ENERGY MONITORING, RECORDING & REPORTING PLAN

LONDON 14

Virtus Data Centres

CONFIDENTIAL

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NDY
A TETRA TECH COMPANY

VERIFICATION

REVISION	DATE ISSUED	PREPARED BY	VERIFIED BY	AUTHORISED BY	COMMENT
1.0	03/10/2024	Ravi Woods	Andreas Alygizos	Steve Dickinson	Initial Issue
2.0	07/11/2024	Andreas Alygizos	Andreas Alygizos	Andreas Alygizos	Updated to reflect team comments
3.0	14/11/2024	Andreas Alygizos	Andreas Alygizos	Andreas Alygizos	Final issue

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1 EXECUTIVE SUMMARY

Norman Disney & Young (NDY) has been appointed by Virtus Data Centres to produce an Energy Monitoring, Recording & Reporting Plan (EMRRP) for LON14 - the fit-out of a new Data Hall currently registered as DC6 on the Prologis Park Heathrow in Stockley Park, London. The application reference for the development is **18399/APP/2022/411**, and the description of the development is as follows:

Installation of plant and equipment to unit DC6 including external plant equipment, external louvres, and associated security fencing and landscaping, to facilitate use of the building as a data centre

This report meets the desired requirements for the EMRRP, as set out within Condition 8 attached to the above permission (dated 03/05/2023).

CO2 REDUCTION, FROM REGULATED ENERGY LOADS (PART L)

Within the planning application, the energy strategy previously demonstrated that the overall carbon emissions from regulated loads (i.e: at Be Green stage) has been calculated at **65%** lower than the AD L2 2021 Baseline.

Condition 8 for Planning Permission 18399/APP/2022/411 states that:

"Prior to commencement of the development hereby approved, a detailed Energy Monitoring, Recording and Reporting Plan (EMRRP) shall be submitted to and approved in writing by the Local Planning Authority. The EMRRP shall accord with the requirements of the Policy SI2 of the London Plan (2021) and the GLA Energy Assessment Guidance (April 2020 or as amended) and demonstrate that the development will secure the 65% saving in CO2 emissions from the regulated energy load in accordance with the Energy Strategy (27 September 2022).

The development must proceed in accordance with the approved reporting structure and where there is a failure to achieve the carbon savings as set out in the Energy Strategy, this failure (tCO2) shall be treated as part of the overall carbon shortfall and shall result in a corresponding carbon offsetting cash in lieu contribution in accordance with the formula set out in the S106 agreement"

Based on this, the energy modelling has been updated, using current design information. From this, it has been calculated that the overall carbon emissions from regulated loads (i.e: at Be Green stage) achieves a **65.5%** saving against the AD L2 2021 Baseline – which is an uplift in comparison to the improvement achieved at planning stage.

"BE SEEN" OPERATIONAL ENERGY MODELLING

The "Be Seen" Stage is the latest stage of the Mayor's Energy Hierarchy as per Policy SI2 of the London Plan 2021. It requires monitoring and reporting of the actual operational energy performance of major developments for at least five years via the Mayor's "Be Seen" monitoring portal. In accordance with this policy, and London Borough of Hillingdon Council policy, the development will be provided with metering to plant and renewable technology. This will allow for future occupiers to monitor their energy usage. The development will have extensive submeters for the regulated energy (including heating, cooling, auxiliary equipment, lighting) and for the energy generated on site.

2 ENERGY STRATEGY UPDATES

2.1 INTRODUCTION

Following the planning application of LON 14, updates to the Energy Strategy have been provided based on construction stage information for the development (as per Condition 8). This section outlines how the development has changed - between planning stage and the current design for the proposed design (i.e: Be Green stage), and shows that:

- At planning stage, the overall carbon emissions savings from regulated loads (i.e: at Be Green stage) measured **65%** against the AD L2 2021 Baseline.
- Based on the current Stage 5 information the savings have increased by 0.5% to an overall of **65.5%** against the Part L2 2021 Baseline.

2.1 ASSESSMENT METHODOLOGY

The Energy Strategy follows the methodology set out in the GLA's Energy Assessment Guidance (published in June 2022) which the Local Plan also adopts. The proposed strategy has incorporated energy efficiency measures and renewable energy technologies, aiming to minimise CO_2 emissions associated with the building's operation utilising the principles of the Mayor's energy hierarchy.

The proposed Development has been modelled following the National Calculation Methodology (NCM) 2021. The IESVE Software version 2023.4.0.0 has been used to estimate the energy consumption and the associated CO_2 emissions from the Proposed Development.

2.2 FABRIC PROPERTIES

A comparison between the fabric properties shown at planning stage, and the current construction stage design, are shown below

TABLE 1: FABRIC PROPERTIES

	PART L BASELINE	PLANNING STAGE (REVISION T04, SEP 2022)	CURRENT STAGE
U-Values of Opaque Fabrics			
Data Halls External Walls	0.18 W/m²K	1.3 W/m²K	1.3 W/m²K
Office External Walls	0.18 W/m²K	0.35 W/m²K	0.35 W/m²K
Roof	0.15 W/m²K	1.5 W/m²K	1.5 W/m²K
Ground Floor	0.15 W/m²K	0.5 W/m²K	0.5 W/m²K
Glazing Properties			
Overall U-Value including frame	1.4 W/m²K	2.2 W/m²K	2.2 W/m²K
g-value	0.28	0.4	0.4
Visible Light Transmittance	60%	70%	70%

2.3 HEATING AND COOLING

The chiller selection within the modelling has been updated following planning submission. We have updated this, based on the newest selection from the manufacturer (Airedale)

The calculation is provided below for the indicative SEER of the data hall cooling, which is the dominant load within the facility. The manufacturers data for this information is included in Appendix A.

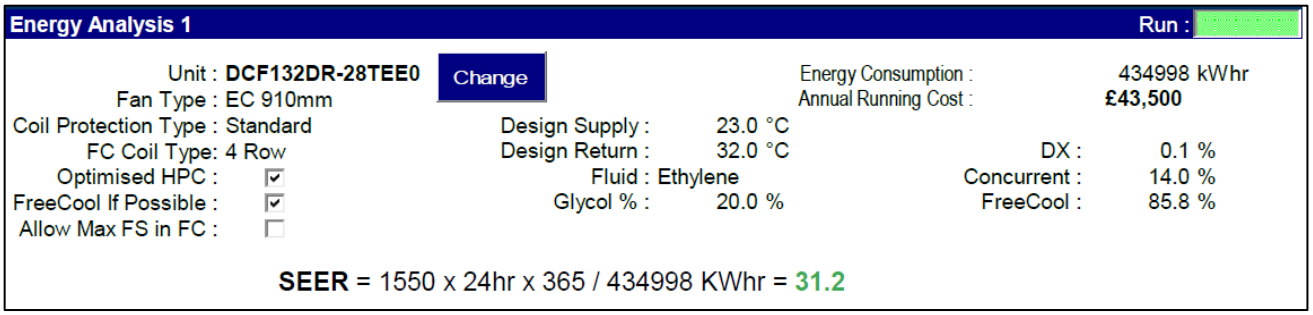


FIGURE 1: COOLING EFFICIENCY CALCULATION

A comparison of the heating & cooling efficiencies, between planning stage and current design, is shown below

TABLE 2: HEATING & COOLING PARAMETERS

	PART L BASELINE	PLANNING STAGE (REVISION T04, SEP 2022)	CURRENT STAGE
GF Offices and Reception			
System Type	Air-Cooled VRV		
Cooling Seasonal Efficiency (SEER)	5	6.36	6.36
Heating Seasonal Efficiency (SCOP)	2.5	4.86	4.86
1F Offices			
System Type	Water-Cooled VRV		
Cooling Seasonal Efficiency (SEER)	5	5	5
Heating Seasonal Efficiency (SCOP)	2.5	2.5	2.5
Data Halls			
System Type	Single Room Cooling		
Cooling Seasonal Efficiency (SEER)	8	31.6	31.2
Heating Seasonal Efficiency (SCOP)	N/A	N/A	N/A

2.4 VENTILATION

A comparison between the ventilation parameters shown at planning stage, and the current construction stage design, are shown below

TABLE 3: VENTILATION PARAMETERS

	PART L BASELINE	PLANNING STAGE (REVISION T04, SEP 2022)	CURRENT STAGE
Offices and Reception			
System Type	Supply & Extract		
Central AHU SFP (W/l/s)	1.6	2.3	2.3
FCU Terminal SFP (W/l/s)	0.3	N/A	N/A
Heat Recovery Efficiency	75%	70%	70%
Data Halls			
System Type	Supply Only		
Central AHU SFP (W/l/s)	1.1	1.01	1.01
FCU Terminal SFP (W/l/s)	0.3	N/A	N/A
Heat Recovery Efficiency	No Heat Recovery	No Heat Recovery	No Heat Recovery
Plant Rooms			
System Type	Supply Only		
Central AHU SFP (W/l/s)	1.1	0.5	0.5
FCU Terminal SFP (W/l/s)	0.3	N/A	N/A
Heat Recovery Efficiency	No Heat Recovery	No Heat Recovery	No Heat Recovery

2.5 DOMESTIC HOT WATER

A comparison between the domestic hot water parameters shown at planning stage, and the current construction stage design, are shown below

TABLE 4: DHW PARAMETERS

	PART L BASELINE	PLANNING STAGE (REVISION T04, SEP 2022)	CURRENT STAGE
DHW (All Areas)			
System Type	Electric Hot Water Heater		
Efficiency	100%	100% (Pre-Heat from Solar Thermal)	100% (Pre-Heat from Solar Thermal)
Storage Volume	None	800L	800L
Storage Losses	N/A	0.0047	0.0047

