Elmsbrook NW, Bicester

Crest Nicholson Chiltern

Residential Summer Overheating Analysis
CIBSE TM59:2017

AES Sustainability Consultants Ltd

March 2021

AES Sustainability Consultants

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Revision	Author	Date	Comment
-	Silvio Junges	12.03.2021	Initial Issue

This report has been commissioned by Crest Nicholson Chiltern to assess the potential risk of overheating to a number of plots at Elmsbrook NW, Bicester. It should be noted that the details presented, including the proposed specifications, are subject to change as the detailed design of the dwellings progresses, whilst ensuring that the overall commitments will be achieved.

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List of figures & tables

1. Executive Summary

Purpose and scope of the statement

1.1. AES Sustainability Consultants Ltd has undertaken calculations to identify whether houses (Evesham or Royden) within Elmsbrook NW, Bicester will be at significant risk of overheating. The samples have been selected as their orientation and glazing areas represent a worst case for the proposed development.

1.2. This report uses room profiles assessed against CIBSE benchmarks outlined in CIBSE TM52:2013 and TM59:2017 for the analysis of the risk of overheating by using CIBSE weather files.

1.3. CIBSE TM59 provides a methodology to assess the risk of overheating in homes and has been used to carry out this analysis.

1.4. Compliance is based on passing BOTH of the following 2 criteria:

1) TM52 Criterion 1 must pass (Operative temperature cannot exceed the upper comfort limit for more than 3% of the occupied summer hours).

2) TM59 Bedrooms only - An additional requirement must be checked for the bedrooms to guarantee comfort during the sleeping hours. The resultant temperature in the bedroom from 10pm to 7am cannot exceed 26°C for more than 1% of annual hours (1% of hours between 22:00-07:00 for bedrooms is 32 hours).

1.5. The modelling has been conducted using design weather data taken from the file CIBSE Swindon Weather Centre - Design Summer Year 1 (CIBSE Swindon DSY 1 - 2050s, high emissions, 50% scenario). The weather files have been chosen as most appropriate following guidance from TM59:2017 and the CL2.1 SBEM Weather location lookup.

Figure 1. Proposed Site Layout

CIBSE Location DSY 1 - 2050s, high emissions, 50% scenario

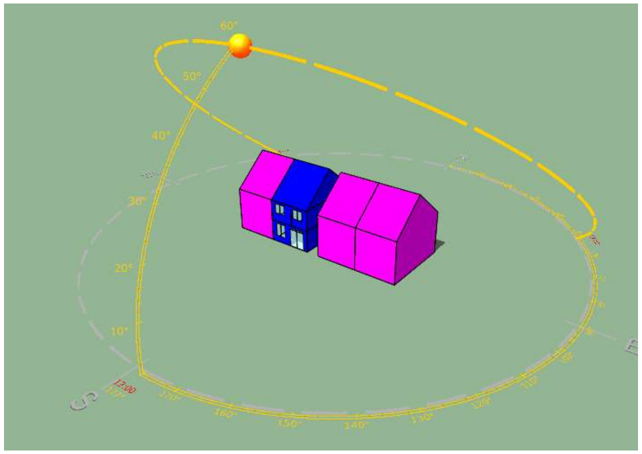
1.6. Initial results indicate that there is a risk of overheating using the base specification with a Windows U value of 1.40 / g-value of 0.72.

Table 1: Thermal modelling results (CIBSE Location DSY 1 - 2050, high emissions, 50% scenario)

	Results Evesham / Royden
Base case (g-value 0.72)	Kitchen / Dining / Family (KDF) Fail
Mitigation Measure 1 (g-value 0.63)	KDF / Living Fail
Mitigation Measure 2 (g-value 0.50)	Pass to all rooms

1.7. The modelled Mitigation measure 2 is shown to be effective for all rooms (Living/ Kitchen/ Bedrooms) on dwellings at ground floor level.

1.8. Based on these results we would recommend that the window specification is revised to incorporate a g- value of 0.50 in order mitigate the high risk of overheating.



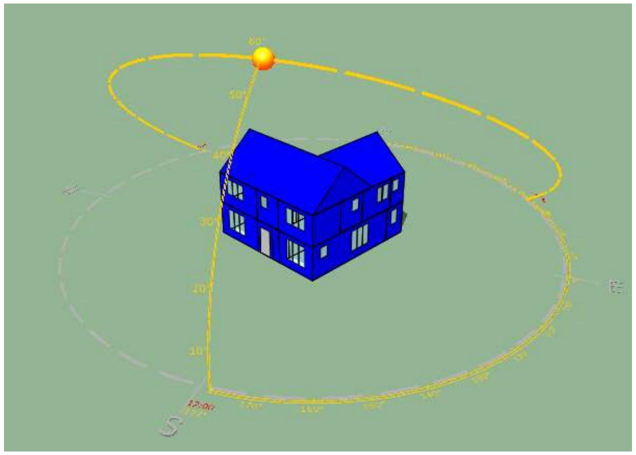


Figure 2 & 3. 3D Model (IES VE)

2. Scope and Limitations

2.1. Part L1A – Building Regulations 2013 Criterion 3 – Limiting the effects of solar gains during the summer states that reasonable provision should be made to limit solar gains. This can be achieved by an appropriate combination of window size and orientation, solar protection through shading and other solar control measures, ventilation (day and night) and high thermal capacity.

2.2. This is assessed within SAP in terms of regulatory compliance, however, this is a not a particularly sensitive analysis. Assessing the risk in accordance with CIBSE guidance provides a more in-depth analysis.

2.3. Living areas and bedrooms are the rooms that should be considered most closely as it is envisaged that these will be the rooms occupied for significant periods of time. Bedroom temperatures are likely to be most critical as people find sleeping difficult in the heat. Rooms such as bathrooms, circulations spaces, store rooms and kitchens do not have overheating criteria or a suggested maximum temperature as it is envisaged that no one will occupy these rooms for a significant period of time.

2.4. The purpose of this report is to ascertain whether internal temperatures are likely to exceed the criterion recommended in CIBSE TM59:2017 – Design methodology for the assessment of overheating risk in homes.

