Overheating Assessment

Camden Goods Yard

On Behalf Of St George West London Ltd

Date: 06th July 2020

CONTENTS

1. Revision History

Revision	Issue Date	Description	Issued By	Checked By
A	28.04.2020	Initial Draft	CC	
B	04.05.2020	Internal review	CC	
B	05.05.2020	First draft for comment	CC	MA
C	08.06.2020	Second draft for comment	CC	MA
D	23.06.2020	Final Draft	CC	MA
E	06.07.2020	Final Issue	CC	MA

Calculations contained within this report have been produced based on information supplied by St George West London Ltd and the design team. Any alterations to the technical specification on which this report is based will invalidate its findings.

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2. Introduction

2.1. Background

Overheating has become a common issue in recent years due to climate change and stricter national and regional policies for energy efficient buildings, improved building fabrics and air-tight buildings. Furthermore, in urban centres, especially in the south and south east of the UK, the Urban Heat Island (UHI) effect is deteriorating the consequences of the already intense and frequent hot summer events to the building industry.

Therefore, it becomes of significant importance to assess the risk of overheating at the early stages of the design process to avoid any expensive modifications to the design at later stages of the development process.

This overheating assessment has been prepared by Energist UK Ltd. for the residential development scheme at Camden Goods Yard

This report follows the steps proposed by the CIBSE TM59 guidance 'Design methodology for the assessment of overheating risk in homes' in order to report the risk of overheating within the development.

It should be noted that the criteria outlined within TM59 does not relate to any statutory guidance or regulatory requirements, and cannot be viewed as a definitive prediction of whether overheating will or will not occur. It is provided for information only, solely as an indication of risk, within the parameters and criteria of the TM59 methodology.

2.2. Development Overview

This overheating assessment has been prepared to accompany an S73 application for the proposed development at Camden Goods Yard. The site has been approved for redevelopment through an earlier planning application as outlined below. However, since the prior approval was granted, considerable changes have occurred in the methodology with which homes are assessed for overheating. This document therefore is provided to assess the scheme to the latest set of requirements, which are substantially more onerous those of the assessment undertaken at the time of the original application.

Planning permission was granted 15th June 2018 for the redevelopment of the existing Morrisons supermarket, surface car park and Petrol Filling Station (PFS) (ref. 2017/3847/P) – to be referred to as the 'extant scheme'. The approved development would deliver 573 new homes and circa 39,500 sq m GEA of non-residential floorspace, including a replacement supermarket, replacement PFS and new A1, A3, B1, D2 and SG floorspace, together with associated public realm and landscaping.

This current application is for an optimisation of the approved scheme. The 'optimisation scheme' makes amendments to predominantly to Buildings A, B, C, F, including inserting additional storeys as a result of reducing floor-to-ceiling heights to 2.5m, inserting extra storeys in addition, as well as alterations to floorplans and reconfiguration of internal layouts. The scheme will deliver 73 additional homes, for a total of 646 new homes. Commercial floorspace will remain largely unchanged.

3. Methodology and Sampling

For the assessment of overheating risk, a Dynamic Thermal Model has been created using the IES-VE 2019 software.

The overheating assessment is based on the CIBSE TM59 Methodology, which is a standardised approach that aims to encourage good design and propose a consistent process for assessing overheating in residential properties, that would be common across the industry.

It proposes typical profiles to describe the internal gains through occupancy, lighting and equipment. For further details with regard to the profiles used for the Dynamic Thermal Modelling, please refer to Appendix D.

TM59 introduces two sets of compliance criteria for assessing overheating which are based on the ventilation type of the home:

For houses predominantly naturally ventilated

- The number of hours for living rooms, kitchens and bedrooms, for which the difference between the internal and external temperatures (ΔT) is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3 per cent of the occupied hours (TM52 criterion 1).
- For bedrooms only, to guarantee comfort during the sleeping hours the operative temperature from 10pm to 7am shall not exceed 26 degrees Celsius for more than 1 per cent of annual hours.

Criteria 2 and 3 of CIBSE TM52 may fail to be met, but both a and b above must be met.

For homes predominantly mechanically ventilated

- The CIBSE Guide A fixed temperature test must be followed, i.e. all occupied rooms should not exceed an operative temperature of 26 degrees Celsius for more than 3 per cent of the annual occupied hours.

Corridors should demonstrate that an operative temperature of 28°C should not be exceeded for more than 3% of the total annual hours.

For further details on the regulations related to overheating please refer to Appendix B.

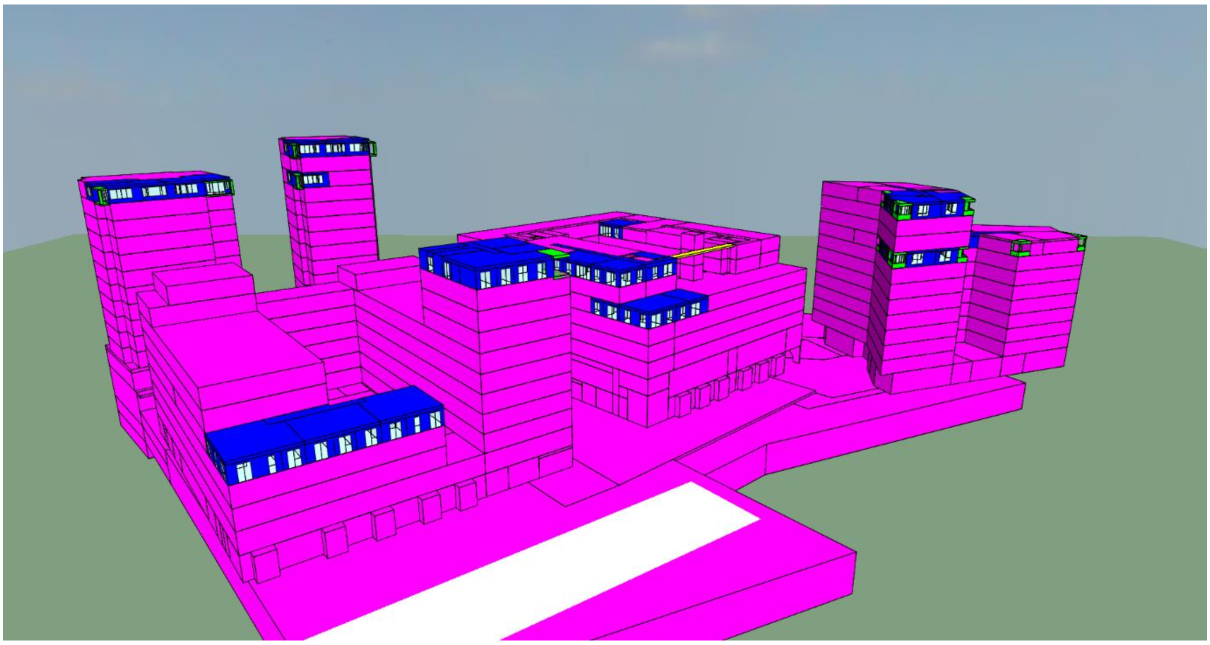
The ventilation strategy shall differ across the site, and within the assessments carried out. Therefore, both sets of criteria have been reported for the applicable dynamic simulations

A total of 24 units have been selected for assessment for overheating, based on worst case apartments, including those on top floors and south/west orientations, those that are single aspect, or those that are highly glazed.