2.6 LIGHTING

A comparison between the lighting parameters shown at planning stage, and the current construction stage design, are shown below

TABLE 5: LIGHTING PARAMETERS

	PART L BASELINE	PLANNING STAGE (REVISION T04, SEP 2022)	CURRENT STAGE
Datacentre Areas			
Data Halls	110 lm/W	141 lm/W	4.24 W/m^2 (From Bouygues Dialux Calculations)
Plant Rooms	110 lm/W	110 lm/W	3.51 W/m^2 (From Bouygues Dialux Calculations)
Main Corridors	110 lm/W	148 lm/W	8.09 W/m^2 (From Bouygues Dialux Calculations)
CRAC Corridors	110 lm/W	148 lm/W	4.28 W/m^2 (From Bouygues Dialux Calculations)
Store	110 lm/W	148 lm/W	9.48 W/m^2 (From Bouygues Dialux Calculations)
Office Areas			
Offices	90 lm/W	60 lm/W	7.21 W/m^2 (From Bouygues Dialux Calculations)
WCs	110 lm/W	110 lm/W	7.90 W/m^2 (From Bouygues Dialux Calculations)
Cupboards	110 lm/W	148 lm/W	5.33 W/m^2 (From Bouygues Dialux Calculations)
Stairs	110 lm/W	148 lm/W	3.79 W/m^2 (From Bouygues Dialux Calculations)
Loading Bay	110 lm/W	148 lm/W	2.77 W/m^2 (From Bouygues Dialux Calculations)

2.7 REGULATED ENERGY STRATEGY SUMMARY

The carbon saving of the regulated carbon emissions, using Part L 2021 methodology, is shown in the table below. These results show that:

- At planning stage, the overall carbon emissions savings from regulated loads (i.e: at Be Green stage) have at **65%** against the AD L2 2021 Baseline.

- Based on the current information, the savings have increased by 0.5% to an overall **65.5%** improvement against the Part L2 2021 Baseline.

TABLE 6: GLA CARBON EMISSION SAVINGS

	PLANNING STAGE			CURRENT STAGE		
	TOTAL REGULATED EMISSIONS (TCO_2/YEAR)	CO_2 SAVINGS (TCO_2/YEAR)	% SAVINGS	TOTAL REGULATED EMISSIONS (TCO_2/YEAR)	CO_2 SAVINGS (TCO_2/YEAR)	% SAVINGS
Part L 2021 Baseline	1322.0			1314.0		
Be Green	460.5	861.5	65%	453.3	860.6	65.5%

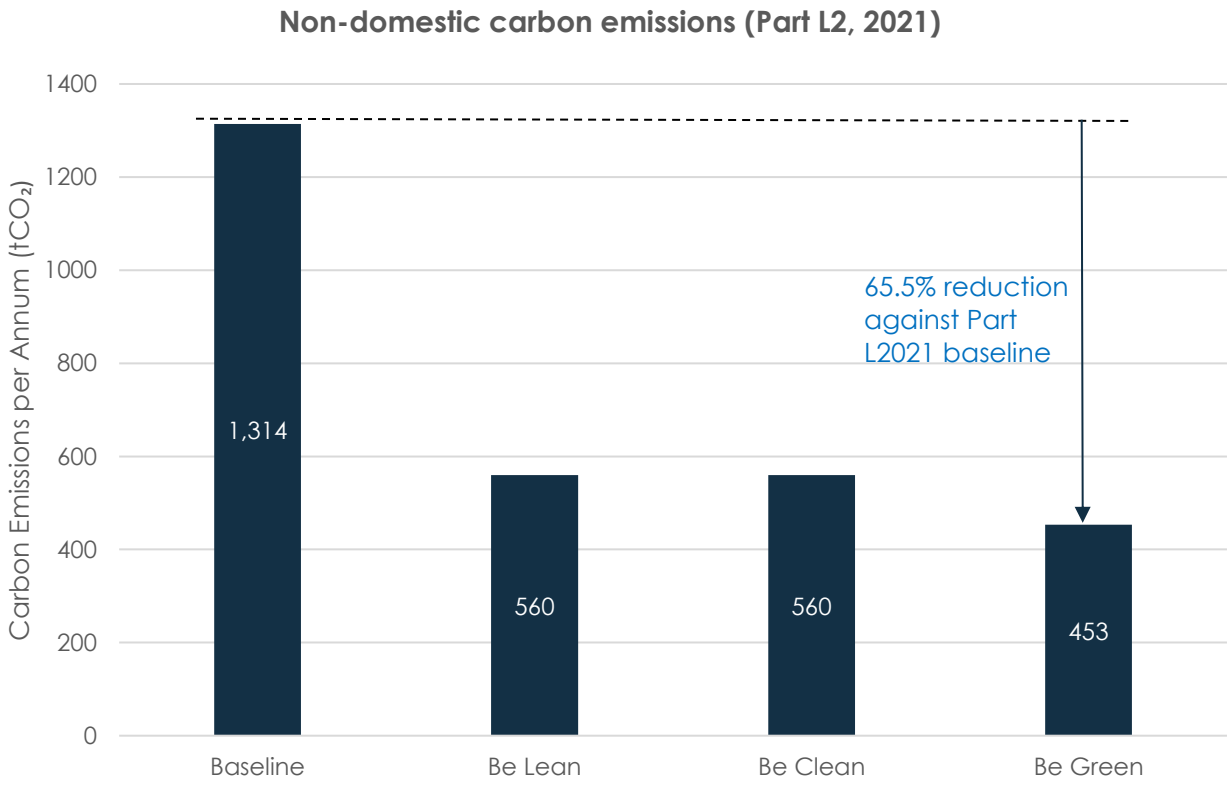


FIGURE 2 GLA CARBON EMISSION SAVINGS

The BRUKL document, based on the Current Design, is shown in **Appendix B.**

3 "BE SEEN" ENERGY MONITORING

3.1 INTRODUCTION

The London Plan 2021 has developed the Be Seen stage on top of the 'Be Lean', 'Be Clean', and 'Be Green' categories.

It has been widely recognised that there are significant discrepancies between the energy consumption estimated at design stage and the actual energy consumption of buildings during operation, which is known as the 'performance gap'. Common practice in the UK with regards to energy modelling at design stage primarily aims to assess compliance with Building Regulations and estimate regulated CO_2 emissions. However, compliance-based energy models are not intended to predict energy use, as they include a number of simplifications and standardisations to allow compliance calculations to be carried out.

The 'Be Seen' stage aims to address the gap between the building theoretical energy performance and the measured reality by:

- Monitoring and reporting of the actual operational energy performance of major developments for at least five years via the Mayor of London's 'Be Seen' monitoring portal.
- Establishing post-construction monitoring as good practice, enabling developers and building owners to better understand their buildings and identify methods for improving energy performance from the project inception stage and throughout the building's lifetime.
- Ensuring that the actual energy and carbon performance of buildings is aligned with the estimated energy and carbon performance will also be a key factor in achieving a zero-carbon London.
- The energy performance data that will be collected will provide an evidence base which could help inform future industry-wide benchmarks or performance ratings for major building typologies based on in-use performance.

Figure 3 summarises the process and responsibilities for the 'Be Seen' process.

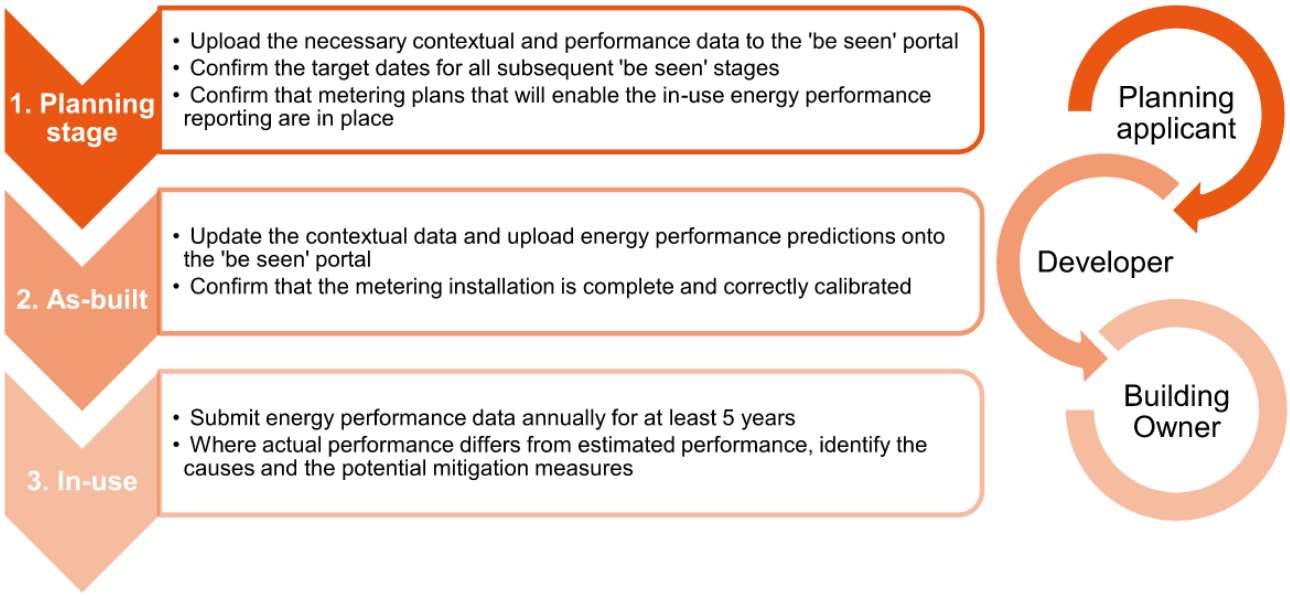


FIGURE 3: 'BE SEEN' PROCESS AND RESPONSIBILITIES. IMAGE COURTESY OF BE SEEN ENERGY MONITORING GUIDANCE (SEPTEMBER 2021)

The Be Seen Energy Monitoring Guidance document, published in September 2021, explains the process that needs to be followed to comply with the 'Be Seen' post-construction monitoring requirement of Policy SI 2 of the London Plan. The 'Be Seen' energy monitoring guidance requires the reporting of energy performance data as a scheme is planned, built out and in use. The responsibility for providing the data at each reporting stage lies with the legal owner of the development at that reporting stage.