2.5. This methodology provides a baseline for all domestic overheating risk assessments. and will:

1) Allow different designs to be compared with a common approach based on reasonable assumptions.
2) Support design decisions that improve comfort without cooling.
3) Provide consistency across the industry as all consultants will be using the same methodology for overheating risk prediction.

2.6. This methodology will not:

1) Guarantee that people will always be comfortable, however they act.
2) Take into account unusual use.

2.7. Compliance is based on passing BOTH of the following 2 criteria:

a) TM52 Criterion 1 must pass (Operative temperature cannot exceed the upper comfort limit for more than 3% of the occupied summer hours)
b) TM59 Bedrooms only - An additional requirement must be checked for the bedrooms to guarantee comfort during the sleeping hours. The resultant temperature in the bedroom from 10pm to 7am cannot exceed 26°C for more than 1% of annual hours (1% of hours between 2200-0700 for bedrooms is 32 hours).

2.8. If a dwelling fails above criteria, measures should be investigated to reduce internal temperatures and therefore reduce the likelihood of overheating.

2.9. To ensure that the CIBSE standards are met it is necessary to use appropriate simulation software in the design process and introduce adequate measures to ensure it is maintained within the completed dwellings. In order to assess the overheating risk IES Virtual Environment has been used. IES Virtual Environment is a state-of-the-art dynamic modelling software tool for assessing building energy, carbon, lighting and thermal comfort.

2.10. IES version 2019 'Apache Sim' has been used to carry out dynamic simulation to analyse the thermal comfort likely to be experienced within dwellings. The full dynamic simulation in accordance with CIBSE TM59:2017 combines the effects of:

- Annual Design Summer Year (DSY) weather data as produced by CIBSE;
- Casual, lighting and people heat gains;
- Thermal mass of the building;
- Solar heat gain.

2.11. All results and strategies are directly affected by the inputs listed in this document. Any deviations from these will affect the results. It is important to note that with any modelling exercise there are assumptions and approximations that have to be made. Details of all assumptions made and approximations used are supplied as part of the report.

2.12. The results give an indication of the predicted environmental conditions based on weather data and the anticipated operation strategy of the building.

2.13. The predicted simulated internal temperatures generated by the software may not match the actual internal air temperatures due to several reasons, for example, change in space function, use of equipment, natural wear and tear of building elements, global climate change and metrological changes, change in operation management of apertures etc.

3. Introduction to Overheating in Modern Dwellings

3.1. The project team should consider the risk of overheating in their building designs very early in the design process as it has the potential to not only cause discomfort for building occupants, but also cause potentially harmful medical conditions such as dehydration or heat exhaustion.

3.2. People may feel hot, uncomfortable and show lower productivity when temperatures reach between 25-28°C. Indoor operative temperatures that stay at or over 28°C for long periods of the day will result in dissatisfaction for many occupants. This can be expressed as the occupant experiencing thermal discomfort and in some cases thermal stress. Thermal discomfort is where occupants feel uncomfortable as they are too hot (or cold). Thermal stress is where the thermal environment will cause potentially harmful medical conditions such as dehydration or heat exhaustion. Vulnerable people, such as the elderly are particularly susceptible to health problems due to overheating.

3.3. Homes in the UK have not historically been associated with overheating. This is most likely due to a combination of the heavyweight materials from which they were constructed, a low level of thermal insulation and high levels of uncontrolled ventilation through minor gaps in the fabric.

3.4. The use of heavyweight materials provides high thermal mass within the building envelope. This ensures that external daily temperature variations are not reproduced as quickly inside the building because the fabric will absorb heat during the day and release it slowly when temperatures drop at night. In this way, the impact of maximum heat levels reached during the day is delayed by the thermal mass of the building and can be counter-balanced by strategies that make use of the cool of the night.

3.5. Modern homes are usually constructed from lightweight materials, are highly insulated, have been built to high standards of air tightness and have double-glazed windows that have coatings specifically designed to trap the sun's heat. This results in more heat being retained within the homes which is not able to be absorbed by the lightweight fabric.

3.6. Rooms with large glazing areas to their South and West facades are likely to be those at highest risk of overheating. South facades receive the highest amount of direct sunlight when the sun is highest, whilst West facades experience unwanted solar gains from low-level sun in the evenings. Proposed mitigation measures need to take account of the difference in the position of the sun during the day as some measures will work on certain facades but not on others. For example, overhangs can block out the sun when it is high in the sky but will have little effect if installed on West facing elevations when the sun is low in the sky.

3.7. Overheating in apartments is a greater risk where apartments are designed with a single-aspect and where community heating pipework is routed through corridors and common spaces. In these situations, high internal temperatures are often caused by a combination of inadequate ventilation and excessive heat discharged by heating pipework.

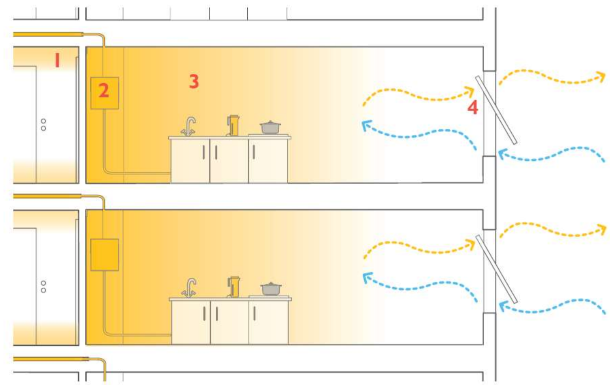


Figure 4. Service design in apartments, cumulative effects of individual heat gains

3.8. Mechanical services installed in apartments cause heat gains in the same way as in houses; however with limited scope for ventilation their impact becomes more significant. Consequently, a different strategy is required to ensure that unwanted heat is removed. In blocks where space and water heating is provided by a community heating system, the CIU is permanently charged with hot water all year round to meet the hot water demand. This unit, particularly if not well insulated, may effectively emit heat like a radiator in the dwelling. It is often positioned in an unventilated cupboard or kitchen so heat transfers directly to the living spaces.

3.9. In addition, the distribution pipework for the community heating system often runs through the corridors and common spaces. Since this pipework is constantly emitting heat, it can cause high temperatures in these spaces, especially when there is insufficient ventilation. Even well-insulated heating systems will emit heat, albeit at a slower rate. Unless there is a strategy to remove this heat it will be transferred from common areas into the adjacent apartments.

