The design solution was not to provide close control comfort cooling to spaces but to consider the cooling output from the VRF heating performance and the resulting cooling capacity used to peak loop high summer internal conditions only.

The principle of operation is as follows:

Mode 1; Natural Ventilation

The occupants can open windows to manage internal conditions

Mode 2: Mechanical ventialtion

The HRU will sense internal occupancy and start to monitor temperature and CO2 ramping up and down as necessary to maintain the preselected set point

The HRU will also facilitate pre occupancy Purge and Post occupancy Purge automatically as well as night time ventilation as necessary operating under the dictates of the Site BMS.

Mode 3: Mechanical ventilation with cooling initiated

The HRU will sense internal occupancy and start to monitor temperature and CO2 ramping up and down as necessary to maintain the preselected set point

The HRU will also facilitate pre occupancy Purge and Post occupancy Purge automatically as well as night time ventilation as necessary operating under the dictates of the Site BMS.

Should the Mode 1 and Mode 2 control fail to maintain conditions below 25 Deg C the cooling will be permitted to operate should the space exceed 26 Deg C, out of range alarms shall be considered to inform the site management if any space is operating below 25 Deg C with cooling initiated

The following summary details this '3 modes' of control approach and the adaptive comfort assessment developed by the design team.

Overall	
Passed:	2 rooms:
Failed:	81 rooms:
Unoccupied:	279 rooms:

Data:			
Days data=	365	01-Jan	31-Dec
Days (summer)=	153	01-May	30-Sep
Data OK?	OK	Full summer	

Passed:	2 rooms:					
Room Name	Room ID	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
180 Cafe Kiosk	18000002	71.2	2.9	10	3	2
37 Entrance lobby	48000001	71.2	2.2	7	2	2

Failed:	81 rooms:					
Room Name	Room ID	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
10 Music Tech Classroom	10000000	71.2	4.8	12	3	1 & 2
103 Electronics Lab	10000005	71.2	6.4	13	4	1 & 2
104 Learning Base 1	10000004	71.2	7.2	17	4	1 & 2
105 Learning Base 2	10000003	71.2	7.3	17	4	1 & 2
111 Sports Hall	11000006	71.2	41.7	38	6	1 & 2 & 3
12 Light recording Room	12000000	71.2	76.5	62	9	1 & 2 & 3
123 Radio E	12000007	71.2	56.1	42	6	1 & 2 & 3
124 Meeting E	12000006	71.2	52.3	38	5	1 & 2 & 3
13 Recording teaching Space	13000000	71.2	4.4	12	3	1 & 2

Table 16 TM52 Results Natural Ventilation [extract from results table]

Failed:	81 rooms:
Unoccupied:	279 rooms:

Data:			
Days data=	365	01-Jan	31-Dec
Days (summer)=	153	01-May	30-Sep
Data OK?	OK	Full summer	

Passed:	2 rooms:					
Room Name	Room ID	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
180 Cafe Kiosk	18000002	71.2	2.3	7	2	2
37 Entrance lobby	48000001	71.2	2.1	6	2	-

Failed:	81 rooms:					
Room Name	Room ID	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
10 Music Tech Classroom	10000000	71.2	3.3	10	3	1 & 2
103 Electronics Lab	10000005	71.2	5.7	12	3	1 & 2
104 Learning Base 1	10000004	71.2	6	12	3	1 & 2
105 Learning Base 2	10000003	71.2	5.9	12	3	1 & 2
111 Sports Hall	11000006	71.2	35	34	5	1 & 2 & 3
12 Light recording Room	12000000	71.2	28.8	32	6	1 & 2 & 3
123 Radio E	12000007	71.2	52	40	6	1 & 2 & 3
124 Meeting E	12000006	71.2	43.7	36	5	1 & 2 & 3
13 Recording teaching Space	13000000	71.2	3.3	12	3	1 & 2
131 Internal Learning 6	1300000C	71.2	71.8	88	15	1 & 2 & 3
132 Media Hub	1300000B	71.2	8.2	18	4	1 & 2
133 SEN	1300000A	71.2	53.5	61	11	1 & 2 & 3
134 SEN Resources	13000009	71.2	56	64	11	1 & 2 & 3

Table 17 TM52 Results Mixed mode Mechanical Ventilation [extract from results table]

Overall	
Passed:	80 rooms:
Failed:	3 rooms:
Unoccupied:	279 rooms:

Data:			
Days data=	365	01-Jan	31-Dec
Days (summer)=	153	01-May	30-Sep
Data OK?	OK	Full summer	

Passed:	80 rooms:					
Room Name	Room ID	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
10 Music Tech Classroom	10000000	71.2	0	0	0	-
103 Electronics Lab	10000005	71.2	0	0	0	-
104 Learning Base 1	10000004	71.2	0	0	0	-
105 Learning Base 2	10000003	71.2	0	0	0	-
12 Light recording Room	12000000	71.2	0.4	4	1	-
123 Radio E	12000007	71.2	0	0	0	-
124 Meeting E	12000006	71.2	0	0	0	-
13 Recording teaching Space	13000000	71.2	0	0	0	-

Failed:	3 rooms:					
Room Name	Room ID	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
111 Sports Hall	11000006	71.2	11.4	20	4	1 & 2
32 Stair Lobby	32000000	71.2	10	18	4	1 & 2
Kitchen 4	4_000000	71.2	95.2	72	8	1 & 2 & 3

Table 18 TM52 Results Mixed mode peak looping VRF [extract from results table]

7.0 Applicability of Renewable and LZC's [Be Green]

The following sections details the considerations and practicalities of Renewable and low Zero Carbon technologies.

7.1 Renewable technologies

Energy resources accepted as renewable or low carbon technologies are defined by the Department of Energy & Climate change Low Carbon Buildings Program. Those which are suitable for consideration in this case are:

- Solar photovoltaics
- Wind turbines
- Solar thermal hot water
- Heat pumps

7.2 Solar Photovoltaics

Photovoltaic's (PVs) generate electricity from daylight using semiconductors.. PV's are also a simple technology requiring little in the way of maintenance and offer a proven way of generating zero carbon, renewable electricity. Photovoltaics generate electricity which displaces that which would otherwise be provided by the national grid. Grid supplied electricity is very polluting when compared to other conventional fuels producing more than 2.5 times more CO2/kWh than natural gas. Given the area of available roof space and minimal over shading, PV is considered to be a suitable low carbon technology for the project.

7.3 Wind turbines

Wind turbines generate electricity via a conventional generator connected to turbine blades which are in turn powered by the prevailing wind. Given the location of the development, building mounted turbines would be required, and for this type of application vertical axis turbines would be best suited. However, for structural implications of mounting wind turbines to the buildings frame, both in terms of Location adjacent the existing higher building, loading and vibration means wind turbines are not viable.

7.4 Solar Thermal

The proposed development has a reasonable DHWS Load but limited plant space internally and it may not be the best and most viable option for the scheme.

7.5 Heat Pumps

The design team have considered the use of Heat pumps in detail and feel it's the best solution for the schemes heating and cooling demands.

The heat pump technology proposed is 3 Pipe Variable Refrigerant Flow [VRF] and the design and apportionment of load allows very efficient transfer of Heating and

cooling between zone of variable heating and cooling demand providing high SCoP's and SEER's. Details of the proposed systems are included in Appendix E.

The Be lean H1 approach has considered the carbon benefits in previous analysis and the H3 Be Clean analysis shall report the renewable carbon reduction only.

Description	Comments applicable to the scheme
District Heating	**There is a private network within a economical distance of the proposed building and extension. However, the carbon factor needs further investigation.**
Air Sourced Heat Pumps	**Possible to serve the Building Heating and Cooling Peak looping Demands**
Ground Sourced Heat Pumps	**Possible to serve the Building Heating and Cooling Demands but the number of bore holes means it's not financial viable**
Biomass Boiler Plant	**Not applicable to the scheme because of cost, building location and space requirements**
Solar Thermal (solar water heating)	**Possible to serve the Domestic hot water systems but would require roof mounted plant and equipment and considering the limited plant space this is felt unsuitable**
Active Solar (Photovoltaic)	**Appropriate for this scheme and could be integrated into the roof fabric**
Small Hydro	**Not applicable to the scheme**
Combined Heat and Power (CHP)	**Not most applicable technology for the scheme based on limited running hours, but this scheme would give a base load to the Local district heating network**
Energy From Waste	**Not applicable to the scheme**
Anaerobic Digestion	**Not applicable to the scheme**

Table 19: LZC Summary of Considerations

A Fourth DSM model has been created [H3] taking account Renewable improvements to establish the emission reductions possible through these actions. The results and input data are shown in the following tables:

	Carbon Dioxide emissions [Tonnes CO2 per annum]	
	Regulated	Unregulated
Baseline: Part L 2013 of the building Regulations Compliant Development	118.26	
After energy Demand reduction	85.33	
After CHP/District Heating	79.96	
After renewable energy	69.21	

	Regulated Carbon Dioxide Savings	
	[Tonnes CO2 per annum]	[%]
Savings from Energy Demand reduction	33	27.84%
Savings from CHP	5	4.55%
Savings from Renewable energy	11	9.09%
Total Cumulative Savings	49	41.48%

Table 20: Hierarchy 3 Improvements

It can be seen from the analysis the H3 [Be Green] actions provide a total 9.09% 11.0 tonnes of Carbon improvement over the baseline DSM compliance results

The H3 supporting BRUKL output is provided in Appendix D for Information.

			Hierarchy 3
System Details	**system name**	**System LZC01 Base Line new and Existing**	**System LZC01 Proposed**
PVS Generator	PV array type	None	Monocrystaline
	Derive performance parameters from PV array type?		Estimated Data
	PV module efficiency		17.00%
	Reference irradiance for NOCT (W/m^2)		1000
	Nominal cell temp. (NOCT) (°C)		45
	Temp. Coefficient for module efficiency		
	Degradation factor		0.99
	Shading factor		1
	Electrical conversion efficiency		0.95
	Area (m^2)		50
	Azimuth (°clockwise from North)		270
	Inclination (°from horizontal)		5
Wind Generator	Hub height (m)	None	None
	Rated power (kW)		
CHP Generator	Fuel type	None	None
	Performance at rated output		
	Heat at output (kW)		
	Thermal efficiency		
	Power efficiency		
	Performance at minimum output		
	fraction of rated heat output		
	Thermal efficiency		
	Power efficiency		
	Base Load Matched to		

Table 21: Hierarchy 3 Solar PV Performance

8.0 Summary of Energy Strategy

The energy strategy considered is based on the Energy Hierarchy as detailed in the introduction of this report.

The building fabric will be improved beyond current regulatory requirements by improving levels of insulation where practical considering the offsite modular design construction methods.

Passive and Active design features have been incorporated including designing internal layouts to maximise the use of natural light and high thermal insulation to reduce energy demand and help moderate internal temperatures throughout the year. A mixed mode mechanical and natural ventilation strategy will be used to provide fresh air to occupied spaces when internal spaces feel ambient noise levels are acceptable to open windows.

Energy efficient lighting and heating systems will be installed which use less energy and have suitable control so as to be operated at optimum performance while providing a comfortable internal environment. This shows that a 34.44% (54 tonnes) improvement is predicted over the baseline energy analysis.

Connecting the complementary systems into the adjacent site wide district heating network, even based on an assumed carbon factor of 0.151 kgCO2/kWh, shows that a 4.55% 5.0 tonne improvement is predicted over the baseline energy analysis.

The Use of solar PV, shows that a 9.09% (11.0 tonne) improvement is predicted over the baseline energy analysis is also possible. As responsible designers, we have allowed enough PV area (150sqm shown on the plans) to allow some margin for any changes during construction. The exact amount of PV will be adjusted to ensure the target reduction is achieved when at as built status. It should also be noted that this amount of PV would preclude the use of a green roof for practical reasons.

The estimated savings anticipated from implementing this energy strategy on the baseline energy demand for the development can be seen in the tables 1 and 2 It is anticipated that these measures in combination would achieve a 41.48%, 49 tonnes of Carbon reduction in emissions compared to the baseline analysis with the use of renewable technologies and Private District heating network. This indicates a savings surplus over the 35% target of 8 Tonnes of Carbon.

Sub-meters will be provided for all substantial energy uses with automated monitoring back and the main site BMS to assist the FM teams in monitoring consumption.

All external lighting will be energy efficient and controlled for the presence of daylight.

Summary		Baseline rev 3 ADL2A Notional Building [2013]		Hierarchy 1 rev 3a Be Lean Reduce the Need for Energy		Hierarchy 2 rev 3a Be Clean Use energy More Efficiency		Hierarchy 3 rev 3a Be Green Use Renewable Energy	
Drawings Provided	Ground floor Plan	Planning		Planning		Planning		Planning	
	First Floor Plan	Planning		Planning		Planning		Planning	
	Second Floor Plan	Planning		Planning		Planning		Planning	
	Third Floor	Planning		Planning		Planning		Planning	
	Sections	Planning		Planning		Planning		Planning	
	Elevations	Planning		Planning		Planning		Planning	
New Build U Values	Walls	0.26	W/m2K	0.24		0.24		0.24	
	Ground Floor	0.22	W/m2K	0.20		0.20		0.20	
	Exposed Floor	0.22	W/m2K	0.21		0.21		0.21	
	Windows	1.6	W/m2K	1.6 [1.2 Punch windows]		1.6 [1.2 Punch windows]		1.6 [1.2 Punch windows]	
	Roof	0.18	W/m2K	0.14		0.14		0.17	
Building Type		Modular		Modular		Modular		Modular	
Air Permeability	New Build	3	m3/hr/m2 @ 50Pa	5		5		5	
	Renewable	None		None		None		150m2 PV	
Power Factor Correction	Not Installed	< 0.9		>0.95		> 0.95		>0.95	
Lighting	Lighting Metering	Yes		Yes		Yes		Yes	
	Out of Range Values	No		No		Yes		Yes	
	Lamp Type	T5 Inference Lamp Type		T5 Inference Lamp Type		T5 Inference Lamp Type		T5 Inference Lamp Type	
	Luminarie Efficacy	60 ll/cW		65 ll/cW		65 ll/cW		65 ll/cW	
	Control	PIR and Daylight Control		PIR and Daylight Control		PIR and Daylight Control		PIR and Daylight Control	
				H2 Services Upgrade		H2 Services Upgrade		H2 Services Upgrade	
						District Carbon Factor 0.151		H3 renewables	
								District Carbon Factor 0.151	
Performance	TER	17.6	kgCO2/m2	12.7	kgCO2/m2	11.9	kgCO2/m2	10.3	kgCO2/m2
	Model Floor Area	6719.1	m2	6719.1	m2	6719.1	m2	6719.1	m2
	Regulated Energy	59.66	Kwh/m2	35.02	Kwh/m2	34.58	Kwh/m2	33.58	Kwh/m2
	Total Energy	83.82	Kwh/m2	59.18	Kwh/m2	58.74	Kwh/m2	56.74	Kwh/m2
	Total Carbon	118.26	TCO2	85.33	TCO2	79.96	TCO2	69.21	TCO2

Table 22: LZC Summary of Analysis

Appendix A : Baseline BRUKL

Appendix B : H1 BRUKL

Appendix C : H2 BRUKL

Appendix D : H3 BRUKL

Appendix E : Dynamic Modelling TM52 Outputs

Appendix F : District heating carbon Factor

Appendix A

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name **Modular and Portable**

150511 UTC Model BL Modular rev 3 As designed

Date: Mon May 11 10:12:32 2015

Administrative information

Building Details

Address: UTC Heathrow, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

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

Owner Details

Name:

Telephone number: Phone

Address: , , Postcode

Certifier details

Name: Nicholas Roy Bradley

Telephone number: 07899 797945

Address: The Croft, 10 Birchwood Court, Bessacarr, Doncaster, DN4 6SX

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

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

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	17.6
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	17.6
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	23.3
1.4	Are emissions from the building less than or equal to the target?	BER > TER
1.5	Are as built details the same as used in the BER calculations?	Separate submission

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

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

2.a Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.26	0.26	1_000000:Surf[6]
Floor	0.25	0.22	0.22	1_000000:Surf[0]
Roof	0.25	0.18	0.18	10000009:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.18	1.98	14000007:Surf[6]
Personnel doors	2.2	2.18	2.18	24000000:Surf[1]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

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

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

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

2.b Building services

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

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	<0.9

1- BL01 LTHW Radiators

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.08	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					NO

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

2- BL03 LTHW_CHW FCU

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	3.13	0	1.6	0.7
Standard value	0.91*	2.55	N/A	1.6	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

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

3- BL02 LTHW Radiators Local Extract

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.9	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					NO

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

4- BL05 LTHW_CHW Central AHU

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	3.13	0	1.6	0.7
Standard value	0.91*	2.55	N/A	1.6	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

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

"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
10 Music Tech Classroom	-	-	-	0.4	-	-	-	1.6	-	-	N/A
103 Electronics Lab	-	-	-	0.4	-	-	-	1.6	-	-	N/A
104 Learning Base 1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
105 Learning Base 2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
11 Recording Audio Control Room	-	-	-	1.5	-	-	-	1.6	-	-	N/A
12 Light recording Room	-	-	-	0.4	-	-	-	1.6	-	-	N/A
123 Radio E	-	-	-	0.4	-	-	-	1.6	-	-	N/A
124 Meeting E	-	-	-	0.4	-	-	-	1.6	-	-	N/A
13 Recording teaching Space	-	-	-	0.4	-	-	-	1.6	-	-	N/A
131 Internal Learning 6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
132 Media Hub	-	-	-	0.4	-	-	-	1.6	-	-	N/A
133 SEN	-	-	-	0.4	-	-	-	1.6	-	-	N/A
134 SEN Resources	-	-	-	0.4	-	-	-	1.6	-	-	N/A
135 IAG Careers	-	-	-	0.4	-	-	-	1.6	-	-	N/A
136 Radio F	-	-	-	0.4	-	-	-	1.6	-	-	N/A
137 Radio G	-	-	-	0.4	-	-	-	1.6	-	-	N/A
138 Meeting F	-	-	-	0.4	-	-	-	1.6	-	-	N/A
139 Meeting G	-	-	-	0.4	-	-	-	1.6	-	-	N/A
14 Practice 1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
140 Internal Learning 7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
144 LRC	-	-	-	1.5	-	-	-	1.6	-	-	N/A
146 Media Hub	-	-	-	0.4	-	-	-	1.6	-	-	N/A
147 Internal Learning 8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
148 Radio H	-	-	-	0.4	-	-	-	1.6	-	-	N/A
149 Meeting H	-	-	-	0.4	-	-	-	1.6	-	-	N/A
15 Practice 2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
151 Seminar Room	-	-	-	0.4	-	-	-	1.6	-	-	N/A
16 Practice 3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
161 Studio Control	-	-	-	1.5	-	-	-	1.6	-	-	N/A
169 Media Hub	-	-	-	0.4	-	-	-	1.6	-	-	N/A
175 Server and Hub Room	-	-	-	0.8	-	-	-	1.6	-	-	N/A
176 Hub Room	-	-	-	0.8	-	-	-	1.6	-	-	N/A
18 Practice 4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
184 Hub Room	-	-	-	0.8	-	-	-	1.6	-	-	N/A
186 Cafe	-	-	-	0.4	-	-	-	1.6	-	-	N/A
19 Recording Audio Control Room	-	-	-	1.5	-	-	-	1.6	-	-	N/A
196 Staff Office	-	-	-	0.4	-	-	-	1.6	-	-	N/A
20 Live Music Studio	-	-	-	0.4	-	-	-	1.6	-	-	N/A
209 Hub Room	-	-	-	0.8	-	-	-	1.6	-	-	N/A
22 Drum Booth	-	-	-	0.4	-	-	-	1.6	-	-	N/A
23 Voice Booth	-	-	-	0.4	-	-	-	1.6	-	-	N/A
28 Sound Control Hub	-	-	-	1.5	-	-	-	1.6	-	-	N/A
35 Media Hub 1	-	-	-	0.4	-	-	-	1.6	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
36 Board Room	-	-	-	0.4	-	-	-	1.6	-	-	N/A
38 Reception_Admin	-	-	-	0.4	-	-	-	1.6	-	-	N/A
39 Interview Meeting	-	-	-	0.4	-	-	-	1.6	-	-	N/A
40 Sick Bay	-	-	-	0.4	-	-	-	1.6	-	-	N/A
41 Principle	-	-	-	0.4	-	-	-	1.6	-	-	N/A
42 Principle PA	-	-	-	0.4	-	-	-	1.6	-	-	N/A
47 Produuction Booth 1	-	-	-	1.5	-	-	-	1.6	-	-	N/A
48 Production Booth 2	-	-	-	1.5	-	-	-	1.6	-	-	N/A
49 Internal Learning	-	-	-	0.4	-	-	-	1.6	-	-	N/A
5 Dining	-	-	-	0.4	-	-	-	1.6	-	-	N/A
50 Media Hub 1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
51 Faculty Office	-	-	-	0.4	-	-	-	1.6	-	-	N/A
52 Faculty Workroom	-	-	-	0.4	-	-	-	1.6	-	-	N/A
53 Store	-	-	-	0.4	-	-	-	1.6	-	-	N/A
54 General Office Finance	-	-	-	0.4	-	-	-	1.6	-	-	N/A
55 Radio A	-	-	-	0.4	-	-	-	1.6	-	-	N/A
56 Radio B	-	-	-	0.4	-	-	-	1.6	-	-	N/A
57 Meeting A	-	-	-	0.4	-	-	-	1.6	-	-	N/A
58 Meeting B	-	-	-	0.4	-	-	-	1.6	-	-	N/A
60 Internal Learning 2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
61 Media Hub	-	-	-	0.4	-	-	-	1.6	-	-	N/A
68 Science Lab 1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
69 Science Lab 2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
70 Science Prep	-	-	-	0.4	-	-	-	1.6	-	-	N/A
71 Science Studio 1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
72 Science Studio 2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
73 IT Technician	-	-	-	0.4	-	-	-	1.6	-	-	N/A
76 First Aid	-	-	-	0.4	-	-	-	1.6	-	-	N/A
81 Science Lab 3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
82 Internal Learning 3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
83 Media Hub 4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
84 Radio C	-	-	-	0.4	-	-	-	1.6	-	-	N/A
85 Radio D	-	-	-	0.4	-	-	-	1.6	-	-	N/A
87 Meeting C	-	-	-	0.4	-	-	-	1.6	-	-	N/A
88 Meeting D	-	-	-	0.4	-	-	-	1.6	-	-	N/A
89 Internal Learning 4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
90 Media Hub	-	-	-	0.4	-	-	-	1.6	-	-	N/A
91 Faculty Office	-	-	-	0.4	-	-	-	1.6	-	-	N/A
92 Faculty Workroom	-	-	-	0.4	-	-	-	1.6	-	-	N/A
93 Art and Electronics Store	-	-	-	0.4	-	-	-	1.6	-	-	N/A
95 Art and Design	-	-	-	0.4	-	-	-	1.6	-	-	N/A
96 Media Hub 6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
97 Internal Learning 5	-	-	-	0.4	-	-	-	1.6	-	-	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	
59 Lobby	-	60	-	55
1 Bin Store	60	-	-	15
10 Music Tech Classroom	60	-	-	603
100 Staff WC	-	60	-	56
103 Electronics Lab	60	-	-	1602
104 Learning Base 1	60	-	-	433
105 Learning Base 2	60	-	-	449
106 Pupil WC	-	60	-	140
107 Staff WC	-	60	-	46
11 Recording Audio Control Room	60	-	-	252
111 Sports Hall	-	60	-	3562
113 Lobby	-	60	-	60
114 Stair Lobby	-	60	-	35
116 Stair	-	60	-	96
12 Light recording Room	60	-	-	330
120 Circulation	-	60	-	296
121 Circulation	-	60	-	296
122 Stair	-	60	-	93
123 Radio E	60	-	-	168
124 Meeting E	60	-	-	223
125 Sports Lobby	-	60	-	129
128 Bridge	-	60	-	67
129 Circulation	-	60	-	247
13 Recording teaching Space	60	-	-	561
130	-	60	-	64
130 Circulation	-	60	-	250
131 Internal Learning 6	60	-	-	491
132 Media Hub	60	-	-	418
133 SEN	60	-	-	90
134 SEN Resources	60	-	-	92
135 IAG Careers	60	-	-	93
136 Radio F	60	-	-	182
137 Radio G	60	-	-	180
138 Meeting F	60	-	-	196
139 Meeting G	60	-	-	193
14 Practice 1	60	-	-	103
140 Internal Learning 7	60	-	-	502
142 Lobby	-	60	-	55
144 LRC	60	-	-	1031
146 Media Hub	60	-	-	415
147 Internal Learning 8	60	-	-	559
148 Radio H	60	-	-	168

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
149 Meeting H	60	-	-	223
15 Practice 2	60	-	-	100
150 Lobby	-	60	-	56
151 Seminar Room	60	-	-	159
152 Maintenance	-	60	-	73
153 Pupil WC 8	-	60	-	140
154 Staff WC	-	60	-	46
155 Exam Store	60	-	-	28
157 Sprinkler Tank	60	-	-	196
158 Stair Lobby	-	60	-	35
16 Practice 3	60	-	-	106
160 Stair	-	60	-	85
161 Studio Control	60	-	-	196
162 TV Studio	60	-	-	664
163 Circulation	-	60	-	143
164 Circulation	-	60	-	62
165 Stair Lobby	-	60	-	30
168 Stair	-	60	-	82
169 Media Hub	60	-	-	432
17 Lobby	-	60	-	49
171 Circulation	-	60	-	241
172 Circulation	-	60	-	241
175 Server and Hub Room	60	-	-	94
176 Hub Room	60	-	-	36
18 Practice 4	60	-	-	132
180 Cafe Kiosk	-	60	-	218
184 Hub Room	60	-	-	46
186 Cafe	-	60	-	194
19 Recording Audio Control Room	60	-	-	175
192 Music Store	60	-	-	17
193 Staff WC	-	60	-	54
194 Pupil Change	-	60	-	243
195 Acc Changing	-	60	-	86
196 Staff Office	60	-	-	142
197 Pupil Changing 2	-	60	-	266
198 Sports Hall Store	60	-	-	66
2 Kitchen Plant	60	-	-	71
20 Live Music Studio	60	-	-	420
200 Change Lobby	-	60	-	29
201 Change Lobby	-	60	-	23
209 Hub Room	60	-	-	13
21 Music Store	60	-	-	20
211 Cleaners Store	60	-	-	9

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
22 Drum Booth	60	-	-	204
23 Voice Booth	60	-	-	145
24 Theatre 1	60	-	-	2197
25 Theatre 2	60	-	-	659
26 Theatre Lobby	-	60	-	120
27 TV Studio	60	-	-	882
28 Sound Control Hub	60	-	-	202
29 Plant Room	60	-	-	127
3 Kitchen WC	-	60	-	46
30 Stair	-	60	-	89
32 Stair Lobby	60	-	-	474
33 Pupil WC	-	60	-	151
34 Staff WC	-	60	-	47
35 Media Hub 1	60	-	-	391
36 Board Room	60	-	-	340
37 Entrance lobby	-	60	15	155
38 Reception_Admin	60	-	-	459
39 Interview Meeting	60	-	-	174
40 Sick Bay	60	-	-	133
41 Principle	60	-	-	185
42 Principle PA	60	-	-	153
43 Pupil WC	-	60	-	146
44 Visitor WC	-	60	-	44
45 Stair	-	60	-	90
47 Produuction Booth 1	60	-	-	130
48 Production Booth 2	60	-	-	130
48 Pulse North Zone	-	60	-	434
48 Pulse	-	60	-	34
48 Pulse South Zone	-	60	-	636
49 Internal Learning	60	-	-	491
5 Dining	-	60	-	622
50 Media Hub 1	60	-	-	418
51 Faculty Office	60	-	-	142
52 Faculty Workroom	60	-	-	228
53 Store	60	-	-	18
54 General Office Finance	60	-	-	230
55 Radio A	60	-	-	182
56 Radio B	60	-	-	180
57 Meeting A	60	-	-	196
58 Meeting B	60	-	-	193
6 Music Store	60	-	-	41
60 Internal Learning 2	60	-	-	502
61 Media Hub	60	-	-	432

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
62 Stair	-	60	-	93
63 Stair Lobby	-	60	-	49
65 Staff WC	-	60	-	56
66 Pupil WC 3	-	60	-	150
67 Cleancers Store	60	-	-	9
68 Science Lab 1	60	-	-	1682
69 Science Lab 2	60	-	-	1688
7 Lobby	-	60	-	31
70 Science Prep	60	-	-	836
71 Science Studio 1	60	-	-	1495
72 Science Studio 2	60	-	-	1519
73 IT Technician	60	-	-	304
74 Pupil WC	-	60	-	142
75 Staff WC	-	60	-	47
76 First Aid	60	-	-	180
78 Stair Lobby	-	60	-	35
79 Stair	-	60	-	96
8 Chair Store	60	-	-	31
80	-	60	-	106
81 Science Lab 3	60	-	-	1849
82 Internal Learning 3	60	-	-	491
83 Media Hub 4	60	-	-	418
84 Radio C	60	-	-	182
85 Radio D	60	-	-	180
86 Lobby	-	60	-	55
87 Meeting C	60	-	-	196
88 Meeting D	60	-	-	193
89 Internal Learning 4	60	-	-	502
9 Stair Lobby	-	60	-	65
90 Media Hub	60	-	-	432
91 Faculty Office	60	-	-	142
92 Faculty Workroom	60	-	-	228
93 Art and Electronics Store	60	-	-	39
95 Art and Design	60	-	-	755
96 Media Hub 6	60	-	-	405
97 Internal Learning 5	60	-	-	559
98 Stair Lobby	-	60	-	49
Kitchen 4	-	60	-	877
Media Storeage	60	-	-	38
119 Bridge	-	60	-	67
Stage Step Area	-	60	-	92