The document sets the requirements outlined below for the planning stage. This includes:

- Contextual data: Provide contextual data relating to the development's reportable units (RUs). This includes non-energy information such as data on location and typology of buildings.
- Building energy use: Report on the energy and fuel imports into each RU of a development.
- Plant parameters: Report on parameters that relate to the performance of heat or cooling generation plant within energy centres that form part of a development. This will include energy inputs and outputs of energy centres, energy use and contribution of heating and cooling technologies, and network efficiency data to monitor losses in district and communal energy networks.
- Carbon emissions: Report on the development's estimated carbon emissions at planning stage based on the appropriate carbon emission factors, as set out in the GLA's Energy Assessment Guidance. When on-site carbon reductions have been maximised, but a carbon shortfall still exists, applicants will be expected to report on and confirm the carbon offsetting contribution to the relevant local authority's fund in line with the net zero carbon target.

Developments can be made up of a mix of uses, phases and tenures. At the planning stage reporting is done for the entire development as a whole. However, to allow for more comprehensive reporting at the as-built and in-use stages, a development is split into a number of 'reportable units' (RUs) which applicants will need to report against individually:

- The energy centre RUs
- The residential RUs
- The non-residential Rus

LON14 is a non-residential RU as it is an individual building/facility with a single non-residential occupier/tenant.

3.2 MONITORING AND REPORTING PLAN

In line with the GLA "Be Seen" requirements, and London Borough of Hillingdon Council policy, the development will be provided with extensive metering. This will allow the monitoring of energy usage, and is outlined in detail this section.

AUTOMATIC METERING AND MONITORING

The development will have extensive submeters for the regulated energy (including heating, cooling, auxiliary equipment, lighting) and for the energy generated on site.

The proposed data centre will be provided with a Power Monitoring System (PMS) covering 100% of the energy usage across the site. The PMS will allow monthly energy usage will be analysed and energy reductions targeted. The Power Usage Effectiveness (PUE) will also be automatically calculated and displayed on the monitoring screen.

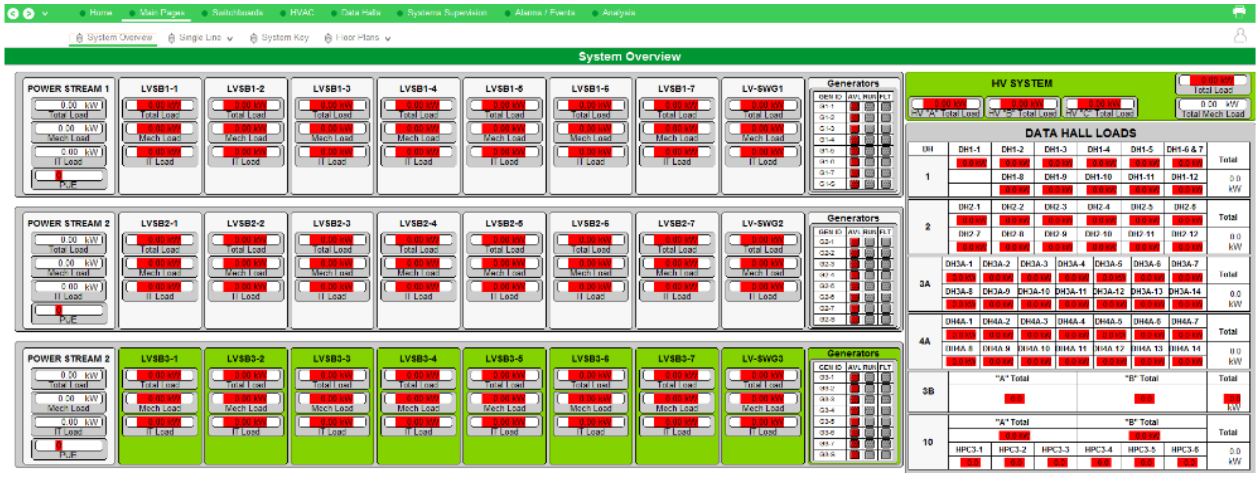


FIGURE 4: SAMPLE PMS GRAPHIC

ENERGY REPORTING FORMATS

Readings will be taken at the end of each year and will be submitted to the Local Planning Authority in a format similar the table below, with regulated energy separately sub-metered from the unregulated energy.

TABLE 7: REPORTING METER READINGS TEMPLATE

METER	USAGE (KWH)
Heating	
Cooling	
Auxiliary	
Lighting	
Domestic Hot Water	
Total Regulated Energy Consumption	
Total Unregulated Consumption	

This in-use data will be submitted to the Local Planning Authority via the GLA website, through the use of the GLA monitoring spreadsheet. The GLA reporting template for the annual in-use performance of the building is shown in the table below:

TABLE 8: ANNUAL IN-USE ENERGY CONSUMPTION TEMPLATE

CATEGORY	PARAMETER	YEAR 1 ENERGY	UNIT	START DATE	END DATE
Building Energy Use	Annual Electricity Consumption		kWh/yr		
	Annual Gas Consumption		kWh/yr		
	Annual Oil Consumption		kWh/yr		
	Annual Biomass Consumption		kWh/yr		
	Annual District Heating Consumption		kWh/yr		
	Annual District Cooling Consumption		kWh/yr		
Renewable Energy	Total Electricity Generation		kWh/yr		
	Solar Thermal Generation		kWh/yr		
	Photovoltaic Generation		kWh/yr		
	Renewable Electricity, Exported		kWh/yr		
	Renewable Electricity, Used on Site		kWh/yr		
Energy Storage	Battery Storage Capacity		kWh		
	Net Electricity Flow to EVs		kWh		
Energy Exported	District Heating Exported		kWh/yr		
	District Cooling Exported		kWh/yr		

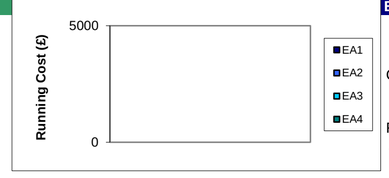
APPENDIX A: CHILLER DATASHEET

DELTACHILL Energy Analysis

Settings

Location : London
Base Load : 1550 kW
Variable Load : 0.0 kW
Days Per Week : 7
Hours Per Day : 24.0
Cost Of Electricity : 0.100 £/kWhr

RUN



Energy Analysis 1

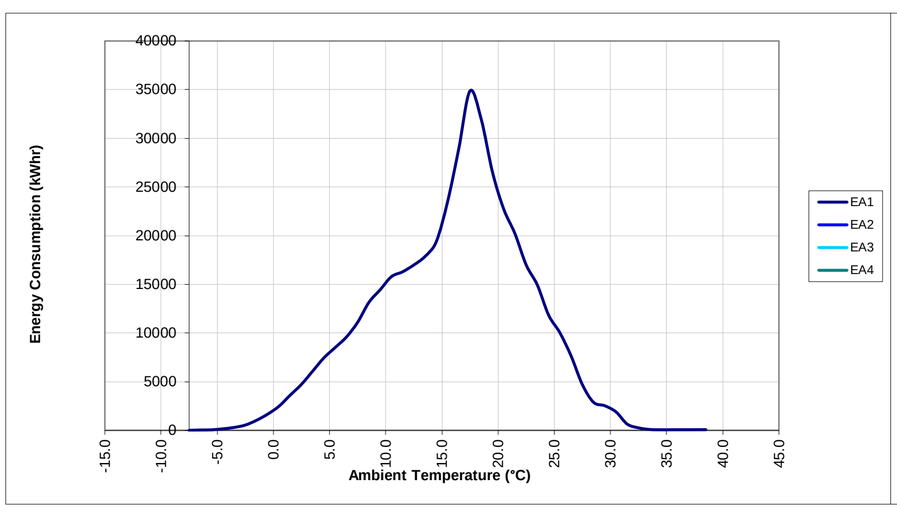
Run :