4. Methodology and Key Assumptions

Methodology

4.1. CIBSE has undertaken considerable consultation and research on the impact of climate change on the indoor environment and weather data. TM52:2013, TM59:2017, CIBSE Guide A 2015, AD Part L1A 2013, AD Part F 2013 and SAP 2012 provide data on maximum average temperatures, ventilation rates and overheating criteria for areas of dwellings as illustrated below. We have used this data as the basis for our analysis and the recommendations presented in this report.

4.2. Building Regulations Part F 2013 states that for dwellings the whole dwelling ventilation rate for the supply of air to the habitable rooms should be no less than the rates detailed in the Table 2 below.

Table 2: Part F minimum standards for new dwellings

Room	Intermittent extract	Continuous extract	
	Minimum rate	Minimum high rate	Minimum low rate
Kitchen	30 l/s adjacent to hob; or 60 l/s elsewhere	13 l/s	Total extract rate should be at least the ***whole dwelling ventilation*** rate given in Table 5.1b
Utility room	30 l/s	8 l/s	
Bathroom	15 l/s	8 l/s	
Sanitary accommodation	6 l/s	6 l/s	

4.3. The proposed ventilation for all of the houses on this development is intermittent. These units individually extract air from wet rooms, such as bathrooms and kitchens.

4.4. Intermittent fans are operated by the occupant and for the purpose of this assessment, they have been ignored.

Weather Data

4.5. Our analysis has been carried out using average weather data appropriate to the location of the proposed development. The weather files that have been used are CIBSE Swindon Weather Centre:

- CIBSE Swindon DSY 1 - 2050s, high emissions, 50% percentile scenario

4.6. Figure 5 below shows a typical metrological year for Swindon using DSY 1 2050 weather data. Dry bulb temperature excees 31.6°C in August and the maximum adaptive temperature is exceeded 46 hours over the course of a year..

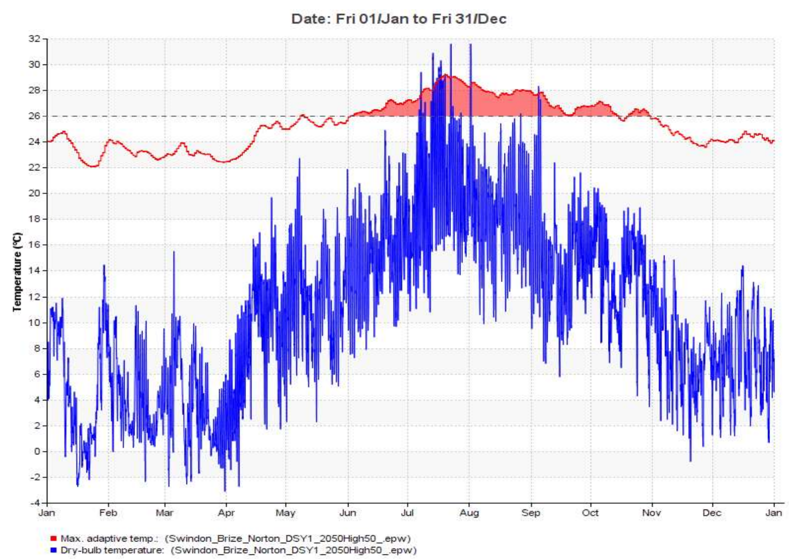


Figure 5: Temperature profile CIBSE Swindon DSY 01 2050, high emissions, 50% percentile scenario [Screenshot - Climate consultant v6.0]

Development Design

4.7. The modelling has been based upon the architectural plans: issue dated 18.01.2021 provided by PAD Architects, on 26.02.2021 to AES. For more detailed designs, please see Appendix B of this report.

4.8. The following design criteria have been used in the modelling software to perform the calculations and modelling to assess the risk of summertime overheating.

Building Fabric

4.9. The building elements were modelled according to the construction specification detailed in the table below, with derivation of an overall U-value calculated using the BRE U-value calculator, or by the software used for the overheating analysis.

Table 3: Baseline Building Fabric

Construction Elements	U-value in [W/m2K]	Kappa in (kJ/m²K)
Ground Floor	0.12	83
External Wall	0.25	60
Main Roofs	0.11	9
Int. Ceiling & Floor	N/A	9
Party Wall	N/A	60
Internal Partitions	N/A	9
Windows	U=1.40	g=0.72
Infiltration	CIBSE A 2015 - Table 4.24	0.25 ACH

*Kappa values stated for structural element only. DSM model accounts for low thermal mass including the plasterboard of the suspended ceiling.

Lighting Gains

4.10. The following table summarises the assumed lighting gains used in the base model. Light energy is assumed to be proportional to the floor area. Only summer months are assessed from 6pm to 11 pm.

Table 4: Lighting Gains

Area	Lighting Gains in (W/m2)	Notes
All rooms	2.0	TM59

Natural Ventilation

4.11. One of the most effective ways of addressing the risk of overheating in homes is to have a well thought out strategy for purge ventilation (supply of large amounts of fresh air in a short period of time).

4.12. This can be achieved by providing means for cross-ventilation, circulating large amounts of air through the home. Where mechanical ventilation is used, occupants should still be able to open windows adequately and in a secure manner, even if only for a short period of time.

Table 5: Ventilation & Shading Strategy

	Notes
Ventilation Strategy	Calculated natural ventilation (MacroFlo). Windows / doors are allowed to be open when internal temperatures are higher than ambient temperatures and internal dry-bulb temperature exceeds 22°C.
Shading Strategy	Shade from neigbouring dwellings included

4.13. Natural ventilation via openable windows has been allowed during times when the room being assessed is occupied. For a more detailed schedule of ventilation assumptions, please see Appendix D of this report.

Occupancy Gains

4.14. Maximum Sensible Gain assumptions are based on CIBSE Guide A 2015 at 75 W/person and Maximum Latent Gain of 55 W/person. See Appendix C for full occupancy profiles.

Equipment Gains

4.15. It is assumed that dwellings with the same number of occupants and bedrooms are usually provided with the same appliances, therefore any gains resulting from them is assumed to be independent of floor area.