A representative mix of unit sizes and tenures has also been selected, ranging from studio apartments to 3B6P family homes.

The units assessed have been selected from Buildings A, B, C & F, which represent the extent of the buildings undergoing alterations within this application. However, the results outlined within can be deemed a representative sample of the entire site.

An image highlighting assessed apartments is shown below (all adjacent buildings have been removed from the imagery for clarity):



4. Model Specifications

4.1. Introduction

This section outlines the specification assigned to the thermal model, based on the design parameters discussed and agreed with the design team.

At an early stage, the design team have explored a range of passive design and energy efficiency measures including enhanced construction details to minimise thermal bridging, high-efficiency specifications, and the use of efficient mechanical ventilation systems.

A full list of passive measures employed within the design have been detailed within the following section 5, which specifically addresses the London Plan Cooling hierarchy, and the steps taken at each stage.

4.2. Thermal Envelope

Building fabric specifications have been assigned based on the Energy Strategy specification for the development.

From the construction build-ups received, it is noted that the structures will consist of relatively low thermal mass. This will limit the buildings ability to maintain a stable thermal environment and could result in the homes being more susceptible to temperature and weather fluctuations.

Glazing G-values (solar transmittance) have been assigned a target value of 0.45, which is seen as a best practice value to balance overheating mitigation, heat loss and daylight provision. It must be understood that the glazing design parameters have not been finalised, and that G-values may vary slightly owing to available products from the selected manufacturer.

4.3. Building Profiling

Building profiles relate to all aspects of building use, from heating/cooling plant operation, to occupancy, lighting and equipment use. As such they form an important data schedule within a thermal and overheating assessment.

The apartment lighting, occupancy, and equipment (plug loads) usage and gain patterns have been assigned as per CIBSE TM59: Design Methodology for the assessment of overheating in homes (2017). Please note that these profiles have been created in order to assess the worst-case scenario within homes, and as such assume a 24-hour occupancy period to bedrooms, to assess the risk for occupants that may use these rooms during a summers day (such as children or the elderly); and a 13-hour occupancy period for living spaces (unoccupied at night), this results in living areas modelled as occupied only during the hottest parts of the day and negating the cooler overnight periods from the assessment.

An overview of all profiles and gains used within the assessment can be found in appendix D.

4.4. Solar Gain

Solar gain will have a significant impact on overheating risk, especially to the southern and western facades. For the initial analysis the window g-value has been assigned as 0.45. This is a good practice value to balance overheating mitigation with other design factors, such as daylight provision, CO_2 emissions and aesthetics.

Some solar shading is provided by way of overhanging balconies, however no specific architectural solar shading (brise soleil, external shutters etc.) is proposed within the design.

A detailed solar shading analysis has been undertaken within the VE by IES-SUNCAST, in order to simulate the solar gain to the rooms; this simulation takes account of building fabric specifications and local shading (e.g. from overhanging balconies) but not trees or other topographical shading.

A blinds specification has not been provided, however, may be required. It should be noted that, in order to comply with TM59, blinds must be inherent to the design and installed as part of the construction works if they are assigned to the simulated model. This assessment shall report the results of simulations both inclusive and exclusive of blinds, in order to provide information to the design team.

Where included in the simulations, blinds have been assigned a shading coefficient of 0.40, and short-wave radiant fraction of 0.30, which is listed by the BRE as a default value for a 'Cream Holland linen blind'.

4.5. Ventilation and Infiltration

The apartments have been modelled as naturally ventilated. The parameters used represent reasonable assumptions or building regulations minimum standards, due to the stage of the design. The windows and doors within the rooms have been assumed to be manually operated and have been modelled based on the provided drawings. Restrictions on windows for noise or air quality purposes have not been included within the calculations, in line with the original overheating analysis. It is widely understood that overheating cannot be fully mitigated by mechanical ventilation systems alone, and closed windows. However, as the windows have been designed as openable, the resident has been given the option to use the windows for the purposes of natural cooling, and this report is provided in order to assess the risk of overheating in this scenario.

Window flow is calculated in IES based on a large array of data, including aerodynamic (equivalent) area, frame percentage, opening angle and pivoting point.

The following parameters have been assigned to the differing window and door types within the thermal model.

- Type 1. Fixed Panel Glazing

Fixed glazing panels that have been assigned as inoperable.

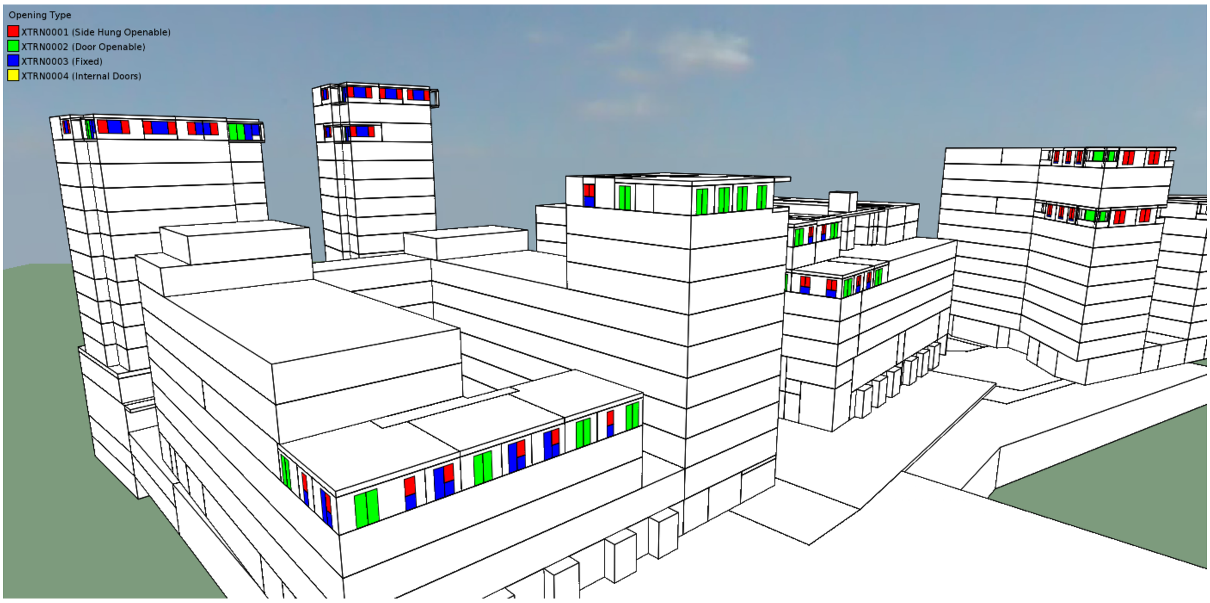
- Type 2 Openable Windows

These windows have been assigned as side hung, and openable to a maximum angle of 90°

- Type 3 Balcony Doors

Balcony doors have been assigned as side-hung, and openable to a maximum angle of 90°

The below image details the types of glazing assigned to the model, and their respective locations.



