



TAR 06485/2 Devonshire Place

Building and Thermal Comfort Modelling Simulation

Thermal Comfort Report



TAR 06485/2 Devonshire Place

Building and Thermal Comfort Modelling Simulation

Thermal Comfort Report

Document Number: 06485/2 BP

Current Status: P01- Live

Date of issue: 13/06/2022

Prepared by: Ollie Toone

Rev	Date	Changes	Author	Checked	Approved
P01	13/06/2022	First issue	OT	TY	LYM

Contents

1. EXECUTIVE SUMMUARY 3

2. INTRODUCTION 4

2.1. Purpose of Report..... 4

2.2. Context..... 4

2.3. Project Location 4

2.4. Limitations 4

3. SITE ANALYSIS 5

3.1. Site Description 5

4. THE BUILDING & MODEL SPECIFICATION 6

4.1. Description..... 6

4.2. Scheme Design 6

4.3. Geometry and Shading..... 6

4.4. Fabric Performance 9

4.5. People 9

4.6. Lighting & Equipment 9

5. VENTILATION DESIGN INPUT10

5.1. Calculation Process.....10

5.2. Outline Strategy Description.....10

6. METHODOLOGY11

6.1. Context.....11

6.2. Software11

6.3. Weather Data11

7. ASSESSMENT CRITERIA12

7.1. CIBSE TM59:2017 ‘Design methodology for the assessment of overheating risk in homes’12

8. RESULTS13

8.1. CIBSE ‘the Limits of Thermal Comfort’ Results13

8.2. CIBSE TM59:2017 Results – SCH30A Apartments (Common Access)14

8.3. CIBSE TM59:2017 Results – SCH21A Apartments (Walk-Up).....15

8.4. CIBSE TM59:2017 Results – SCH35 House.....16

8.5. CIBSE TM59:2017 Results – SCH37 House.....17

9. CONCLUSIONS.....18

9.1. Conclusions.....18

10. RECOMMENDATIONS.....18

11. ASSUMPTIONS REGISTER.....19

12. REFERENCES20

13. APPENDICES.....21

APPENDIX A..... 22

IESVE Site Maps Model Locations 22

APPENDIX B..... 23

Occupancy, Lighting & Equipment Profiles..... 23

APPENDIX D 26

Natural Ventilation Strategy..... 26

APPENDIX D 31

Effective Opening Area Calculation Guidance 31

List of Figures

Figure 1: Devonshire Place development location.....	4	Table 1: Results Summary for Cardiff_DSY1_2020_High50.	3
Figure 2: Development location with labelled locations of relevant IESVE models to undergo DSM.	4	Table 2: Dwelling variations and constituent room types.	6
Figure 3: Devonshire Place site plan.	5	Table 3: Dwelling variations and their associated floor area volumes (m2).	6
Figure 4: SCH30 Apartments (Common Access), Devonshire Place, 21st June at 08:00	7	Table 4: Drawing register as provided by the architect.	6
Figure 5: SCH30 Apartments (Common Access), Devonshire Place, 21st June at 12:00.	7	Table 5: Shading devices.	6
Figure 6: SCH30 Apartments (Common Access), Devonshire Place, 21st June at 16:00.	7	Table 6: Fabric performance.	9
Figure 7: SCH21 Apartments (Walk-Up), Devonshire Place, 21st June at 08:00.....	7	Table 7: People and Occupancy Gains.	9
Figure 8: SCH21 Apartments (Walk-Up), Devonshire Place, 21st June at 12:00.....	7	Table 8: Lighting & Equipment.	9
Figure 9: SCH21 Apartments (Walk-Up), Devonshire Place, 21st June at 16:00.....	7	Table 9: Natural and Mechanical Ventilation Matrix.	10
Figure 10: SCH35 2-bedroom house, Devonshire Place, 21st June at 08:00.....	8	Table 10: User expectation.....	12
Figure 11: SCH35 2-bedroom house, Devonshire Place, 21st June at 12:00.....	8	Table 11: Tested Scenarios for Cardiff DSY1 weather file.	13
Figure 12: SCH35 2-bedroom house, Devonshire Place, 21st June at 16:00.....	8	Table 12: Modelling results for SCH30A using Cardiff_DSY1_High50 weather file.....	14
Figure 13: Figure 15: SCH37 3-bedroom house (adjoining SCH37), Devonshire Place, 21st June at 08:00.....	8	Table 13: Modelling Results for the SCH21 using DSY1_2020_High50 weather file	15
Figure 14: Figure 15: SCH37 3-bedroom house (adjoining SCH37), Devonshire Place, 21st June at 12:00.....	8	Table 14 – Modelling Results for the SCH35 using DSY1_2020_High50 weather file.....	16
Figure 15: Figure 15: SCH37 3-bedroom house (adjoining SCH37), Devonshire Place, 21st June at 16:00.....	8	Table 15 – Modelling Results for the SCH37 using DSY1_2020_High50 weather file.....	17
Figure 16: Thermal Mass Delayed Reaction Explained	9	Table 16: Summary of SDS Recommendations in order to meet CIBSE: TM59 criteria and mitigate the risks of overheating throughout the assessed dwellings.....	18
Figure 17: Opening Effective Area Considerations (CIBSE AM10)	10	Table 17 – Assumptions Register	19
Figure 18 – Contributing Factors, Overheating	11		
Figure 19: Cardiff_2020_DSY 1_High 50 weather file.	11		
Figure 20: Natural ventilation strategy proposed for SCH30A Apartments (Common Access). Figure illustrative of a variety of window opening types utilized. 1 bedroom ground floor apartment highlighted in yellow.....	14		
Figure 21: Natural ventilation strategy proposed for SCH30A Apartments (Common Access). Figure illustrative of a variety of window opening types utilized. 1 bedroom ground floor apartment assessed highlight in yellow.....	14		
Figure 22: Natural ventilation strategy proposed for SCH21A Apartments (Walk-Up). Figure illustrative of a variety of window opening types utilized.	15		
Figure 23: Natural ventilation strategy proposed for SCH21A Apartments (Walk-Up). Figure illustrative of a variety of window opening types utilized.	15		
Figure 24: Natural ventilation strategy proposed for SCH21A Apartments (Walk-Up).). Figure illustrative of a variety of window opening types utilized.	16		
Figure 25: Natural ventilation strategy proposed for SCH35 House. Figure illustrative of a variety of window opening types utilized.....	16		
Figure 26: Natural ventilation strategy proposed for SCH35 House. Figure illustrative of a variety of window opening types utilized.....	16		
Figure 27: Natural ventilation strategy proposed for SCH37 House. Figure illustrative of a variety of window opening types utilized.....	17		
Figure 28: Natural ventilation strategy proposed for SCH37 House. Figure illustrative of a variety of window opening types utilized.....	17		
Figure 29:.....	18		

List of Tables

1. EXECUTIVE SUMMUARY

Services Design Solution Ltd (SDS) have been appointed by Tarbed Ltd. & Linc Cymru Housing Association to undertake a dynamic thermal comfort study of the proposed ‘Devonshire Place’ residential development to assess whether the building achieves comfort conditions in accordance with CIBSE TM59 guidance. A suitable sample of units within the proposed development have been selected to undergoing thermal modelling for the purpose of a TM59 thermal comfort report.

The development is surrounded by residential buildings and low traffic streets, with the M4 motorway and A48 approximately 350m and 150m away from the development. It is assumed that external noise is kept at an acceptable level, and therefore, allowing adequate natural ventilation through openable windows. N.B. The viability of providing natural ventilation depends on noise survey results and must be confirmed by an accredited acoustician

The base model of this study suggested that where windows were fixed closed, significant overheating risk resulted.

To identify and mitigate risk of overheating, several models were run. Table 1 gives an overview of the simulated scenario which achieved compliance for all tested units, along with the mitigation proposals to reduce temperatures to within acceptable levels for the CIBSE approved DSY1_2020_High50 weather file (Cardiff).

Overheating risk was found to be reduced in rooms with cross flow natural ventilation potential, or in rooms which have a double opening window aspect.

Table 1: Results Summary for Cardiff_DSY1_2020_High50.

Devonshire Place		
Option	Description	CIBSE TM59:2017
Base Option	Notes: - Glazing g-value = 0.63 - Natural ventilation strategy implemented - Windows openable to 100mm	Fail
Option 1	- Glazing g-value = 0.63 - Glazing g-value = 0.45 in SCH30A apartment block and similar 3-storey types throughout - Auxiliary ventilation of 35 l/s present in kitchen & kitchen/living areas across all dwelling variations. Highly recommend consideration is given to MVHR units within dwellings for acoustic, security and thermal comfort reasons.	Pass.

The thermal modelling results for the assessed occupied spaces in the early models indicated that there was initially a risk of overheating to the occupied rooms of the building in accordance with the mandatory CIBSE TM59 overheating criteria.

However, the risk of overheating for the Cardiff_DSY1_2020_High50 weather file (and warmer future weather files too) can be reduced to within acceptable levels where the following is provided:

- ◆ (A): Reduce solar heat gain through the specification of solar control glass achieving a g-value of no greater than 0.63 to all glazed opening across the development. A significantly lower value of 0.5, not modelled, is recommended to further reduce risk.
- ◆ (B): Reduce solar heat gain through the specification of solar control glass achieving a g-value of 0.45 in the-storey block SCH30A, and associated 3-storey buildings
- ◆ (C): Natural ventilation strategy via fully opened windows (to the 100mm restricted position), in living areas 09:00 – 22:00 and bedrooms 00:00 – 24:00.
- ◆ (D): Implementation of auxiliary ventilation with a flow rate of 35l/s in kitchen areas (kitchen, kitchen/dining, kitchen/dining/living) across the development.
- ◆ (E): We highly recommend consideration be given in the cost plan for installation of MVHR units in each dwelling from the outset. These will provide a more energy efficient and acceptable environment acoustically, with cleaner indoor air conditions, with greater security than opening windows as they can be run to help cool the dwellings whilst occupants are out.

Across the development block, auxiliary ventilation is required to bring the risk of overheating to within acceptable levels. A flow rate of 35l/s was modelled to ensure TM59 criteria was passed, however this simulation the auxiliary ventilation is continuously operating. Subsequently, Mechanical Ventilation with Heat Recovery (MVHR) would provide a more robust solution than continuous auxiliary ventilation using a standard kitchen fan unit, where there would be a likely increased risk of fan failure.

SCH30A Apartments (Common Access) required further consideration to bring the risk of overheating to within an acceptable level. Thermal modelling identified south-east facing bedrooms of the three-storey apartment block as areas of particular concern due to the south-east facing aspect (leading to high after solar heat gain) and lesser contact exposure to external air, resulting from the shape of the apartment block. This required a tailored approach to address the risk and requires a reduction in g-value throughout this building type from 0.63 to 0.45 to meet TM59 criteria.

Whilst the risk of overheating is reduced to acceptable levels using the current proposed fenestration strategy and Cardiff DSY1_2020_High50 weather file, we suggest adopting additional measures to reduce design and operation risk against hotter summertime events and also to safeguard potentially vulnerability of building users. Measures would include use of MVHR systems to further decrease overheating risk between May & September. See summary of additional recommendations below and refer to the Recommendations & Conclusions (Section 9) for further information.

- ◆ Consider reducing the overall glazing-to-wall ratio to minimise solar gains. Note that openable elements must still achieve the same ‘physical free opening areas’ as indicated in Appendix B. The performance specification detailed throughout this report must be followed to maintain the integrity of the results presented.