4.16. The following equipment gains have been assumed for the rooms being assessed. Equipment gains for the living room are based on CIBSE TM59. Variation profiles are shown in Appendix C.

Table 6: Equipment gains

Room	Equipment gains (W)	
Living/Kitchen	450	ICT (information and communications technologies), Audio-visual and Kitchen appliances and others
Bedroom	80	Laptop or TV
HIU (in cupboard)	78	Cupboard pipework for gain and HIU 50W

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5. Results – Summertime Overheating Modelling

5.1. The following table illustrate the results using the design specification, mechanical and natural ventilation. The results are compared with the recommendations from TM59:2017 as stated earlier in this report.

Items within the table:

- Items in Red DO NOT comply with the CIBSE recommendations
- Items in Green DO comply with the CIBSE recommendations

5.2. Natural ventilation via openable windows has been allowed once the internal air temperature exceeds a comfortable temperature, which is modelled as 22°C.

5.3. Compliance is based on passing BOTH of the following 2 criteria:

1) TM52 Criterion 1 must pass (Operative temperature cannot exceed the upper comfort limit for more than 3% of the occupied summer hours)

2) TM59 Bedrooms only - An additional requirement must be checked for the bedrooms to guarantee comfort during the sleeping hours. The resultant temperature in the bedroom from 10pm to 7am cannot exceed 26°C for more than 1% of annual hours. (1% of hours between 22:00-07:00 for bedrooms is 32).

Results - Natural Ventilation - (Base Case)

5.4. The below table shows the detailed results against CIBSE TM59:2017 criteria when using a glazing g-value of 0.50 to all elevations.

Table 7. Results – Natural Ventilation (Base Case)

Houses	Room Name	Criteria 1	Criteria 2	Pass / Fail
Eavesham	Living	4.1	N/A	Fail
	Kitchen	2.5	N/A	Pass
	Bedroom 01	1.8	27	Pass
	Bedroom 02	1.1	14	Pass
	Bedroom03	2.1	20	Pass
Royden	Living Room	2.9	N/A	Pass
	Kitchen / Dining / Family	3.5	N/A	Fail
	Bedroom 01	1.9	29	Pass
	Bedroom 02	1.5	23	Pass
	Bedroom 03	1.3	22	Pass
	Bedroom 04	2.1	25	Pass
	Bedroom 05	1.6	21	Pass

5.5. The results show there is a significant risk of overheating within the living & Kitchen / Dining / Family when compared with CIBSE TM59. The maximum hours of exceedance are not above the 3% threshold.

5.6. The results show that the predicted hours over and above 26°C in Bedrooms between 10pm and 7am are less than 32 hours in total and therefore the second design criteria is met.

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Results - Natural Ventilation - (Mitigation 1)

5.7. The below table shows the detailed results against CIBSE TM59:2017 criteria when using a glazing g-value of 0.63 to all elevations.

Table 8. Results – Natural Ventilation (Mitigation 1)

Houses	Room Name	Criteria 1	Criteria 2	Pass / Fail
Eavesham	Living	3.8	N/A	Fail
	Kitchen	2.3	N/A	Pass
	Bedroom 01	1.6	26	Pass
	Bedroom 02	1.1	14	Pass
	Bedroom03	1.9	20	Pass
Royden	Living Room	2.7	N/A	Pass
	Kitchen / Dining / Family	3.2	N/A	Fail
	Bedroom 01	1.7	29	Pass
	Bedroom 02	1.4	21	Pass
	Bedroom 03	1.2	20	Pass
	Bedroom 04	2.0	25	Pass
	Bedroom 05	1.5	20	Pass

5.8. The results show there is a significant risk of overheating within the living & Kitchen / Dining / Family when compared with CIBSE TM59. The maximum hours of exceedance are not above the 3% threshold.

5.9. The results show that the predicted hours over and above 26°C in Bedrooms between 10pm and 7am are less than 32 hours in total and therefore the second design criteria is met.

Results - Natural Ventilation - (Mitigation 2)

5.10. The below table shows the detailed results against CIBSE TM59:2017 criteria when using a glazing g-value of 0.50 to all elevations.

Table 9. Results – Natural Ventilation (Mitigation 2)

Houses	Room Name	Criteria 1	Criteria 2	Pass / Fail
Eavesham	Living	2.9	N/A	Pass
	Kitchen	1.9	N/A	Pass
	Bedroom 01	1.4	24	Pass
	Bedroom 02	1.0	13	Pass
	Bedroom03	1.6	13	Pass
Royden	Living Room	2.4	N/A	Pass
	Kitchen / Dining / Family	2.9	N/A	Pass
	Bedroom 01	1.4	28	Pass
	Bedroom 02	1.3	21	Pass
	Bedroom 03	1.1	20	Pass
	Bedroom 04	1.6	24	Pass
	Bedroom 05	1.3	18	Pass

5.11. The results show there is no significant risk of overheating within any rooms when compared with CIBSE TM59. The maximum hours of exceedance are not above the 3% threshold.

5.12. The results show that the predicted hours over and above 26°C in Bedrooms between 10pm and 7am are less than 32 hours in total and therefore the second design criteria is met.

References

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Thermal simulation software: IES Virtual Environment – Version 2019

Weather file: CIBSE, in collaboration with UK Climate Impacts Programme (UKCIP). - http://www.cibse.org/index.cfm?go=page.view&item=1300

Appendix A – TM59 Risk factors

Risk Factors

A simple list of risk factors is provided below to assist in determining developments that have low risk of overheating and therefore do not require dynamic thermal modelling.

It is recommended that the risk factors are used for the assessment of all units and properties are identified as being at risk when they have answered 'yes' against any one of the risk factors below.