Internal doors have been modelled between rooms within the apartments. These have been set as open during the day, to promote airflow throughout the home, however closed at night for privacy.

The flow rates from the mechanical ventilation systems have not yet been finalised. Within the calculations the effect of different flow rates has been evaluated, as well as the effect of MEV systems vs MVHR systems. The profile for each simulation is noted within the following sections, with the window operational profiles for each set of results.

The infiltration rates have been assumed based on the design air permeability of the building. Air leakage has been set at 0.25 ACH, which approximately translates to an air permeability of 5.0 $m^3/(h.m^2)$ at 50 pa.

Communal corridors shall be tempered via a roof mounted mechanical ventilation system, extracting air from the stairwells and supplying to the corridors via the smoke shafts. The system shall include an active cooling coil in order to target the design internal temperature of 23°C. The system shall include sophisticated controls to maximise energy efficiency and ensure that the whenever suitable, external air is used to maintain a comfortable temperature. In periods of excessive external temperature, the air shall be mechanically cooled by the system and recirculated in order to minimise cooling demand.

4.6. Weather Data and Simulation Parameters

The development is for a location in Camden, and as such, the closest available weather data source is for Greater London.

In 2014, the CIBSE published 'TM49: Design Summer Years for London' which was aimed to address the question of whether the current Design Summer Year (DSY) was the most appropriate for assessment of the summertime cooling needs of buildings in London. Prior to the publication of TM49, the DSY for London was that of the 1989 summer, recorded at the London Heathrow Weather station, as this represents a near-extreme warm summer over the period 1950-2006 (five summers have been warmer). TM49 has sought to address the issue of the Urban Heat Island effect, and that of managing an uncertain future climate; and as a result, a wider array of data is now available to assist developers in mitigating future overheating risk.

Three weather locations are now available for London; The London Weather Centre, used for central urban assessments within the GLA Central Activity Zone; Heathrow, used for the majority of assessments within greater London, lower density and suburban areas; and Gatwick, used for assessments in rural and peri-urban areas.

For the purposes of this assessment, the Heathrow weather station location has been used. The TM59 guidance recommends using a morphed, predictive data file, rather than the 'current' DSY. In line with this guidance, the CIBSE DSY 1 weather data for the 2020's, 50th percentile, high emissions scenario has been used for this assessment.

Additional data sets are available, including the more extreme DSY's 2 and 3, are available to test designs of particular concern, or to develop heatwave plans. Whilst compliance with the TM59 criteria is linked solely to DSY 1, and therefore these additional data sets are not strictly relevant, they have been included within appendix C in line with the latest guidance from the GLA. It must be understood that these results are provided for information only, and that current or emerging policy do not require these weather situations to report a pass of the requirements. These weather data sets are extremely challenging, and in some cases not possible to meet. For example, in the case of DSY3 and the mechanically ventilated criteria. The criteria dictate not exceeding 26°C for more than 3% of hours, however, the external weather conditions exceed 26° for 4.1% of hours, making this criteria impossible to achieve without active cooling.

Further detail on the weather data used can be found within CIBSE TM49 and appendix E of this report.

The simulation was set to cycle at ten-minute intervals, updating the dynamic changes based on alterations to the environment and to report every 60 minutes; during the assessed summer period (1st May – 30th September). Each zone modelled and listed in the attached results is based on the above data sets and the Architect's drawings provided and referenced within this report.

5. PASSIVE DESIGN – LONDON COOLING HIERARCHY

The ‘cooling hierarchy’, referred within Policy 5.9 of The London Plan indicates the preferred approach to reducing overheating risk and a reliance upon mechanical cooling. The hierarchal steps are:

1. Minimise heat generation through energy efficient design.
2. Reduce the amount of heat entering a building in summer.
3. Manage the heat within the building through exposed thermal mass and high ceilings.
4. Passive ventilation.
5. Mechanical ventilation
6. Mechanical Cooling

Throughout the development proposals, a vast array of passive design measures have been adopted in order to reduce demand, and minimise overheating risk. These follow the London Plan hierarchy and an overview is provided below.

Minimising Internal Heat Generation

The heating system infrastructure has been designed in line with CIBSE CP1, with low flow temperatures, and minimisation of pipe runs in order to reduce internal heat generation. In addition, lighting systems are designed as high efficiency to limit gains, and all commercial tenants will be encouraged to purchase energy efficient equipment, which in turn shall also reduce heat gains to spaces

Reducing External Heat Gains

A relatively low glazing g-value of 0.45 has been specified in order to reduce solar gains. This has been selected after considerable investigation as a good balance between heat loss, overheating mitigation, and daylight provision. In addition, shading shall be provided to homes by way of overhanging balconies, and many commercial spaces benefit from recessed windows, overhangs, and shading from other buildings. In addition, spaces that are highly glazed for aesthetic purposes, such as the Building A concierge at the entrance to the development, have been designed with a northern orientation, in order to minimise cooling demands to these spaces.

Heat Management

Many residential spaces benefit from high ceilings on order to reduce overheating risk, with some homes up to 2.7m and no home under 2.5m. This is noted as good practice and allows heat to collect at high level, away from occupants. Many commercial spaces are double height in order to provide the same benefits, and most non-residential spaces report a ceiling height >3.0m. Owing to the lightweight frame design within the approved strategy, the opportunity for exposing thermal mass is limited. Within commercial spaces that are shell and core, commercial tenants will be encouraged to adopt exposed mass solutions, in order to reduce the cooling demand further.

Passive Ventilation

All residential spaces shall have openable windows in order to purge heat. These have been designed as large openings or Juliet balconies to allow rapid natural cooling, which shall minimise the length of time that windows must be open in order to cool the room. Non-residential spaces are primarily ventilated mechanically, owing to design requirements and site constraints.

Mechanical Ventilation

All occupied commercial spaces shall be provided with mechanical ventilation systems in order to ensure fresh air supply. These systems shall be provided with summer bypass' in order to provide a degree of free cooling during the summer. It is important to understand that a mechanical ventilation system alone cannot maintain comfortable temperatures within a space as in periods of high temperatures it is simply supplying hot air to the spaces from outside.

Cooling

Certain residential spaces are designed with comfort cooling in line with the extant scheme. However, the cooling demand has been minimised by the adoption of passive mitigation measures, and the cooling systems are provided in addition to the above measures, not in place of. The cooling systems have not been included within this analysis. The residential cooling proposals are in line with the extant permission, and shall have a negligible impact on the site regulated emissions as detailed within the revised energy strategy.

Commercial spaces are also to be provided with cooling. The calculations demonstrate that the above passive measures have reduced the regulated cooling demand to 18% less than that of the notional target. This exceeds the requirements of the London Plan cooling hierarchy and guidance from the GLA.