2. INTRODUCTION

2.1. Purpose of Report

This report has been prepared to provide the design team with the proposed design information at RIBA Stage 2 to explore the current risk of overheating against the industry standard CIBSE TM59.

2.2. Context

This report sets out to explore the current design proposals and suggested mitigation options to reduce the risk of overheating in accordance with CIBSE TM59.

2.3. Project Location

The proposed development is located at Devonshire Place, Port Talbot, United Kingdom. Its approximate location is shown in red below.



Figure 1: Devonshire Place development location.



Figure 2: Development location with labelled locations of relevant IESVE models to undergo DSM.

2.4. Limitations

This report is for the purposes of the interested parties relating to the project only. The specification and detail included throughout this report should be closely followed to retain the integrity of the results.

3. SITE ANALYSIS

3.1. Site Description

- ◆ The site is predominately surrounded by low and mid-rise residential buildings, resulting in minimal shading effects on the proposed development.
- ◆ The development is immediately surrounded by residential buildings, convenience stores, and low traffic streets. The M4 corridor is approximately 350m to the northwest, and A48 approximately 100m to the southeast. It is assumed that external noise is kept at an acceptable level, and therefore, allowing adequate natural ventilation through openable windows.
- ◆ Factors such as solar gains and wind speed were considered when carrying out the thermal comfort assessment.
- ◆ A more detailed version of the site with the labelled IESVE model locations is available in Appendix A.



Figure 3: Devonshire Place site plan.

4. THE BUILDING & MODEL SPECIFICATION

4.1. Description

The proposed new build ‘Devonshire Place’ consists of a several variations of residential developments including apartment blocks with communal entrances (one bedroom), apartments with private entrances (two bedroom), and private houses (two- and three-bedroom variations). In addition to these areas, the dwellings are also composed of WCs, circulation, airing cupboards with heating units, storage spaces, utility areas, and home offices adjoining main living areas. These dwelling types and their constituent rooms are summarised in Table 2 below.

Table 2: Dwelling variations and constituent room types.

DRAWING NUMBER	REVISION	DWELLING TYPE	ROOM TYPES PRESENT
SCH30 – 1B2P	A	Apartments (Common Access) – 1 bedroom	Bedroom, Kitchen/Dining/Kitchen area, Bathroom, Storage, A/C
SCH21 – 2B3P	-	Apartments (Walk-Up) – 2 bedrooms	Bedrooms, Kitchen/Dining/Living area with adjoining Home Office, Bathroom, Storage
SHC35 – 2B4P	-	House – 2 bedrooms	Bedrooms, Kitchen/Living/Dining area with adjoining Home Office, Bathrooms, W/C, Storage, A/C
SCH37 – 3B5P	-	House – 3 bedrooms	Bedrooms, Kitchen/Dining area with adjoining Home Office, Utility Room, Bathrooms, W/C, Storage, A/C

4.2. Scheme Design

The total floor area of dwellings (per apartment/house, excluding roof space) are listed below in Table 3.

Table 3: Dwelling variations and their associated floor area volumes (m2).

DRAWING NUMBER	REV	DWELLING NAME	INTERNAL FLOOR AREA (m²)
SCH30	A	1B2P Apartment (Common Access)	51.8
SCH21	-	2B3P Apartment (Walk-Up)	59.9
SCH35	-	2B4P House	84.4
SCH37	-	3B5P House	94

The thermal comfort model has been based upon drawings as created and provided by the architect/client. The drawings provided, upon which this thermal comfort report is based on, are provided below in Table 4.

Table 4: Drawing register as provided by the architect.

DRAWING NUMBER	REVISION	DRAWING TITLE	DATE
SCH03	B	Site Plan	June 2022
SCH30	A	1B2P Apartments (Common Access)	June 2022
SCH21	-	2B3P Apartments (Walk-Up)	June 2022
SHC35	-	2B4P House	June 2022
SCH37	-	3B5P House	June 2022

4.3. Geometry and Shading

Solar shading has been calculated for the building to take account of any shading devices, overhangs, surrounding buildings and topography.

Table 5: Shading devices.

Space	Internal Shading	External Shading
Building	No internal blinds or curtains included in this assessment	No overhanging elements or significant local shade. Some local shading present as part of the balcony of the wider SCH30 Apartment block.

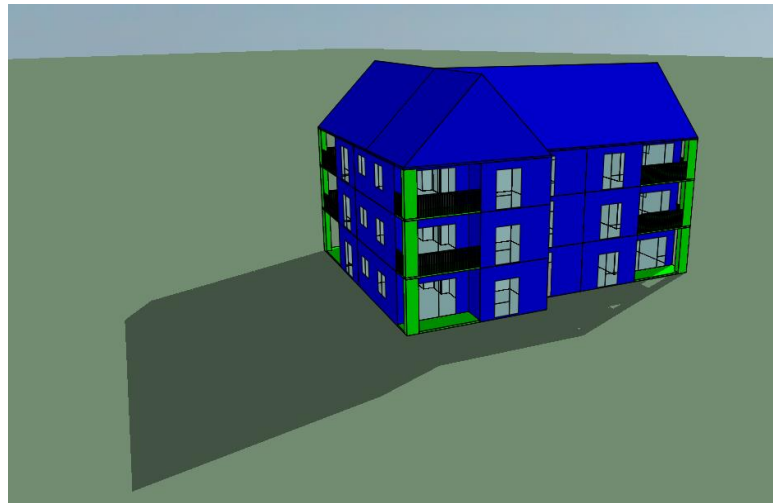


Figure 4: SCH30 Apartments (Common Access), Devonshire Place, 21st June at 08:00

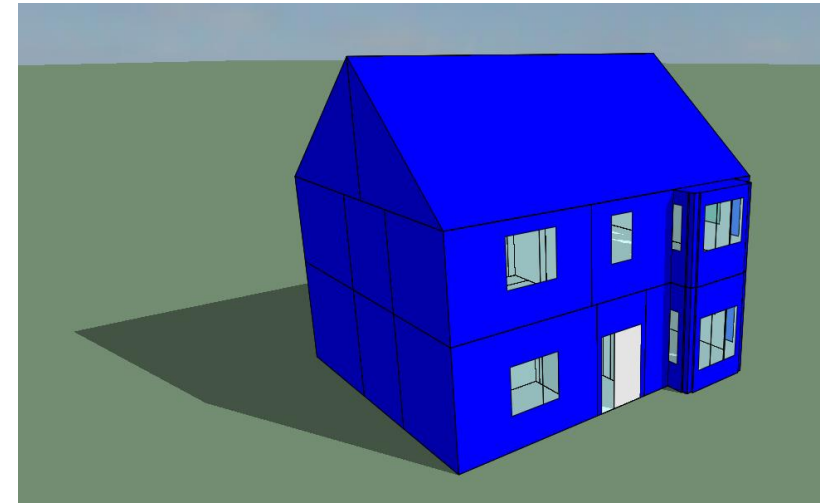


Figure 7: SCH21 Apartments (Walk-Up), Devonshire Place, 21st June at 08:00.

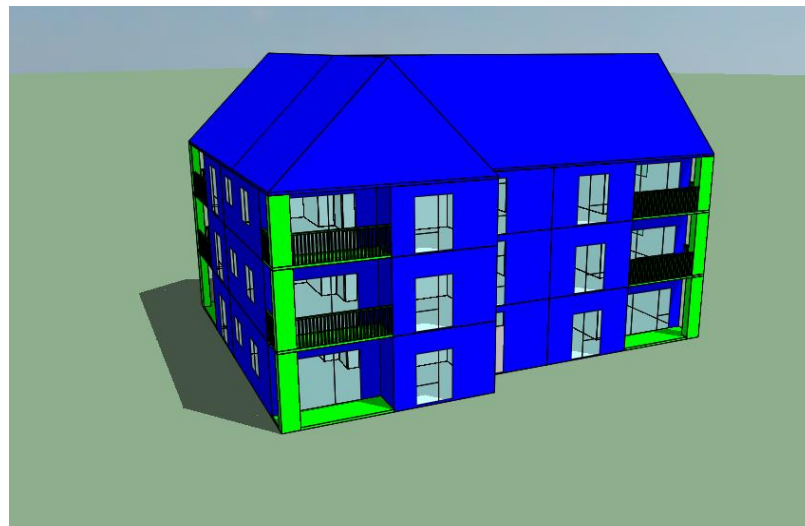


Figure 5: SCH30 Apartments (Common Access), Devonshire Place, 21st June at 12:00.

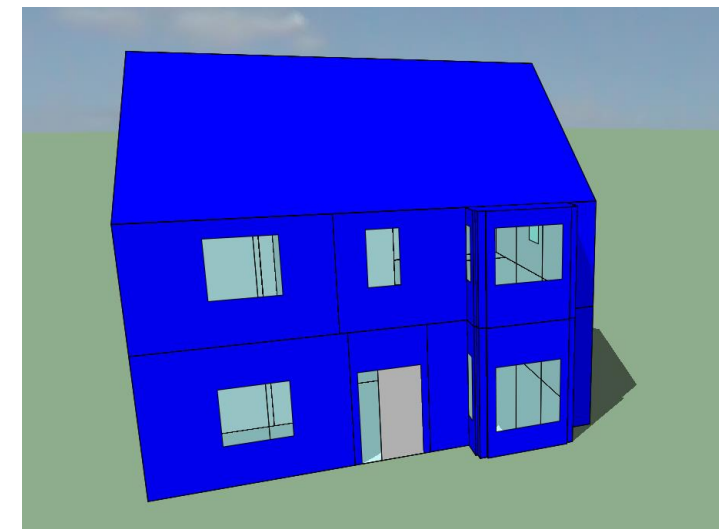


Figure 8: SCH21 Apartments (Walk-Up), Devonshire Place, 21st June at 12:00.

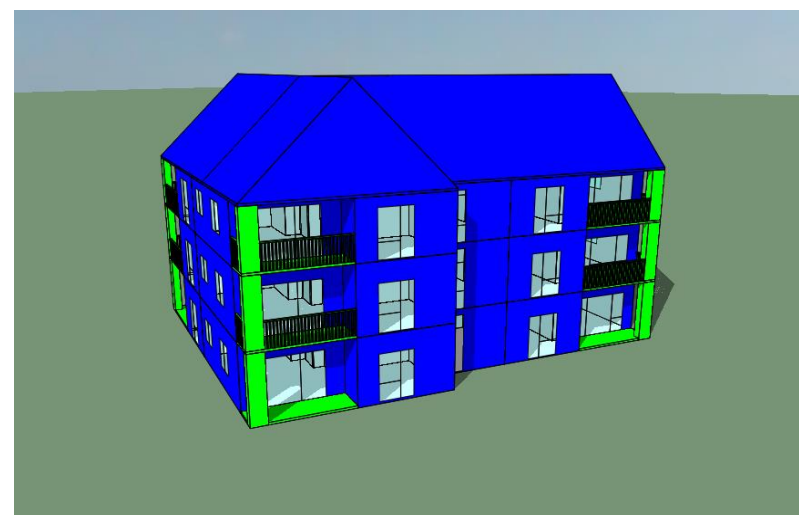


Figure 6: SCH30 Apartments (Common Access), Devonshire Place, 21st June at 16:00.