☐ Site location – South East England, Urban e.g. central London or in a high density urban area (UHI effect)

☐ Occupancy – Vulnerable people (elderly, disabled, young children), occupants likely to be at home during the day (e.g. students)

☐ Dwelling type – top floor, single aspect

☒ Fabric type – lightweight, dark colour facades, air tight constructions

☒ Orientation – South, south east/west

☒ Glazing – glazing ratio greater than 25%, roof lights

☐ Environmental factors that restrict the opening of windows – noise and air quality (e.g. near busy roads, railways, airports and flight paths, industrial activities, security (e.g. ground floor flats)

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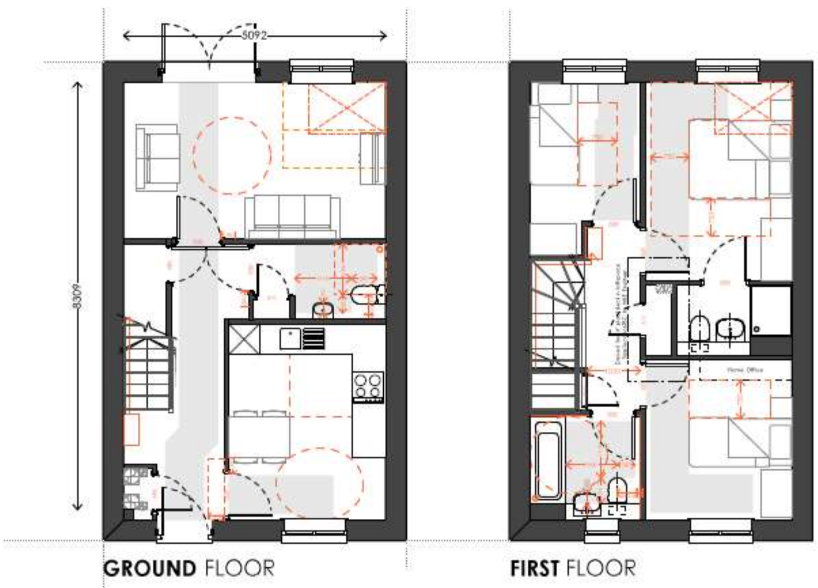
Appendix B – Dwelling designs

Development Design

The modelling has been based upon the architectural plans: issue dated 18.01.2021 provided by PAD Architects, on 26.02.2021 TO AES.

Floor Name:	Ground / First Floor	
Plot Number:	Evesham	



Floor Name:	Elevations	
Plot Number:	Evesham	

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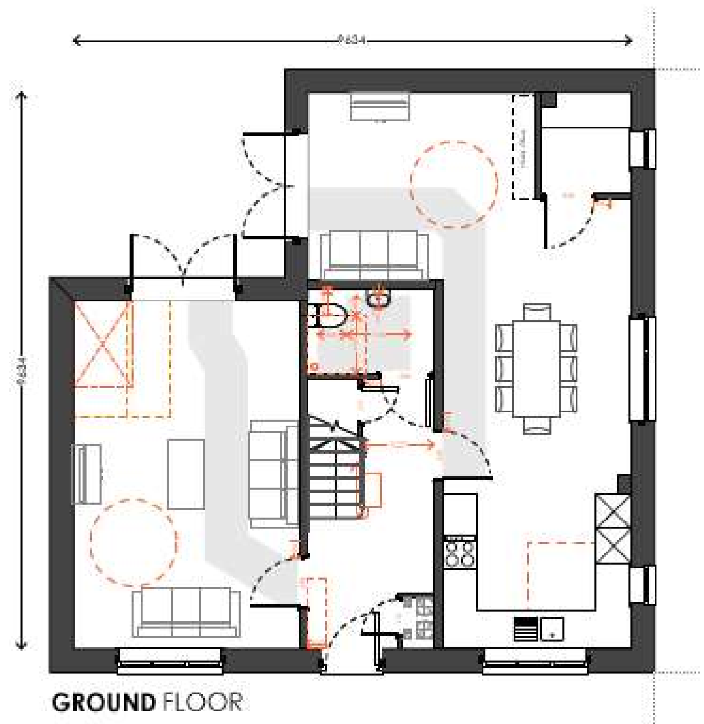
Floor Name:	Ground Floor
Plot Number:	Royden



Floor Name:	First Floor
Plot Number:	Royden

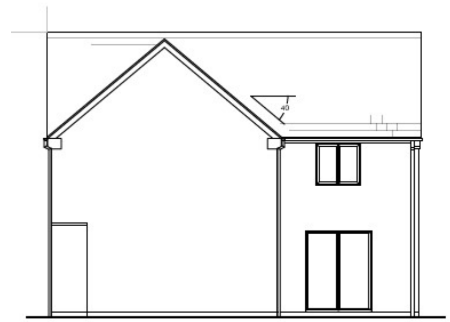
Floor Name:	Front / Side Elevation
Plot Number:	Royden

FRONT ELEVATION

SIDE ELEVATION

Floor Name:	Rear / Side Elevation
Plot Number:	Royden

SIDE ELEVATION



REAR ELEVATION

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Appendix C – Modelling schedules

It is noted that the CIBSE TM59 method only assesses the overheating risk during occupied hours. The occupancy assumed is based on a typical lifestyle pattern for the occupants of each storey. The graphs illustrate the hours during which occupancy gains have been assumed.

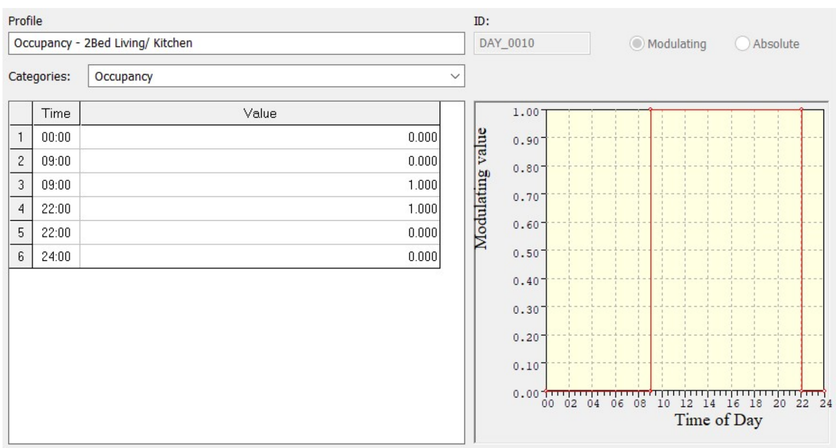
The houses have been modelled as occupied for 24 hours a day.

Kitchen / Living Rooms

Kitchen/Living rooms will be unoccupied during the sleeping hours and occupied during the rest of the day. This is the worst case scenario since the room will be modelled as occupied during the hottest hours of the day.