	Notional Site	Actual Site	Reduction
Site-Wide Cooling Demand	221.8 MJ/m²	181.9 MJ/m²	18%

6. Results

The below section details the headline results of the analysis. The full results tables can be found within appendix C.

In line with the requirements of the latest policy guidance, the results below have been presented with and without internal blinds applied. For the simulation including blinds, the window parameters have been adjusted so that the windows are closed whenever blinds are in operation. This is to ensure that the blind does not interrupt with the ventilation strategy within the simulation, and that the performance is based on a worst-case scenario.

6.1. Simulation 1

The following table details the headline results of the initial simulation, with blinds provided to all southern and western oriented glazing. The full results bales can be found within appendix C

Criterion	Rooms Passing	Pass Rate
1 – Hours of exceedance	61 of 61	100%
2 – Overnight temperature	40 of 40	100%

6.2. Simulation 2

The following table details the headline results, with blinds removed from the simulation.

Criterion	Rooms Passing	Pass Rate
1 – Hours of exceedance	50 of 61	82.0%
2 – Overnight temperature	39 of 40	97.5%

7. Conclusions

The preceding results demonstrate that the passive measures employed within the design shall achieve compliance with the requirements set out under the London Plan, and latest guidance from the GLA.

The large window openings shall allow rapid and plentiful ventilation, permitting the effective purging of heat from the spaces, and the solar gain reduction measures shall reduce the direct solar radiation entering the home.

The high pass rate within the 'no blinds' scenario indicates good design, with the majority of spaces passing the requirements without this additional solar gain control.

It must be understood that this report is in no way a guarantee that overheating will, or will never, occur within the proposed development. It relies on standardised behavioural and weather variations which can never be 100% accurate. The results and conclusions refer to the overheating risk, as defined by the criteria set out in this report, and is therefore only an indicator of risk with regard to this assessment methodology. It should also be noted that a pass of the criteria indicates that overheating risk will not be excessive, not that it will be mitigated entirely.

However, whilst overheating could still occur, this report demonstrates that the design measures proposed by the applicant have reduced the risk to levels that satisfy the requirements of CIBSE TM59, and the local and regional planning policies.

It must also be noted that the results presented within this report rely on the assumption that windows can be opened by the resident in order to mitigate overheating. It is understood that many factors will affect whether residents have windows open or closed, such as overheating, noise, air quality etc. However, as the windows are physically openable, the residents have the option to use them for the purposes of overheating mitigation, and this report is based on the assumption that this shall occur. It should be understood that the only way to practically comply with the overheating guidance is for windows to be openable for heat purge, or for active cooling to be provided. Mechanical ventilation systems alone are not a viable solution for addressing overheating.

APPENDIX A: ACRONYMS

Acronym	Definition
CIBSE	Chartered Institute of Building Services Engineers
TM	Technical Memorandum
GLA	Greater London Authority
UHI	Urban Heat Island
IESVE	Integrated Environmental Solutions Virtual Environment
DSY	Design Summer Year
MEV	Mechanical Extract Ventilation
MVHR	Mechanical Ventilation with Heat Recovery
HIU	Heat Interface Unit
ASHP	Air Source Heat Pump
CHP	Combined Heat & Power
DHN	District Heat Network
DHW	Domestic Hot Water
GSHP	Ground Source Heat Pump
LPA	Local Planning Authority
SBEM	Simplified Building Energy Model

Appendix B: Methodologies & Guidance

CIBSE TM 52:2013 – The Limits of Thermal Comfort: Avoiding Overheating in European Buildings

The CIBSE TM52 guidance has been published in 2013 and uses the adaptive approach to assess whether a building will be overheating. TM52 uses the deviation from a set comfort temperature to assess whether a development is overheating.

CIBSE TM52 uses 3 criteria for assessing overheating. These are:

- **Criterion 1 – Hours of Exceedance (He):** The number of hours (He) during which DT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3% of occupied hours.
  If data are not available for the whole period (or if occupancy is only for a part of the period) then 3 per cent of available hours should be used.

- **Criterion 2 – Daily Weighted Exceedance (We):** To allow for the severity of overheating the weighted exceedance (We) shall be less than or equal to 6 in any one day.

- **Criterion 3 – Upper Limit Temperature (Tupp):** To set an absolute maximum value for the indoor operative temperature the value of DT shall not exceed 4 K.

For a dwelling to be considered as overheating, it must be failing in 2 of the above criteria.

CIBSE TM 59:2017 - Design Methodology for the Assessment of Overheating Risk in Homes

In May 2017, the Chartered Institute of Building Services Engineers (CIBSE) published the Technical Memorandum TM59.

The new methodology is based on the use of dynamic thermal modelling for assessing the overheating risk in residential developments and should be especially considered for:

- Large developments.
- Developments in urban areas, particularly in Southern England.
- Blocks of flats.
- Dwellings with high levels of insulation and air tightness.

- Single aspect flats.

Developments assessed under TM59 methodology are required to pass using the DSY1 (current design summer year) weather file most appropriate to the site location, for the 2020s, high emissions, 50% percentile scenario.

Other extreme weather files (DSY2 and DSY3) as well as future weather files for climate change adaptation should be considered in buildings of particular concern (e.g. care homes) and/or where required in the client's brief.

TM59 introduces two sets of compliance criteria for assessing overheating which are based on the ventilation type of the dwelling. That is,

1. **For houses predominantly naturally ventilated**
   a. The number of hours for living rooms, kitchens and bedrooms, which ΔT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3 per cent of the occupied hours (TM52 criterion 1).

   b. For bedrooms only, to guarantee comfort during the sleeping hours the operative temperature from 10pm to 7am shall not exceed 26 degrees Celsius for more than 1 per cent of annual hours.

Criteria 2 and 3 of CIBSE TM52 may fail to be met, but both a and b above must be met.

2. **For homes predominantly mechanically ventilated** (for example because of air quality or noise issues), the CIBSE Guide A fixed temperature test must be followed, i.e. all occupied rooms should not exceed an operative temperature of 26 degrees Celsius for more than 3 per cent of the annual occupied hours.