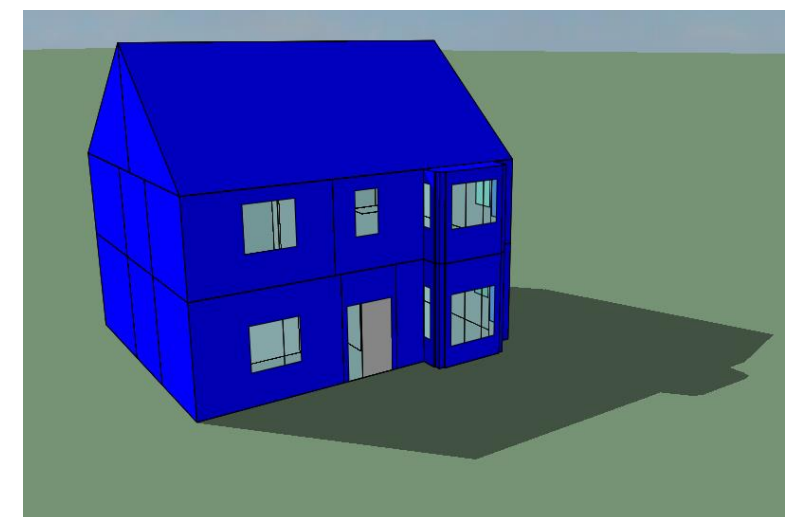


Figure 9: SCH21 Apartments (Walk-Up), Devonshire Place, 21st June at 16:00.

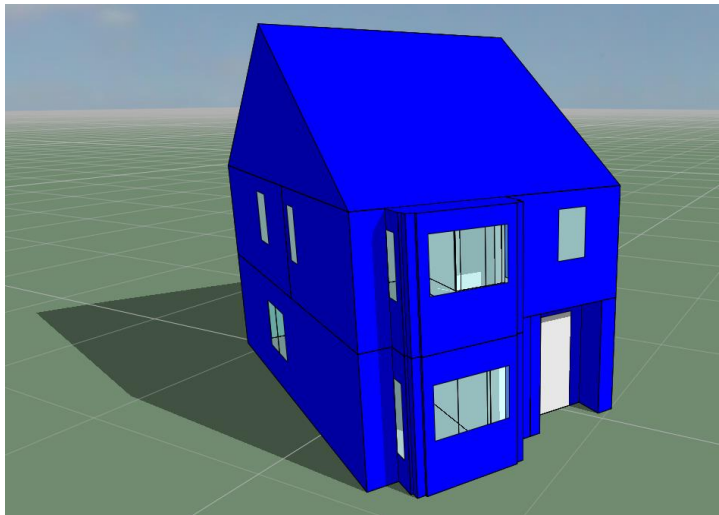


Figure 10: SCH35 2-bedroom house, Devonshire Place, 21st June at 08:00.

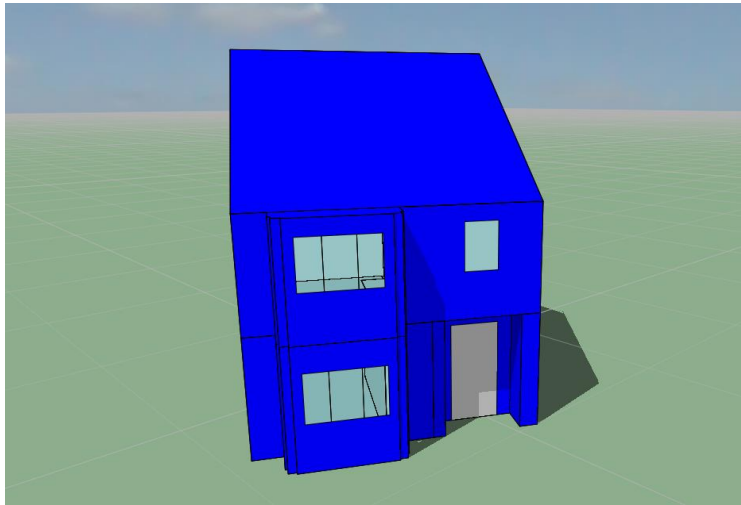


Figure 11: SCH35 2-bedroom house, Devonshire Place, 21st June at 12:00

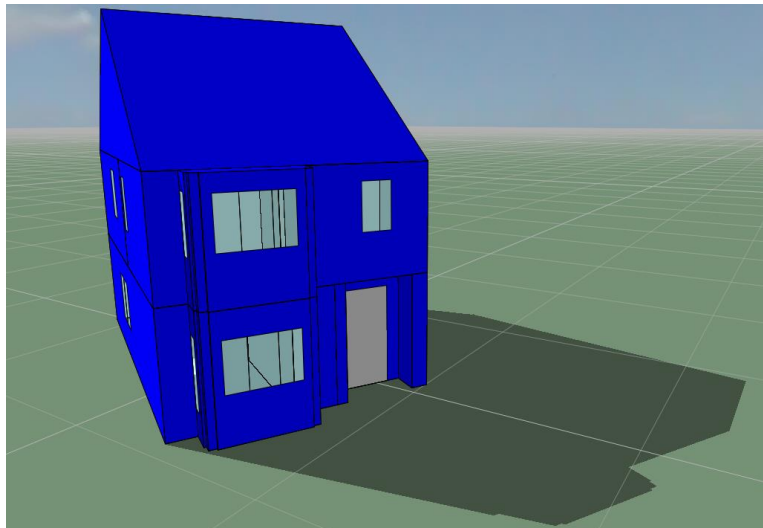


Figure 12: SCH35 2-bedroom house, Devonshire Place, 21st June at 16:00.

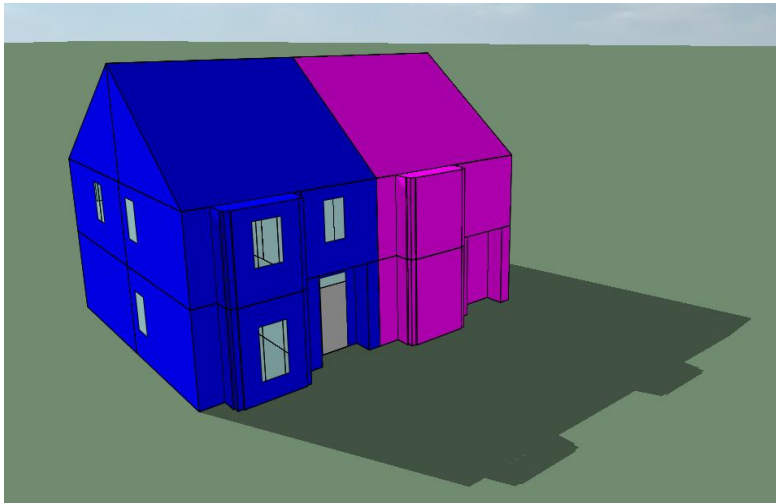


Figure 13: Figure 15: SCH37 3-bedroom house (adjoining SCH37), Devonshire Place, 21st June at 08:00.

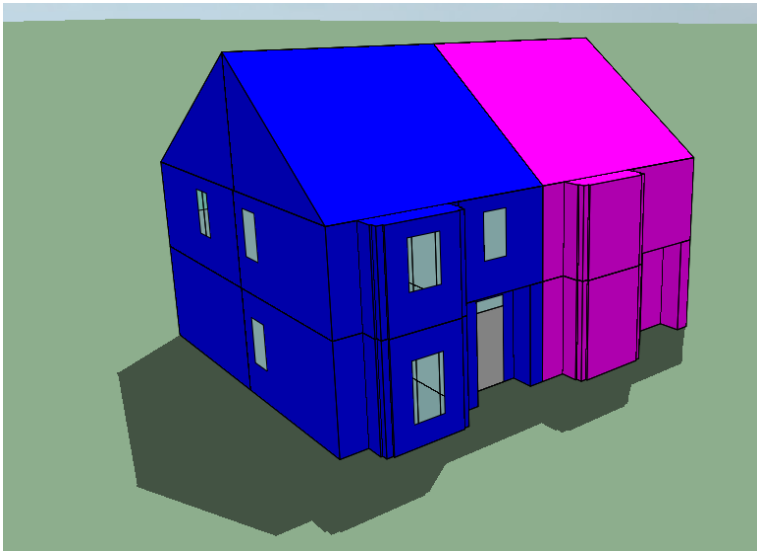


Figure 14: Figure 15: SCH37 3-bedroom house (adjoining SCH37), Devonshire Place, 21st June at 12:00.

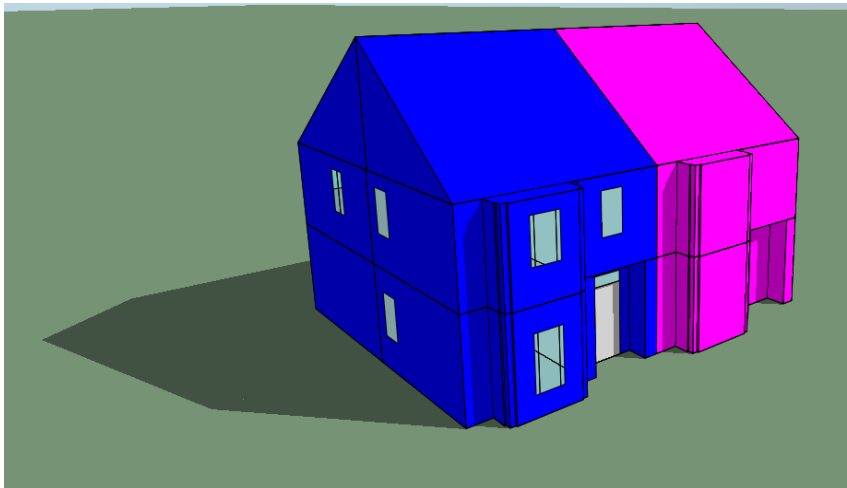


Figure 15: Figure 15: SCH37 3-bedroom house (adjoining SCH37), Devonshire Place, 21st June at 16:00.

4.4. Fabric Performance

The thermal comfort model has used the values provided in the table below. Building constructions have been modelled as proposed, accurately reflecting thermal properties such as thermal mall, insulation, and solar transmittance for glazing. Fabric performance is based on values provided by Robert Limbrick as shown in Table 2. These fabric performance values may be amended to match future cost-plans, however any changes to the construction values used in the following modelling scenarios will impact the results of this thermal comfort report.

Table 6: Fabric performance.

Item	Construction Type	Units	Additional Information	
		Target U-value (W/m²K)	Thermal Mass (kJ/(m²K)	Other
1.1	Wall	0.13	33.1	N/A
1.2	Floor	0.11	85	N/A
1.3	Roof	0.11	98.75	N/A
1.4	Windows	1.2	N/A	G = 0.63, LT = 71%
1.5	Personnel doors	1.2	16.875	N/A
1.7	Air permeability	4.0	N/A	m³/h.m² @ 50Pa

* G = G-value (solar gain through glass).

**LT = Light Transmission (daylight through glass).

The values above have been derived using the BRE U-value calculator, or by the software used for the overheating analysis.

The table provides a predicted level of thermal mass for each element. This is to provide an indication only. This building is thought to be generally of a lightweight construction, and low thermal mass.

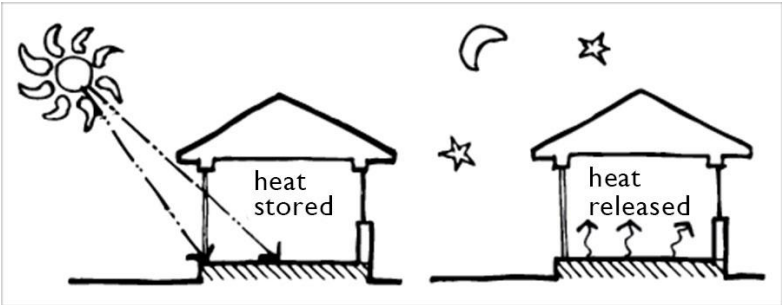


Figure 16: Thermal Mass Delayed Reaction Explained

4.5. People

The following occupancy gain, and profiles are based on the internal gains recommended by CIBSE TM59:2017 for residential buildings. Where not available, the National Calculation Methodology (NCM) values have been used. Refer to Appendix A for further details.