No differences between weekdays and weekend are considered.

Living / Kitchen occupancy



	Time	Value
1	00:00	0.000
2	09:00	0.000
3	09:00	1.000
4	22:00	1.000
5	22:00	0.000
6	24:00	0.000

1, 2 bed dwelling kitchen/living

1 person from 9am to 10pm at 100% gains

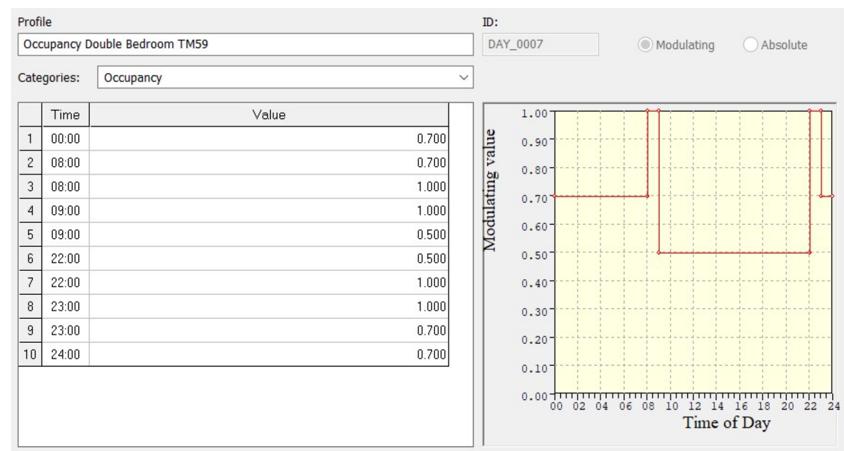
Room is unoccupied for the rest of the day

Double bedrooms

Bedrooms will be set with a 24h occupancy profile which means that 1 person is always considered inside the room during the daytime, and two people in each double bedroom at night.

For dwellings with more than 1 bedroom, 1 person will be considered during the daytime in both the bedrooms in order to assess the worst case scenario. This means that one excess person to the real number of occupants will be considered in the dwelling during the day (a visitor).

Double Bedroom occupancy



	Time	Value
1	00:00	0.700
2	08:00	0.700
3	08:00	1.000
4	09:00	1.000
5	09:00	0.500
6	22:00	0.500
7	22:00	1.000
8	23:00	1.000
9	23:00	0.700
10	24:00	0.700

2 people are in the bedroom with 30% reduced gains from 11pm to 8am and with full gains from 8am to 9am and from 10pm to 11pm; 1 person at full gain is in the bedroom from 9am to 10pm

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Single bedrooms

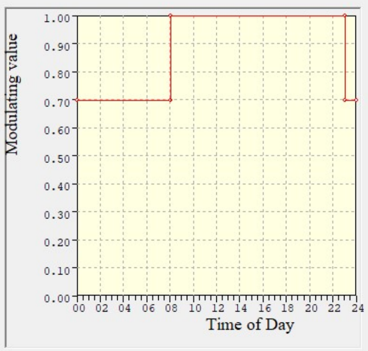
Bedrooms will be set with a 24h occupancy profile which means that 1 person is always considered inside the room during the daytime, and two people in each double bedroom at night.

For houses with more than 1 bedroom, 1 person will be considered during the daytime in both the bedrooms in order to assess the worst case scenario. This means that one excess person to the real number of occupants will be considered in the dwelling during the day (a visitor).

Single Bedroom occupancy

Profile: Single Bedroom Occupancy
ID: DAY_0004
Modulating / Absolute
Categories:

	Time	Value
1	00:00	0.700
2	08:00	0.700
3	08:00	1.000
4	23:00	1.000
5	23:00	0.700
6	24:00	0.700



1 person is in the bedroom with 30% reduced gains from 11pm to 8am and with full gains from 8am to 11pm

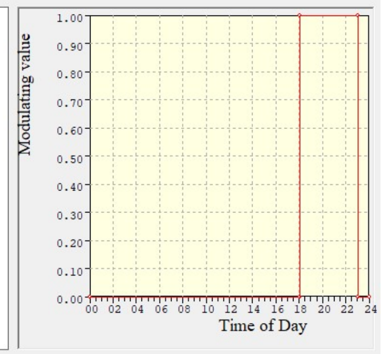
Lighting

Light energy is assumed to be proportional to floor area, so W/m² is used for lighting load. 2 W/m² from 6pm to 11pm is used as default to reflect an efficient new build.

Lighting

Profile: Lighting TM59
ID: DAY_0009
Modulating / Absolute
Categories: Lighting

	Time	Value
1	00:00	0.000
2	18:00	0.000
3	18:00	1.000
4	23:00	1.000
5	23:00	0.000
6	24:00	0.000



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Equipment loads and profiles

It is assumed that houses with the same number of occupants and bedrooms are usually provided with the same appliances, therefore the heat load from appliances is assumed to be independent of floor area for the purpose of overheating risk assessment. Heat loads from appliances are defined in Watts.

Single/ Double Bedrooms

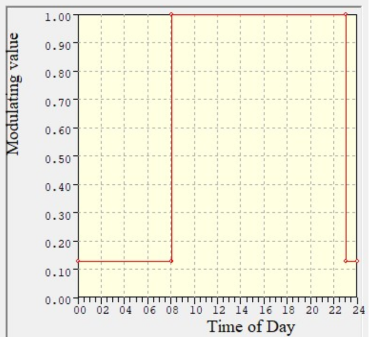
Profile: Equipment Double Bedroom TM59

ID: DAY_0008

Modulating / Absolute

Categories: Equipment

	Time	Value
1	00:00	0.130
2	08:00	0.130
3	08:00	1.000
4	23:00	1.000
5	23:00	0.130
6	24:00	0.130



Assumed equipment in the bedroom (e.g. laptop or TV) with a peak load of 80 W from 8am to 11pm and a base load of 10 W during the sleeping hours.