Appendix C: Full Results Tables

7.1. DSY1 – Blinds Provided

Room Name	Criterion 1	Criterion 2	Result	Criterion 2 %
A (N) 1B2P SW - Living	1.7	NA	Pass	N/A
A (N) 1B2P SW - Bed	1.4	18	Pass	0.5%
A (S) SW Studio - Studio	0.5	23	Pass	0.7%
A (S) SW/SE 1B2P - Bed	0.9	19	Pass	0.6%
A (S) SW/SE 1B2P - Living	0.9	NA	Pass	N/A
A (S) SE 3B6P - Bed	0.1	22	Pass	0.7%
A (S) SE 3B6P - Bed	0.1	22	Pass	0.7%
B.L5 SW Studio - Studio	0.2	16	Pass	0.5%
B.L5.SW 2 Bed - Bedroom 1	0.1	21	Pass	0.6%
B.L5.SW 2 Bed - Bedroom 2	0.3	22	Pass	0.7%
B.L5.SW 2 Bed - Living Room	1.2	NA	Pass	N/A
B.L5.SW 1 Bed - Bedroom 1	0.3	19	Pass	0.6%
B.L5.SW 1 Bed - Living Room	0.2	NA	Pass	N/A
B.07.SW Courtyard 1 Bed - Bedroom 1	0.5	21	Pass	0.6%
B.07.SW Courtyard 1 Bed - Living Space	1.1	NA	Pass	N/A
B.07.SW 1 Bed - Bedroom 1	1	23	Pass	0.7%
B.07.SW 1 Bed - Living Space	2.8	NA	Pass	N/A
B.07.SW 2 Bed - Bedroom 1	0.7	22	Pass	0.7%
B.07.SW 2 Bed - Bedroom 2	1.3	23	Pass	0.7%
B.07.SW 2 Bed - Living Space	1.4	NA	Pass	N/A
08.W.S.2B4P - Bed 2	0.6	17	Pass	0.5%
08.W.S.2B4P - Bed 1	0.2	16	Pass	0.5%
08.W.S.2B4P - Living	0.2	NA	Pass	N/A
08.W.SE.2B4P - Bed 2	0.2	15	Pass	0.5%
08.W.SE.2B4P - Living Room	0.2	NA	Pass	N/A
08.W.W.1B2P - Bed 1	0.3	13	Pass	0.4%
08.W.W.2B4P - Living	0.4	NA	Pass	N/A
08.W.SE.2B4P - Bed 1	0	14	Pass	0.4%
08.W.S.2B4P - Bed 2	0.6	17	Pass	0.5%
08.W.S.2B4P - Bed 1	0.2	16	Pass	0.5%
08.W.S.2B4P - Living	0.2	NA	Pass	N/A
08.W.SE.2B4P - Bed 2	0.2	15	Pass	0.5%
08.W.SE.2B4P - Living Room	0.2	NA	Pass	N/A
08.W.W.1B2P - Bed 1	0.3	13	Pass	0.4%
08.W.W.1B2P - Living	0.5	NA	Pass	N/A
08.W.SE.2B4P - Bed 1	0	14	Pass	0.4%
F.04.SW/SE 3B 5P - Bed 1	0.4	17	Pass	0.5%
F.04.SW/SE 3B 5P - Bed 3	1.2	24	Pass	0.7%
F.04.SW/SE 3B 5P - Bed 2	0.3	24	Pass	0.7%

F.04.SE 2B4P - Living	0.4	NA	Pass	N/A
F.04.SE 2B4P - Bed 2	0.3	26	Pass	0.8%
F.04.SE 2B4P - Bed 1	0.1	26	Pass	0.8%
F.04.SE.3B5P - Bed 1	0.3	16	Pass	0.5%
F.04.SE.3B5P - Bed 3	0.3	15	Pass	0.5%
F.04.SE.3B5P - Bed 2	0	21	Pass	0.6%
F.10.SW/SE 3B6P - Bed 1	0.5	16	Pass	0.5%
F.10.SW/SE 3B6P - Bed 2	0.1	16	Pass	0.5%
F.10.SW/SE 3B6P - Living	0.8	NA	Pass	N/A
F.10.SW/SE 3B6P - Bed 3	0.4	16	Pass	0.5%
F.10.Studio - Studio	0.2	16	Pass	0.5%
F.10.1B2P - Living	0.3	NA	Pass	N/A
F.10.1B2P - Bed 1	0.1	16	Pass	0.5%
A (N) SE 2B4P - Bed 1	0.1	16	Pass	0.5%
A (N) SE 2B4P - Bed 2	0.7	16	Pass	0.5%
A (N) SE 2B4P - Living	1	NA	Pass	N/A
A (N) SW 1B2P - Living	2	NA	Pass	N/A
A (N) SW 1B2P - Bed 1	1.6	20	Pass	0.6%
A (S) SE 3B6P - Bed	0.1	22	Pass	0.7%
A (S) SE 3B6P - Living	0.5	NA	Pass	N/A
F.04.SE.3B5P - Living	1	NA	Pass	N/A
F.04.SW/SE 3B 5P - Living	2.4	NA	Pass	N/A

7.2. DSY1 – No Blinds

Room Name	Criterion 1	Criterion 2	Result	Criterion 2 %
A (S) SW Studio - Studio	1.7	26	Pass	0.8%
A (S) SE 3B6P - Bed	0.6	25	Pass	0.8%
A (S) SE 3B6P - Bed	0.6	25	Pass	0.8%
B.L5 SW Studio - Studio	0.5	20	Pass	0.6%
B.L5.SW 2 Bed - Bedroom 1	0.6	24	Pass	0.7%
B.L5.SW 2 Bed - Bedroom 2	1	23	Pass	0.7%
B.L5.SW 1 Bed - Bedroom 1	1.5	22	Pass	0.7%
B.L5.SW 1 Bed - Living Room	2	NA	Pass	N/A
B.07.SW Courtyard 1 Bed - Bedroom 1	1.7	25	Pass	0.8%
B.07.SW 1 Bed - Bedroom 1	2.2	24	Pass	0.7%
B.07.SW 2 Bed - Bedroom 1	1.8	24	Pass	0.7%
B.07.SW 2 Bed - Bedroom 2	2.6	24	Pass	0.7%
08.W.S.2B4P - Bed 2	1.5	21	Pass	0.6%
08.W.S.2B4P - Bed 1	1.1	21	Pass	0.6%
08.W.S.2B4P - Living	1.8	NA	Pass	N/A
08.W.SE.2B4P - Bed 2	0.9	20	Pass	0.6%
08.W.SE.2B4P - Living Room	1.1	NA	Pass	N/A
08.W.W.1B2P - Bed 1	1.1	13	Pass	0.4%