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?
10 Music Tech Classroom	NO (-62.9%)	NO
103 Electronics Lab	NO (-89.1%)	NO
104 Learning Base 1	NO (-91.6%)	NO
105 Learning Base 2	NO (-91.6%)	NO
11 Recording Audio Control Room	N/A	N/A
111 Sports Hall	N/A	N/A
12 Light recording Room	N/A	N/A
123 Radio E	N/A	N/A
124 Meeting E	N/A	N/A
13 Recording teaching Space	NO (-66.3%)	NO
131 Internal Learning 6	NO (-29.7%)	NO
132 Media Hub	NO (-87.7%)	NO
133 SEN	N/A	N/A
134 SEN Resources	N/A	N/A
135 IAG Careers	N/A	N/A
136 Radio F	YES (+11.5%)	NO
137 Radio G	YES (+7.3%)	NO
138 Meeting F	N/A	N/A
139 Meeting G	N/A	N/A
14 Practice 1	NO (-81.5%)	NO
140 Internal Learning 7	NO (-19.6%)	NO
144 LRC	NO (-88.6%)	NO
146 Media Hub	NO (-91%)	NO
147 Internal Learning 8	NO (-88.5%)	NO
148 Radio H	N/A	N/A
149 Meeting H	N/A	N/A
15 Practice 2	N/A	N/A
151 Seminar Room	NO (-100%)	NO
16 Practice 3	N/A	N/A
161 Studio Control	N/A	N/A
162 TV Studio	N/A	N/A
169 Media Hub	NO (-87%)	NO
175 Server and Hub Room	N/A	N/A
176 Hub Room	N/A	N/A
18 Practice 4	NO (-83.7%)	NO
184 Hub Room	N/A	N/A
186 Cafe	N/A	N/A
19 Recording Audio Control Room	N/A	N/A
196 Staff Office	N/A	N/A
20 Live Music Studio	N/A	N/A
209 Hub Room	N/A	N/A
22 Drum Booth	N/A	N/A
23 Voice Booth	N/A	N/A
24 Theatre 1	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
25 Theatre 2	N/A	N/A
27 TV Studio	N/A	N/A
28 Sound Control Hub	N/A	N/A
32 Stair Lobby	NO (-64%)	NO
35 Media Hub 1	NO (-76.1%)	NO
36 Board Room	NO (-84.5%)	NO
37 Entrance lobby	NO (-71.3%)	NO
38 Reception_Admin	NO (-77.3%)	NO
39 Interview Meeting	NO (-82.3%)	NO
40 Sick Bay	N/A	N/A
41 Principle	N/A	N/A
42 Principle PA	N/A	N/A
47 Produuction Booth 1	N/A	N/A
48 Production Booth 2	N/A	N/A
49 Internal Learning	NO (-30.9%)	NO
5 Dining	NO (-53.9%)	NO
50 Media Hub 1	NO (-88.3%)	NO
51 Faculty Office	NO (-94.1%)	NO
52 Faculty Workroom	N/A	N/A
53 Store	N/A	N/A
54 General Office Finance	N/A	N/A
55 Radio A	YES (+10.6%)	NO
56 Radio B	YES (+6.9%)	NO
57 Meeting A	N/A	N/A
58 Meeting B	N/A	N/A
60 Internal Learning 2	NO (-19.9%)	NO
61 Media Hub	NO (-88.3%)	NO
68 Science Lab 1	NO (-88.2%)	NO
69 Science Lab 2	NO (-90.2%)	NO
70 Science Prep	NO (-91.3%)	NO
71 Science Studio 1	NO (-90.8%)	NO
72 Science Studio 2	NO (-88.5%)	NO
73 IT Technician	NO (-93.3%)	NO
76 First Aid	N/A	N/A
81 Science Lab 3	NO (-89.7%)	NO
82 Internal Learning 3	NO (-28.3%)	NO
83 Media Hub 4	NO (-88.2%)	NO
84 Radio C	YES (+12.4%)	NO
85 Radio D	YES (+9.5%)	NO
87 Meeting C	N/A	N/A
88 Meeting D	N/A	N/A
89 Internal Learning 4	NO (-16.2%)	NO
90 Media Hub	NO (-88.3%)	NO
91 Faculty Office	NO (-94.1%)	NO
92 Faculty Workroom	N/A	N/A
93 Art and Electronics Store	N/A	N/A
95 Art and Design	NO (-89.4%)	NO
96 Media Hub 6	NO (-91.2%)	NO
97 Internal Learning 5	NO (-88.8%)	NO

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

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

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	6719.1	6719.1
External area [m²]	7879.9	7879.9
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	2823.32	2921.42
Average U-value [W/m²K]	0.36	0.37
Alpha value* [%]	11.67	10

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

Building Use

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

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	8.8	12.52
Cooling	3.92	2.06
Auxiliary	11.66	11.14
Lighting	18.95	13.58
Hot water	16.33	6.07
Equipment*	24.16	24.16
TOTAL**	**59.66**	**45.38**

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

Energy Production by Technology [kWh/m²]

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

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	71.59	67
Primary energy* [kWh/m²]	136.66	102.86
Total emissions [kg/m²]	23.3	17.6

* 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	14.7	0	5	0	2	0.81	0	0.91	0
	Notional	21.4	0	6.9	0	1.1	0.86	0	----	----
[ST] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	28	93	10	7.7	15.5	0.78	3.36	0.91	4.5
	Notional	42.4	55.2	13.7	4	17.4	0.86	3.79	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	24.9	0	8.5	0	38	0.81	0	0.91	0
	Notional	47.6	0	15.3	0	19.8	0.86	0	----	----
[ST] Constant volume system (variable fresh air rate), [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	52	19.6	18.7	2.2	15.7	0.77	2.47	0.91	4.5
	Notional	89.9	16.6	29	1.2	14.4	0.86	3.79	----	----

Key to terms

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

Key Features

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

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.26	1_000000:Surf[6]
Floor	0.2	0.22	1_000000:Surf[0]
Roof	0.15	0.18	10000009:Surf[0]
Windows, roof windows, and rooflights	1.5	0.26	1_000000:Surf[2]
Personnel doors	1.5	2.18	24000000:Surf[1]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

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

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

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	3

Appendix B

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name **Modular and Portable**

150515 UTC Model H1 Modular rev 3a

As designed

Date: Fri May 15 11:21:48 2015

Administrative information

Building Details

Address: UTC Heathrow, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

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

Owner Details

Name:

Telephone number: Phone

Address: , , Postcode

Certifier details

Name: Nicholas Roy Bradley

Telephone number: 07899 797945

Address: The Croft, 10 Birchwood Court, Bessacarr, Doncaster, DN4 6SX

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

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	15.3
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	15.3
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	12.7
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	Are as built details the same as used in the BER calculations?	Separate submission

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

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

2.a Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.26	0.26	1_000000:Surf[6]
Floor	0.25	0.22	0.22	1_000000:Surf[0]
Roof	0.25	0.18	0.18	10000009:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.18	1.98	14000007:Surf[6]
Personnel doors	2.2	2.18	2.18	24000000:Surf[1]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

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

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

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

2.b Building services

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

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	>0.95

1- 02 VRF HRU Ducted Units

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.5	3.5	0	0	0.75
Standard value	2.5*	3.2	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.

2- 05 LTHW Radiant Panels Local Extract

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.96	-	0.9	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- 01 VRF Ducted Units

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.5	3.5	0	0	0.75
Standard value	2.5*	3.2	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- 06 LTHW UFH Natural vent

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.96	-	0.3	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

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

5- 03 LTHW Radiators Nat Vent

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.96	-	0.15	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.

6- 04 LTHW Radiant Panels Nat Vent

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.96	-	0.9	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.

7- 08 Packaged AHU

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.5	3.5	0	1.6	0.75
Standard value	2.5*	3.2	N/A	1.6	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

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

8- 07 Comms Room

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4	3.5	0	0	-
Standard value	2.5*	3.2	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

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

"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
10 Music Tech Classroom	0.4	-	-	-	-	-	-	-	-	-	N/A
103 Electronics Lab	0.4	-	-	-	-	-	-	-	-	-	N/A
104 Learning Base 1	0.4	-	-	-	-	-	-	-	-	-	N/A
105 Learning Base 2	0.4	-	-	-	-	-	-	-	-	-	N/A
11 Recording Audio Control Room	1.5	-	-	-	-	-	-	-	-	-	N/A
12 Light recording Room	0.4	-	-	-	-	-	-	-	-	-	N/A
123 Radio E	0.4	-	-	-	-	-	-	-	-	-	N/A
124 Meeting E	0.4	-	-	-	-	-	-	-	-	-	N/A
13 Recording teaching Space	0.4	-	-	-	-	-	-	-	-	-	N/A
131 Internal Learning 6	0.4	-	-	-	-	-	-	-	-	-	N/A
132 Media Hub	0.4	-	-	-	-	-	-	-	-	-	N/A
133 SEN	0.4	-	-	-	-	-	-	-	-	-	N/A
134 SEN Resources	0.4	-	-	-	-	-	-	-	-	-	N/A
135 IAG Careers	0.4	-	-	-	-	-	-	-	-	-	N/A
136 Radio F	0.4	-	-	-	-	-	-	-	-	-	N/A
137 Radio G	0.4	-	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
138 Meeting F	0.4	-	-	-	-	-	-	-	-	-	N/A
139 Meeting G	0.4	-	-	-	-	-	-	-	-	-	N/A
14 Practice 1	0.4	-	-	-	-	-	-	-	-	-	N/A
140 Internal Learning 7	0.4	-	-	-	-	-	-	-	-	-	N/A
144 LRC	1.5	-	-	-	-	-	-	-	-	-	N/A
146 Media Hub	0.4	-	-	-	-	-	-	-	-	-	N/A
147 Internal Learning 8	0.4	-	-	-	-	-	-	-	-	-	N/A
148 Radio H	0.4	-	-	-	-	-	-	-	-	-	N/A
149 Meeting H	0.4	-	-	-	-	-	-	-	-	-	N/A
15 Practice 2	0.4	-	-	-	-	-	-	-	-	-	N/A
151 Seminar Room	0.4	-	-	-	-	-	-	-	-	-	N/A
16 Practice 3	0.4	-	-	-	-	-	-	-	-	-	N/A
161 Studio Control	1.5	-	-	-	-	-	-	-	-	-	N/A
169 Media Hub	0.4	-	-	-	-	-	-	-	-	-	N/A
18 Practice 4	0.4	-	-	-	-	-	-	-	-	-	N/A
186 Cafe	0.4	-	-	-	-	-	-	-	-	-	N/A
19 Recording Audio Control Room	1.5	-	-	-	-	-	-	-	-	-	N/A
196 Staff Office	0.4	-	-	-	-	-	-	-	-	-	N/A
20 Live Music Studio	0.4	-	-	-	-	-	-	-	-	-	N/A
22 Drum Booth	0.4	-	-	-	-	-	-	-	-	-	N/A
23 Voice Booth	0.4	-	-	-	-	-	-	-	-	-	N/A
28 Sound Control Hub	1.5	-	-	-	-	-	-	-	-	-	N/A
35 Media Hub 1	0.4	-	-	-	-	-	-	-	-	-	N/A
36 Board Room	0.4	-	-	-	-	-	-	-	-	-	N/A
38 Reception_Admin	0.4	-	-	-	-	-	-	-	-	-	N/A
39 Interview Meeting	0.4	-	-	-	-	-	-	-	-	-	N/A
40 Sick Bay	0.4	-	-	-	-	-	-	-	-	-	N/A
41 Principle	0.4	-	-	-	-	-	-	-	-	-	N/A
42 Principle PA	0.4	-	-	-	-	-	-	-	-	-	N/A
47 Produuction Booth 1	1.5	-	-	-	-	-	-	-	-	-	N/A
48 Production Booth 2	1.5	-	-	-	-	-	-	-	-	-	N/A
49 Internal Learning	0.4	-	-	-	-	-	-	-	-	-	N/A
5 Dining	0.4	-	-	-	-	-	-	-	-	-	N/A
50 Media Hub 1	0.4	-	-	-	-	-	-	-	-	-	N/A
51 Faculty Office	0.4	-	-	-	-	-	-	-	-	-	N/A
52 Faculty Workroom	0.4	-	-	-	-	-	-	-	-	-	N/A
53 Store	0.4	-	-	-	-	-	-	-	-	-	N/A
54 General Office Finance	0.4	-	-	-	-	-	-	-	-	-	N/A
55 Radio A	0.4	-	-	-	-	-	-	-	-	-	N/A
56 Radio B	0.4	-	-	-	-	-	-	-	-	-	N/A
57 Meeting A	0.4	-	-	-	-	-	-	-	-	-	N/A
58 Meeting B	0.4	-	-	-	-	-	-	-	-	-	N/A
60 Internal Learning 2	0.4	-	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
61 Media Hub	0.4	-	-	-	-	-	-	-	-	-	N/A
68 Science Lab 1	0.4	-	-	-	-	-	-	-	-	-	N/A
69 Science Lab 2	0.4	-	-	-	-	-	-	-	-	-	N/A
70 Science Prep	0.4	-	-	-	-	-	-	-	-	-	N/A
71 Science Studio 1	0.4	-	-	-	-	-	-	-	-	-	N/A
72 Science Studio 2	0.4	-	-	-	-	-	-	-	-	-	N/A
73 IT Technician	0.4	-	-	-	-	-	-	-	-	-	N/A
76 First Aid	0.4	-	-	-	-	-	-	-	-	-	N/A
81 Science Lab 3	0.4	-	-	-	-	-	-	-	-	-	N/A
82 Internal Learning 3	0.4	-	-	-	-	-	-	-	-	-	N/A
83 Media Hub 4	0.4	-	-	-	-	-	-	-	-	-	N/A
84 Radio C	0.4	-	-	-	-	-	-	-	-	-	N/A
85 Radio D	0.4	-	-	-	-	-	-	-	-	-	N/A
87 Meeting C	0.4	-	-	-	-	-	-	-	-	-	N/A
88 Meeting D	0.4	-	-	-	-	-	-	-	-	-	N/A
89 Internal Learning 4	0.4	-	-	-	-	-	-	-	-	-	N/A
90 Media Hub	0.4	-	-	-	-	-	-	-	-	-	N/A
91 Faculty Office	0.4	-	-	-	-	-	-	-	-	-	N/A
92 Faculty Workroom	0.4	-	-	-	-	-	-	-	-	-	N/A
93 Art and Electronics Store	0.4	-	-	-	-	-	-	-	-	-	N/A
95 Art and Design	0.4	-	-	-	-	-	-	-	-	-	N/A
96 Media Hub 6	0.4	-	-	-	-	-	-	-	-	-	N/A
97 Internal Learning 5	0.4	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
59 Lobby	-	65	-	51
1 Bin Store	65	-	-	14
10 Music Tech Classroom	65	-	-	557
100 Staff WC	-	65	-	52
103 Electronics Lab	65	-	-	1479
104 Learning Base 1	65	-	-	400
105 Learning Base 2	65	-	-	414
106 Pupil WC	-	65	-	129
107 Staff WC	-	65	-	42
11 Recording Audio Control Room	65	-	-	233
111 Sports Hall	-	65	-	3288
113 Lobby	-	65	-	55
114 Stair Lobby	-	65	-	33
116 Stair	-	65	-	89
12 Light recording Room	65	-	-	305
120 Circulation	-	65	-	273

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
121 Circulation	-	65	-	274
122 Stair	-	65	-	86
123 Radio E	65	-	-	155
124 Meeting E	65	-	-	206
125 Sports Lobby	-	65	-	119
128 Bridge	-	65	-	62
129 Circulation	-	65	-	228
13 Recording teaching Space	65	-	-	518
130	-	65	-	59
130 Circulation	-	65	-	230
131 Internal Learning 6	65	-	-	453
132 Media Hub	65	-	-	386
133 SEN	65	-	-	83
134 SEN Resources	65	-	-	85
135 IAG Careers	65	-	-	86
136 Radio F	65	-	-	168
137 Radio G	65	-	-	166
138 Meeting F	65	-	-	181
139 Meeting G	65	-	-	178
14 Practice 1	65	-	-	95
140 Internal Learning 7	65	-	-	464
142 Lobby	-	65	-	51
144 LRC	65	-	-	952
146 Media Hub	65	-	-	383
147 Internal Learning 8	65	-	-	516
148 Radio H	65	-	-	155
149 Meeting H	65	-	-	206
15 Practice 2	65	-	-	92
150 Lobby	-	65	-	52
151 Seminar Room	65	-	-	147
152 Maintenance	-	65	-	67
153 Pupil WC 8	-	65	-	129
154 Staff WC	-	65	-	42
155 Exam Store	65	-	-	26
157 Sprinkler Tank	65	-	-	181
158 Stair Lobby	-	65	-	33
16 Practice 3	65	-	-	98
160 Stair	-	65	-	79
161 Studio Control	65	-	-	181
162 TV Studio	65	-	-	613
163 Circulation	-	65	-	132
164 Circulation	-	65	-	57
165 Stair Lobby	-	65	-	28