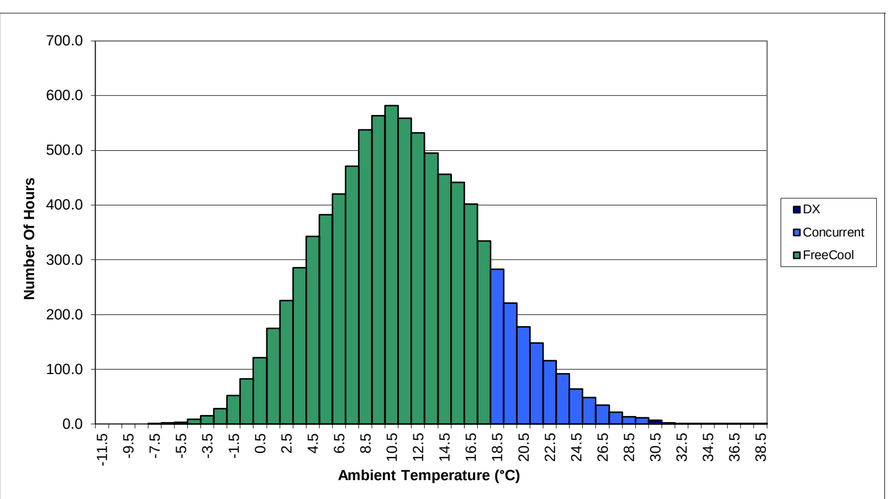
Unit : **DCF132DR-28TEE0** Change
Fan Type : EC 910mm
Coil Protection Type : Standard
FC Coil Type: 4 Row
Optimised HPC : ☑
FreeCool If Possible : ☑
Allow Max FS in FC : ☐

Design Supply : 23.0 °C
Design Return : 32.0 °C
Fluid : Ethylene
Glycol % : 20.0 %

Energy Consumption : 434998 kWhr
Annual Running Cost : **£43,500**

DX : 0.1 %
Concurrent : 14.0 %
FreeCool : 85.8 %





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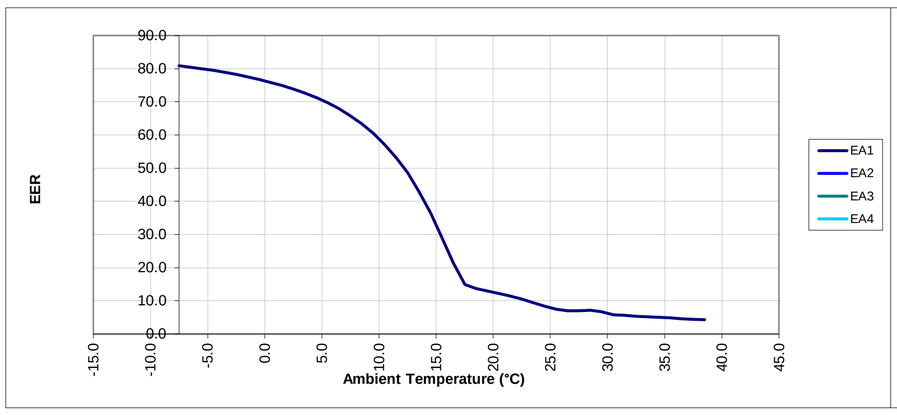
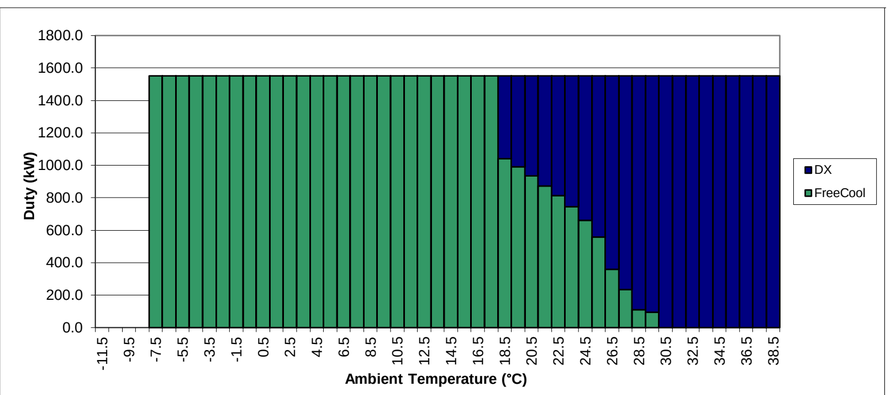
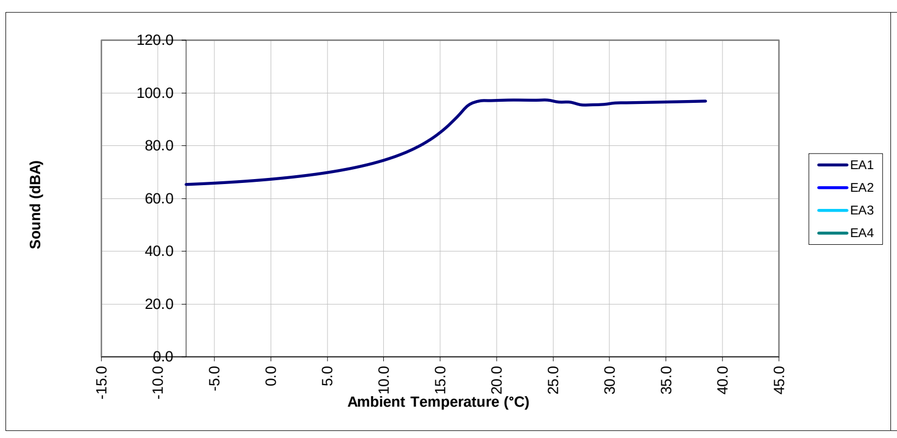
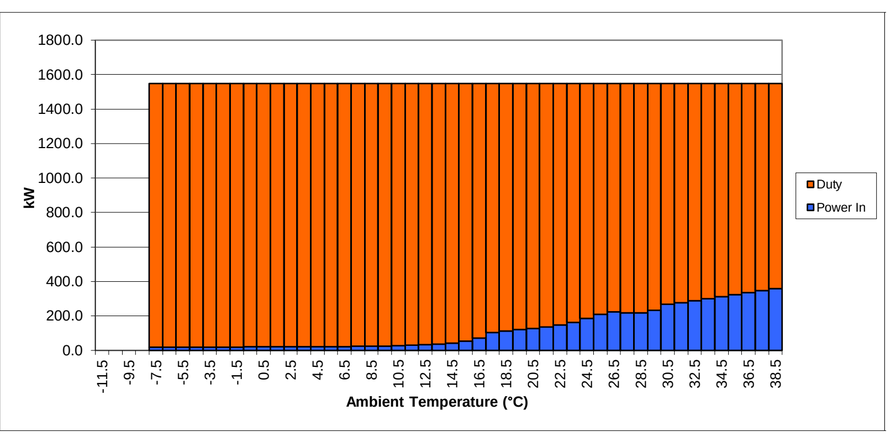




EA1 : ☑ EA2 : ☑ EA3 : ☑ EA4 : ☑





DELTACHILL Energy Analysis 1

Location : London
Base Load : 1550.0 kW
Variable Load : 0.0 kW
Days Per Week : 7
Hours Per Day : 24.0
Cost Of Electricity : 0.100 £/kWhr