08.W.W.2B4P - Living	1.2	NA	Pass	N/A
08.W.SE.2B4P - Bed 1	0.2	16	Pass	0.5%
08.W.S.2B4P - Bed 2	1.5	21	Pass	0.6%
08.W.S.2B4P - Bed 1	1.1	21	Pass	0.6%
08.W.S.2B4P - Living	1.8	NA	Pass	N/A
08.W.SE.2B4P - Bed 2	0.9	20	Pass	0.6%
08.W.SE.2B4P - Living Room	1.1	NA	Pass	N/A
08.W.W.1B2P - Bed 1	1.1	13	Pass	0.4%
08.W.W.1B2P - Living	1.3	NA	Pass	N/A
08.W.SE.2B4P - Bed 1	0.2	16	Pass	0.5%
F.04.SW/SE 3B 5P - Bed 1	1.6	21	Pass	0.6%
F.04.SW/SE 3B 5P - Bed 3	2.5	30	Pass	0.9%
F.04.SW/SE 3B 5P - Bed 2	0.9	27	Pass	0.8%
F.04.SE 2B4P - Living	0.9	NA	Pass	N/A
F.04.SE 2B4P - Bed 2	0.8	34	Fail	1.0%
F.04.SE 2B4P - Bed 1	0.7	32	Pass	1.0%
F.04.SE.3B5P - Bed 1	0.7	17	Pass	0.5%
F.04.SE.3B5P - Bed 3	0.5	17	Pass	0.5%
F.04.SE.3B5P - Bed 2	0.1	24	Pass	0.7%
F.10.SW/SE 3B6P - Bed 1	1.6	20	Pass	0.6%
F.10.SW/SE 3B6P - Bed 2	0.7	18	Pass	0.5%
F.10.SW/SE 3B6P - Living	2	NA	Pass	N/A
F.10.SW/SE 3B6P - Bed 3	1.1	21	Pass	0.6%
F.10.Studio - Studio	0.5	16	Pass	0.5%
F.10.1B2P - Living	1.2	NA	Pass	N/A
F.10.1B2P - Bed 1	0.4	17	Pass	0.5%
A (N) SE 2B4P - Bed 1	0.8	19	Pass	0.6%
A (N) SE 2B4P - Bed 2	2.6	19	Pass	0.6%
A (S) SE 3B6P - Bed	0.6	25	Pass	0.8%
A (S) SE 3B6P - Living	1.7	NA	Pass	N/A
F.04.SE.3B5P - Living	2.1	NA	Pass	N/A
A (N) 1B2P SW - Living	4	NA	Fail	N/A
A (N) 1B2P SW - Bed	3.4	21	Fail	0.6%
A (S) SW/SE 1B2P - Bed	3	22	Pass	0.7%
A (S) SW/SE 1B2P - Living	3.1	NA	Fail	N/A
B.L5.SW 2 Bed - Living Room	3.1	NA	Fail	N/A
B.07.SW Courtyard 1 Bed - Living Space	3.2	NA	Fail	N/A
B.07.SW 1 Bed - Living Space	4.6	NA	Fail	N/A
B.07.SW 2 Bed - Living Space	3.5	NA	Fail	N/A
A (N) SE 2B4P - Living	3.3	NA	Fail	N/A
A (N) SW 1B2P - Living	4.3	NA	Fail	N/A
A (N) SW 1B2P - Bed 1	3.4	23	Fail	0.7%
F.04.SW/SE 3B 5P - Living	4.4	NA	Fail	N/A

7.3. DSY2

Room Name	Criterion 1	Criterion 2	Result	Criterion 2 %
A (N) 1B2P SW - Bed	2	25	Pass	0.8%
A (S) SW Studio - Studio	1.2	37	Fail	1.1%
A (S) SW/SE 1B2P - Living	2.9	NA	Pass	N/A
A (S) SE 3B6P - Bed	0.9	34	Fail	1.0%
A (S) SE 3B6P - Bed	0.9	34	Fail	1.0%
B.L5 SW Studio - Studio	0.7	24	Pass	0.7%
B.L5.SW 2 Bed - Bedroom 1	0.7	32	Pass	1.0%
B.L5.SW 2 Bed - Bedroom 2	1	34	Fail	1.0%
B.L5.SW 2 Bed - Living Room	2.3	NA	Pass	N/A
B.L5.SW 1 Bed - Bedroom 1	0.9	29	Pass	0.9%
B.L5.SW 1 Bed - Living Room	1.3	NA	Pass	N/A
B.07.SW Courtyard 1 Bed - Bedroom 1	1.2	34	Fail	1.0%
B.07.SW Courtyard 1 Bed - Living Space	2.2	NA	Pass	N/A
B.07.SW 1 Bed - Bedroom 1	1.8	34	Fail	1.0%
B.07.SW 2 Bed - Bedroom 1	1.3	34	Fail	1.0%
B.07.SW 2 Bed - Bedroom 2	2	34	Fail	1.0%
B.07.SW 2 Bed - Living Space	2.6	NA	Pass	N/A
08.W.S.2B4P - Bed 2	0.9	23	Pass	0.7%
08.W.S.2B4P - Bed 1	0.7	23	Pass	0.7%
08.W.S.2B4P - Living	1.4	NA	Pass	N/A
08.W.SE.2B4P - Bed 2	0.9	22	Pass	0.7%
08.W.SE.2B4P - Living Room	1.3	NA	Pass	N/A
08.W.W.1B2P - Bed 1	0.8	19	Pass	0.6%
08.W.W.2B4P - Living	1.2	NA	Pass	N/A
08.W.SE.2B4P - Bed 1	0.3	21	Pass	0.6%
08.W.S.2B4P - Bed 2	0.9	23	Pass	0.7%
08.W.S.2B4P - Bed 1	0.7	23	Pass	0.7%
08.W.S.2B4P - Living	1.4	NA	Pass	N/A
08.W.SE.2B4P - Bed 2	0.9	22	Pass	0.7%
08.W.SE.2B4P - Living Room	1.3	NA	Pass	N/A
08.W.W.1B2P - Bed 1	0.8	19	Pass	0.6%
08.W.W.1B2P - Living	1.3	NA	Pass	N/A
08.W.SE.2B4P - Bed 1	0.3	21	Pass	0.6%
F.04.SW/SE 3B 5P - Bed 1	1	24	Pass	0.7%
F.04.SW/SE 3B 5P - Bed 3	2	37	Fail	1.1%
F.04.SW/SE 3B 5P - Bed 2	1.1	40	Fail	1.2%
F.04.SE 2B4P - Living	1.4	NA	Pass	N/A
F.04.SE 2B4P - Bed 2	1	44	Fail	1.3%
F.04.SE 2B4P - Bed 1	0.9	44	Fail	1.3%
F.04.SE.3B5P - Bed 1	1	22	Pass	0.7%
F.04.SE.3B5P - Bed 3	0.8	22	Pass	0.7%

F.04.SE.3B5P - Bed 2	0.4	42	Fail	1.3%
F.10.SW/SE 3B6P - Bed 1	1.1	23	Pass	0.7%
F.10.SW/SE 3B6P - Bed 2	0.9	23	Pass	0.7%
F.10.SW/SE 3B6P - Living	2.6	NA	Pass	N/A
F.10.SW/SE 3B6P - Bed 3	1.3	23	Pass	0.7%
F.10.Studio - Studio	0.7	22	Pass	0.7%
F.10.1B2P - Living	1.3	NA	Pass	N/A
F.10.1B2P - Bed 1	0.5	22	Pass	0.7%
A (N) SE 2B4P - Bed 1	0.8	23	Pass	0.7%
A (N) SE 2B4P - Living	2.9	NA	Pass	N/A
A (S) SE 3B6P - Bed	0.9	34	Fail	1.0%
A (S) SE 3B6P - Living	1.9	NA	Pass	N/A
F.04.SE.3B5P - Living	3	NA	Pass	N/A
A (N) 1B2P SW - Living	3.5	NA	Fail	N/A
A (S) SW/SE 1B2P - Bed	2.2	26	Pass	0.8%
B.07.SW 1 Bed - Living Space	4.2	NA	Fail	N/A
A (N) SE 2B4P - Bed 2	2	22	Pass	0.7%
A (N) SW 1B2P - Living	3.8	NA	Fail	N/A
A (N) SW 1B2P - Bed 1	2.2	29	Pass	0.9%
F.04.SW/SE 3B 5P - Living	3.9	NA	Fail	N/A