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
168 Stair	-	65	-	76
169 Media Hub	65	-	-	399
17 Lobby	-	65	-	46
171 Circulation	-	65	-	223
172 Circulation	-	65	-	222
175 Server and Hub Room	65	-	-	87
176 Hub Room	65	-	-	33
18 Practice 4	65	-	-	122
180 Cafe Kiosk	-	65	-	201
184 Hub Room	65	-	-	43
186 Cafe	-	65	-	179
19 Recording Audio Control Room	65	-	-	161
192 Music Store	65	-	-	15
193 Staff WC	-	65	-	50
194 Pupil Change	-	65	-	224
195 Acc Changing	-	65	-	80
196 Staff Office	65	-	-	131
197 Pupil Changing 2	-	65	-	246
198 Sports Hall Store	65	-	-	61
2 Kitchen Plant	65	-	-	65
20 Live Music Studio	65	-	-	388
200 Change Lobby	-	65	-	27
201 Change Lobby	-	65	-	21
209 Hub Room	65	-	-	12
21 Music Store	65	-	-	18
211 Cleaners Store	65	-	-	8
22 Drum Booth	65	-	-	188
23 Voice Booth	65	-	-	134
24 Theatre 1	65	-	-	2028
25 Theatre 2	65	-	-	608
26 Theatre Lobby	-	65	-	110
27 TV Studio	65	-	-	814
28 Sound Control Hub	65	-	-	187
29 Plant Room	65	-	-	118
3 Kitchen WC	-	65	-	42
30 Stair	-	65	-	82
32 Stair Lobby	65	-	-	438
33 Pupil WC	-	65	-	139
34 Staff WC	-	65	-	43
35 Media Hub 1	65	-	-	361
36 Board Room	65	-	-	314
37 Entrance lobby	-	65	15	143
38 Reception_Admin	65	-	-	423

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
39 Interview Meeting	65	-	-	160
40 Sick Bay	65	-	-	122
41 Principle	65	-	-	171
42 Principle PA	65	-	-	141
43 Pupil WC	-	65	-	135
44 Visitor WC	-	65	-	40
45 Stair	-	65	-	83
47 Produuction Booth 1	65	-	-	120
48 Production Booth 2	65	-	-	120
48 Pulse North Zone	-	65	-	401
48 Pulse	-	65	-	32
48 Pulse South Zone	-	65	-	587
49 Internal Learning	65	-	-	453
5 Dining	-	65	-	574
50 Media Hub 1	65	-	-	386
51 Faculty Office	65	-	-	131
52 Faculty Workroom	65	-	-	210
53 Store	65	-	-	17
54 General Office Finance	65	-	-	212
55 Radio A	65	-	-	168
56 Radio B	65	-	-	166
57 Meeting A	65	-	-	181
58 Meeting B	65	-	-	178
6 Music Store	65	-	-	38
60 Internal Learning 2	65	-	-	464
61 Media Hub	65	-	-	399
62 Stair	-	65	-	86
63 Stair Lobby	-	65	-	45
65 Staff WC	-	65	-	52
66 Pupil WC 3	-	65	-	138
67 Cleancers Store	65	-	-	8
68 Science Lab 1	65	-	-	1553
69 Science Lab 2	65	-	-	1558
7 Lobby	-	65	-	29
70 Science Prep	65	-	-	771
71 Science Studio 1	65	-	-	1380
72 Science Studio 2	65	-	-	1402
73 IT Technician	65	-	-	281
74 Pupil WC	-	65	-	131
75 Staff WC	-	65	-	44
76 First Aid	65	-	-	166
78 Stair Lobby	-	65	-	33
79 Stair	-	65	-	89

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
8 Chair Store	65	-	-	29
80	-	65	-	98
81 Science Lab 3	65	-	-	1706
82 Internal Learning 3	65	-	-	453
83 Media Hub 4	65	-	-	386
84 Radio C	65	-	-	168
85 Radio D	65	-	-	166
86 Lobby	-	65	-	51
87 Meeting C	65	-	-	181
88 Meeting D	65	-	-	178
89 Internal Learning 4	65	-	-	464
9 Stair Lobby	-	65	-	60
90 Media Hub	65	-	-	399
91 Faculty Office	65	-	-	131
92 Faculty Workroom	65	-	-	210
93 Art and Electronics Store	65	-	-	36
95 Art and Design	65	-	-	697
96 Media Hub 6	65	-	-	374
97 Internal Learning 5	65	-	-	516
98 Stair Lobby	-	65	-	45
Kitchen 4	-	65	-	810
Media Storeage	65	-	-	35
119 Bridge	-	65	-	62
Stage Step Area	-	65	-	85

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?
10 Music Tech Classroom	NO (-62.9%)	NO
103 Electronics Lab	NO (-89.1%)	NO
104 Learning Base 1	NO (-91.6%)	NO
105 Learning Base 2	NO (-91.6%)	NO
11 Recording Audio Control Room	N/A	N/A
111 Sports Hall	N/A	N/A
12 Light recording Room	N/A	N/A
123 Radio E	N/A	N/A
124 Meeting E	N/A	N/A
13 Recording teaching Space	NO (-66.3%)	NO
131 Internal Learning 6	NO (-29.7%)	NO
132 Media Hub	NO (-87.7%)	NO
133 SEN	N/A	N/A
134 SEN Resources	N/A	N/A
135 IAG Careers	N/A	N/A
136 Radio F	YES (+11.5%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
137 Radio G	YES (+7.3%)	NO
138 Meeting F	N/A	N/A
139 Meeting G	N/A	N/A
14 Practice 1	NO (-81.5%)	NO
140 Internal Learning 7	NO (-19.6%)	NO
144 LRC	NO (-88.6%)	NO
146 Media Hub	NO (-91%)	NO
147 Internal Learning 8	NO (-88.5%)	NO
148 Radio H	N/A	N/A
149 Meeting H	N/A	N/A
15 Practice 2	N/A	N/A
151 Seminar Room	NO (-100%)	NO
16 Practice 3	N/A	N/A
161 Studio Control	N/A	N/A
162 TV Studio	N/A	N/A
169 Media Hub	NO (-87%)	NO
175 Server and Hub Room	N/A	N/A
176 Hub Room	N/A	N/A
18 Practice 4	NO (-83.7%)	NO
184 Hub Room	N/A	N/A
186 Cafe	N/A	N/A
19 Recording Audio Control Room	N/A	N/A
196 Staff Office	N/A	N/A
20 Live Music Studio	N/A	N/A
209 Hub Room	N/A	N/A
22 Drum Booth	N/A	N/A
23 Voice Booth	N/A	N/A
24 Theatre 1	N/A	N/A
25 Theatre 2	N/A	N/A
27 TV Studio	N/A	N/A
28 Sound Control Hub	N/A	N/A
32 Stair Lobby	NO (-64%)	NO
35 Media Hub 1	NO (-76.1%)	NO
36 Board Room	NO (-84.5%)	NO
37 Entrance lobby	NO (-71.3%)	NO
38 Reception_Admin	NO (-77.3%)	NO
39 Interview Meeting	NO (-82.3%)	NO
40 Sick Bay	N/A	N/A
41 Principle	N/A	N/A
42 Principle PA	N/A	N/A
47 Produuction Booth 1	N/A	N/A
48 Production Booth 2	N/A	N/A
49 Internal Learning	NO (-30.9%)	NO
5 Dining	NO (-53.9%)	NO
50 Media Hub 1	NO (-88.3%)	NO
51 Faculty Office	NO (-94.1%)	NO
52 Faculty Workroom	N/A	N/A
53 Store	N/A	N/A
54 General Office Finance	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
55 Radio A	YES (+10.6%)	NO
56 Radio B	YES (+6.9%)	NO
57 Meeting A	N/A	N/A
58 Meeting B	N/A	N/A
60 Internal Learning 2	NO (-19.9%)	NO
61 Media Hub	NO (-88.3%)	NO
68 Science Lab 1	NO (-88.2%)	NO
69 Science Lab 2	NO (-90.2%)	NO
70 Science Prep	NO (-91.3%)	NO
71 Science Studio 1	NO (-90.8%)	NO
72 Science Studio 2	NO (-88.5%)	NO
73 IT Technician	NO (-93.3%)	NO
76 First Aid	N/A	N/A
81 Science Lab 3	NO (-89.7%)	NO
82 Internal Learning 3	NO (-28.3%)	NO
83 Media Hub 4	NO (-88.2%)	NO
84 Radio C	YES (+12.4%)	NO
85 Radio D	YES (+9.5%)	NO
87 Meeting C	N/A	N/A
88 Meeting D	N/A	N/A
89 Internal Learning 4	NO (-16.2%)	NO
90 Media Hub	NO (-88.3%)	NO
91 Faculty Office	NO (-94.1%)	NO
92 Faculty Workroom	N/A	N/A
93 Art and Electronics Store	N/A	N/A
95 Art and Design	NO (-89.4%)	NO
96 Media Hub 6	NO (-91.2%)	NO
97 Internal Learning 5	NO (-88.8%)	NO

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

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

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	6719.1	6719.1
External area [m²]	7879.9	7879.9
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	5	3
Average conductance [W/K]	2823.32	2921.42
Average U-value [W/m²K]	0.36	0.37
Alpha value* [%]	11.67	10

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

Building Use

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

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	3.25	7.45
Cooling	2.79	2.43
Auxiliary	3.03	5.04
Lighting	13.35	13.58
Hot water	8.62	6.07
Equipment*	24.16	24.16
TOTAL**	**31.04**	**34.58**

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

Energy Production by Technology [kWh/m²]

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

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	69.94	91.64
Primary energy* [kWh/m²]	79.35	107.11
Total emissions [kg/m²]	12.7	15.3

* 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	27.9	0	8.6	0	2	0.9	0	0.96	0
	Notional	29.5	0	9.5	0	1.2	0.86	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	32.8	0	10.1	0	14.3	0.9	0	0.96	0
	Notional	42.3	0	13.6	0	19.8	0.86	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	12.8	0	4	0	2	0.9	0	0.96	0
	Notional	6.3	0	2	0	1.2	0.86	0	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	52	94	3.3	6.4	1	4.41	4.11	4.5	5.5
	Notional	117.7	62.1	12.8	4.5	5	2.56	3.79	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	37.8	58.5	2.4	4	1.1	4.41	4.11	4.5	5.5
	Notional	92.9	46.8	10.1	3.4	5.2	2.56	3.79	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	10.6	1045.2	0.8	77.7	6.4	3.92	3.74	4	5
	Notional	8.1	1005.5	0.9	73.7	7.2	2.56	3.79	----	----
[ST] Single-duct VAV, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	59.7	18.3	4.4	1.3	14.6	3.77	3.9	4.5	5.5
	Notional	86.7	18.4	9.4	1.4	14.4	2.56	3.79	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	16.8	0	5.2	0	2	0.9	0	0.96	0
	Notional	11.4	0	3.7	0	1.2	0.86	0	----	----

Key to terms

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

Key Features

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

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.26	1_000000:Surf[6]
Floor	0.2	0.22	1_000000:Surf[0]
Roof	0.15	0.18	10000009:Surf[0]
Windows, roof windows, and rooflights	1.5	0.26	1_000000:Surf[2]
Personnel doors	1.5	2.18	24000000:Surf[1]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

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

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

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	5

Appendix C

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name **Modular and Portable**

150515 UTC Model H2 Modular rev 3a

As designed

Date: Fri May 15 10:35:09 2015

Administrative information

Building Details

Address: UTC Heathrow, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

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

Owner Details

Name:

Telephone number: Phone

Address: , , Postcode

Certifier details

Name: Nicholas Roy Bradley

Telephone number: 07899 797945

Address: The Croft, 10 Birchwood Court, Bessacarr, Doncaster, DN4 6SX

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

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	15.2
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	15.2
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	11.9
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	Are as built details the same as used in the BER calculations?	Separate submission

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

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

2.a Building fabric

Element	$U_{a\text{-Limit}}$	$U_{a\text{-Calc}}$	$U_{i\text{-Calc}}$	Surface where the maximum value occurs*
Wall**	0.35	0.26	0.26	1_000000:Surf[6]
Floor	0.25	0.22	0.22	1_000000:Surf[0]
Roof	0.25	0.18	0.18	10000009:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.18	1.98	14000007:Surf[6]
Personnel doors	2.2	2.18	2.18	24000000:Surf[1]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

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

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

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

2.b Building services

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

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	>0.95

1- 02 VRF HRU Ducted Units

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.5	3.5	0	0	0.75
Standard value	2.5*	3.2	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.

2- 05 LTHW Radiant Panels Local Extract

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.9	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

3- 01 VRF Ducted Units

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.5	3.5	0	0	0.75
Standard value	2.5*	3.2	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- 06 LTHW UFH Natural vent

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.3	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

5- 03 LTHW Radiators Nat Vent

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.15	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

6- 04 LTHW Radiant Panels Nat Vent

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.9	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

7- 08 Packaged AHU

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.5	3.5	0	1.6	0.75
Standard value	2.5*	3.2	N/A	1.6	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

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

8- 07 Comms Room

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4	3.5	0	0	-
Standard value	2.5*	3.2	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