Living/Kitchen room – 1 Bedroom, 2 Bedroom Apartments

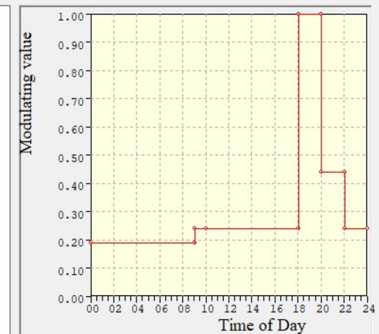
Profile: Equipment - 2Bed Living/ Kitchen

ID: DAY_0011

Modulating / Absolute

Categories: Equipment

	Time	Value
1	00:00	0.190
2	09:00	0.190
3	09:00	0.240
4	10:00	0.240
5	18:00	0.240
6	18:00	1.000
7	20:00	1.000
8	20:00	0.440
9	22:00	0.440
10	22:00	0.240
11	24:00	0.240



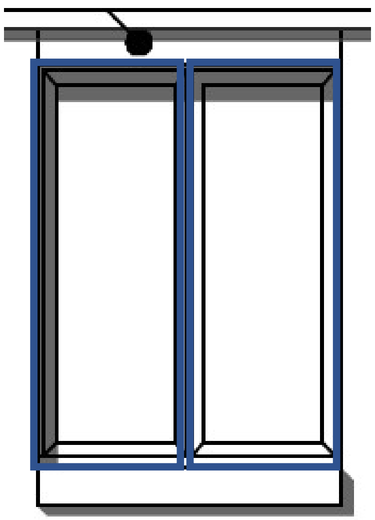
Peak load of 450 W from 6pm to 10pm. 200 W is assumed from 8pm to 10pm. 110 W is assumed from 9am to 6pm and from 10pm to 12pm. For the rest of the day a base load of 85 W is assumed.

Appendix D - Assumptions for Natural Ventilation

In order to address the risk of security at ground floor level windows have been assumed closed when the rooms are not occupied.

In absence of a security risk above this level, all windows have been assumed openable 24/7 if the below conditions are met. The window schedule details below refer only to the openable parts of the windows. Glazing area which is not openable has been characterised as such in the software.

Evesham / GF Kitchen Window



Exposure Type:
Exposed wall

Category:
Window – side hung

Openable Area:
70% (frame factor 70%)

Max Angle Open:
30°

Proportions:
0.50 < Length/Height < 1

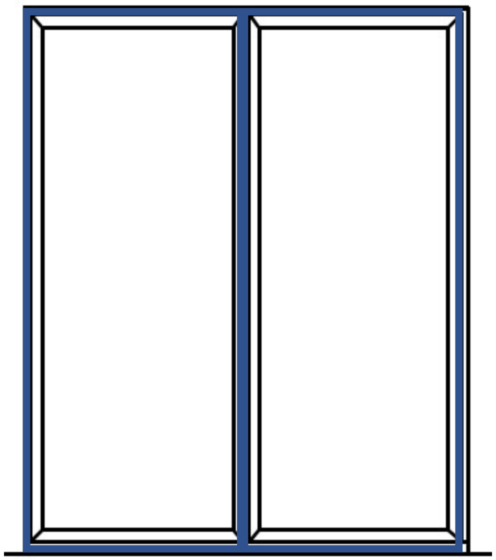
Equivalent area:
41%

Assumed openable::
09:00 – 22:00

Opening threshold 22°C, and internal temperature higher than ambient temperature

Notes: Closed during unoccupied night hours

Evesham / GF French Door



Exposure Type:
Exposed wall

Category:
Door – side hung

Openable Area:
70% (frame factor 70%)

Max Angle Open:
30°

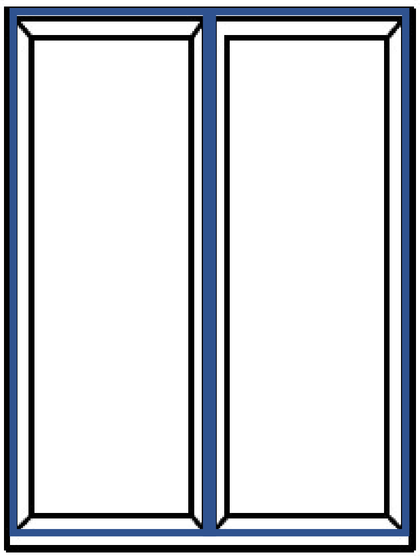
Proportions:
Length/Height < 1

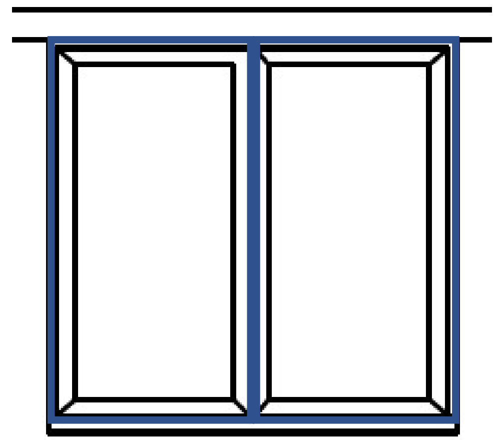
Equivalent area:
41%

Assumed openable::
09:00 – 22:00

Opening threshold 22°C, and internal temperature higher than ambient temperature

Notes: Closed during unoccupied night hours

Evesham / GF LDK window	
	Exposure Type: Exposed wall Category: Window – side hung Openable Area: 70% (frame factor 70%) Max Angle Open: 30° Proportions: 0.50 < Length/Height < 1 Equivalent area: 41% Assumed openable:: 09:00 – 22:00 Opening threshold 22°C, and internal temperature higher than ambient temperature
Notes:	Closed during unoccupied night hours

Evesham / FF Bedrooms	
	Exposure Type: Exposed wall Category: Window – side hung Openable Area: 70% (frame factor 70%) Max Angle Open: 30° Proportions: 0.50 < Length/Height < 1 Equivalent area: 41% Assumed openable:: 24/7 Opening threshold 22°C, and internal temperature higher than ambient temperature
Notes:	N/A