7.4. DSY3

Room Name	Criterion 1	Criterion 2	Result	Criterion 2 %
A (S) SW Studio - Studio	1.6	55	Fail	1.7%
A (S) SW/SE 1B2P - Bed	2.9	40	Fail	1.2%
A (S) SE 3B6P - Bed	1	51	Fail	1.6%
A (S) SE 3B6P - Bed	1	51	Fail	1.6%
B.L5 SW Studio - Studio	1	39	Fail	1.2%
B.L5.SW 2 Bed - Bedroom 1	1	49	Fail	1.5%
B.L5.SW 2 Bed - Bedroom 2	1.2	48	Fail	1.5%
B.L5.SW 1 Bed - Bedroom 1	1.1	47	Fail	1.4%
B.L5.SW 1 Bed - Living Room	1.5	NA	Pass	N/A
B.07.SW Courtyard 1 Bed - Bedroom 1	1.6	49	Fail	1.5%
B.07.SW Courtyard 1 Bed - Living Space	2.5	NA	Pass	N/A
B.07.SW 1 Bed - Bedroom 1	2.6	49	Fail	1.5%
B.07.SW 2 Bed - Bedroom 1	1.9	49	Fail	1.5%
B.07.SW 2 Bed - Bedroom 2	2.8	49	Fail	1.5%
08.W.S.2B4P - Bed 2	1.4	42	Fail	1.3%
08.W.S.2B4P - Bed 1	1.1	41	Fail	1.2%
08.W.S.2B4P - Living	1.7	NA	Pass	N/A
08.W.SE.2B4P - Bed 2	1.1	37	Fail	1.1%
08.W.SE.2B4P - Living Room	1.4	NA	Pass	N/A
08.W.W.1B2P - Bed 1	1.2	31	Pass	0.9%

08.W.W.2B4P - Living	1.7	NA	Pass	N/A
08.W.SE.2B4P - Bed 1	0.5	34	Fail	1.0%
08.W.S.2B4P - Bed 2	1.4	42	Fail	1.3%
08.W.S.2B4P - Bed 1	1.1	41	Fail	1.2%
08.W.S.2B4P - Living	1.7	NA	Pass	N/A
08.W.SE.2B4P - Bed 2	1.1	37	Fail	1.1%
08.W.SE.2B4P - Living Room	1.4	NA	Pass	N/A
08.W.W.1B2P - Bed 1	1.2	31	Pass	0.9%
08.W.W.1B2P - Living	1.9	NA	Pass	N/A
08.W.SE.2B4P - Bed 1	0.5	34	Fail	1.0%
F.04.SW/SE 3B 5P - Bed 1	1.3	43	Fail	1.3%
F.04.SW/SE 3B 5P - Bed 2	1.3	62	Fail	1.9%
F.04.SE 2B4P - Living	1.5	NA	Pass	N/A
F.04.SE 2B4P - Bed 2	1.3	66	Fail	2.0%
F.04.SE 2B4P - Bed 1	1.1	69	Fail	2.1%
F.04.SE.3B5P - Bed 1	1.2	35	Fail	1.1%
F.04.SE.3B5P - Bed 3	1	35	Fail	1.1%
F.04.SE.3B5P - Bed 2	0.6	63	Fail	1.9%
F.10.SW/SE 3B6P - Bed 1	1.5	40	Fail	1.2%
F.10.SW/SE 3B6P - Bed 2	1	37	Fail	1.1%
F.10.SW/SE 3B6P - Living	2.8	NA	Pass	N/A
F.10.SW/SE 3B6P - Bed 3	1.4	40	Fail	1.2%
F.10.Studio - Studio	0.9	35	Fail	1.1%
F.10.1B2P - Living	1.7	NA	Pass	N/A
F.10.1B2P - Bed 1	0.8	36	Fail	1.1%
A (N) SE 2B4P - Bed 1	1.1	36	Fail	1.1%
A (N) SE 2B4P - Bed 2	2.8	35	Fail	1.1%
A (S) SE 3B6P - Bed	1	51	Fail	1.6%
A (S) SE 3B6P - Living	2	NA	Pass	N/A
A (N) 1B2P SW - Living	4.7	NA	Fail	N/A
A (N) 1B2P SW - Bed	3	42	Fail	1.3%
B.07.SW 2 Bed - Living Space	3.7	NA	Fail	N/A
F.04.SW/SE 3B 5P - Bed 3	3.2	60	Fail	1.8%
A (N) SE 2B4P - Living	3.6	NA	Fail	N/A
A (N) SW 1B2P - Living	5.1	NA	Fail	N/A
A (N) SW 1B2P - Bed 1	3.1	46	Fail	1.4%
F.04.SE.3B5P - Living	3.5	NA	Fail	N/A
F.04.SW/SE 3B 5P - Living	5.9	NA	Fail	N/A

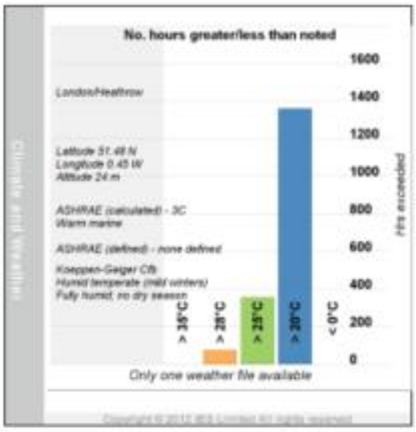
Appendix D: TM59 Operational Profiles

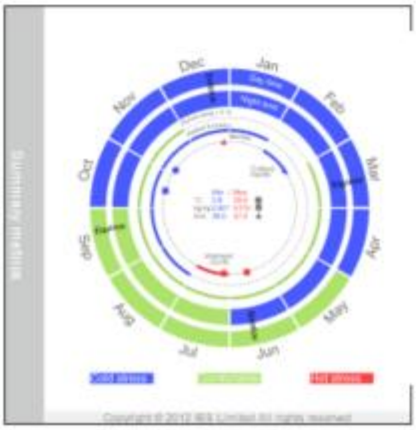
Table 2 Occupancy and equipment gain descriptions