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

"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
10 Music Tech Classroom	0.4	-	-	-	-	-	-	-	-	-	N/A
103 Electronics Lab	0.4	-	-	-	-	-	-	-	-	-	N/A
104 Learning Base 1	0.4	-	-	-	-	-	-	-	-	-	N/A
105 Learning Base 2	0.4	-	-	-	-	-	-	-	-	-	N/A
11 Recording Audio Control Room	1.5	-	-	-	-	-	-	-	-	-	N/A
12 Light recording Room	0.4	-	-	-	-	-	-	-	-	-	N/A
123 Radio E	0.4	-	-	-	-	-	-	-	-	-	N/A
124 Meeting E	0.4	-	-	-	-	-	-	-	-	-	N/A
13 Recording teaching Space	0.4	-	-	-	-	-	-	-	-	-	N/A
131 Internal Learning 6	0.4	-	-	-	-	-	-	-	-	-	N/A
132 Media Hub	0.4	-	-	-	-	-	-	-	-	-	N/A
133 SEN	0.4	-	-	-	-	-	-	-	-	-	N/A
134 SEN Resources	0.4	-	-	-	-	-	-	-	-	-	N/A
135 IAG Careers	0.4	-	-	-	-	-	-	-	-	-	N/A
136 Radio F	0.4	-	-	-	-	-	-	-	-	-	N/A
137 Radio G	0.4	-	-	-	-	-	-	-	-	-	N/A
138 Meeting F	0.4	-	-	-	-	-	-	-	-	-	N/A
139 Meeting G	0.4	-	-	-	-	-	-	-	-	-	N/A
14 Practice 1	0.4	-	-	-	-	-	-	-	-	-	N/A
140 Internal Learning 7	0.4	-	-	-	-	-	-	-	-	-	N/A
144 LRC	1.5	-	-	-	-	-	-	-	-	-	N/A
146 Media Hub	0.4	-	-	-	-	-	-	-	-	-	N/A
147 Internal Learning 8	0.4	-	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
148 Radio H	0.4	-	-	-	-	-	-	-	-	-	N/A
149 Meeting H	0.4	-	-	-	-	-	-	-	-	-	N/A
15 Practice 2	0.4	-	-	-	-	-	-	-	-	-	N/A
151 Seminar Room	0.4	-	-	-	-	-	-	-	-	-	N/A
16 Practice 3	0.4	-	-	-	-	-	-	-	-	-	N/A
161 Studio Control	1.5	-	-	-	-	-	-	-	-	-	N/A
169 Media Hub	0.4	-	-	-	-	-	-	-	-	-	N/A
18 Practice 4	0.4	-	-	-	-	-	-	-	-	-	N/A
186 Cafe	0.4	-	-	-	-	-	-	-	-	-	N/A
19 Recording Audio Control Room	1.5	-	-	-	-	-	-	-	-	-	N/A
196 Staff Office	0.4	-	-	-	-	-	-	-	-	-	N/A
20 Live Music Studio	0.4	-	-	-	-	-	-	-	-	-	N/A
22 Drum Booth	0.4	-	-	-	-	-	-	-	-	-	N/A
23 Voice Booth	0.4	-	-	-	-	-	-	-	-	-	N/A
28 Sound Control Hub	1.5	-	-	-	-	-	-	-	-	-	N/A
35 Media Hub 1	0.4	-	-	-	-	-	-	-	-	-	N/A
36 Board Room	0.4	-	-	-	-	-	-	-	-	-	N/A
38 Reception_Admin	0.4	-	-	-	-	-	-	-	-	-	N/A
39 Interview Meeting	0.4	-	-	-	-	-	-	-	-	-	N/A
40 Sick Bay	0.4	-	-	-	-	-	-	-	-	-	N/A
41 Principle	0.4	-	-	-	-	-	-	-	-	-	N/A
42 Principle PA	0.4	-	-	-	-	-	-	-	-	-	N/A
47 Produuction Booth 1	1.5	-	-	-	-	-	-	-	-	-	N/A
48 Production Booth 2	1.5	-	-	-	-	-	-	-	-	-	N/A
49 Internal Learning	0.4	-	-	-	-	-	-	-	-	-	N/A
5 Dining	0.4	-	-	-	-	-	-	-	-	-	N/A
50 Media Hub 1	0.4	-	-	-	-	-	-	-	-	-	N/A
51 Faculty Office	0.4	-	-	-	-	-	-	-	-	-	N/A
52 Faculty Workroom	0.4	-	-	-	-	-	-	-	-	-	N/A
53 Store	0.4	-	-	-	-	-	-	-	-	-	N/A
54 General Office Finance	0.4	-	-	-	-	-	-	-	-	-	N/A
55 Radio A	0.4	-	-	-	-	-	-	-	-	-	N/A
56 Radio B	0.4	-	-	-	-	-	-	-	-	-	N/A
57 Meeting A	0.4	-	-	-	-	-	-	-	-	-	N/A
58 Meeting B	0.4	-	-	-	-	-	-	-	-	-	N/A
60 Internal Learning 2	0.4	-	-	-	-	-	-	-	-	-	N/A
61 Media Hub	0.4	-	-	-	-	-	-	-	-	-	N/A
68 Science Lab 1	0.4	-	-	-	-	-	-	-	-	-	N/A
69 Science Lab 2	0.4	-	-	-	-	-	-	-	-	-	N/A
70 Science Prep	0.4	-	-	-	-	-	-	-	-	-	N/A
71 Science Studio 1	0.4	-	-	-	-	-	-	-	-	-	N/A
72 Science Studio 2	0.4	-	-	-	-	-	-	-	-	-	N/A
73 IT Technician	0.4	-	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
76 First Aid	0.4	-	-	-	-	-	-	-	-	-	N/A
81 Science Lab 3	0.4	-	-	-	-	-	-	-	-	-	N/A
82 Internal Learning 3	0.4	-	-	-	-	-	-	-	-	-	N/A
83 Media Hub 4	0.4	-	-	-	-	-	-	-	-	-	N/A
84 Radio C	0.4	-	-	-	-	-	-	-	-	-	N/A
85 Radio D	0.4	-	-	-	-	-	-	-	-	-	N/A
87 Meeting C	0.4	-	-	-	-	-	-	-	-	-	N/A
88 Meeting D	0.4	-	-	-	-	-	-	-	-	-	N/A
89 Internal Learning 4	0.4	-	-	-	-	-	-	-	-	-	N/A
90 Media Hub	0.4	-	-	-	-	-	-	-	-	-	N/A
91 Faculty Office	0.4	-	-	-	-	-	-	-	-	-	N/A
92 Faculty Workroom	0.4	-	-	-	-	-	-	-	-	-	N/A
93 Art and Electronics Store	0.4	-	-	-	-	-	-	-	-	-	N/A
95 Art and Design	0.4	-	-	-	-	-	-	-	-	-	N/A
96 Media Hub 6	0.4	-	-	-	-	-	-	-	-	-	N/A
97 Internal Learning 5	0.4	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
59 Lobby	-	65	-	51
1 Bin Store	65	-	-	14
10 Music Tech Classroom	65	-	-	557
100 Staff WC	-	65	-	52
103 Electronics Lab	65	-	-	1479
104 Learning Base 1	65	-	-	400
105 Learning Base 2	65	-	-	414
106 Pupil WC	-	65	-	129
107 Staff WC	-	65	-	42
11 Recording Audio Control Room	65	-	-	233
111 Sports Hall	-	65	-	3288
113 Lobby	-	65	-	55
114 Stair Lobby	-	65	-	33
116 Stair	-	65	-	89
12 Light recording Room	65	-	-	305
120 Circulation	-	65	-	273
121 Circulation	-	65	-	274
122 Stair	-	65	-	86
123 Radio E	65	-	-	155
124 Meeting E	65	-	-	206
125 Sports Lobby	-	65	-	119
128 Bridge	-	65	-	62
129 Circulation	-	65	-	228

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
13 Recording teaching Space	65	-	-	518
130	-	65	-	59
130 Circulation	-	65	-	230
131 Internal Learning 6	65	-	-	453
132 Media Hub	65	-	-	386
133 SEN	65	-	-	83
134 SEN Resources	65	-	-	85
135 IAG Careers	65	-	-	86
136 Radio F	65	-	-	168
137 Radio G	65	-	-	166
138 Meeting F	65	-	-	181
139 Meeting G	65	-	-	178
14 Practice 1	65	-	-	95
140 Internal Learning 7	65	-	-	464
142 Lobby	-	65	-	51
144 LRC	65	-	-	952
146 Media Hub	65	-	-	383
147 Internal Learning 8	65	-	-	516
148 Radio H	65	-	-	155
149 Meeting H	65	-	-	206
15 Practice 2	65	-	-	92
150 Lobby	-	65	-	52
151 Seminar Room	65	-	-	147
152 Maintenance	-	65	-	67
153 Pupil WC 8	-	65	-	129
154 Staff WC	-	65	-	42
155 Exam Store	65	-	-	26
157 Sprinkler Tank	65	-	-	181
158 Stair Lobby	-	65	-	33
16 Practice 3	65	-	-	98
160 Stair	-	65	-	79
161 Studio Control	65	-	-	181
162 TV Studio	65	-	-	613
163 Circulation	-	65	-	132
164 Circulation	-	65	-	57
165 Stair Lobby	-	65	-	28
168 Stair	-	65	-	76
169 Media Hub	65	-	-	399
17 Lobby	-	65	-	46
171 Circulation	-	65	-	223
172 Circulation	-	65	-	222
175 Server and Hub Room	65	-	-	87
176 Hub Room	65	-	-	33

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
18 Practice 4	65	-	-	122
180 Cafe Kiosk	-	65	-	201
184 Hub Room	65	-	-	43
186 Cafe	-	65	-	179
19 Recording Audio Control Room	65	-	-	161
192 Music Store	65	-	-	15
193 Staff WC	-	65	-	50
194 Pupil Change	-	65	-	224
195 Acc Changing	-	65	-	80
196 Staff Office	65	-	-	131
197 Pupil Changing 2	-	65	-	246
198 Sports Hall Store	65	-	-	61
2 Kitchen Plant	65	-	-	65
20 Live Music Studio	65	-	-	388
200 Change Lobby	-	65	-	27
201 Change Lobby	-	65	-	21
209 Hub Room	65	-	-	12
21 Music Store	65	-	-	18
211 Cleaners Store	65	-	-	8
22 Drum Booth	65	-	-	188
23 Voice Booth	65	-	-	134
24 Theatre 1	65	-	-	2028
25 Theatre 2	65	-	-	608
26 Theatre Lobby	-	65	-	110
27 TV Studio	65	-	-	814
28 Sound Control Hub	65	-	-	187
29 Plant Room	65	-	-	118
3 Kitchen WC	-	65	-	42
30 Stair	-	65	-	82
32 Stair Lobby	65	-	-	438
33 Pupil WC	-	65	-	139
34 Staff WC	-	65	-	43
35 Media Hub 1	65	-	-	361
36 Board Room	65	-	-	314
37 Entrance lobby	-	65	15	143
38 Reception_Admin	65	-	-	423
39 Interview Meeting	65	-	-	160
40 Sick Bay	65	-	-	122
41 Principle	65	-	-	171
42 Principle PA	65	-	-	141
43 Pupil WC	-	65	-	135
44 Visitor WC	-	65	-	40
45 Stair	-	65	-	83

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
47 Produuction Booth 1	65	-	-	120
48 Production Booth 2	65	-	-	120
48 Pulse North Zone	-	65	-	401
48 Pulse	-	65	-	32
48 Pulse South Zone	-	65	-	587
49 Internal Learning	65	-	-	453
5 Dining	-	65	-	574
50 Media Hub 1	65	-	-	386
51 Faculty Office	65	-	-	131
52 Faculty Workroom	65	-	-	210
53 Store	65	-	-	17
54 General Office Finance	65	-	-	212
55 Radio A	65	-	-	168
56 Radio B	65	-	-	166
57 Meeting A	65	-	-	181
58 Meeting B	65	-	-	178
6 Music Store	65	-	-	38
60 Internal Learning 2	65	-	-	464
61 Media Hub	65	-	-	399
62 Stair	-	65	-	86
63 Stair Lobby	-	65	-	45
65 Staff WC	-	65	-	52
66 Pupil WC 3	-	65	-	138
67 Cleancers Store	65	-	-	8
68 Science Lab 1	65	-	-	1553
69 Science Lab 2	65	-	-	1558
7 Lobby	-	65	-	29
70 Science Prep	65	-	-	771
71 Science Studio 1	65	-	-	1380
72 Science Studio 2	65	-	-	1402
73 IT Technician	65	-	-	281
74 Pupil WC	-	65	-	131
75 Staff WC	-	65	-	44
76 First Aid	65	-	-	166
78 Stair Lobby	-	65	-	33
79 Stair	-	65	-	89
8 Chair Store	65	-	-	29
80	-	65	-	98
81 Science Lab 3	65	-	-	1706
82 Internal Learning 3	65	-	-	453
83 Media Hub 4	65	-	-	386
84 Radio C	65	-	-	168
85 Radio D	65	-	-	166

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
86 Lobby	-	65	-	51
87 Meeting C	65	-	-	181
88 Meeting D	65	-	-	178
89 Internal Learning 4	65	-	-	464
9 Stair Lobby	-	65	-	60
90 Media Hub	65	-	-	399
91 Faculty Office	65	-	-	131
92 Faculty Workroom	65	-	-	210
93 Art and Electronics Store	65	-	-	36
95 Art and Design	65	-	-	697
96 Media Hub 6	65	-	-	374
97 Internal Learning 5	65	-	-	516
98 Stair Lobby	-	65	-	45
Kitchen 4	-	65	-	810
Media Storeage	65	-	-	35
119 Bridge	-	65	-	62
Stage Step Area	-	65	-	85

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?
10 Music Tech Classroom	NO (-62.9%)	NO
103 Electronics Lab	NO (-89.1%)	NO
104 Learning Base 1	NO (-91.6%)	NO
105 Learning Base 2	NO (-91.6%)	NO
11 Recording Audio Control Room	N/A	N/A
111 Sports Hall	N/A	N/A
12 Light recording Room	N/A	N/A
123 Radio E	N/A	N/A
124 Meeting E	N/A	N/A
13 Recording teaching Space	NO (-66.3%)	NO
131 Internal Learning 6	NO (-29.7%)	NO
132 Media Hub	NO (-87.7%)	NO
133 SEN	N/A	N/A
134 SEN Resources	N/A	N/A
135 IAG Careers	N/A	N/A
136 Radio F	YES (+11.5%)	NO
137 Radio G	YES (+7.3%)	NO
138 Meeting F	N/A	N/A
139 Meeting G	N/A	N/A
14 Practice 1	NO (-81.5%)	NO
140 Internal Learning 7	NO (-19.6%)	NO
144 LRC	NO (-88.6%)	NO
146 Media Hub	NO (-91%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
147 Internal Learning 8	NO (-88.5%)	NO
148 Radio H	N/A	N/A
149 Meeting H	N/A	N/A
15 Practice 2	N/A	N/A
151 Seminar Room	NO (-100%)	NO
16 Practice 3	N/A	N/A
161 Studio Control	N/A	N/A
162 TV Studio	N/A	N/A
169 Media Hub	NO (-87%)	NO
175 Server and Hub Room	N/A	N/A
176 Hub Room	N/A	N/A
18 Practice 4	NO (-83.7%)	NO
184 Hub Room	N/A	N/A
186 Cafe	N/A	N/A
19 Recording Audio Control Room	N/A	N/A
196 Staff Office	N/A	N/A
20 Live Music Studio	N/A	N/A
209 Hub Room	N/A	N/A
22 Drum Booth	N/A	N/A
23 Voice Booth	N/A	N/A
24 Theatre 1	N/A	N/A
25 Theatre 2	N/A	N/A
27 TV Studio	N/A	N/A
28 Sound Control Hub	N/A	N/A
32 Stair Lobby	NO (-64%)	NO
35 Media Hub 1	NO (-76.1%)	NO
36 Board Room	NO (-84.5%)	NO
37 Entrance lobby	NO (-71.3%)	NO
38 Reception_Admin	NO (-77.3%)	NO
39 Interview Meeting	NO (-82.3%)	NO
40 Sick Bay	N/A	N/A
41 Principle	N/A	N/A
42 Principle PA	N/A	N/A
47 Produuction Booth 1	N/A	N/A
48 Production Booth 2	N/A	N/A
49 Internal Learning	NO (-30.9%)	NO
5 Dining	NO (-53.9%)	NO
50 Media Hub 1	NO (-88.3%)	NO
51 Faculty Office	NO (-94.1%)	NO
52 Faculty Workroom	N/A	N/A
53 Store	N/A	N/A
54 General Office Finance	N/A	N/A
55 Radio A	YES (+10.6%)	NO
56 Radio B	YES (+6.9%)	NO
57 Meeting A	N/A	N/A
58 Meeting B	N/A	N/A
60 Internal Learning 2	NO (-19.9%)	NO
61 Media Hub	NO (-88.3%)	NO
68 Science Lab 1	NO (-88.2%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
69 Science Lab 2	NO (-90.2%)	NO
70 Science Prep	NO (-91.3%)	NO
71 Science Studio 1	NO (-90.8%)	NO
72 Science Studio 2	NO (-88.5%)	NO
73 IT Technician	NO (-93.3%)	NO
76 First Aid	N/A	N/A
81 Science Lab 3	NO (-89.7%)	NO
82 Internal Learning 3	NO (-28.3%)	NO
83 Media Hub 4	NO (-88.2%)	NO
84 Radio C	YES (+12.4%)	NO
85 Radio D	YES (+9.5%)	NO
87 Meeting C	N/A	N/A
88 Meeting D	N/A	N/A
89 Internal Learning 4	NO (-16.2%)	NO
90 Media Hub	NO (-88.3%)	NO
91 Faculty Office	NO (-94.1%)	NO
92 Faculty Workroom	N/A	N/A
93 Art and Electronics Store	N/A	N/A
95 Art and Design	NO (-89.4%)	NO
96 Media Hub 6	NO (-91.2%)	NO
97 Internal Learning 5	NO (-88.8%)	NO