Total Energy Consumption : **434998** kWhr
Annual Running Cost : £ 43,500

LOWER LOADING STAGE

	External Ambient Temperature °C (min)	°C (mid)	°C (max)	Hrs	Base kW	Variable kW	Total kW	Total: **Unit Mode**	**Stage**	**Total Unit Duty** kW	**Total Unit DX Duty** kW	**Total Unit FreeCool Duty** kW	**Total Unit Power Input** kW	**Sound Power** dBA	**Sound Pressure** dBA	Circuit 1 Mode	Circuit 1 Compressors Active	Circuit 1 Duty kW	Circuit 1 DX Duty kW	Circuit 1 FreeCool Duty kW	Circuit 1 Power Input kW	Circuit 1 Fan Speed rpm	Circuit 1 Fan Cycling %	Circuit 2 Mode	Circuit 2 Compressors Active	Circuit 2 Duty kW	Circuit 2 DX Duty kW	Circuit 2 FreeCool Duty kW	Circuit 2 Power Input kW	Circuit 2 Fan Speed rpm	Circuit 2 Fan Cycling %	Circuit 3 Mode	Circuit 3 Compressors Active	Circuit 3 Duty kW	Circuit 3 DX Duty kW	Circuit 3 FreeCool Duty kW	Circuit 3 Power Input kW	Circuit 3 Fan Speed rpm	Circuit 3 Fan Cycling %
	-8	-7.5	-7	0.3	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	-7	-6.5	-6	2.1	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	-6	-5.5	-5	2.9	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	-5	-4.5	-4	8.1	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	-4	-3.5	-3	15.2	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	-3	-2.5	-2	27.5	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	-2	-1.5	-1	51.7	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	-1	-0.5	0	82.8	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	0	0.5	1	121.4	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	1	1.5	2	175.1	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	2	2.5	3	225.3	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	3	3.5	4	285.5	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	4	4.5	5	342.8	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	5	5.5	6	382.8	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	6	6.5	7	420.0	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	7	7.5	8	471.4	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	8	8.5	9	537.5	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	9	9.5	10	563.8	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	10	10.5	11	582.3	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	11	11.5	12	559.2	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	12	12.5	13	531.9	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	13	13.5	14	495.5	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	14	14.5	15	456.7	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	15	15.5	16	441.9	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	16	16.5	17	401.7	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	17	17.5	18	334.4	775.0	0.0	775.0	Off	0	0.0	0.0	0.0	0.0	0.0	0.0	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off	0	0.0	0.0	0.0	0.0	0.0	N/A	Off		0.0					
	18	18.5	19	282.8	775.0	0.0	775.0	Concurrent	1	499.2	145.0	354.3	35.2	96.4	63.6	Concurrent	1	219.2	145.0	74.2	11.2	480.0	24.3	FreeCool	0	280.1	0.0	280.1	24.0	1210.0	N/A	Off		0.0					
	19	19.5	20	221.0	775.0	0.0	775.0	Concurrent	1	440.7	144.2	296.5	35.5	96.4	63.6	Concurrent	1	208.1	144.2	63.9	11.6	480.0	25.8	FreeCool	0	232.6	0.0	232.6	23.9	1210.0	N/A	Off		0.0					
	20	20.5	21	177.9	775.0	0.0	775.0	Concurrent	1	381.5	143.5	238.0	35.8	96.4	63.6	Concurrent	1	196.5	143.5	53.0	11.9	480.0	27.5	FreeCool	0	185.0	0.0	185.0	23.9	1210.0	N/A	Off		0.0					
	21	21.5	22	148.1	775.0	0.0	775.0	Concurrent	1	320.9	142.8	178.1	36.1	96.4	63.6	Concurrent	1	183.8	142.8	41.0	12.3	480.0	29.3	FreeCool	0	137.1	0.0	137.1	23.8	1210.0	N/A	Off		0.0					
	22	22.5	23	115.4	775.0	0.0	775.0	Concurrent	2	727.7	351.1	376.6	62.0	97.2	64.4	Concurrent	2	501.7	351.1	150.6	38.3	549.0	None	FreeCool	0	226.0	0.0	226.0	23.7	1210.0	N/A	Off		0.0					
	23	23.5	24	91.2	775.0	0.0	775.0	Concurrent	2	643.8	351.1	292.7	62.6	97.1	64.3	Concurrent	2	472.7	351.1	121.6	38.9	603.0	None	FreeCool	0	171.1	0.0	171.1	23.7	1210.0	N/A	Off		0.0					
	24	24.5	25	63.7	775.0	0.0	775.0	Concurrent	2	551.4	351.1	200.3	63.5	96.9	64.1	Concurrent	2	437.7	351.1	86.6	39.9	668.0	None	FreeCool	0	113.8	0.0	113.8	23.6	1210.0	N/A	Off		0.0					
	25	25.5	26	47.9	775.0	0.0	775.0	DX	2	280.4	280.4	0.0	27.3	88.7	55.9	DX	1	140.2	140.2	0.0	13.6	480.0	40.0	DX	1	140.2	140.2	0.0	13.6	480.0	40.0	Off		0.0					
	26	26.5	27	34.3	775.0	0.0	775.0	Concurrent	3	708.4	522.0	186.4	108.2	97.7	64.9	Concurrent	3	609.8	522.0	87.8	84.8	939.0	None	FreeCool	0	98.6	0.0	98.6	23.5	1210.0	N/A	Off		0.0					
	27	27.5	28	21.5	775.0	0.0	775.0	Concurrent	4	772.9	657.0	115.9	101.2	95.5	62.7	Concurrent	3	595.0	517.8	77.2	86.9	942.0	None	Concurrent	1	177.8	139.1	38.7	14.2	480.0	48.7	Off		0.0					
	28	28.5	29	13.2	775.0	0.0	775.0	DX	4	684.6	684.6	0.0	92.2	95.2	62.4	DX	2	342.3	342.3	0.0	46.1	753.4	None	DX	2	342.3	342.3	0.0	46.1	753.4	None	Off		0.0					
	29	29.5	30	10.9	775.0	0.0	775.0	DX	4	678.9	678.9	0.0	95.3	95.2	62.4	DX	2	339.4	339.4	0.0	47.7	760.0	None	DX	2	339.4	339.4	0.0	47.7	760.0	None	Off		0.0					
	30	30.5	31	7.1	775.0	0.0	775.0	DX	4	672.8	672.8	0.0	98.5	95.2	62.4	DX	2	336.4	336.4	0.0	49.2	763.0	None	DX	2	336.4	336.4	0.0	49.2	763.0	None	Off		0.0					
	31	31.5	32	2.3	775.0	0.0	775.0	DX	4	666.6	666.6	0.0	101.6	95.2	62.4	DX	2	333.3	333.3	0.0	50.8	765.0	None	DX	2	333.3	333.3	0.0	50.8	765.0	None	Off		0.0					
	32	32.5	33	0.9	775.0	0.0	775.0	DX	4	660.3	660.3	0.0	104.7	95.2	62.4	DX	2	330.2	330.2	0.0	52.4	768.0	None	DX	2	330.2	330.2	0.0	52.4	768.0	None	Off		0.0					
	33	33.5	34	0.3	775.0	0.0	775.0	DX	4	653.9	653.9	0.0	107.8	95.2	62.4	DX	2	327.0	327.0	0.0	53.9	770.0	None	DX	2	327.0	327.0	0.0	53.9	770.0	None	Off		0.0					
	34	34.5	35	0.2	775.0	0.0	775.0	DX	4	647.5	647.5	0.0	111.0	95.2	62.4	DX	2	323.7	323.7	0.0	55.5	773.0	None	DX	2	323.7	323.7	0.0	55.5	773.0	None	Off		0.0					
	35	35.5	36	0.2	775.0	0.0	775.0	DX	4	641.0	641.0	0.0	114.1	95.2	62.4	DX	2	320.5	320.5	0.0	57.1	776.0	None	DX	2	320.5	320.5	0.0	57.1	776.0	None	Off		0.0					
	36	36.5	37	0.2	775.0	0.0	775.0	DX	4	633.9	633.9	0.0	117.2	95.2	62.4	DX	2	316.9	316.9	0.0	58.6	772.1	None	DX	2	316.9	316.9	0.0	58.6	772.1	None	Off		0.0					
	37	37.5	38	0.2	775.0	0.0	775.0	DX	4	627.2	627.2	0.0	120.4	95.2	62.4	DX	2	313.6	313.6	0.0	60.2	775.3	None	DX	2	313.6	313.6	0.0	60.2	775.3	None	Off		0.0					
	38	38.5	39	0.2	775.0	0.0	775.0	DX	4	620.9	620.9	0.0	123.6	95.3	62.5	DX	2	310.4	310.4	0.0	61.8	785.0	None	DX	2	310.4	310.4	0.0	61.8	785.0	None	Off		0.0					
	39	39.5	40	0.2	775.0	0.0	775.0	DX	5	771.2	771.2	0.0	176.8	97.0	64.2	DX	3	464.4	464.4	0.0	113.4	985.0	None	DX	2	306.8	306.8	0.0	63.4	782.2	None	Off		0.0					
49	40	40.5	41	0.1	775.0	0.0	775.0	DX	5	763.0	763.0	0.0	180.7	97.0	64.2	DX	3	459.6	459.6	0.0	115.7	989.0	None	DX	2	303.4	303.4	0.0	65.0	785.8	None	Off		0.0					
50	41	41.5	42	0.1	775.0	0.0	775.0	DX	5	754.7	754.7	0.0	184.6	97.0	64.2	DX	3	454.8	454.8	0.0	118.0	993.1	None	DX	2	299.9	299.9	0.0	66.6	790.0	None	Off		0.0					
51	42	42.5	43	0.1	775.0	0.0	775.0	DX	5	746.4	746.4	0.0	188.6	97.0	64.2	DX	3	450.0	450.0	0.0	120.3	997.2	None	DX	2	296.4	296.4	0.0	68.3	794.0	None	Off		0.0					
52	43	43.5	44	0.1	775.0	0.0	775.0	DX	5	737.9	737.9	0.0	192.6	97.0	64.2	DX	3	445.1	445.1	0.0	122.7	1001.4	None	DX	2	292.8	292.8	0.0	69.9	798.0	None	Off		0.0					
53	44	44.5	45	0.1	775.0	0.0	775.0	DX	5	729.4	729.4	0.0	196.7	97.1	64.3	DX	3	440.2	440.2	0.0	125.1	1005.6	None	DX	2	289.2	289.2	0.0	71.6	802.6	None	Off		0.0					