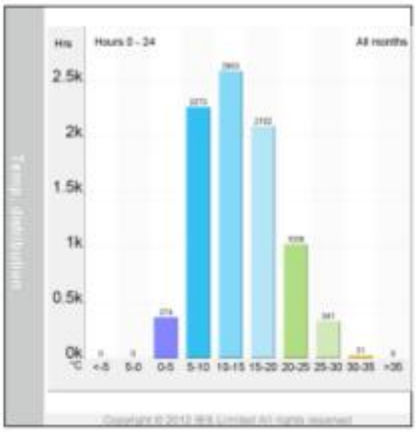
Unit/ room type	Occupancy	Equipment load
Studio	2 people at 70% gains from 11 pm to 8 am 2 people at 100% gains from 8 am to 11 pm	Peak load of 450 W from 6 pm to 8 pm*. 200 W from 8 pm to 10 pm 110 W from 9 am to 6 pm and 10 pm to 12 pm Base load of 85 W for the rest of the day
1-bedroom apartment: living room/kitchen	1 person from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 450 W from 6 pm to 8 pm 200 W from 8 pm to 10 pm 110 W from 9 am to 6 pm and from 10 pm to 12 pm Base load of 85 W for the rest of the day
1-bedroom apartment: living room	1 person at 75% gains from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 150 W from 6 pm to 10 pm 60 W from 9 am to 6 pm and from 10 pm to 12 pm Base load of 35 W for the rest of the day
1-bedroom apartment: kitchen	1 person at 25% gains from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 300 W from 6 pm to 8 pm Base load of 50 W for the rest of the day
2-bedroom apartment: living room/kitchen	2 people from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 450 W from 6 pm to 8 pm 200 W from 8 pm to 10 pm 110 W from 9 am to 6 pm and from 10 pm to 12 pm Base load of 85 W for the rest of the day
2-bedroom apartment: living room	2 people at 75% gains from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 150 W from 6 pm to 10 pm 60 W from 9 am to 6 pm and from 10 pm to 12 pm Base load of 35 W for the rest of the day
2-bedroom apartment: kitchen	2 people at 25% gains from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 300 W from 6 pm to 8 pm Base load of 50 W for the rest of the day
3-bedroom apartment: living room/kitchen	3 people from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 450 W from 6 pm to 8 pm 200W from 8 pm to 10 pm 110 W from 9 am to 6 pm and from 10 pm to 12 pm Base load of 85 W for the rest of the day
3-bedroom apartment: living room	3 people at 75% gains from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 150 W from 6 pm to 10 pm 60 W from 9 am to 6 pm and from 10 pm to 12 pm Base load of 35 W for the rest of the day
3-bedroom apartment: kitchen	3 people at 25% gains from 9 am to 10 pm; room is unoccupied for the rest of the day	Peak load of 300 W from 6 pm to 8 pm base load of 50 W for the rest of the day
Double bedroom	2 people at 70% gains from 11 pm to 8 am 2 people at full gains from 8 am to 9 am and from 10 pm to 11 pm 1 person at full gains in the bedroom from 9 am to 10 pm	Peak load of 80 W from 8 am to 11 pm Base load of 10 W during the sleeping hours
Single bedroom (too small to accommodate double bed)	1 person at 70% gains from 11 pm to 8 am 1 person at full gains from 8 am to 11 pm	Peak load of 80 W from 8 am to 11 pm Base load of 10 W during sleeping hours
Communal corridors	Assumed to be zero	Pipework heat loss only; see section 3.1 above

APPENDIX E: CLIMATE METRICS – DSY 1

Climate metrics







London/Heathrow

ASHRAE 90.1[1] (calculated)	3C	Warm marine (NB: for this weather file the ASHRAE climate type (A/B/C) had to be overridden by the degree day tests)
ASHRAE 90.1[1] (defined)	none defined	
Koeppen-Geiger[1]	Cfb	Humid temperate (mild winters), Fully humid; no dry season, Warm summer (marine), Mild winters with heavy precipitation, warm/short/dry summers, on western continental coasts

Chosen weather file is London_LWC_DSY1_2020High50.epw

Rainfall location: London -Heathrow, United Kingdom

Heating and cooling degree days are similar; summer/winter seasons are both dominant - minimise heating and cooling energy.

Latitude is mid - solar radiation on south/east/west walls is significant. Solar radiation on roofs is significant.

Summer is warm. Summer also has a moderate diurnal range. Summer also has cool summer nights.

Winter is mild.

Wind patterns: Typically westerly winds.

Temperature[2]:

Warmest month Jul
Max annual temperature (Jul) 33.6 °C
Warmest six months Jul Aug Sep Jun May Oct
Coldest month Feb
Min annual temperature (Nov) 0.9 °C
Coldest six months Feb Dec Jan Apr Nov Mar
Number of months warmer than 10.0°C mean = 7

Diurnal temperature swing[3]:

0 months swing > 20 °C, of which 0 are in the warmest 6M
0 months swing 15 to 20 °C, of which 0 are in the warmest 6M
0 months swing 10 to 15 °C, of which 0 are in the warmest 6M
9 months swing 5 to 10 °C, of which 6 are in the warmest 6M
3 months swing < 5 °C

Moisture and humidity[4]:

Max. moisture content 0.014 kg/kg
Min. moisture content 0.001 kg/kg
Mean moisture content 0.007 kg/kg
Mean relative humidity 69.4 %

Wind[5]:

Annual mean speed 4.7 m/s
Annual mean direction E of N 229.5°

Precipitation[6]:

Annual rainfall 611.0 mm
Driest month Feb with 36.0 mm rainfall
Wettest month Dec with 67.0 mm rainfall
Wettest summer month Oct
Wettest winter month Nov
Driest summer month Jul
Driest winter month Feb
Wettest six months Dec Nov Oct Aug Sep Jan

Solar energy[7]:

Annual hourly mean global radiation(a) 123.3 W/m²
Mean daily global radiation(b) 2948.7 Wh/m²
Annual solar resource(c) 1079.9 kWh/m².yr
Annual mean cloud cover(d) 5.1 oktas

Degree days[8]:

HDD(18.3) = 1925.2
CDD(10.0) = 1629.7

The climate report provides the headlines you need to know about the weather file you have selected.

1. The Ashrae 90.1 climate classes are based around the Koeppen-Geiger classification system, but provide better definition in temperate and maritime zones. See also Koeppen Geiger and Kottek, Greiser.Beck, Rudolf and Rubel. Both the climate zone defined by ASHRAE and the climate zone calculated from the assigned weather data are displayed. The analysis in this report is based on the calculated climate zone.

2. Note the coincidence of wet or dry seasons and warm or cold seasons e.g. Wet summers, dry summers, wet winters etc.

3. A good diurnal swing (monthly mean of the daily swing) during the warmest months indicates the potential for passive night time cooling and the use of thermal mass.

4. Moisture content the nominal comfort range is 0.004-0.012 kg/kg If moisture content is 0.020 kg/kg or above either all year or in summertime it is an issue. High humidity high temp. cause comfort stress.

5. Wind speeds:
less than 1.5 ms light and calm
1.5-8 ms breeze
8-14 ms strong breeze
greater than 14 ms gale and above

6. Typically what does annual rainfall mean:
Wet 1700mm
Temperate 500 to 1500mm
Dry 300mm
Desert 100mm

7. Globally what is the range?
a. 150 to 450
b. 2000 to 6500
c. 800 to 2200
d. 1.5 to 8

8. Globally what is the range?
HDD 0 to 8000
CDD 0 to 6500