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

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

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	6719.1	6719.1
External area [m²]	7879.9	7879.9
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	2823.32	0
Average U-value [W/m²K]	0.36	0
Alpha value* [%]	11.67	10

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

Building Use

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

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	2.39	7.22
Cooling	3.04	2.43
Auxiliary	3.03	5.04
Lighting	13.35	13.58
Hot water	8.27	5.82
Equipment*	24.16	24.16
TOTAL**	**30.07**	**34.09**

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

Energy Production by Technology [kWh/m²]

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

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	67.75	91.64
Primary energy* [kWh/m²]	77.1	106.37
Total emissions [kg/m²]	11.9	15.2

* 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] District heating, [HFT] Natural Gas, [CFT] Electricity										
	Actual	21.5	0	6	0	2	1	0	1	0
	Notional	29.5	0	8.2	0	1.2	1	0	----	----
[ST] Central heating using water: radiators, [HS] District heating, [HFT] Natural Gas, [CFT] Electricity										
	Actual	27	0	7.5	0	14.3	1	0	1	0
	Notional	42.3	0	11.8	0	19.8	1	0	----	----
[ST] Central heating using water: radiators, [HS] District heating, [HFT] Natural Gas, [CFT] Electricity										
	Actual	8	0	2.2	0	2	1	0	1	0
	Notional	6.3	0	1.8	0	1.2	1	0	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	44.8	101	2.8	6.8	1	4.41	4.11	4.5	5.5
	Notional	117.7	62.1	12.8	4.5	5	2.56	3.79	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	31.3	63.6	2	4.3	1.1	4.41	4.11	4.5	5.5
	Notional	92.9	46.8	10.1	3.4	5.2	2.56	3.79	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	7.7	1144.2	0.5	85.1	6.4	3.92	3.74	4	5
	Notional	8.1	1005.5	0.9	73.7	7.2	2.56	3.79	----	----
[ST] Single-duct VAV, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	47.2	20.6	3.5	1.5	14.6	3.77	3.9	4.5	5.5
	Notional	86.7	18.4	9.4	1.4	14.4	2.56	3.79	----	----
[ST] Central heating using water: radiators, [HS] District heating, [HFT] Natural Gas, [CFT] Electricity										
	Actual	10.6	0	2.9	0	2	1	0	1	0
	Notional	11.4	0	3.2	0	1.2	1	0	----	----

Key to terms

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

Key Features

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

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.26	1_000000:Surf[6]
Floor	0.2	0.22	1_000000:Surf[0]
Roof	0.15	0.18	10000009:Surf[0]
Windows, roof windows, and rooflights	1.5	0.26	1_000000:Surf[2]
Personnel doors	1.5	2.18	24000000:Surf[1]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

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

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

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	3

Appendix D

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name **Modular and Portable**

150515 UTC Model H3 Modular rev 3a

As designed

Date: Fri May 15 10:49:32 2015

Administrative information

Building Details

Address: UTC Heathrow, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

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

Owner Details

Name:

Telephone number: Phone

Address: , , Postcode

Certifier details

Name: Nicholas Roy Bradley

Telephone number: 07899 797945

Address: The Croft, 10 Birchwood Court, Bessacarr, Doncaster, DN4 6SX

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

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	15.1
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	15.1
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	10.3
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	Are as built details the same as used in the BER calculations?	Separate submission

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

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

2.a Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.26	0.26	1_000000:Surf[6]
Floor	0.25	0.22	0.22	1_000000:Surf[0]
Roof	0.25	0.18	0.18	10000009:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.18	1.98	14000007:Surf[6]
Personnel doors	2.2	2.18	2.18	24000000:Surf[1]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

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

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

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

2.b Building services

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

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	>0.95

1- 02 VRF HRU Ducted Units

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.5	3.5	0	0	0.75
Standard value	2.5*	3.2	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.

2- 05 LTHW Radiant Panels Local Extract

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.9	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

3- 01 VRF Ducted Units

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.5	3.5	0	0	0.75
Standard value	2.5*	3.2	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- 06 LTHW UFH Natural vent

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.3	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

5- 03 LTHW Radiators Nat Vent

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.15	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

6- 04 LTHW Radiant Panels Nat Vent

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.9	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

7- 08 Packaged AHU

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.5	3.5	0	1.6	0.75
Standard value	2.5*	3.2	N/A	1.6	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

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

8- 07 Comms Room

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4	3.5	0	0	-
Standard value	2.5*	3.2	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

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

"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
10 Music Tech Classroom	0.4	-	-	-	-	-	-	-	-	-	N/A
103 Electronics Lab	0.4	-	-	-	-	-	-	-	-	-	N/A
104 Learning Base 1	0.4	-	-	-	-	-	-	-	-	-	N/A
105 Learning Base 2	0.4	-	-	-	-	-	-	-	-	-	N/A
11 Recording Audio Control Room	1.5	-	-	-	-	-	-	-	-	-	N/A
12 Light recording Room	0.4	-	-	-	-	-	-	-	-	-	N/A
123 Radio E	0.4	-	-	-	-	-	-	-	-	-	N/A
124 Meeting E	0.4	-	-	-	-	-	-	-	-	-	N/A
13 Recording teaching Space	0.4	-	-	-	-	-	-	-	-	-	N/A
131 Internal Learning 6	0.4	-	-	-	-	-	-	-	-	-	N/A
132 Media Hub	0.4	-	-	-	-	-	-	-	-	-	N/A
133 SEN	0.4	-	-	-	-	-	-	-	-	-	N/A
134 SEN Resources	0.4	-	-	-	-	-	-	-	-	-	N/A
135 IAG Careers	0.4	-	-	-	-	-	-	-	-	-	N/A
136 Radio F	0.4	-	-	-	-	-	-	-	-	-	N/A
137 Radio G	0.4	-	-	-	-	-	-	-	-	-	N/A
138 Meeting F	0.4	-	-	-	-	-	-	-	-	-	N/A
139 Meeting G	0.4	-	-	-	-	-	-	-	-	-	N/A
14 Practice 1	0.4	-	-	-	-	-	-	-	-	-	N/A
140 Internal Learning 7	0.4	-	-	-	-	-	-	-	-	-	N/A
144 LRC	1.5	-	-	-	-	-	-	-	-	-	N/A
146 Media Hub	0.4	-	-	-	-	-	-	-	-	-	N/A
147 Internal Learning 8	0.4	-	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
148 Radio H	0.4	-	-	-	-	-	-	-	-	-	N/A
149 Meeting H	0.4	-	-	-	-	-	-	-	-	-	N/A
15 Practice 2	0.4	-	-	-	-	-	-	-	-	-	N/A
151 Seminar Room	0.4	-	-	-	-	-	-	-	-	-	N/A
16 Practice 3	0.4	-	-	-	-	-	-	-	-	-	N/A
161 Studio Control	1.5	-	-	-	-	-	-	-	-	-	N/A
169 Media Hub	0.4	-	-	-	-	-	-	-	-	-	N/A
18 Practice 4	0.4	-	-	-	-	-	-	-	-	-	N/A
186 Cafe	0.4	-	-	-	-	-	-	-	-	-	N/A
19 Recording Audio Control Room	1.5	-	-	-	-	-	-	-	-	-	N/A
196 Staff Office	0.4	-	-	-	-	-	-	-	-	-	N/A
20 Live Music Studio	0.4	-	-	-	-	-	-	-	-	-	N/A
22 Drum Booth	0.4	-	-	-	-	-	-	-	-	-	N/A
23 Voice Booth	0.4	-	-	-	-	-	-	-	-	-	N/A
28 Sound Control Hub	1.5	-	-	-	-	-	-	-	-	-	N/A
35 Media Hub 1	0.4	-	-	-	-	-	-	-	-	-	N/A
36 Board Room	0.4	-	-	-	-	-	-	-	-	-	N/A
38 Reception_Admin	0.4	-	-	-	-	-	-	-	-	-	N/A
39 Interview Meeting	0.4	-	-	-	-	-	-	-	-	-	N/A
40 Sick Bay	0.4	-	-	-	-	-	-	-	-	-	N/A
41 Principle	0.4	-	-	-	-	-	-	-	-	-	N/A
42 Principle PA	0.4	-	-	-	-	-	-	-	-	-	N/A
47 Produuction Booth 1	1.5	-	-	-	-	-	-	-	-	-	N/A
48 Production Booth 2	1.5	-	-	-	-	-	-	-	-	-	N/A
49 Internal Learning	0.4	-	-	-	-	-	-	-	-	-	N/A
5 Dining	0.4	-	-	-	-	-	-	-	-	-	N/A
50 Media Hub 1	0.4	-	-	-	-	-	-	-	-	-	N/A
51 Faculty Office	0.4	-	-	-	-	-	-	-	-	-	N/A
52 Faculty Workroom	0.4	-	-	-	-	-	-	-	-	-	N/A
53 Store	0.4	-	-	-	-	-	-	-	-	-	N/A
54 General Office Finance	0.4	-	-	-	-	-	-	-	-	-	N/A
55 Radio A	0.4	-	-	-	-	-	-	-	-	-	N/A
56 Radio B	0.4	-	-	-	-	-	-	-	-	-	N/A
57 Meeting A	0.4	-	-	-	-	-	-	-	-	-	N/A
58 Meeting B	0.4	-	-	-	-	-	-	-	-	-	N/A
60 Internal Learning 2	0.4	-	-	-	-	-	-	-	-	-	N/A
61 Media Hub	0.4	-	-	-	-	-	-	-	-	-	N/A
68 Science Lab 1	0.4	-	-	-	-	-	-	-	-	-	N/A
69 Science Lab 2	0.4	-	-	-	-	-	-	-	-	-	N/A
70 Science Prep	0.4	-	-	-	-	-	-	-	-	-	N/A
71 Science Studio 1	0.4	-	-	-	-	-	-	-	-	-	N/A
72 Science Studio 2	0.4	-	-	-	-	-	-	-	-	-	N/A
73 IT Technician	0.4	-	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
76 First Aid	0.4	-	-	-	-	-	-	-	-	-	N/A
81 Science Lab 3	0.4	-	-	-	-	-	-	-	-	-	N/A
82 Internal Learning 3	0.4	-	-	-	-	-	-	-	-	-	N/A
83 Media Hub 4	0.4	-	-	-	-	-	-	-	-	-	N/A
84 Radio C	0.4	-	-	-	-	-	-	-	-	-	N/A
85 Radio D	0.4	-	-	-	-	-	-	-	-	-	N/A
87 Meeting C	0.4	-	-	-	-	-	-	-	-	-	N/A
88 Meeting D	0.4	-	-	-	-	-	-	-	-	-	N/A
89 Internal Learning 4	0.4	-	-	-	-	-	-	-	-	-	N/A
90 Media Hub	0.4	-	-	-	-	-	-	-	-	-	N/A
91 Faculty Office	0.4	-	-	-	-	-	-	-	-	-	N/A
92 Faculty Workroom	0.4	-	-	-	-	-	-	-	-	-	N/A
93 Art and Electronics Store	0.4	-	-	-	-	-	-	-	-	-	N/A
95 Art and Design	0.4	-	-	-	-	-	-	-	-	-	N/A
96 Media Hub 6	0.4	-	-	-	-	-	-	-	-	-	N/A
97 Internal Learning 5	0.4	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
59 Lobby	-	65	-	51
1 Bin Store	65	-	-	14
10 Music Tech Classroom	65	-	-	557
100 Staff WC	-	65	-	52
103 Electronics Lab	65	-	-	1479
104 Learning Base 1	65	-	-	400
105 Learning Base 2	65	-	-	414
106 Pupil WC	-	65	-	129
107 Staff WC	-	65	-	42
11 Recording Audio Control Room	65	-	-	233
111 Sports Hall	-	65	-	3288
113 Lobby	-	65	-	55
114 Stair Lobby	-	65	-	33
116 Stair	-	65	-	89
12 Light recording Room	65	-	-	305
120 Circulation	-	65	-	273
121 Circulation	-	65	-	274
122 Stair	-	65	-	86
123 Radio E	65	-	-	155
124 Meeting E	65	-	-	206
125 Sports Lobby	-	65	-	119
128 Bridge	-	65	-	62
129 Circulation	-	65	-	228

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
13 Recording teaching Space	65	-	-	518
130	-	65	-	59
130 Circulation	-	65	-	230
131 Internal Learning 6	65	-	-	453
132 Media Hub	65	-	-	386
133 SEN	65	-	-	83
134 SEN Resources	65	-	-	85
135 IAG Careers	65	-	-	86
136 Radio F	65	-	-	168
137 Radio G	65	-	-	166
138 Meeting F	65	-	-	181
139 Meeting G	65	-	-	178
14 Practice 1	65	-	-	95
140 Internal Learning 7	65	-	-	464
142 Lobby	-	65	-	51
144 LRC	65	-	-	952
146 Media Hub	65	-	-	383
147 Internal Learning 8	65	-	-	516
148 Radio H	65	-	-	155
149 Meeting H	65	-	-	206
15 Practice 2	65	-	-	92
150 Lobby	-	65	-	52
151 Seminar Room	65	-	-	147
152 Maintenance	-	65	-	67
153 Pupil WC 8	-	65	-	129
154 Staff WC	-	65	-	42
155 Exam Store	65	-	-	26
157 Sprinkler Tank	65	-	-	181
158 Stair Lobby	-	65	-	33
16 Practice 3	65	-	-	98
160 Stair	-	65	-	79
161 Studio Control	65	-	-	181
162 TV Studio	65	-	-	613
163 Circulation	-	65	-	132
164 Circulation	-	65	-	57
165 Stair Lobby	-	65	-	28
168 Stair	-	65	-	76
169 Media Hub	65	-	-	399
17 Lobby	-	65	-	46
171 Circulation	-	65	-	223
172 Circulation	-	65	-	222
175 Server and Hub Room	65	-	-	87
176 Hub Room	65	-	-	33

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
18 Practice 4	65	-	-	122
180 Cafe Kiosk	-	65	-	201
184 Hub Room	65	-	-	43
186 Cafe	-	65	-	179
19 Recording Audio Control Room	65	-	-	161
192 Music Store	65	-	-	15
193 Staff WC	-	65	-	50
194 Pupil Change	-	65	-	224
195 Acc Changing	-	65	-	80
196 Staff Office	65	-	-	131
197 Pupil Changing 2	-	65	-	246
198 Sports Hall Store	65	-	-	61
2 Kitchen Plant	65	-	-	65
20 Live Music Studio	65	-	-	388
200 Change Lobby	-	65	-	27
201 Change Lobby	-	65	-	21
209 Hub Room	65	-	-	12
21 Music Store	65	-	-	18
211 Cleaners Store	65	-	-	8
22 Drum Booth	65	-	-	188
23 Voice Booth	65	-	-	134
24 Theatre 1	65	-	-	2028
25 Theatre 2	65	-	-	608
26 Theatre Lobby	-	65	-	110
27 TV Studio	65	-	-	814
28 Sound Control Hub	65	-	-	187
29 Plant Room	65	-	-	118
3 Kitchen WC	-	65	-	42
30 Stair	-	65	-	82
32 Stair Lobby	65	-	-	438
33 Pupil WC	-	65	-	139
34 Staff WC	-	65	-	43
35 Media Hub 1	65	-	-	361
36 Board Room	65	-	-	314
37 Entrance lobby	-	65	15	143
38 Reception_Admin	65	-	-	423
39 Interview Meeting	65	-	-	160
40 Sick Bay	65	-	-	122
41 Principle	65	-	-	171
42 Principle PA	65	-	-	141
43 Pupil WC	-	65	-	135
44 Visitor WC	-	65	-	40
45 Stair	-	65	-	83