Table 7: People and Occupancy Gains.

Room Name	Occupancy (People)	Maximum Sensible Gain (W/P)*	Maximum Latent Gain (W/P)*	Occupancy Profile
Single Bedroom	1	75	55	Refer to Appendix A
Double Bedroom	2	75	55	
Kitchen (2 bed apart.)	2	75	55	
Kitchen (3 bed apart.)	3	75	55	
Kitchen (4 bed apart.)	4	75	55	
Living/Dining (4 bed apart.)	4	75	55	

*Watts Per Person.

It has been assumed that the building will be occupied throughout the year both during weekdays and weekends.

4.6. Lighting & Equipment

The following lighting and equipment gain, and profiles are based on the internal gains recommended by CIBSE TM59:2017 for residential buildings & CIBSE TM52. Where not available, the NCM values have been used. Refer to Appendix A for further details.

Table 8: Lighting & Equipment.

Methodology	Room Name	Lighting			
		Maximum Sensible Gain (W)*	Variation Profile	Maximum Sensible Gain (W/m²)	Variation Profile
CIBSE: TM59 (2017)	Bedroom (double)	80	Refer to Appendix A	2.00	Refer to Appendix A
CIBSE: TM59 (2017)	Kitchen (2, 3 & 4 bed apart.)	450		2.00	
CIBSE: TM59 (2017)	Living (2, 3 & 4 bed apart.)	150		2.00	

The following lighting and equipment gain, and profiles are based on the internal gains recommended by CIBSE TM59:2017 for residential buildings. Where not available, the NCM values have been used. Refer to Appendix A for further details.

5. VENTILATION DESIGN INPUT

5.1. Calculation Process

The thermal model calculates natural ventilation capacity based on mainly window opening times, window free opening area and exposure to wind.

Windows in this model are assumed to be closed when external wind speed exceeds 13 m/s which is recorded to be ‘Strong breeze’ on the Beaufort Scale, and when internal temperature is below 22°C. This attempt to simulate how the occupants could potentially use the windows during windy days which could cause discomfort due to excessive air movement inside a space.

The effective opening area available differs significantly depending on the selected window type. Please refer to Appendix D: Calculating Opening – Effective Area for more information.

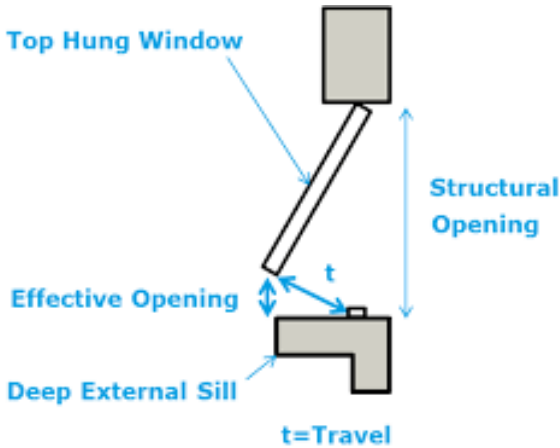


Figure 17: Opening Effective Area Considerations (CIBSE AM10)

5.2. Outline Strategy Description

The current design allows for natural ventilation using openable windows. Please refer to Appendix B for the natural ventilation and opening strategy. A natural ventilation strategy has been adopted (where possible) to maximise the supply of fresh air into the building to reduce internal air temperatures and ensure good air quality throughout the year. Please refer to Table 9 for the proposed full natural ventilation strategy for the current weather file (Cardiff 2020 DSY 1 High 50).

Window opening times follow the occupancy of the assessed area. In the model, windows are assumed to be closed at night in living and kitchen areas (22:00 – 09:00) as per CIBSE thermal profile required; windows are assumed to be open continuously in bedrooms.

The first 900mm of window height remains fixed for security purposes as per CIBSE recommendations. Windows above this height specified by the architect as openable above this height can be opened to 100mm (see Appendix B). Any variance to these stated model assumptions will influence the results of the thermal comfort report.

The current design utilises a natural ventilation strategy, with auxiliary ventilation extract in kitchen & kitchen/living areas across all dwelling variations. The future use of MVHR will be discussed in Recommendations & Conclusions sections but is not considered in our initial thermal model. The below table summarises the philosophy for natural and auxiliary ventilation for our proposed solution(s).

Table 9: Natural and Mechanical Ventilation Matrix.

House Type	Natural Ventilation	Auxiliary Ventilation	Control
Devonshire Place	All Dwelling – Restricted Windows (throw range 100mm). Specific windows identified as openable from drawings provided by the architect. Openable Windows See Appendix B.	Auxiliary ventilation utilised in kitchen & kitchen/living areas. Flow rate of 35 l/s used as reasonable assumption as per CIBSE recommendations.	Manually openable windows and doors. Auxiliary ventilation operating continuously in kitchen & kitchen/living areas.

6. METHODOLOGY

6.1. Context

The current way of assessing overheating risk can be achieved using an appropriate combination of window size, orientation, solar protection through shading, glazing specification, ventilation, and high thermal capacity. This is not a particularly sensitive analysis and can ultimately lead to buildings that overheat.

Overheating has become a key problem in modern building design. The need to reduce energy consumption whilst dealing with global climate change has reduced the options available for building comfort, low energy buildings. Research has been directed towards methods for increasing indoor winter temperatures, but this can lead to lightweight, highly insulated buildings that respond poorly in the summer.



Figure 18 – Contributing Factors, Overheating

CIBSE established an Overheating task force, which developed Technical Memorandum Fifty-Nine (TM59) in response to this problem.

6.2. Software

IES Apache Simulation has been used to carry out this dynamic simulation to analyse the thermal comfort likely to be experienced within the building. The full dynamic simulation in accordance with CIBSE TM59:2017 combines the effects of:

- ◆ Weather Data
- ◆ Internal heat gains
- ◆ Fresh air supply
- ◆ Occupancy profiles
- ◆ Building fabric
- ◆ Solar heat gains and shading

The results provide an indication of the predicted environmental conditions that may be experienced within the building. It should be noted that these are predicted values only and the temperatures generated by the software may not match the actual internal air temperatures for reasons such as change in function of space, use, occupancy and behavioural usage patterns, wear and tear of building elements, global climate change and changes in operation and building management protocols.

6.3. Weather Data

CIBSE Guide A 2015 states that “CIBSE recommend the use of an appropriate Design Summer Year (DSY) for the purposes of assessing overheating risk. Suitable years are available for 14 locations across the UK.”. For this assessment Cardiff, 2020, has been used, in accordance with the CIBSE TM59 criteria.

The DSY1 weather file is the minimum CIBSE TM59 requirement. However, the use of additional weather files is recommended to explore the building’s performance where there is particular concern, such as the presence of vulnerable people or to future-proof the building against global climate change. This report will include the necessary mitigation solutions for the 2020 DSY1 weather file.

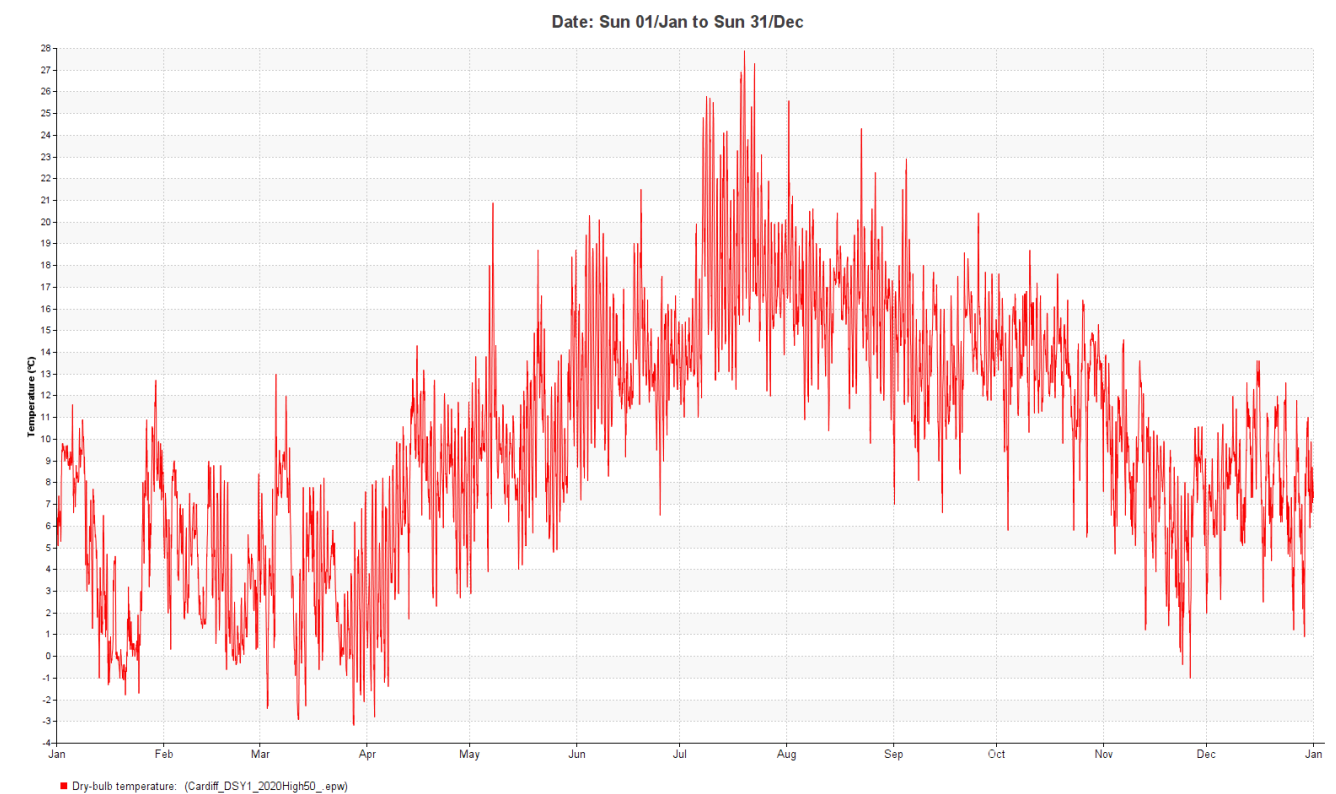


Figure 19: Cardiff_2020_DSY 1_High 50 weather file.

7. ASSESSMENT CRITERIA

7.1. CIBSE TM59:2017 ‘Design methodology for the assessment of overheating risk in homes’

The main function rooms within the building should be considered most closely as it is envisaged that these will be the rooms occupied for significant periods of time. Rooms such as WCs, circulations spaces and storerooms 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.

CIBSE TM59:2017 sets out the following three criteria, which, taken together provide a robust yet balanced assessment of residential overheating risk in the UK:

- ◆ **Predominately naturally ventilated**
 - (a) For living rooms, kitchens, and bedrooms the first criterion sets a limit for the number of hours that the operative temperature exceeds the comfort temperature by 1 K or more during the occupied hours over the summer period (1st May to 30th September). The exceedance limit is 3% of occupied times.
 - (b) For bedrooms only: to guarantee comfort during the sleeping hours the operative temperature in the bedroom from 10 pm to 7 am shall not exceed 26 °C for more than 1% of annual hours. (Note: 1% of the annual hours between 22:00 and 07:00 for bedrooms is 32 hours, so 33 or more hours above 26 °C will be recorded as a failure).
- Both (a) and (b) must show a pass for all relevant rooms.