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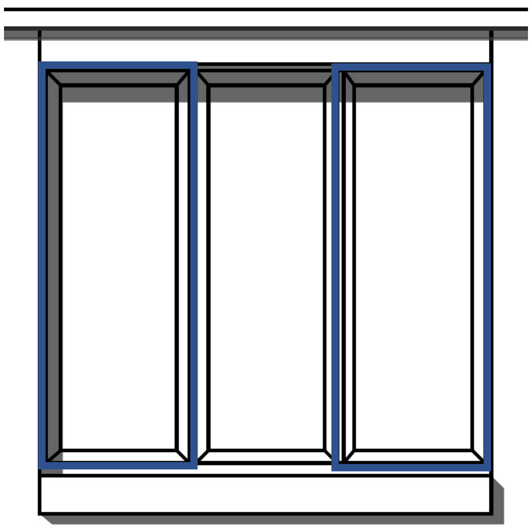
<table>
<tr><th colspan="2">Royden / GF Living & LDK</th></tr>
<tr><td></td><td>Exposure Type:
Exposed wall

Category:
Window – side hung

Openable Area:
70% (frame factor 70%)

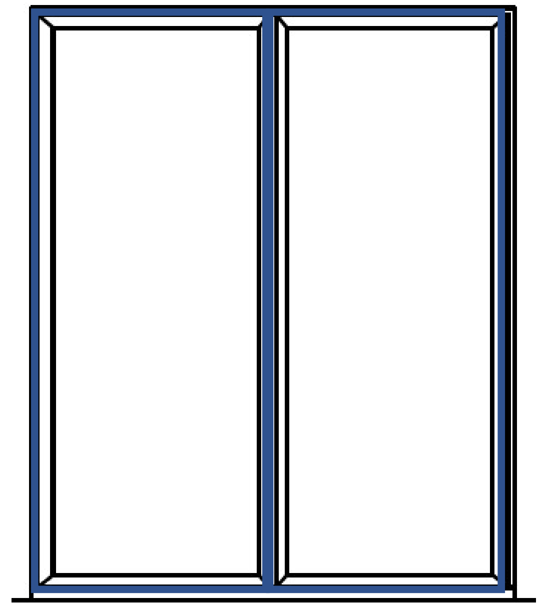
Max Angle Open:
30°

Proportions:
0.50 < Length/Height < 1

Equivalent area:
41%

Assumed openable::
09:00 – 22:00

Opening threshold 22°C, and internal temperature higher than ambient temperature</td></tr>
<tr><td>Notes:</td><td>Closed during unoccupied night hours</td></tr>
</table>

<table>
<tr><th colspan="2">Royden / GF Living & LDK</th></tr>
<tr><td></td><td>Exposure Type:
Exposed wall

Category:
Door – side hung

Openable Area:
70% (frame factor 70%)

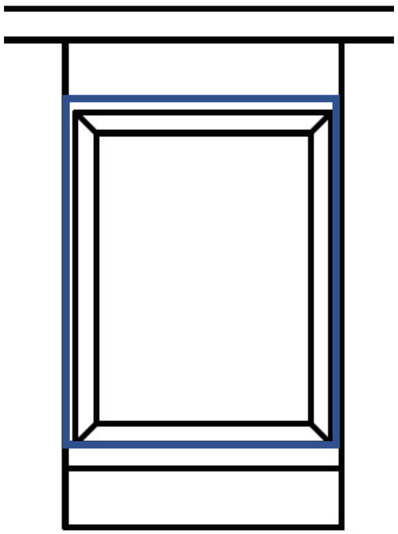
Max Angle Open:
30°

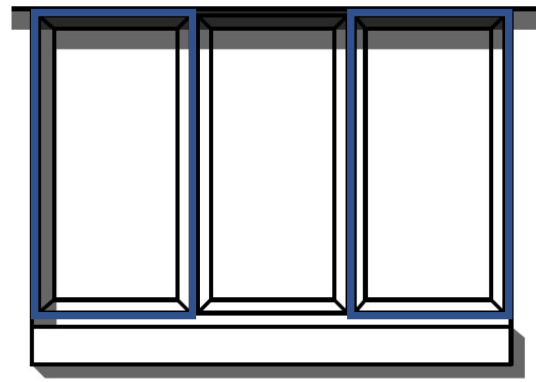
Proportions:
0.50 < Length/Height < 1

Equivalent area:
41%

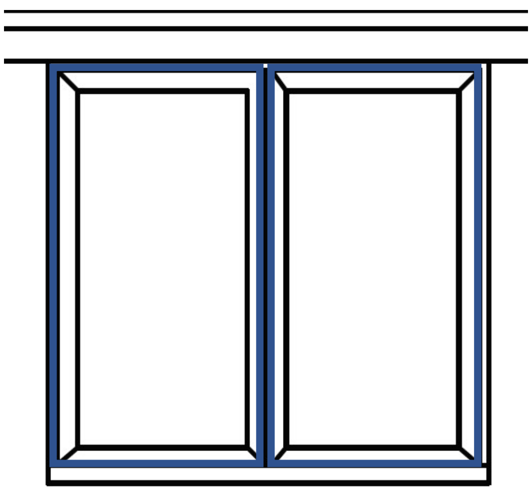
Assumed openable::
09:00 – 22:00

Opening threshold 22°C, and internal temperature higher than ambient temperature</td></tr>
<tr><td>Notes:</td><td>Closed during unoccupied night hours</td></tr>
</table>

Royden / GF LDK	
	Exposure Type: Exposed wall Category: Window – side hung Openable Area: 70% (frame factor 70%) Max Angle Open: 30° Proportions: 0.50 < Length/Height < 1 Equivalent area: 41% Assumed openable:: 09:00 – 22:00 Opening threshold 22°C, and internal temperature higher than ambient temperature
Notes:	Closed during unoccupied night hours

Royden / FF Bedrooms	
	Exposure Type: Exposed wall Category: Window – side hung Openable Area: 70% (frame factor 70%) Max Angle Open: 30° Proportions: 0.50 < Length/Height < 1 Equivalent area: 41% Assumed openable:: 24/7 Opening threshold 22°C, and internal temperature higher than ambient temperature
Notes:	N/A

Royden / FF Bedrooms



Exposure Type:

Exposed wall

Category:

Window – side hung

Openable Area:

70% (frame factor 70%)

Max Angle Open:

30°

Proportions:

0.50 < Length/Height < 1

Equivalent area:

41%

Assumed openable::

24/7

Opening threshold 22°C, and internal temperature higher than ambient temperature

Notes:	N/A