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
47 Produuction Booth 1	65	-	-	120
48 Production Booth 2	65	-	-	120
48 Pulse North Zone	-	65	-	401
48 Pulse	-	65	-	32
48 Pulse South Zone	-	65	-	587
49 Internal Learning	65	-	-	453
5 Dining	-	65	-	574
50 Media Hub 1	65	-	-	386
51 Faculty Office	65	-	-	131
52 Faculty Workroom	65	-	-	210
53 Store	65	-	-	17
54 General Office Finance	65	-	-	212
55 Radio A	65	-	-	168
56 Radio B	65	-	-	166
57 Meeting A	65	-	-	181
58 Meeting B	65	-	-	178
6 Music Store	65	-	-	38
60 Internal Learning 2	65	-	-	464
61 Media Hub	65	-	-	399
62 Stair	-	65	-	86
63 Stair Lobby	-	65	-	45
65 Staff WC	-	65	-	52
66 Pupil WC 3	-	65	-	138
67 Cleancers Store	65	-	-	8
68 Science Lab 1	65	-	-	1553
69 Science Lab 2	65	-	-	1558
7 Lobby	-	65	-	29
70 Science Prep	65	-	-	771
71 Science Studio 1	65	-	-	1380
72 Science Studio 2	65	-	-	1402
73 IT Technician	65	-	-	281
74 Pupil WC	-	65	-	131
75 Staff WC	-	65	-	44
76 First Aid	65	-	-	166
78 Stair Lobby	-	65	-	33
79 Stair	-	65	-	89
8 Chair Store	65	-	-	29
80	-	65	-	98
81 Science Lab 3	65	-	-	1706
82 Internal Learning 3	65	-	-	453
83 Media Hub 4	65	-	-	386
84 Radio C	65	-	-	168
85 Radio D	65	-	-	166

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
86 Lobby	-	65	-	51
87 Meeting C	65	-	-	181
88 Meeting D	65	-	-	178
89 Internal Learning 4	65	-	-	464
9 Stair Lobby	-	65	-	60
90 Media Hub	65	-	-	399
91 Faculty Office	65	-	-	131
92 Faculty Workroom	65	-	-	210
93 Art and Electronics Store	65	-	-	36
95 Art and Design	65	-	-	697
96 Media Hub 6	65	-	-	374
97 Internal Learning 5	65	-	-	516
98 Stair Lobby	-	65	-	45
Kitchen 4	-	65	-	810
Media Storeage	65	-	-	35
119 Bridge	-	65	-	62
Stage Step Area	-	65	-	85

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?
10 Music Tech Classroom	NO (-62.9%)	NO
103 Electronics Lab	NO (-89.1%)	NO
104 Learning Base 1	NO (-91.6%)	NO
105 Learning Base 2	NO (-91.6%)	NO
11 Recording Audio Control Room	N/A	N/A
111 Sports Hall	N/A	N/A
12 Light recording Room	N/A	N/A
123 Radio E	N/A	N/A
124 Meeting E	N/A	N/A
13 Recording teaching Space	NO (-66.3%)	NO
131 Internal Learning 6	NO (-29.7%)	NO
132 Media Hub	NO (-87.7%)	NO
133 SEN	N/A	N/A
134 SEN Resources	N/A	N/A
135 IAG Careers	N/A	N/A
136 Radio F	YES (+11.5%)	NO
137 Radio G	YES (+7.3%)	NO
138 Meeting F	N/A	N/A
139 Meeting G	N/A	N/A
14 Practice 1	NO (-81.5%)	NO
140 Internal Learning 7	NO (-19.6%)	NO
144 LRC	NO (-88.6%)	NO
146 Media Hub	NO (-91%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
147 Internal Learning 8	NO (-88.5%)	NO
148 Radio H	N/A	N/A
149 Meeting H	N/A	N/A
15 Practice 2	N/A	N/A
151 Seminar Room	NO (-100%)	NO
16 Practice 3	N/A	N/A
161 Studio Control	N/A	N/A
162 TV Studio	N/A	N/A
169 Media Hub	NO (-87%)	NO
175 Server and Hub Room	N/A	N/A
176 Hub Room	N/A	N/A
18 Practice 4	NO (-83.7%)	NO
184 Hub Room	N/A	N/A
186 Cafe	N/A	N/A
19 Recording Audio Control Room	N/A	N/A
196 Staff Office	N/A	N/A
20 Live Music Studio	N/A	N/A
209 Hub Room	N/A	N/A
22 Drum Booth	N/A	N/A
23 Voice Booth	N/A	N/A
24 Theatre 1	N/A	N/A
25 Theatre 2	N/A	N/A
27 TV Studio	N/A	N/A
28 Sound Control Hub	N/A	N/A
32 Stair Lobby	NO (-64%)	NO
35 Media Hub 1	NO (-76.1%)	NO
36 Board Room	NO (-84.5%)	NO
37 Entrance lobby	NO (-71.3%)	NO
38 Reception_Admin	NO (-77.3%)	NO
39 Interview Meeting	NO (-82.3%)	NO
40 Sick Bay	N/A	N/A
41 Principle	N/A	N/A
42 Principle PA	N/A	N/A
47 Produuction Booth 1	N/A	N/A
48 Production Booth 2	N/A	N/A
49 Internal Learning	NO (-30.9%)	NO
5 Dining	NO (-53.9%)	NO
50 Media Hub 1	NO (-88.3%)	NO
51 Faculty Office	NO (-94.1%)	NO
52 Faculty Workroom	N/A	N/A
53 Store	N/A	N/A
54 General Office Finance	N/A	N/A
55 Radio A	YES (+10.6%)	NO
56 Radio B	YES (+6.9%)	NO
57 Meeting A	N/A	N/A
58 Meeting B	N/A	N/A
60 Internal Learning 2	NO (-19.9%)	NO
61 Media Hub	NO (-88.3%)	NO
68 Science Lab 1	NO (-88.2%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
69 Science Lab 2	NO (-90.2%)	NO
70 Science Prep	NO (-91.3%)	NO
71 Science Studio 1	NO (-90.8%)	NO
72 Science Studio 2	NO (-88.5%)	NO
73 IT Technician	NO (-93.3%)	NO
76 First Aid	N/A	N/A
81 Science Lab 3	NO (-89.7%)	NO
82 Internal Learning 3	NO (-28.3%)	NO
83 Media Hub 4	NO (-88.2%)	NO
84 Radio C	YES (+12.4%)	NO
85 Radio D	YES (+9.5%)	NO
87 Meeting C	N/A	N/A
88 Meeting D	N/A	N/A
89 Internal Learning 4	NO (-16.2%)	NO
90 Media Hub	NO (-88.3%)	NO
91 Faculty Office	NO (-94.1%)	NO
92 Faculty Workroom	N/A	N/A
93 Art and Electronics Store	N/A	N/A
95 Art and Design	NO (-89.4%)	NO
96 Media Hub 6	NO (-91.2%)	NO
97 Internal Learning 5	NO (-88.8%)	NO

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

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

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	6719.1	6719.1
External area [m²]	7879.9	7879.9
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	2823.32	0
Average U-value [W/m²K]	0.36	0
Alpha value* [%]	11.67	10

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

Building Use

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

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	2.59	7.22
Cooling	2.56	2.43
Auxiliary	3.34	5.04
Lighting	13.35	13.58
Hot water	8.27	5.82
Equipment*	24.16	24.16
TOTAL**	**30.11**	**34.09**

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

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	3	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]	63.54	91.64
Primary energy* [kWh/m²]	77.66	106.37
Total emissions [kg/m²]	10.3	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] District heating, [HFT] Natural Gas, [CFT] Electricity										
	Actual	22.2	0	6.2	0	2	1	0	1	0
	Notional	29.5	0	8.2	0	1.2	1	0	----	----
[ST] Central heating using water: radiators, [HS] District heating, [HFT] Natural Gas, [CFT] Electricity										
	Actual	27.7	0	7.7	0	14.3	1	0	1	0
	Notional	42.3	0	11.8	0	19.8	1	0	----	----
[ST] Central heating using water: radiators, [HS] District heating, [HFT] Natural Gas, [CFT] Electricity										
	Actual	8.3	0	2.3	0	2	1	0	1	0
	Notional	6.3	0	1.8	0	1.2	1	0	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	52.7	78.1	3.3	5.3	1.7	4.41	4.11	4.5	5.5
	Notional	117.7	62.1	12.8	4.5	5	2.56	3.79	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	36.3	50.4	2.3	3.4	1.7	4.41	4.11	4.5	5.5
	Notional	92.9	46.8	10.1	3.4	5.2	2.56	3.79	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	8	1130.6	0.6	84	6.4	3.92	3.74	4	5
	Notional	8.1	1005.5	0.9	73.7	7.2	2.56	3.79	----	----
[ST] Single-duct VAV, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	48.3	20.4	3.6	1.5	14.6	3.77	3.9	4.5	5.5
	Notional	86.7	18.4	9.4	1.4	14.4	2.56	3.79	----	----
[ST] Central heating using water: radiators, [HS] District heating, [HFT] Natural Gas, [CFT] Electricity										
	Actual	11.1	0	3.1	0	2	1	0	1	0
	Notional	11.4	0	3.2	0	1.2	1	0	----	----

Key to terms

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

Key Features

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

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.26	1_000000:Surf[6]
Floor	0.2	0.22	1_000000:Surf[0]
Roof	0.15	0.18	10000009:Surf[0]
Windows, roof windows, and rooflights	1.5	0.26	1_000000:Surf[2]
Personnel doors	1.5	2.18	24000000:Surf[1]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

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

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

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	3

Appendix E

Overall	
Passed:	80 rooms:
Failed:	3 rooms:
Unoccupied:	279 rooms:

Data:			
Days data=	365	01-Jan	31-Dec
Days (summer)=	153	01-May	30-Sep
Data OK?	OK	Full summer	

Occupancy:
Note: r “available hours”.
g summer months.
ırther information.

Passed:	80 rooms:					
Room Name	Room ID	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
10 Music Tech Classroom	10000000	71.2	0	0	0	-
103 Electronics Lab	10000005	71.2	0	0	0	-
104 Learning Base 1	10000004	71.2	0	0	0	-
105 Learning Base 2	10000003	71.2	0	0	0	-
12 Light recording Room	12000000	71.2	0.4	4	1	-
123 Radio E	12000007	71.2	0	0	0	-
124 Meeting E	12000006	71.2	0	0	0	-
13 Recording teaching Space	13000000	71.2	0	0	0	-
131 Internal Learning 6	1300000C	71.2	0	0	0	-
132 Media Hub	1300000B	71.2	0	0	0	-
133 SEN	1300000A	71.2	0.2	1	1	-
134 SEN Resources	13000009	71.2	0	0	0	-
135 IAG Careers	13000008	71.2	0.2	1	1	-
136 Radio F	13000007	71.2	0	0	0	-
137 Radio G	13000006	71.2	0	0	0	-
138 Meeting F	13000005	71.2	0	0	0	-
139 Meeting G	13000004	71.2	0	0	0	-
14 Practice 1	14000000	71.2	0	0	0	-
140 Internal Learning 7	14000007	71.2	0	0	0	-
144 LRC	14000005	71.2	0	0	0	-
146 Media Hub	14000004	71.2	0	0	0	-
147 Internal Learning 8	14000003	71.2	0	0	0	-
148 Radio H	14000002	71.2	0	0	0	-
149 Meeting H	14000001	71.2	0	0	0	-
15 Practice 2	15000000	71.2	0.2	1	1	-
151 Seminar Room	15000007	71.2	0	0	0	-
16 Practice 3	16000000	71.2	0	0	0	-
162 TV Studio	16000006	71.2	0	0	0	-
169 Media Hub	16000001	71.2	0	0	0	-
18 Practice 4	18000003	71.2	0	0	0	-
180 Cafe Kiosk	18000002	71.2	0.9	4	1	-
186 Cafe	18000004	71.2	0	0	0	-
196 Staff Office	19000006	71.2	0	0	0	-
20 Live Music Studio	20000000	71.2	0	0	0	-
22 Drum Booth	22000000	71.2	0	0	0	-
23 Voice Booth	23000000	71.2	0	0	0	-
24 Theatre 1	24000000	71.2	0	0	0	-
25 Theatre 2	25000000	71.2	0	0	0	-
27 TV Studio	27000000	71.2	0	0	0	-
35 Media Hub 1	35000000	71.2	0	0	0	-
36 Board Room	36000000	71.2	0	0	0	-
37 Entrance lobby	48000001	71.2	0.5	2	1	-
38 Reception_Admin	38000000	71.2	0	0	0	-
39 Interview Meeting	39000000	71.2	0	0	0	-
40 Sick Bay	40000000	71.2	0.1	1	1	-
41 Principle	41000000	71.2	0	0	0	-
42 Principle PA	42000000	71.2	0	0	0	-
49 Internal Learning	49000000	71.2	0	0	0	-
5 Dining	5_000000	71.2	0	0	0	-
50 Media Hub 1	50000000	71.2	0	0	0	-
51 Faculty Office	51000000	71.2	0	0	0	-
52 Faculty Workroom	52000000	71.2	0	0	0	-
54 General Office Finance	54000000	71.2	0	0	0	-
55 Radio A	55000000	71.2	0	0	0	-
56 Radio B	56000000	71.2	0	0	0	-
57 Meeting A	57000000	71.2	0	0	0	-
58 Meeting B	58000000	71.2	0	0	0	-
60 Internal Learning 2	60000000	71.2	0	0	0	-
61 Media Hub	61000000	71.2	0	0	0	-
68 Science Lab 1	68000000	71.2	0	0	0	-
69 Science Lab 2	69000000	71.2	0	0	0	-
70 Science Prep	70000000	71.2	0	0	0	-
71 Science Studio 1	71000000	71.2	0	0	0	-
72 Science Studio 2	72000000	71.2	0	0	0	-
73 IT Technician	73000000	71.2	0	0	0	-
76 First Aid	76000000	71.2	0	0	0	-
81 Science Lab 3	81000000	71.2	0	0	0	-
82 Internal Learning 3	82000000	71.2	0	0	0	-
83 Media Hub 4	83000000	71.2	0	0	0	-
84 Radio C	84000000	71.2	0	0	0	-
85 Radio D	85000000	71.2	0	0	0	-
87 Meeting C	87000000	71.2	0	0	0	-
88 Meeting D	88000000	71.2	0	0	0	-
89 Internal Learning 4	89000000	71.2	0	0	0	-
90 Media Hub	90000000	71.2	0	0	0	-
91 Faculty Office	91000000	71.2	0	0	0	-
92 Faculty Workroom	92000000	71.2	0	0	0	-
95 Art and Design	95000000	71.2	0	0	0	-
96 Media Hub 6	96000000	71.2	0	0	0	-
97 Internal Learning 5	97000000	71.2	0	0	0	-

Failed:	3 rooms:					
Room Name	Room ID	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
111 Sports Hall	11000006	71.2	11.4	20	4	1 & 2
32 Stair Lobby	32000000	71.2	10	18	4	1 & 2
Kitchen 4	4_000000	71.2	95.2	72	8	1 & 2 & 3

Overall			
Passed:	2 rooms:		
Failed:	81 rooms:		
Unoccupied:	279 rooms:		

Data:			
Days data=	365	01-Jan	31-Dec
Days (summer)=	153	01-May	30-Sep
Data OK?	OK	Full summer	