UPPER LOADING STAGE

°C (min)	Total: **Unit Mode**	**Stage**	**Total Unit Duty** kW	**Total Unit DX Duty** kW	**Total Unit FreeCool Duty** kW	**Total Unit Power Input** kW	**Sound Power** dBA	**Sound Pressure** dBA	Circuit 1 Mode	Circuit 1 Compressors Active	Circuit 1 Duty kW	Circuit 1 DX Duty kW	Circuit 1 FreeCool Duty kW	Circuit 1 Power Input kW	Circuit 1 Fan Speed rpm	Circuit 1 Fan Cycling %	Circuit 2 Mode	Circuit 2 Compressors Active	Circuit 2 Duty kW	Circuit 2 DX Duty kW	Circuit 2 FreeCool Duty kW	Circuit 2 Power Input kW	Circuit 2 Fan Speed rpm	Circuit 2 Fan Cycling %
-8	FreeCool	0	775.0	0.0	775.0	1.4	65.3	32.5	FreeCool	0	387.5	0.0	387.5	0.7	275.4	None	FreeCool	0	387.5	0.0	387.5	0.7	275.4	None
-7	FreeCool	0	775.0	0.0	775.0	1.4	65.5	32.7	FreeCool	0	387.5	0.0	387.5	0.7	281.7	None	FreeCool	0	387.5	0.0	387.5	0.7	281.7	None
-6	FreeCool	0	775.0	0.0	775.0	1.5	65.7	32.9	FreeCool	0	387.5	0.0	387.5	0.7	288.3	None	FreeCool	0	387.5	0.0	387.5	0.7	288.3	None
-5	FreeCool	0	775.0	0.0	775.0	1.5	65.9	33.1	FreeCool	0	387.5	0.0	387.5	0.8	295.5	None	FreeCool	0	387.5	0.0	387.5	0.8	295.5	None
-4	FreeCool	0	775.0	0.0	775.0	1.6	66.2	33.4	FreeCool	0	387.5	0.0	387.5	0.8	303.1	None	FreeCool	0	387.5	0.0	387.5	0.8	303.1	None
-3	FreeCool	0	775.0	0.0	775.0	1.7	66.5	33.7	FreeCool	0	387.5	0.0	387.5	0.8	311.4	None	FreeCool	0	387.5	0.0	387.5	0.8	311.4	None
-2	FreeCool	0	775.0	0.0	775.0	1.8	66.8	34.0	FreeCool	0	387.5	0.0	387.5	0.9	320.3	None	FreeCool	0	387.5	0.0	387.5	0.9	320.3	None
-1	FreeCool	0	775.0	0.0	775.0	1.9	67.1	34.3	FreeCool	0	387.5	0.0	387.5	0.9	329.9	None	FreeCool	0	387.5	0.0	387.5	0.9	329.9	None
0	FreeCool	0	775.0	0.0	775.0	2.0	67.5	34.7	FreeCool	0	387.5	0.0	387.5	1.0	340.3	None	FreeCool	0	387.5	0.0	387.5	1.0	340.3	None
1	FreeCool	0	775.0	0.0	775.0	2.1	67.9	35.1	FreeCool	0	387.5	0.0	387.5	1.1	351.7	None	FreeCool	0	387.5	0.0	387.5	1.1	351.7	None
2	FreeCool	0	775.0	0.0	775.0	2.3	68.4	35.6	FreeCool	0	387.5	0.0	387.5	1.1	364.1	None	FreeCool	0	387.5	0.0	387.5	1.1	364.1	None
3	FreeCool	0	775.0	0.0	775.0	2.4	68.9	36.1	FreeCool	0	387.5	0.0	387.5	1.2	377.8	None	FreeCool	0	387.5	0.0	387.5	1.2	377.8	None
4	FreeCool	0	775.0	0.0	775.0	2.6	69.5	36.7	FreeCool	0	387.5	0.0	387.5	1.3	392.9	None	FreeCool	0	387.5	0.0	387.5	1.3	392.9	None
5	FreeCool	0	775.0	0.0	775.0	2.9	70.2	37.4	FreeCool	0	387.5	0.0	387.5	1.4	409.7	None	FreeCool	0	387.5	0.0	387.5	1.4	409.7	None
6	FreeCool	0	775.0	0.0	775.0	3.2	70.9	38.1	FreeCool	0	387.5	0.0	387.5	1.6	428.6	None	FreeCool	0	387.5	0.0	387.5	1.6	428.6	None
7	FreeCool	0	775.0	0.0	775.0	3.6	71.8	39.0	FreeCool	0	387.5	0.0	387.5	1.8	449.8	None	FreeCool	0	387.5	0.0	387.5	1.8	449.8	None
8	FreeCool	0	775.0	0.0	775.0	4.0	72.7	39.9	FreeCool	0	387.5	0.0	387.5	2.0	474.1	None	FreeCool	0	387.5	0.0	387.5	2.0	474.1	None
9	FreeCool	0	775.0	0.0	775.0	4.6	73.9	41.1	FreeCool	0	387.5	0.0	387.5	2.3	502.0	None	FreeCool	0	387.5	0.0	387.5	2.3	502.0	None
10	FreeCool	0	775.0	0.0	775.0	5.3	75.2	42.4	FreeCool	0	387.5	0.0	387.5	2.7	534.7	None	FreeCool	0	387.5	0.0	387.5	2.7	534.7	None
11	FreeCool	0	775.0	0.0	775.0	6.3	76.7	43.9	FreeCool	0	387.5	0.0	387.5	3.2	573.5	None	FreeCool	0	387.5	0.0	387.5	3.2	573.5	None
12	FreeCool	0	775.0	0.0	775.0	7.7	78.5	45.7	FreeCool	0	387.5	0.0	387.5	3.9	620.4	None	FreeCool	0	387.5	0.0	387.5	3.9	620.4	None
13	FreeCool	0	775.0	0.0	775.0	9.8	80.7	47.9	FreeCool	0	387.5	0.0	387.5	4.9	678.9	None	FreeCool	0	387.5	0.0	387.5	4.9	678.9	None
14	FreeCool	0	775.0	0.0	775.0	13.0	83.4	50.6	FreeCool	0	387.5	0.0	387.5	6.5	753.9	None	FreeCool	0	387.5	0.0	387.5	6.5	753.9	None
15	FreeCool	0	775.0	0.0	775.0	18.3	86.8	54.0	FreeCool	0	387.5	0.0	387.5	9.2	853.6	None	FreeCool	0	387.5	0.0	387.5	9.2	853.6	None
16	FreeCool	0	775.0	0.0	775.0	27.8	90.9	58.1	FreeCool	0	387.5	0.0	387.5	13.9	988.7	None	FreeCool	0	387.5	0.0	387.5	13.9	988.7	None
17	FreeCool	0	775.0	0.0	775.0	43.9	95.4	62.6	FreeCool	0	387.5	0.0	387.5	22.0	1158.5	None	FreeCool	0	387.5	0.0	387.5	22.0	1158.5	None
18	Concurrent	2	1023.5	352.4	671.1	60.1	97.5	64.7	Concurrent	2	588.9	352.4	236.5	36.1	480.0	84.7	FreeCool	0	434.6	0.0	434.6	24.0	1210.0	N/A
19	Concurrent	2	954.0	351.9	602.0	60.6	97.5	64.7	Concurrent	2	570.3	351.9	218.4	36.6	480.0	90.9	FreeCool	0	383.6	0.0	383.6	23.9	1210.0	N/A
20	Concurrent	2	881.8	351.5	530.3	61.1	97.5	64.7	Concurrent	2	549.8	351.5	198.3	37.2	480.0	98.0	FreeCool	0	332.0	0.0	332.0	23.9	1210.0	N/A
21	Concurrent	2	805.1	351.1	454.1	61.6	97.4	64.6	Concurrent	2	526.1	351.1	175.0	37.8	504.0	None	FreeCool	0	279.1	0.0	279.1	23.8	1210.0	N/A
22	Concurrent	3	1251.0	537.9	713.1	99.9	97.7	64.8	Concurrent	3	871.5	537.9	333.6	76.2	927.0	None	FreeCool	0	379.5	0.0	379.5	23.7	1210.0	N/A
23	Concurrent	3	1115.4	534.0	581.4	102.0	97.7	64.9	Concurrent	3	806.3	534.0	272.3	78.3	930.0	None	FreeCool	0	309.1	0.0	309.1	23.7	1210.0	N/A
24	Concurrent	3	979.7	530.0	449.7	104.1	97.7	64.9	Concurrent	3	740.9	530.0	210.9	80.5	933.0	None	FreeCool	0	238.8	0.0	238.8	23.6	1210.0	N/A
25	Concurrent	3	844.1	526.0	318.0	106.2	97.7	64.9	Concurrent	3	675.4	526.0	149.4	82.6	936.0	None	FreeCool	0	168.6	0.0	168.6	23.5	1210.0	N/A
26	Concurrent	4	835.1	661.6	173.5	98.7	95.5	62.7	Concurrent	3	641.6	522.0	119.7	84.8	939.0	None	Concurrent	1	193.5	139.7	53.8	13.9	480.0	44.0
27	Concurrent	5	1240.4	863.2	377.1	131.5	96.8	64.0	Concurrent	3	715.3	517.8	197.4	86.9	942.0	None	Concurrent	2	525.1	345.4	179.7	44.5	754.5	None
28	Concurrent	5	1127.2	856.0	271.2	135.2	96.8	64.0	Concurrent	3	655.3	513.6	141.6	89.1	945.0	None	Concurrent	2	471.9	342.3	129.6	46.1	753.4	None
29	Concurrent	5	1015.1	848.9	166.2	138.9	96.8	64.0	Concurrent	3	595.5	509.5	86.1	91.2	949.0	None	Concurrent	2	419.6	339.4	80.2	47.7	760.0	None
30	DX	5	841.6	841.6	0.0	142.6	96.9	64.1	DX	3	505.2	505.2	0.0	93.4	952.0	None	DX	2	336.4	336.4	0.0	49.2	763.0	None
31	DX	5	834.1	834.1	0.0	146.4	96.9	64.1	DX	3	500.8	500.8	0.0	95.6	955.0	None	DX	2	333.3	333.3	0.0	50.8	765.0	None
32	DX	5	826.6	826.6	0.0	150.1	96.9	64.1	DX	3	496.4	496.4	0.0	97.8	959.0	None	DX	2	330.2	330.2	0.0	52.4	768.0	None
33	DX	5	818.9	818.9	0.0	153.9	96.9	64.1	DX	3	492.0	492.0	0.0	99.9	961.6	None	DX	2	327.0	327.0	0.0	53.9	770.0	None
34	DX	5	811.2	811.2	0.0	157.6	96.9	64.1	DX	3	487.5	487.5	0.0	102.1	965.4	None	DX	2	323.7	323.7	0.0	55.5	773.0	None
35	DX	5	803.4	803.4	0.0	161.4	96.9	64.1	DX	3	483.0	483.0	0.0	104.4	969.3	None	DX	2	320.5	320.5	0.0	57.1	776.0	None
36	DX	5	795.3	795.3	0.0	165.2	96.9	64.1	DX	3	478.4	478.4	0.0	106.6	973.1	None	DX	2	316.9	316.9	0.0	58.6	772.1	None
37	DX	5	787.4	787.4	0.0	169.0	96.9	64.1	DX	3	473.8	473.8	0.0	108.8	977.0	None	DX	2	313.6	313.6	0.0	60.2	775.3	None
38	DX	5	779.5	779.5	0.0	172.9	97.0	64.2	DX	3	469.1	469.1	0.0	111.1	981.0	None	DX	2	310.4	310.4	0.0	61.8	785.0	None
39	DX	6	928.8	928.8	0.0	226.8	98.2	65.4	DX	3	464.4	464.4	0.0	113.4	985.0	None	DX	3	464.4	464.4	0.0	113.4	985.0	None
40	DX	6	919.3	919.3	0.0	231.4	98.2	65.4	DX	3	459.6	459.6	0.0	115.7	989.0	None	DX	3	459.6	459.6	0.0	115.7	989.0	None
41	DX	6	909.7	909.7	0.0	236.0	98.3	65.5	DX	3	454.8	454.8	0.0	118.0	993.1	None	DX	3	454.8	454.8	0.0	118.0	993.1	None
42	DX	6	900.0	900.0	0.0	240.7	98.3	65.5	DX	3	450.0	450.0	0.0	120.3	997.2	None	DX	3	450.0	450.0	0.0	120.3	997.2	None
43	DX	6	890.2	890.2	0.0	245.4	98.3	65.5	DX	3	445.1	445.1	0.0	122.7	1001.4	None	DX	3	445.1	445.1	0.0	122.7	1001.4	None
44	DX	6	880.3	880.3	0.0	250.1	98.3	65.5	DX	3	440.2	440.2	0.0	125.1	1005.6	None	DX	3	440.2	440.2	0.0	125.1	1005.6	None