It should be noted that the comfort temperature is based on the expectation of the building users. To take this into account, CIBSE TM59:2017 categorise buildings based on the level of user expectation and their applicability to building types as indicated in Table 8.

Building Category 2 was used in this study in accordance with CIBSE recommendation to assess internal comfort in new homes with normal levels of expectations.

Table 10: User expectation.

Category	Explanation	Suggested acceptable range (K)
1	High Level of expectation	±2
2	<i>Normal expectation (new buildings)</i>	<i>±3</i>
3	Moderate expectation (for existing buildings)	±4
4	Values outside criteria for the above categories	>4

To ensure that the CIBSE standards are met it is necessary to use appropriate simulation software. A dynamic 3D model has been created using ‘Integrated Environmental Solutions (IES) Software’, an advanced environmental modelling tool. The software also complies with CIBSE Application Manual AM11: 2015, Building Energy and Environmental Modelling.

8. RESULTS

8.1. CIBSE ‘the Limits of Thermal Comfort’ Results

CIBSE TM59:2017 ‘Design methodology for the assessment of overheating risk in homes’

As previously stated, the results have been compared against the recommendations given in CIBSE TM59, using the assessment criteria below:

- ◆ **Predominately naturally ventilated:**
 - CIBSE TM52 Criterion 1: Hours of exceedance – living rooms, kitchens, and bedrooms.
 - Comfort during sleeping hours – bedrooms only.
- ◆ **Corridors**
 - CIBSE fixed temperature test – all corridors (not mandatory).

A room or building that fails any of the two criteria is potentially at risk of overheating.

Items within the table:

- ◆ Items in **RED** DO NOT comply with the CIBSE recommendations
- ◆ Items in **GREEN** DO comply with the CIBSE recommendations

A brief description of each option has been provided in the below table.

Table 11: Tested Scenarios for Cardiff DSY1 weather file.

Devonshire (Predominately Naturally Ventilated)		
Option	Description	CIBSE TM59:2017
Base Option	Notes: - Glazing g-value = 0.63 - Natural ventilation strategy implemented - Windows openable to 100mm	Fail
Option 1	- Glazing g-value = 0.63 - Glazing g-value = 0.45 in SCH30A apartment blocks throughout - Auxiliary ventilation present in kitchen & kitchen/living areas across all dwelling variations of 35 l/s. This is suggestive that an MVHR strategy would be beneficial	Pass

8.2. CIBSE TM59:2017 Results – SCH30A Apartments (Common Access)

Table 12: Modelling results for SCH30A using Cardiff_DSY1_High50 weather file.

06485 SCH30A (Proposed) - Cardiff_DSY1_2020_High_50			
Room	Overall	TM59 Criteria predominantly naturally ventilated	
		Living rooms, kitchens and bedrooms. TM52 Criterion 1 (hours over comfort temperature <3% occupied hours)	The operative temperature in bedrooms from 10 pm to 7 am shall not exceed 26 °C for more than 1% of annual hours.
GB Bedroom 003	Pass	2.4	0.8%
GF Kitchen/Dining 003	Pass	0.5	0.2%
Option 1	G-value of 0.63 in Kitchen/Dining G-value of 0.45 in Bedroom. Windows openable to 100mm during specified hours. Aux ventilation in kitchen.		

Initial analysis considered windows to be fixed and closed; the results of the thermal comfort modelling study using this specification indicates that there is a risk of overheating to the dwelling when assessed against the criteria outline in CIBSE TM59 and using the future weather file 2020_DSY 1_High 50.

To mitigate the risk of overheating, a natural ventilation strategy was implemented to decrease the risk of overheating throughout the development (with opening locations and effective areas shown in Figures 22 & 23 and Appendix B).

In addition to a natural ventilation strategy and a glazing G-value of 0.63 to all glazed excluding the kitchen/dining area. Auxiliary ventilation was also utilised in the kitchen/dining areas to reduce the risk of overheating and meeting TM59 criteria. As significant overheating risk was identified as being an area of particular concern in the south-east facing bedrooms, a glazing G-value of 0.45 was applied in these areas.

The results of the thermal comfort modelling study using the specification detailed throughout this report indicates that the risk of overheating is reduced to within an acceptable level when assessed against the criteria outline in CIBSE TM59 and using the future weather file Cardiff_2020_DSY 1_High 50.

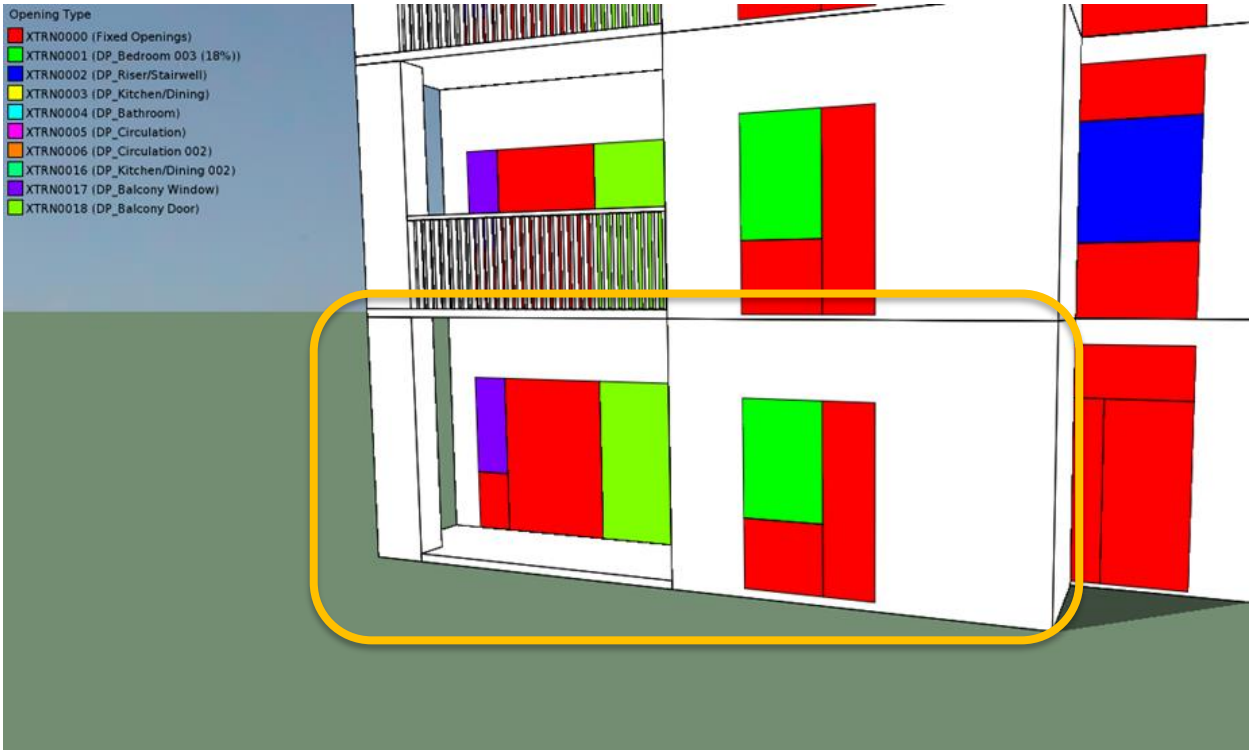


Figure 20: Natural ventilation strategy proposed for SCH30A Apartments (Common Access). Figure illustrative of a variety of window opening types utilized. 1 bedroom ground floor apartment highlighted in yellow.

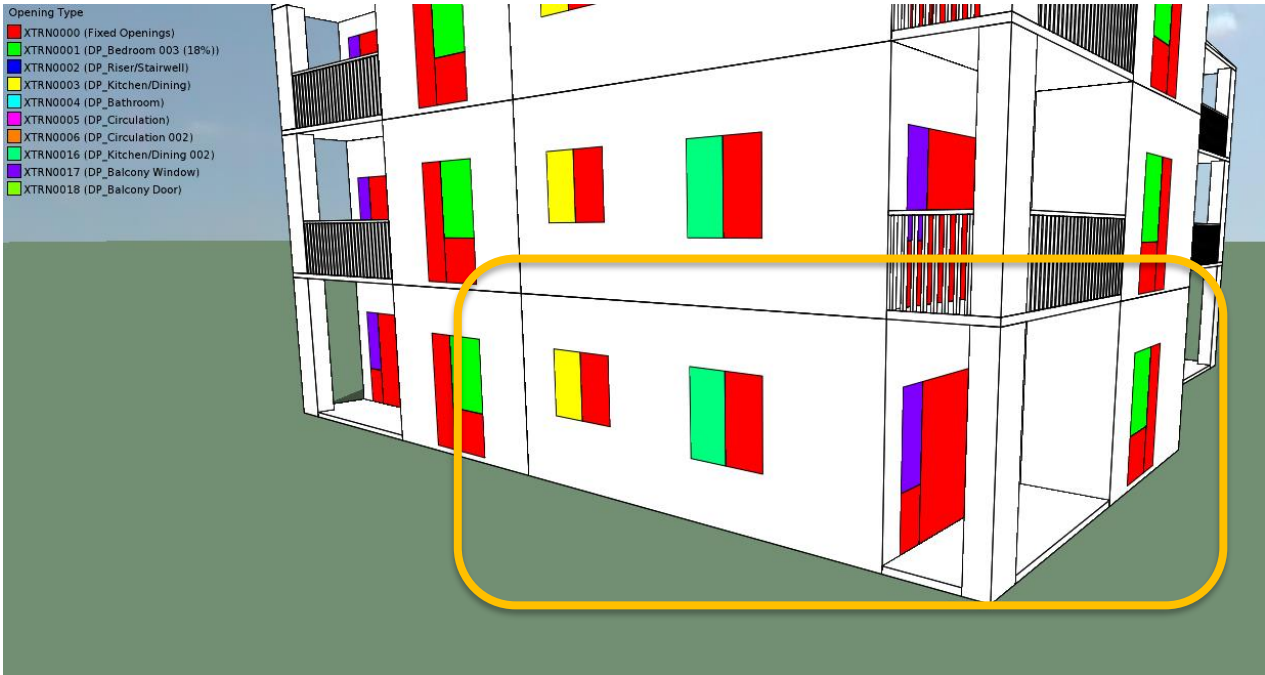


Figure 21: Natural ventilation strategy proposed for SCH30A Apartments (Common Access). Figure illustrative of a variety of window opening types utilized. 1 bedroom ground floor apartment assessed highlight in yellow.

8.3. CIBSE TM59:2017 Results – SCH21A Apartments (Walk-Up)

Table 13: Modelling Results for the SCH21 using DSY1_2020_High50 weather file

06485 SCH21A (Proposed) - Cardiff_DSY1_2020_High_50			
Room	Overall	TM59 Criteria predominantly naturally ventilated	
		Living rooms, kitchens and bedrooms. TM52 Criterion 1 (hours over comfort temperature <3% occupied hours)	The operative temperature in bedrooms from 10 pm to 7 am shall not exceed 26 °C for more than 1% of annual hours.
FF Bedroom 001	Pass	2.4	0.9%
FF Bedroom 002	Pass	1.4	0.5%
FF Kitchen/Dining/Living	Pass	1.9	0.5%
GF Bedroom 001	Pass	1.4	0.5%
GF Bedroom 002	Pass	2.5	0.8%
GF Kitchen/Living/Dining	Pass	2.4	0.6%
Option 1	G-value of 0.63 to all glazed areas. Windows openable to 100mm during specified hours. Aux ventilation in kitchen.		