Passed:	2 rooms:					
Room Name	Room ID	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
180 Cafe Kiosk	18000002	71.2	2.9	10	3	2
37 Entrance lobby	48000001	71.2	2.2	7	2	2

Failed:	81 rooms:					
Room Name	Room ID	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
10 Music Tech Classroom	10000000	71.2	4.8	12	3	1 & 2
103 Electronics Lab	10000005	71.2	6.4	13	4	1 & 2
104 Learning Base 1	10000004	71.2	7.2	17	4	1 & 2
105 Learning Base 2	10000003	71.2	7.3	17	4	1 & 2
111 Sports Hall	11000006	71.2	41.7	38	6	1 & 2 & 3
12 Light recording Room	12000000	71.2	76.5	62	9	1 & 2 & 3
123 Radio E	12000007	71.2	56.1	42	6	1 & 2 & 3
124 Meeting E	12000006	71.2	52.3	38	5	1 & 2 & 3
13 Recording teaching Space	13000000	71.2	4.4	12	3	1 & 2
131 Internal Learning 6	1300000C	71.2	90.9	137	21	1 & 2 & 3
132 Media Hub	1300000B	71.2	13.5	26	6	1 & 2 & 3
133 SEN	1300000A	71.2	87.2	203	29	1 & 2 & 3
134 SEN Resources	13000009	71.2	87.2	206	29	1 & 2 & 3
135 IAG Careers	13000008	71.2	83.5	181	26	1 & 2 & 3
136 Radio F	13000007	71.2	94.6	143	22	1 & 2 & 3
137 Radio G	13000006	71.2	94.1	139	22	1 & 2 & 3
138 Meeting F	13000005	71.2	59.7	48	7	1 & 2 & 3
139 Meeting G	13000004	71.2	58	47	7	1 & 2 & 3
14 Practice 1	14000000	71.2	6.9	18	4	1 & 2
140 Internal Learning 7	14000007	71.2	90.3	132	21	1 & 2 & 3
144 LRC	14000005	71.2	6.7	14	4	1 & 2
146 Media Hub	14000004	71.2	7.5	17	4	1 & 2
147 Internal Learning 8	14000003	71.2	7.3	15	4	1 & 2
148 Radio H	14000002	71.2	62.1	42	6	1 & 2 & 3
149 Meeting H	14000001	71.2	63.5	41	6	1 & 2 & 3
15 Practice 2	15000000	71.2	85.4	151	21	1 & 2 & 3
151 Seminar Room	15000007	71.2	83.6	103	15	1 & 2 & 3
16 Practice 3	16000000	71.2	72.6	57	8	1 & 2 & 3
162 TV Studio	16000006	71.2	92.4	78	9	1 & 2 & 3
169 Media Hub	16000001	71.2	8.6	18	4	1 & 2
18 Practice 4	18000003	71.2	5.2	12	3	1 & 2
186 Cafe	18000004	71.2	72.1	57	8	1 & 2 & 3
196 Staff Office	19000006	71.2	70.6	44	6	1 & 2 & 3
20 Live Music Studio	20000000	71.2	87.1	83	10	1 & 2 & 3
22 Drum Booth	22000000	71.2	91.2	81	9	1 & 2 & 3
23 Voice Booth	23000000	71.2	91.3	86	10	1 & 2 & 3
24 Theatre 1	24000000	71.2	77.2	58	7	1 & 2 & 3
25 Theatre 2	25000000	71.2	63.4	42	6	1 & 2 & 3
27 TV Studio	27000000	71.2	66.9	51	7	1 & 2 & 3
32 Stair Lobby	32000000	71.2	13.2	25	5	1 & 2 & 3
35 Media Hub 1	35000000	71.2	5.3	12	3	1 & 2
36 Board Room	36000000	71.2	3.7	11	3	1 & 2
38 Reception_Admin	38000000	71.2	3.6	10	3	1 & 2
39 Interview Meeting	39000000	71.2	4.2	11	3	1 & 2
40 Sick Bay	40000000	71.2	39	34	6	1 & 2 & 3
41 Principle	41000000	71.2	29.4	31	5	1 & 2 & 3
42 Principle PA	42000000	71.2	21.1	25	4	1 & 2
49 Internal Learning	49000000	71.2	90.5	130	20	1 & 2 & 3
5 Dining	5_000000	71.2	85.6	77	16	1 & 2 & 3
50 Media Hub 1	50000000	71.2	9.1	19	5	1 & 2 & 3
51 Faculty Office	51000000	71.2	5.5	12	3	1 & 2
52 Faculty Workroom	52000000	71.2	27.9	32	5	1 & 2 & 3
54 General Office Finance	54000000	71.2	24.4	27	4	1 & 2
55 Radio A	55000000	71.2	92.6	134	20	1 & 2 & 3
56 Radio B	56000000	71.2	91.7	129	20	1 & 2 & 3
57 Meeting A	57000000	71.2	69.6	61	8	1 & 2 & 3
58 Meeting B	58000000	71.2	70.6	62	8	1 & 2 & 3
60 Internal Learning 2	60000000	71.2	88.8	125	20	1 & 2 & 3
61 Media Hub	61000000	71.2	9.7	21	5	1 & 2 & 3
68 Science Lab 1	68000000	71.2	6.4	13	4	1 & 2
69 Science Lab 2	69000000	71.2	7.6	18	4	1 & 2
70 Science Prep	70000000	71.2	14.4	26	5	1 & 2 & 3
71 Science Studio 1	71000000	71.2	7.1	17	4	1 & 2
72 Science Studio 2	72000000	71.2	6.5	16	4	1 & 2
73 IT Technician	73000000	71.2	4.2	11	3	1 & 2
76 First Aid	76000000	71.2	49.5	12	2	1 & 2
81 Science Lab 3	81000000	71.2	9.6	20	4	1 & 2
82 Internal Learning 3	82000000	71.2	91.7	142	21	1 & 2 & 3
83 Media Hub 4	83000000	71.2	9.8	23	5	1 & 2 & 3
84 Radio C	84000000	71.2	95.2	149	22	1 & 2 & 3
85 Radio D	85000000	71.2	94.7	147	22	1 & 2 & 3
87 Meeting C	87000000	71.2	63.8	54	7	1 & 2 & 3
88 Meeting D	88000000	71.2	61.9	52	7	1 & 2 & 3
89 Internal Learning 4	89000000	71.2	91.4	141	22	1 & 2 & 3
90 Media Hub	90000000	71.2	8.7	19	5	1 & 2 & 3
91 Faculty Office	91000000	71.2	5.7	12	3	1 & 2
92 Faculty Workroom	92000000	71.2	33.2	31	5	1 & 2 & 3
95 Art and Design	95000000	71.2	4.8	12	3	1 & 2
96 Media Hub 6	96000000	71.2	7.3	17	4	1 & 2
97 Internal Learning 5	97000000	71.2	7.7	18	4	1 & 2
Kitchen 4	4_000000	71.2	98.8	123	13	1 & 2 & 3

Overall			
Passed:	2 rooms:		
Failed:	81 rooms:		
Unoccupied:	279 rooms:		

Data:			
Days data=	365	01-Jan	31-Dec
Days (summer)=	153	01-May	30-Sep
Data OK?	OK	Full summer	

Passed:	2 rooms:					
Room Name	Room ID	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
180 Cafe Kiosk	18000002	71.2	2.3	7	2	2
37 Entrance lobby	48000001	71.2	2.1	6	2	-

Failed:	81 rooms:					
Room Name	Room ID	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
10 Music Tech Classroom	10000000	71.2	3.3	10	3	1 & 2
103 Electronics Lab	10000005	71.2	5.7	12	3	1 & 2
104 Learning Base 1	10000004	71.2	6	12	3	1 & 2
105 Learning Base 2	10000003	71.2	5.9	12	3	1 & 2
111 Sports Hall	11000006	71.2	35	34	5	1 & 2 & 3
12 Light recording Room	12000000	71.2	28.8	32	6	1 & 2 & 3
123 Radio E	12000007	71.2	52	40	6	1 & 2 & 3
124 Meeting E	12000006	71.2	43.7	36	5	1 & 2 & 3
13 Recording teaching Space	13000000	71.2	3.3	12	3	1 & 2
131 Internal Learning 6	1300000C	71.2	71.8	88	15	1 & 2 & 3
132 Media Hub	1300000B	71.2	8.2	18	4	1 & 2
133 SEN	1300000A	71.2	53.5	61	11	1 & 2 & 3
134 SEN Resources	13000009	71.2	56	64	11	1 & 2 & 3
135 IAG Careers	13000008	71.2	52.5	58	11	1 & 2 & 3
136 Radio F	13000007	71.2	90.9	127	21	1 & 2 & 3
137 Radio G	13000006	71.2	90.7	127	21	1 & 2 & 3
138 Meeting F	13000005	71.2	56	47	7	1 & 2 & 3
139 Meeting G	13000004	71.2	53.5	43	6	1 & 2 & 3
14 Practice 1	14000000	71.2	5	12	3	1 & 2
140 Internal Learning 7	14000007	71.2	72.7	90	16	1 & 2 & 3
144 LRC	14000005	71.2	5.8	12	3	1 & 2
146 Media Hub	14000004	71.2	6.3	14	4	1 & 2
147 Internal Learning 8	14000003	71.2	6.3	13	3	1 & 2
148 Radio H	14000002	71.2	57.5	40	6	1 & 2 & 3
149 Meeting H	14000001	71.2	54.8	37	5	1 & 2 & 3
15 Practice 2	15000000	71.2	49.2	54	9	1 & 2 & 3
151 Seminar Room	15000007	71.2	33.9	41	7	1 & 2 & 3
16 Practice 3	16000000	71.2	44.2	38	6	1 & 2 & 3
162 TV Studio	16000006	71.2	89.4	72	8	1 & 2 & 3
169 Media Hub	16000001	71.2	6.9	17	4	1 & 2
18 Practice 4	18000003	71.2	4.1	11	3	1 & 2
186 Cafe	18000004	71.2	3.3	8	2	1 & 2
196 Staff Office	19000006	71.2	49.7	33	4	1 & 2
20 Live Music Studio	20000000	71.2	54	46	7	1 & 2 & 3
22 Drum Booth	22000000	71.2	85.7	71	8	1 & 2 & 3
23 Voice Booth	23000000	71.2	87.7	76	9	1 & 2 & 3
24 Theatre 1	24000000	71.2	72.6	55	7	1 & 2 & 3
25 Theatre 2	25000000	71.2	53.9	37	5	1 & 2 & 3
27 TV Studio	27000000	71.2	58.3	46	6	1 & 2 & 3
32 Stair Lobby	32000000	71.2	10.3	21	5	1 & 2 & 3
35 Media Hub 1	35000000	71.2	5.3	12	3	1 & 2
36 Board Room	36000000	71.2	3.6	10	3	1 & 2
38 Reception_Admin	38000000	71.2	3.3	10	3	1 & 2
39 Interview Meeting	39000000	71.2	4.2	11	3	1 & 2
40 Sick Bay	40000000	71.2	36.1	33	6	1 & 2 & 3
41 Principle	41000000	71.2	25.7	30	5	1 & 2 & 3
42 Principle PA	42000000	71.2	16.7	23	4	1 & 2
49 Internal Learning	49000000	71.2	67.1	81	14	1 & 2 & 3
5 Dining	5_000000	71.2	70.6	64	15	1 & 2 & 3
50 Media Hub 1	50000000	71.2	6.9	18	4	1 & 2
51 Faculty Office	51000000	71.2	5	12	3	1 & 2
52 Faculty Workroom	52000000	71.2	20.9	29	5	1 & 2 & 3
54 General Office Finance	54000000	71.2	18.1	23	4	1 & 2
55 Radio A	55000000	71.2	86	114	18	1 & 2 & 3
56 Radio B	56000000	71.2	86.5	113	18	1 & 2 & 3
57 Meeting A	57000000	71.2	58.5	52	7	1 & 2 & 3
58 Meeting B	58000000	71.2	59.7	53	7	1 & 2 & 3
60 Internal Learning 2	60000000	71.2	71.3	88	16	1 & 2 & 3
61 Media Hub	61000000	71.2	7.3	18	4	1 & 2
68 Science Lab 1	68000000	71.2	5.7	12	3	1 & 2
69 Science Lab 2	69000000	71.2	6.4	15	4	1 & 2
70 Science Prep	70000000	71.2	10.7	21	5	1 & 2 & 3
71 Science Studio 1	71000000	71.2	6.3	13	4	1 & 2
72 Science Studio 2	72000000	71.2	5.9	12	3	1 & 2
73 IT Technician	73000000	71.2	4	10	3	1 & 2
76 First Aid	76000000	71.2	24.9	8	2	1 & 2
81 Science Lab 3	81000000	71.2	8.1	18	4	1 & 2
82 Internal Learning 3	82000000	71.2	73	92	15	1 & 2 & 3
83 Media Hub 4	83000000	71.2	7.4	18	4	1 & 2
84 Radio C	84000000	71.2	92	134	20	1 & 2 & 3
85 Radio D	85000000	71.2	91.8	132	20	1 & 2 & 3
87 Meeting C	87000000	71.2	58	50	7	1 & 2 & 3
88 Meeting D	88000000	71.2	56.4	50	7	1 & 2 & 3
89 Internal Learning 4	89000000	71.2	74.3	97	17	1 & 2 & 3
90 Media Hub	90000000	71.2	7	18	4	1 & 2
91 Faculty Office	91000000	71.2	5	12	3	1 & 2
92 Faculty Workroom	92000000	71.2	19.9	27	4	1 & 2
95 Art and Design	95000000	71.2	4.2	12	3	1 & 2
96 Media Hub 6	96000000	71.2	6.2	14	4	1 & 2
97 Internal Learning 5	97000000	71.2	6.4	13	3	1 & 2
Kitchen 4	4_000000	71.2	4.3	11	3	1 & 2

Appendix F

District heating Carbon Factor supporting information provided.

CHP Emissions		
Q_{htot}	8,528,609 kWh	Annual Heating Demand for Space Heating Plus Network
M	43.7%	Percentage of Heating Met By CHP
Q_h	3,723,000 kWh	Annual Heating Supplied by CHP
$Q_{e\ chp}$	3,394,800 kWh	Electricity Generated by CHP
$Q_{e\ pec}$	170,572 kWh	Energy Centre Parasiitic Electricity Consumption. (Estimated as 2% of Annual Heating Demand as Heat Networks UK Draft COP CP1 2014)
Q_e	3,224,228 kWh	Net Electricity Generated
Cf_e	0.519 $KgCO_2/kWh$	CO_2 Factor For Grid Displaced Elec
C_e	1,673,374 Kg	CO_2 Saved Owing To Elec From CHP
Q_{fchp}	8,107,900 kWh	Annual Fuel Consumption Of CHP
Cf_{chp}	0.216 $KgCO_2/kWh$	CO_2 Factor For Fuel Supply To CHP
C_{chp}	1,751,306 Kg	Resulting CO_2 Emissions Due To Fuel Consumed By CHP
E_{con}	86.0%	Seasonal Efficiency of Conventional Boiler
Q_{con}	5,587,917 kWh	Annual Fuel Consumption of Conventional Boiler
Cf_{con}	0.216 $KgCO_2/kWh$	CO_2 Factor For Fuel Supply To Conventional Boiler
C_{con}	1,206,990 kg	Resulting CO_2 Emissions Due To Gas for Conventional Boiler
	0.151 $KgCO_2/kWh$	CO_2 Emissions per kWh of Heat

Notes:

Based Upon Vital Energi Peak Load Assessment Rev P 21.04.2015

Based Upon Energy Pro 15.04.22-VQ13033-Retail-600kWe-Rev-P