Full B2B Chiller

°C (min)	**Lower Stage Active** %	**Upper Stage Active** %	**Total DX Duty** kW	**Total FreeCool Duty** kW	**Total Unit Duty** kW	**Total Unit Power Input** kW	**Pump Power Input** kW	**Overall Unit Power Input** kW	**EER**	**Energy Consumption** kWhr	**Average Sound Power** dBA	**Average Sound Pressure** dBA
-8	0.0	100.0	0.0	1550.0	1550.0	2.7	16.44	19.2	80.89	6	65.3	32.5
-7	0.0	100.0	0.0	1550.0	1550.0	2.8	16.44	19.3	80.45	40	65.5	32.7
-6	0.0	100.0	0.0	1550.0	1550.0	2.9	16.44	19.4	79.97	56	65.7	32.9
-5	0.0	100.0	0.0	1550.0	1550.0	3.1	16.44	19.5	79.45	158	65.9	33.1
-4	0.0	100.0	0.0	1550.0	1550.0	3.2	16.44	19.7	78.88	299	66.2	33.4
-3	0.0	100.0	0.0	1550.0	1550.0	3.4	16.44	19.8	78.25	545	66.5	33.7
-2	0.0	100.0	0.0	1550.0	1550.0	3.5	16.44	20.0	77.55	1033	66.8	34.0
-1	0.0	100.0	0.0	1550.0	1550.0	3.7	16.44	20.2	76.78	1671	67.1	34.3
0	0.0	100.0	0.0	1550.0	1550.0	4.0	16.44	20.4	75.93	2478	67.5	34.7
1	0.0	100.0	0.0	1550.0	1550.0	4.2	16.44	20.7	74.97	3620	67.9	35.1
2	0.0	100.0	0.0	1550.0	1550.0	4.5	16.44	21.0	73.90	4726	68.4	35.6
3	0.0	100.0	0.0	1550.0	1550.0	4.9	16.44	21.3	72.68	6089	68.9	36.1
4	0.0	100.0	0.0	1550.0	1550.0	5.3	16.44	21.7	71.30	7452	69.5	36.7
5	0.0	100.0	0.0	1550.0	1550.0	5.8	16.44	22.2	69.72	8510	70.2	37.4
6	0.0	100.0	0.0	1550.0	1550.0	6.4	16.44	22.8	67.91	9586	70.9	38.1
7	0.0	100.0	0.0	1550.0	1550.0	7.1	16.44	23.5	65.82	11101	71.8	39.0
8	0.0	100.0	0.0	1550.0	1550.0	8.0	16.44	24.5	63.38	13144	72.7	39.9
9	0.0	100.0	0.0	1550.0	1550.0	9.2	16.44	25.6	60.53	14437	73.9	41.1
10	0.0	100.0	0.0	1550.0	1550.0	10.7	16.44	27.1	57.18	15784	75.2	42.4
11	0.0	100.0	0.0	1550.0	1550.0	12.7	16.44	29.1	53.22	16286	76.7	43.9
12	0.0	100.0	0.0	1550.0	1550.0	15.5	16.44	31.9	48.53	16988	78.5	45.7
13	0.0	100.0	0.0	1550.0	1550.0	19.6	16.44	36.1	42.99	17864	80.7	47.9
14	0.0	100.0	0.0	1550.0	1550.0	26.0	16.44	42.4	36.53	19381	83.4	50.6
15	0.0	100.0	0.0	1550.0	1550.0	36.6	16.44	53.1	29.20	23459	86.8	54.0
16	0.0	100.0	0.0	1550.0	1550.0	55.5	16.44	72.0	21.53	28914	90.9	58.1
17	0.0	100.0	0.0	1550.0	1550.0	87.8	16.44	104.3	14.86	34869	95.4	62.6
18	47.4	52.6	508.2	1041.8	1550.0	96.6	16.44	113.0	13.72	31959	97.0	64.2
19	34.9	65.1	559.0	991.0	1550.0	103.6	16.44	120.1	12.91	26538	97.1	64.3
20	21.4	78.6	614.2	935.8	1550.0	111.4	16.44	127.8	12.13	22736	97.2	64.4
21	6.2	93.8	676.2	873.8	1550.0	120.1	16.44	136.5	11.36	20215	97.3	64.5
22	91.0	9.0	735.9	814.1	1550.0	130.9	16.44	147.3	10.52	17002	97.3	64.5
23	72.2	27.8	804.0	746.0	1550.0	147.1	16.44	163.6	9.48	14919	97.2	64.4
24	47.8	52.2	889.0	661.0	1550.0	169.4	16.44	185.8	8.34	11837	97.3	64.5
25	12.3	87.7	991.9	558.1	1550.0	193.0	16.44	209.4	7.40	10032	96.6	63.8
26	47.4	52.6	1190.8	359.2	1550.0	206.5	16.44	222.9	6.95	7645	96.5	63.7
27	99.5	0.5	1315.9	234.1	1550.0	202.6	16.44	219.0	7.08	4709	95.5	62.7
28	79.6	20.4	1439.2	110.8	1550.0	201.9	16.44	218.3	7.10	2882	95.5	62.7
29	71.4	28.6	1455.0	95.0	1550.0	215.6	16.44	232.0	6.68	2529	95.7	62.9
30	39.4	60.6	1550.0	0.0	1550.0	250.4	16.44	266.9	5.81	1895	96.2	63.4
31	35.3	64.7	1550.0	0.0	1550.0	261.1	16.44	277.6	5.58	638	96.3	63.5
32	31.0	69.0	1550.0	0.0	1550.0	272.0	16.44	288.5	5.37	260	96.4	63.6
33	26.6	73.4	1550.0	0.0	1550.0	283.2	16.44	299.6	5.17	90	96.4	63.6
34	22.1	77.9	1550.0	0.0	1550.0	294.6	16.44	311.1	4.98	62	96.5	63.7
35	17.5	82.5	1550.0	0.0	1550.0	306.3	16.44	322.7	4.80	65	96.6	63.8
36	12.6	87.4	1550.0	0.0	1550.0	318.3	16.44	334.8	4.63	67	96.7	63.9
37	7.7	92.3	1550.0	0.0	1550.0	330.6	16.44	347.0	4.47	69	96.8	64.0
38	2.9	97.1	1550.0	0.0	1550.0	343.0	16.44	359.5	4.31	72	96.9	64.1
39	97.6	2.4	1550.0	0.0	1550.0	356.0	16.44	372.4	4.16	74	97.0	64.2
40	92.3	7.7	1550.0	0.0	1550.0	369.2	16.44	385.6	4.02	39	97.1	64.3
41	86.9	13.1	1550.0	0.0	1550.0	382.7	16.44	399.2	3.88	40	97.2	64.4
42	81.4	18.6	1550.0	0.0	1550.0	396.6	16.44	413.1	3.75	41	97.3	64.5
43	75.6	24.4	1550.0	0.0	1550.0	410.9	16.44	427.4	3.63	43	97.4	64.6
44	69.8	30.2	1550.0	0.0	1550.0	425.6	16.44	442.1	3.51	44	97.4	64.6

*All figures provided in this analysis are given as a guide only, AIAC Ltd does not accept liability for any error or omission, or for any reliance placed on the information contained in this table.
*EN 14825 Electrical Thermostat Off (PTO), Standby Mode (PSB), Off Mode (POFF) and Crankcase Heater Mode (PCK) not included in this analysis

APPENDIX B: BRUKL REPORT (BASED ON CURRENT DESIGN)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2021

Project name

U14633-DC6-LON14-Be Green-20241107-FINAL

As designed

Date: Thu Nov 07 13:44:31 2024

Administrative information

Building Details

Address: Hayes, London, UB3 1QF

Certifier details

Name: NDY

Telephone number: 44 20 7553 9494

Address: 1 Angel Court, London, EC2R 7HJ

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.25

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.25

BRUKL compliance module version: v6.1.e.1

Foundation area [m²]: 5053.82

The CO_2 emission and primary energy rates of the building must not exceed the targets

Target CO_2 emission rate (TER), $kgCO_2/m^2annum$	75.36	
Building CO_2 emission rate (BER), $kgCO_2/m^2annum$	25.99	
Target primary energy rate (TPER), kWh_{PE}/m^2annum	822.94	
Building primary energy rate (BPER), kWh_{PE}/m^2annum	283.84	
Do the building's emission and primary energy rates exceed the targets?	BER =< TER	BPER =< TPER

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

Fabric element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	First surface with maximum value
Walls*	0.26	0.35	0.35	RM00000F:Surf[0]
Floors	0.18	0.48	0.5	RM00001B:Surf[0]
Pitched roofs	0.16	-	-	No pitched roofs in building
Flat roofs	0.18	1.56	1.56	RF000001:Surf[0]
Windows** and roof windows	1.6	2.28	2.28	GF000000:Surf[2]
Rooflights***	2.2	-	-	No roof lights in building
Personnel doors^	1.6	2.2	2.2	GF000002:Surf[1]
Vehicle access & similar large doors	1.3	-	-	No vehicle access doors in building
High usage entrance doors	3	-	-	No high usage entrance doors in building

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

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

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

* 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.