Initial analysis considered windows to be fixed and closed; the results of the thermal comfort modelling study using this specification indicates that there is a risk of overheating to the dwelling when assessed against the criteria outline in CIBSE TM59 and using the future weather file 2020_DSY 1_High 50.

To mitigate the risk of overheating, a natural ventilation strategy was implemented to decrease the risk of overheating throughout the development (with opening locations and effective areas shown in Figures 22 & 23 and Appendix B).

In addition to a natural ventilation strategy and a glazing G-value of 0.63 to all glazed excluding the kitchen/dining area. Auxiliary ventilation was also utilised in the kitchen/dining areas to reduce the risk of overheating and meeting TM59 criteria

The results of the thermal comfort modelling study using the specification detailed throughout this report indicates that the risk of overheating is reduced to within an acceptable level when assessed against the criteria outline in CIBSE TM59 and using the future weather file Cardiff_2020_DSY 1_High 50.

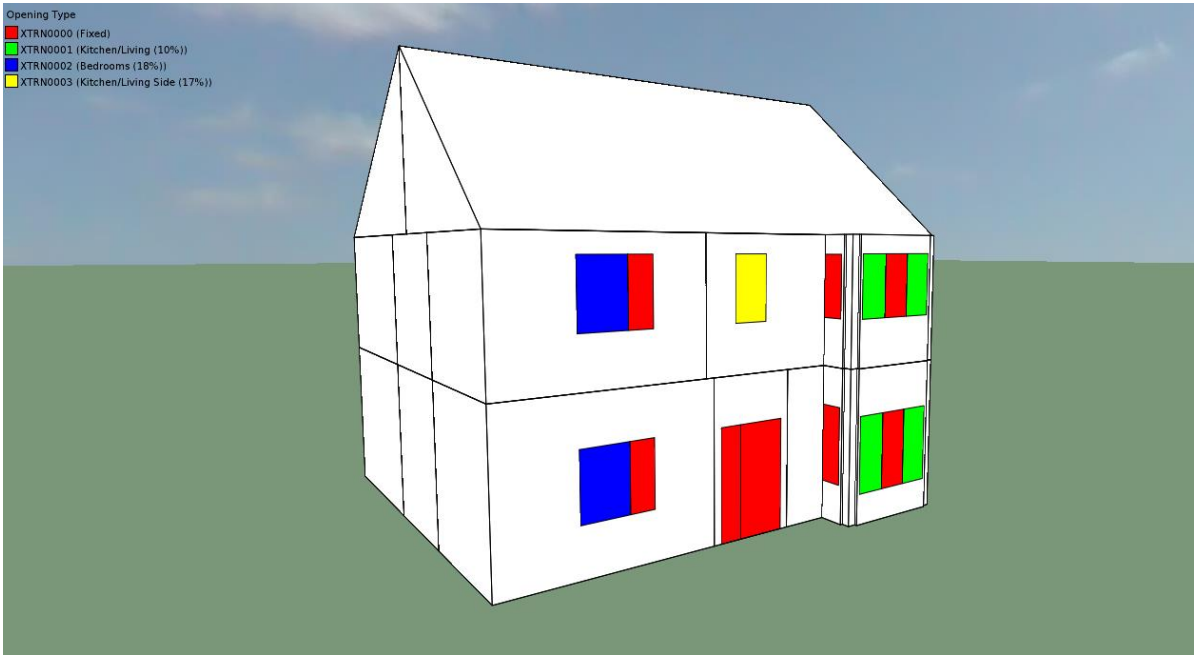


Figure 22: Natural ventilation strategy proposed for SCH21A Apartments (Walk-Up). Figure illustrative of a variety of window opening types utilized.

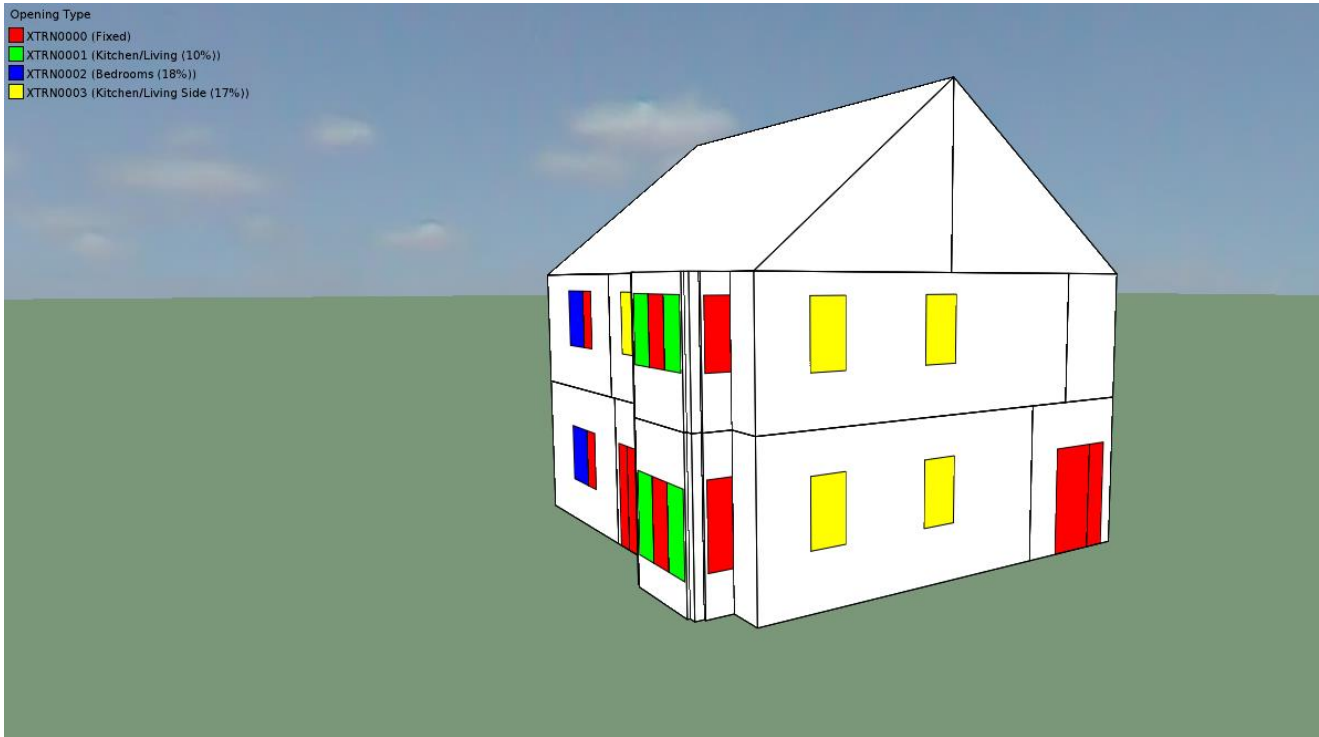


Figure 23: Natural ventilation strategy proposed for SCH21A Apartments (Walk-Up). Figure illustrative of a variety of window opening types utilized.

8.4. CIBSE TM59:2017 Results – SCH35 House

Table 14 – Modelling Results for the SCH35 using DSY1_2020_High50 weather file

06485 SCH35 (Proposed) - Cardiff_DSY1_2020_High_50			
Room	Overall	TM59 Criteria predominantly naturally ventilated	
		Living rooms, kitchens and bedrooms. TM52 Criterion 1 (hours over comfort temperature <3% occupied hours)	The operative temperature in bedrooms from 10 pm to 7 am shall not exceed 26 °C for more than 1% of annual hours.
GF Kitchen/Dining Area	Pass	0.8	0.0%
SF Bedroom 001	Pass	0	0.0%
SF Bedroom 002	Pass	0.5	0.0%
Option 1	G-value of 0.63 to all glazed areas. Windows openable to 100mm during specified hours. Aux ventilation in kitchen.		

Initial analysis considered windows to be fixed and closed; the results of the thermal comfort modelling study using this specification indicates that there is a risk of overheating to the dwelling when assessed against the criteria outline in CIBSE TM59 and using the future weather file 2020_DSY 1_High 50.

To mitigate the risk of overheating, a natural ventilation strategy was implemented to decrease the risk of overheating throughout the development (with opening locations and effective areas shown in Figures 22 & 23 and Appendix B).

In addition to a natural ventilation strategy and a glazing G-value of 0.63 to all glazed excluding the kitchen/dining area. Auxiliary ventilation was also utilised in the kitchen/dining areas to reduce the risk of overheating and meeting TM59 criteria

The results of the thermal comfort modelling study using the specification detailed throughout this report indicates that the risk of overheating is reduced to within an acceptable level when assessed against the criteria outline in CIBSE TM59 and using the future weather file Cardiff_2020_DSY 1_High 50.

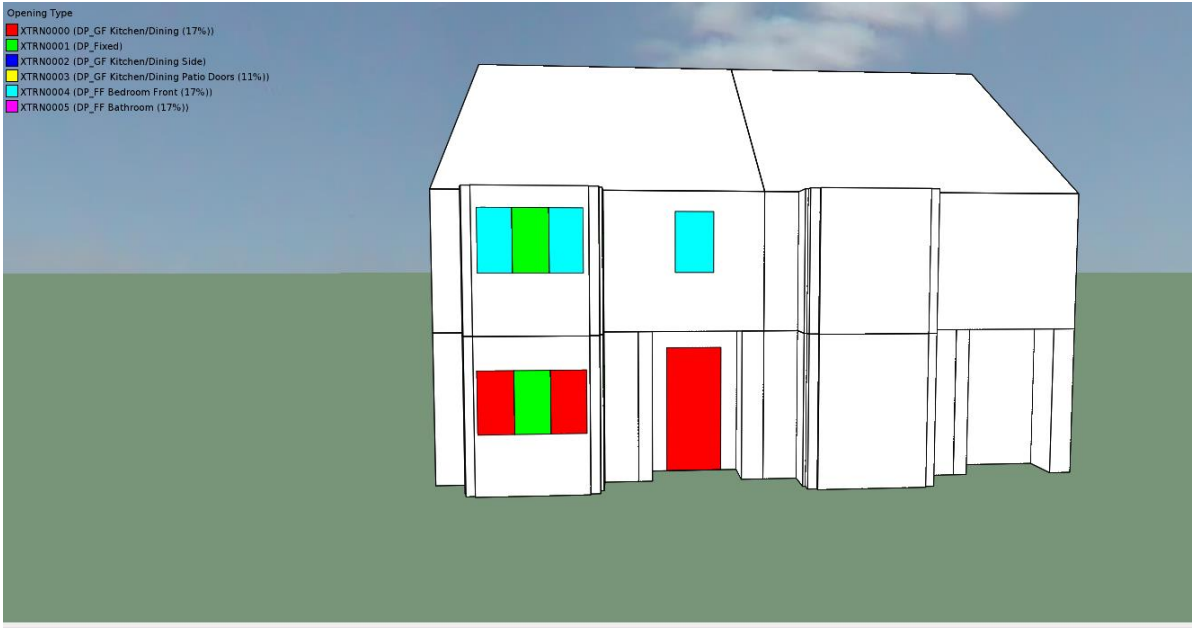


Figure 25: Natural ventilation strategy proposed for SCH35 House. Figure illustrative of a variety of window opening types utilized.