*** Values for rooflights refer to the horizontal position.

^ For fire doors, limiting U-value is 1.8 W/m²K

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

Air permeability	Limiting standard	This building
$m^3/(h.m^2)$ at 50 Pa	8	3

Building services

For details on the standard values listed below, system-specific guidance, and additional regulatory requirements, refer to the Approved Documents.

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

1- 4-Telco room (Cooling only)-CRAC-Be Green

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	2.5	4.48	0	-	-
Standard value	2.5*	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 all types >12 kW output, except absorption and gas engine heat pumps.					

2- 3-Cooling Only (CRAC units)-Data Halls

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	31.2	0	1.6	-
Standard value	2.5*	4.5**	N/A	1.5^	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. ** Standard shown is for air-cooled chillers >=400 kW. For chillers <400 kW, limiting SEER is 4. ^ Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.					

3- 2-Split/Multisplit-Ground Floor Offices (Existing VRV)-Be Green

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.86	6.36	0	-	0.75
Standard value	2.5*	5	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.					

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

Zone-level mechanical ventilation, exhaust, and terminal units

ID	System type in the Approved Documents
A	Local supply or extract ventilation units
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 balanced supply and extract ventilation system
E	Local balanced supply and extract ventilation units
F	Other local ventilation units
G	Fan assisted terminal variable air volume units
H	Fan coil units
I	Kitchen extract with the fan remote from the zone and a grease filter
NB: Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.	

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	2.3	2	0.5	0.5	0.4	1	Zone	Standard
01-Comms (Telco)	-	0.8	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	2.3	2	0.5	0.5	0.4	1	Zone	Standard
01-Comms (Telco)	-	0.8	-	-	-	-	-	-	-	-	N/A
01-Data Hall	-	-	-	-	-	-	-	0.3	-	-	N/A
01-Data Hall	-	-	-	-	-	-	-	0.3	-	-	N/A
01-Data Hall	-	-	-	-	-	-	-	0.3	-	-	N/A
GF-Comms (Telco)	-	0.8	-	-	-	-	-	-	-	-	N/A
GF-Comms (Telco)	-	0.8	-	-	-	-	-	-	-	-	N/A
GF-Data Hall	-	-	-	-	-	-	-	0.3	-	-	N/A
GF-Data Hall	-	-	-	-	-	-	-	0.3	-	-	N/A
GF-Data Hall	-	-	-	-	-	-	-	0.3	-	-	N/A
GF-Office Core	-	-	-	1.6	-	-	-	-	-	-	N/A
01-Office Core	-	-	-	1.6	-	-	-	-	-	-	N/A
GF-Offices	-	-	-	1.6	-	-	-	-	-	-	N/A
01-Offices	-	-	-	1.6	-	-	-	-	-	-	N/A

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
Standard value	95	80	0.3
01-Battery room	110	-	-
01-Comms (Telco)	60	-	-
01-Comms (Telco)	60	-	-
01-Data Hall	141	-	-
01-Data Hall	141	-	-
01-Data Hall	141	-	-
01-Main Corridors	120	-	-
01-Main Corridors	120	-	-
01-Main Corridors	120	-	-
01-Main Corridors	120	-	-
01-Main Corridors	120	-	-
01-Main Corridors	120	-	-
01-Main Corridors	120	-	-
01-Main Corridors	120	-	-
01-Main Corridors	120	-	-
01-Main Corridors	120	-	-
01-Secondary Corridors	120	-	-
01-Secondary Corridors	120	-	-
01-Secondary Corridors	120	-	-
01-Secondary Corridors	120	-	-
01-Secondary Corridors	120	-	-
01-Staircases	140	-	-
01-Storage	140	-	-
01-Storage	44	-	-
GF-Battery room	110	-	-
GF-Comms (Telco)	60	-	-

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
Standard value	95	80	0.3
GF-Comms (Telco)	60	-	-
GF-Data Hall	141	-	-
GF-Data Hall	141	-	-
GF-Data Hall	141	-	-
GF-Loading bay	140	-	-
GF-Main Corridors	120	-	-
GF-Main Corridors	120	-	-
GF-Main Corridors	120	-	-
GF-Main Corridors	120	-	-
GF-Main Corridors	120	-	-
GF-Main Corridors	120	-	-
GF-Main Corridors	120	-	-
GF-Main Corridors	120	-	-
GF-Main Corridors	120	-	-
GF-Secondary Corridors	120	-	-
GF-Secondary Corridors	120	-	-
GF-Secondary Corridors	120	-	-
GF-Secondary Corridors	120	-	-
GF-Secondary Corridors	120	-	-
GF-Secondary Corridors	120	-	-
GF-Staircases	140	-	-
GF-Storage	140	-	-
GF-Storage	140	-	-
GF-Main Corridors	120	-	-
GF-Office WC	100	-	-
GF-Office Core	100	-	-
01-Office WC	100	-	-
01-Office Core	100	-	-
GF-Offices	100	-	-
Circ	120	-	-
01-Offices	100	-	-

The spaces in the building should have appropriate passive control measures to limit solar gains in summer

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
01-Comms (Telco)	N/A	N/A
01-Comms (Telco)	N/A	N/A
01-Data Hall	N/A	N/A
01-Data Hall	N/A	N/A
01-Data Hall	N/A	N/A
GF-Comms (Telco)	N/A	N/A
GF-Comms (Telco)	N/A	N/A
GF-Data Hall	N/A	N/A
GF-Data Hall	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
GF-Data Hall	N/A	N/A
GF-Office WC	NO (-99.9%)	NO
GF-Office Core	YES (+132.7%)	NO
01-Office WC	N/A	N/A
01-Office Core	YES (+15.8%)	NO
GF-Offices	YES (+21%)	NO
01-Offices	NO (-13.9%)	NO

Regulation 25A: Consideration of high efficiency alternative energy systems

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

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m^2]	17436.2	17436.2
External area [m^2]	22056.1	22056.1
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	3
Average conductance [W/K]	20140.3	4877.5
Average U-value [W/m^2K]	0.91	0.22
Alpha value* [%]	13.25	10

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

Building Use

% Area	Building Type
	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
13	**Offices and Workshop Businesses**
	General Industrial and Special Industrial Groups
	Storage or Distribution
	Hotels
	Residential Institutions: Hospitals and Care Homes
	Residential Institutions: Residential Schools
	Residential Institutions: Universities and Colleges
	Secure Residential Institutions
	Residential Spaces
	Non-residential Institutions: Community/Day Centre
	Non-residential Institutions: Libraries, Museums, and Galleries
	Non-residential Institutions: Education
	Non-residential Institutions: Primary Health Care Building
	Non-residential Institutions: Crown and County Courts
	General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger Terminals
	Others: Emergency Services
87	**Others: Miscellaneous 24hr Activities**
	Others: Car Parks 24 hrs
	Others: Stand Alone Utility Block

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

	Actual	Notional
Heating	0.37	0.07
Cooling	82.89	450.21
Auxiliary	76.12	70.26
Lighting	32.96	37.55
Hot water	0.23	0.22
Equipment*	2176.16	2176.16
TOTAL**	**192.58**	**558.32**

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

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*0*	*0*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	7269.01	7507.4
Primary energy [kWh_{PE}/m^2]	283.84	822.94
Total emissions [kg/m^2]	25.99	75.36

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] ASHP, [HFT] Electricity, [CFT] Electricity										
	Actual	83	72.3	4.8	4.2	6	4.77	4.75	4.86	6.36
	Notional	9	111.5	0.9	6.7	1.3	2.78	4.63	----	----
[ST] Fan coil systems, [HS] ASHP, [HFT] Electricity, [CFT] Electricity										
	Actual	0	14923.7	0	166.8	155.7	0.92	24.85	1	31.2
	Notional	0	15397.5	0	923.5	144.4	2.78	4.63	----	----
[ST] Single room cooling system, [HS] ASHP, [HFT] Electricity, [CFT] Electricity										
	Actual	0	1152.2	0	95.6	6.4	2.45	3.35	2.5	4.48
	Notional	0	1790.2	0	107.4	7.2	2.78	4.63	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

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

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