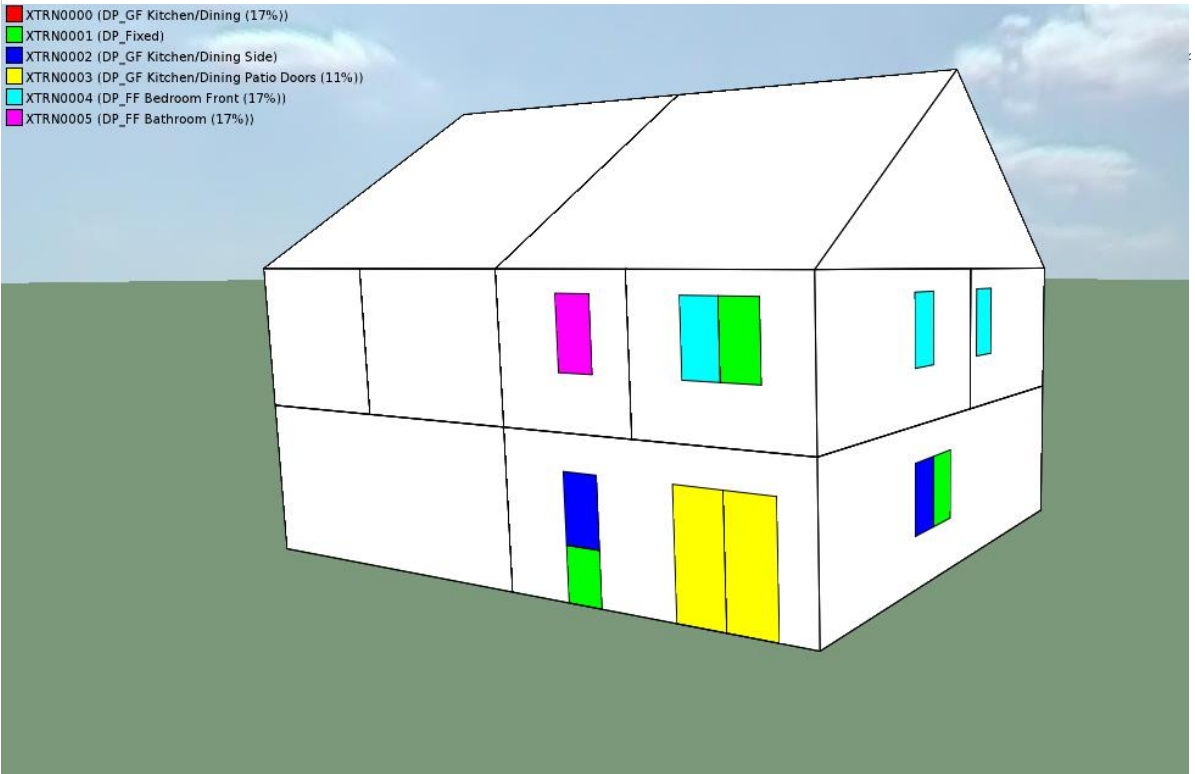


Figure 26: Natural ventilation strategy proposed for SCH35 House. Figure illustrative of a variety of window opening types utilized.

8.5. CIBSE TM59:2017 Results – SCH37 House

Table 15 – Modelling Results for the SCH37 using DSY1_2020_High50 weather file

06485 SCH37(Proposed) - Cardiff_DSY1_2020_High_50			
Room	Overall	TM59 Criteria predominantly naturally ventilated	
		Living rooms, kitchens and bedrooms. TM52 Criterion 1 (hours over comfort temperature <3% occupied hours)	The operative temperature in bedrooms from 10 pm to 7 am shall not exceed 26 °C for more than 1% of annual hours.
FF Bedroom 001	Pass	0.5	0.0%
FF Bedroom 002	Pass	0	0.0%
FF Bedroom 003	Pass	1	0.0%
GF Kitchen/Dining/Utility	Pass	0.5	0.0%
GF Lounge	Pass	2.2	0.0%
Option 1	G-value of 0.63 to all glazed areas. Windows openable to 100mm during specified hours. Aux ventilation in kitchen.		



Figure 28: Natural ventilation strategy proposed for SCH37 House. Figure illustrative of a variety of window opening types utilized.

Initial analysis considered windows to be fixed and closed; the results of the thermal comfort modelling study using this specification indicates that there is a risk of overheating to the dwelling when assessed against the criteria outline in CIBSE TM59 and using the future weather file 2020_DSY 1_High 50.

To mitigate the risk of overheating, a natural ventilation strategy was implemented to decrease the risk of overheating throughout the development (with opening locations and effective areas shown in Figures 22 & 23 and Appendix B).

In addition to a natural ventilation strategy and a glazing G-value of 0.63 to all glazed excluding the kitchen/dining area. Auxiliary ventilation was also utilised in the kitchen/dining areas to reduce the risk of overheating and meeting TM59 criteria.

The results of the thermal comfort modelling study using the specification detailed throughout this report indicates that the risk of overheating is reduced to within an acceptable level when assessed against the criteria outline in CIBSE TM59 and using the future weather file Cardiff_2020_DSY 1_High 50.

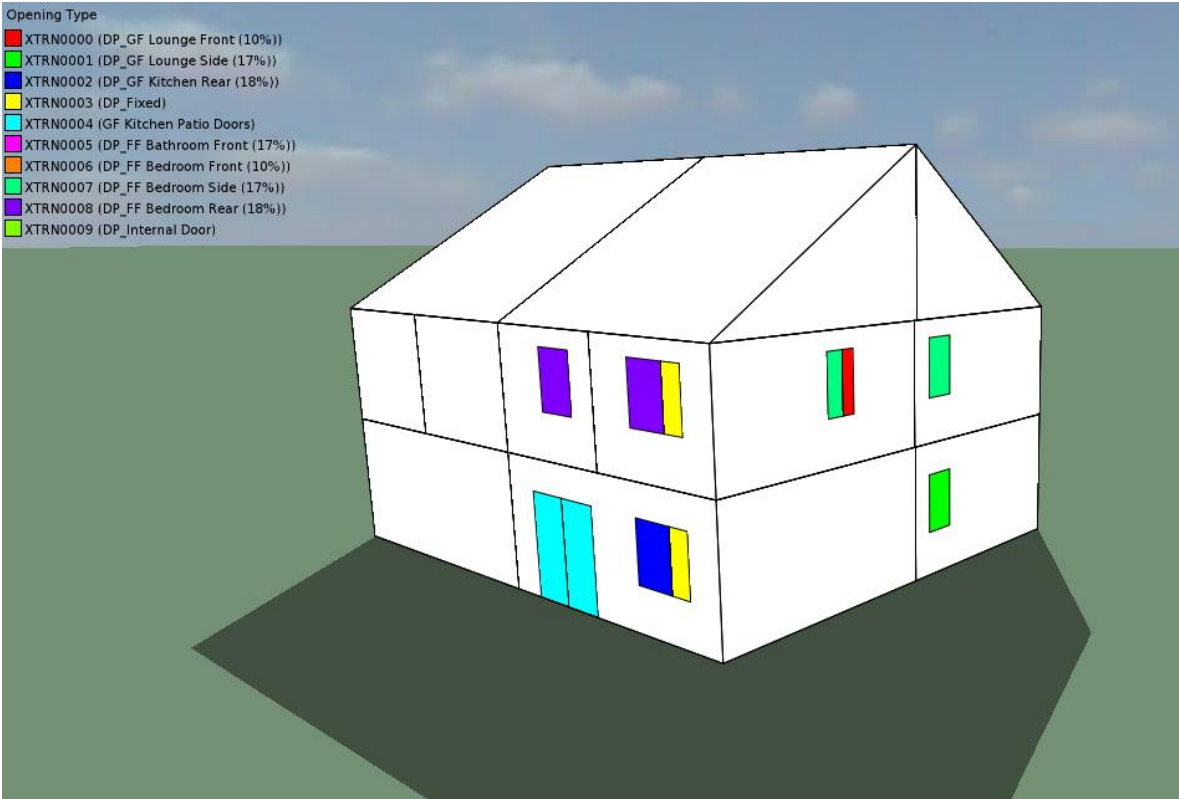


Figure 27: Natural ventilation strategy proposed for SCH37 House. Figure illustrative of a variety of window opening types utilized.

9. CONCLUSIONS

9.1. Conclusions

The thermal comfort thermal modelling results for the assessed occupied spaces indicate that there is risk of overheating to the occupied rooms of the building in accordance with the mandatory CIBSE TM59 overheating criteria. However, the risk of overheating for the Cardiff_DSY1_2020_High50 weather file can be reduced to within acceptable levels where the following is provided:

- ◆ Reduce solar heat gain through the specification of solar control glass achieving a g-value of 0.63. Significantly reduced overheating risk is achieved where this value is reduced to 0.5, which would have benefits when considering global warming implications.
- ◆ Achieve specified window ‘physical free opening areas’ as indicated in Appendix B.
- ◆ Bedroom night-time natural ventilation strategy via opened windows (to the 100mm restricted position).
- ◆ Reduce solar heat gain through the specification of solar control glass achieving a g-value of 0.45 for high-risk areas identified (SCH30A Apartment bedrooms and living rooms).

We conclude that across the development block, auxiliary ventilation was required to bring the risk of overheating to within acceptable levels. A kitchen extract flow rate of 35l/s was modelled (minimum Approved Document Part F requirement of 30 l/s) to ensure TM59 criteria was passed, however this simulation ensure auxiliary ventilation is continuously operating.

We conclude Mechanical Ventilation with Heat Recovery (MVHR) units may provide a more robust solution than continuous auxiliary ventilation from a kitchen fan which tend not to be designed for continuous operation, and are noisy..

SCH30A Apartments (Common Access) required further consideration to bring the risk of overheating to within an acceptable level as per CIBSE TM59. Thermal modelling identified south-east facing bedrooms of the three-storey apartment block as areas of particular concern due to the south-east facing aspect (leading to high after solar heat gain) and lesser contact exposure to external air, resulting from the shape of the apartment block. This required a tailored approach to address the risk, and requires a reduction in g-value from 0.63 to 0.45 to meet TM59 criteria.

Whilst the risk of overheating is reduced to within acceptable levels using the current proposed fenestration strategy and DSY1_2020_High50 weather file, we suggest adopting additional mitigating measures to de-risk the design against hotter summertime events and to safeguard the potential vulnerability of building users, including the use of MVHR systems to further decrease the risk of overheating between May & September..

Note that these results are based on several assumptions, which affect the accuracy of the results. A detailed review of the report content should be undertaken by the client to ensure accuracy.

10. RECOMMENDATIONS

Table 16: Summary of SDS Recommendations in order to meet CIBSE: TM59 criteria and mitigate the risks of overheating throughout the assessed dwellings.

DWELLING	SDS RECOMMENDED SOLUTION
SCH30A 1B2P Apartments	- Reduce solar gain through the specification of solar control glass achieving a G-value of 0.63 (preferably 0.5) in all rooms - Reduce solar heat gain through the specification of solar control glass achieving a G-value of 0.45 in all areas identified as at particularly at risk of overheating - Natural ventilation strategy implemented via fully opened windows (to 100mm restricted position) in living areas 09:00 – 22:00 and bedrooms 00:00 – 24:00 - Implementation of auxiliary ventilation with a flow rate of 35 l/s in kitchen areas
SCH21 2B3P Apartments	- Reduce solar gain through the specification of solar control glass achieving a G-value of 0.63 (preferably 0.5) in all rooms - Natural ventilation strategy implemented via fully opened windows (to 100mm restricted position) in living areas 09:00 – 22:00 and bedrooms 00:00 – 24:00 - Implementation of auxiliary ventilation with a flow rate of 35 l/s in kitchen areas
SCH35 2B4P House	- Reduce solar gain through the specification of solar control glass achieving a G-value of 0.63 (preferably 0.5) in all rooms - Natural ventilation strategy implemented via fully opened windows (to 100mm restricted position) in living areas 09:00 – 22:00 and bedrooms 00:00 – 24:00 - Implementation of auxiliary ventilation with a flow rate of 35 l/s in kitchen areas
SCH35 3B5P House	- Reduce solar gain through the specification of solar control glass achieving a G-value of 0.63 (preferably 0.5) in all rooms - Natural ventilation strategy implemented via fully opened windows (to 100mm restricted position) in living areas 09:00 – 22:00 and bedrooms 00:00 – 24:00 - Implementation of auxiliary ventilation with a flow rate of 35 l/s in kitchen areas

11. ASSUMPTIONS REGISTER

There are several assumptions which have been made when undertaking the simulation. If any of these assumptions are incorrect, or should the parameters be varied throughout the evolution of the project design, the simulation and calculations should be re-visited to ensure the resultant outputs take account of any updates.

- ◆ *Where the architectural design fails to comply with the assumption stated or has been changed after this report without re-iteration, the accuracy of this report is compromised which may result in consequential non-compliance with the Client requirements and Building Regulations.*

Table 17 – Assumptions Register

Item	Assumption	Reason / Limitation / Risk
1	Fabric U-values and thermal mass.	If the fabric performance differs from the values stated within this report, a potential risk of overheating increases and failure to comply with CIBSE TM59 is increased.
2	Space usage profiles are assumed (the duration of population).	If the usage profiles are unrealistic and space usage is significantly greater than assumed in this report, potential risk of overheating increases which constitutes a failure to comply with CIBSE TM59.
3	Window opening, temperature set points and times open, as per Appendix B.	If the opening profiles are unrealistic and opening duration is less than assumed, a potential risk of overheating increases and failure to comply with CIBSE TM59 is increased.
4	Window physical free opening area (m ²) as stated in Appendix C.	If the window opening free area is unrealistic and less than stated in this report, a potential risk of overheating increases as does a failure to comply with CIBSE TM59.
5	Heat gain and variation assumptions where data is unavailable.	If the heat gains and times of which they assumed to provide heat are unrealistic and greater than assumed in this report, a potential risk of overheating is increased as is a failure to comply with CIBSE TM59.

12. REFERENCES

A BSRIA Guide: The Illustrated Guide to Ventilation. (Compiled by Kevin Pennycook). (BSRIA BG 2/2009 – June 2010 Update). ISBN 978 0 86022 673 4.

CIBSE AM10. Natural Ventilation in Non-domestic Buildings. Chartered Institute of Building Services Engineers, London, 2005. ISBN 1 903287 56 1

CIBSE AM11. Building Performance Modelling. Chartered Institute of Building Services Engineers, London, 2015. ISBN 978-1-906846-67-1.

CIBSE Guide A: Environmental Design. Chartered Institute of Building Services Engineers, London, 2015.

CIBSE TM59: Design methodology for the assessment of overheating risk in homes. Chartered Institute of Building Services Engineers, London, 2017.

National Calculation Methodology, 2013 Edition: NCM Modelling Guide (for buildings other dwellings in England).

Non-Domestic Building Services Compliance Guide, 2013 Edition. HM Government. ISBN 978-1-85946-535-6.

The Building Regulations 2010: Conservation of Fuel and Power Part L1A. Conservation of fuel and power (Dwellings) (2021 edition). HM Government. ISBN 978-1-91412-478-5

The Building Regulations 2010: Conservation of Fuel and Power Part L2A. Conservation of fuel and power (New buildings other than dwellings) (2013 edition incorporating 2016 amendments). HM Government. ISBN 978-1-85946-512-7.

The Building Regulations 2010: Ventilation. Means of Ventilation F1 (2010 edition incorporating 2010 and 2013 amendments). HM Government. ISBN 978 1 85946 679 7

Thermal simulation software: IES Virtual Environment – Version 2021.3.0.0

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

13. APPENDICES

Appendix A

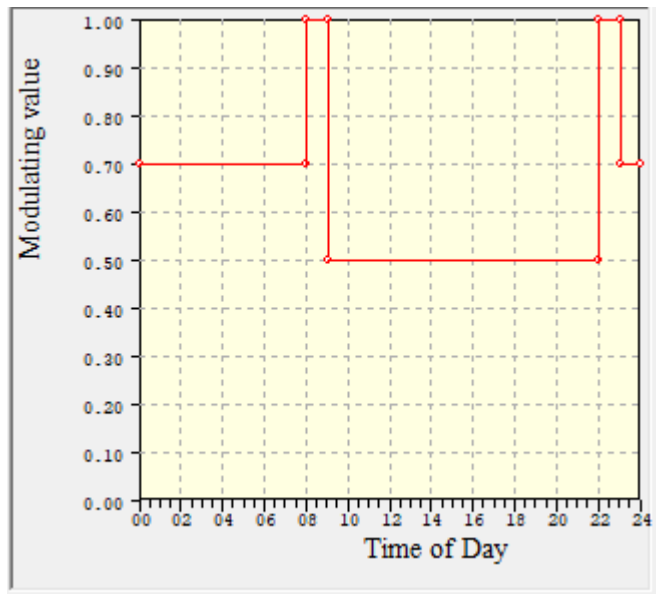
IESVE Site Maps Model Locations



Appendix B

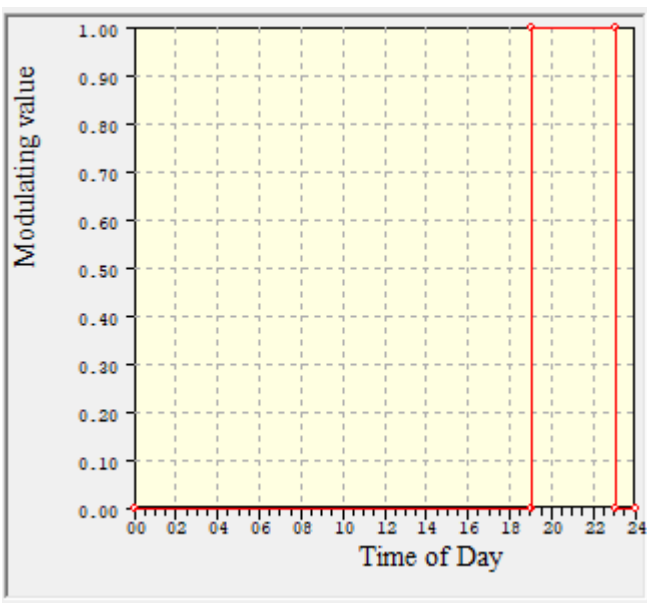
Occupancy, Lighting & Equipment Profiles

Double Bedrooms – Occupancy Variation Profile



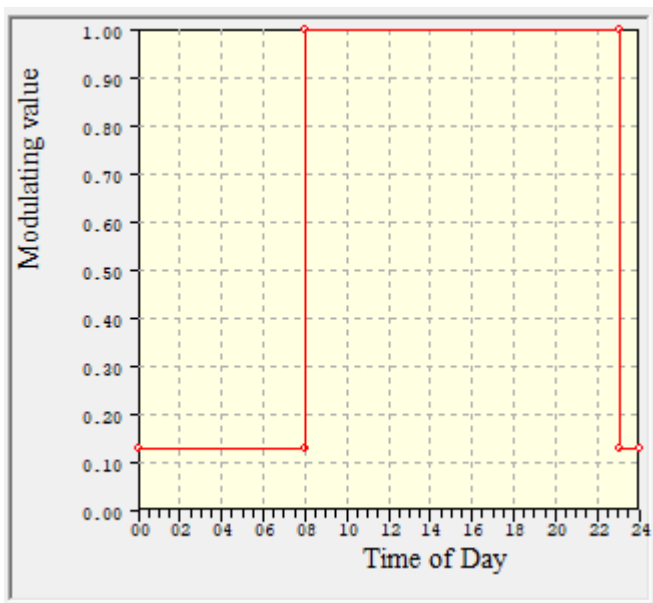
For the purposes of the overheating heating assessment the space is occupied 24/7 throughout the year including bank holidays in accordance with TM59 guidelines.

Double Bedrooms - Lighting Variation Profile



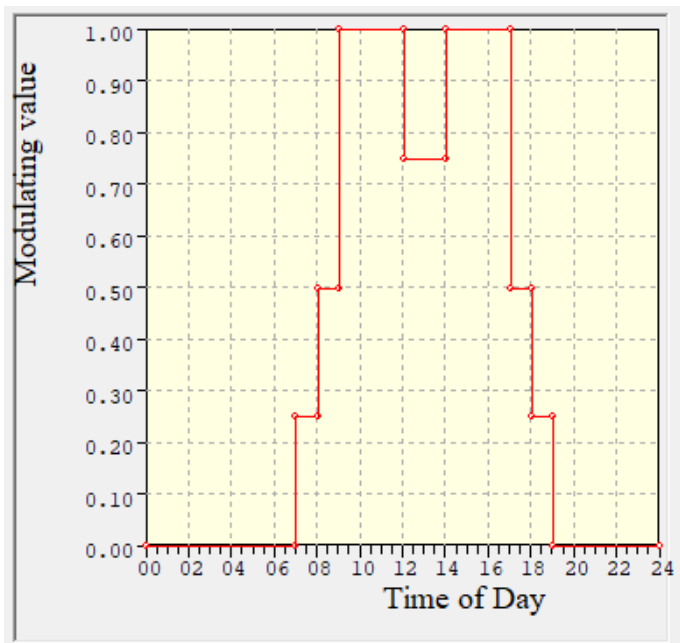
For the purposes of the overheating heating assessment lighting is fully on from 19:00 to 23:00 in accordance with TM59 guidelines.

Double Bedrooms - Equipment Variation Profile



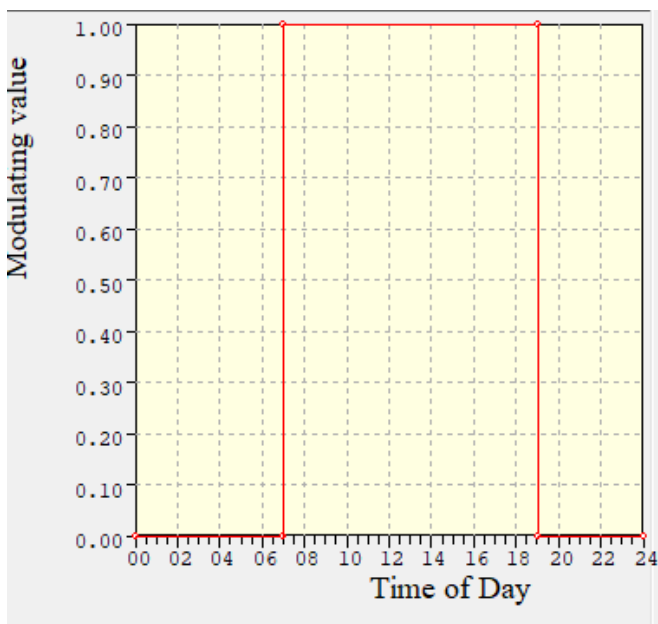
For the purposes of the overheating heating assessment equipment is fully on from 08:00 to 23:00. This profile also considers equipment standby between 23:00 and 08:00 in accordance with TM59 guidelines.

Office – Occupancy Variation Profile



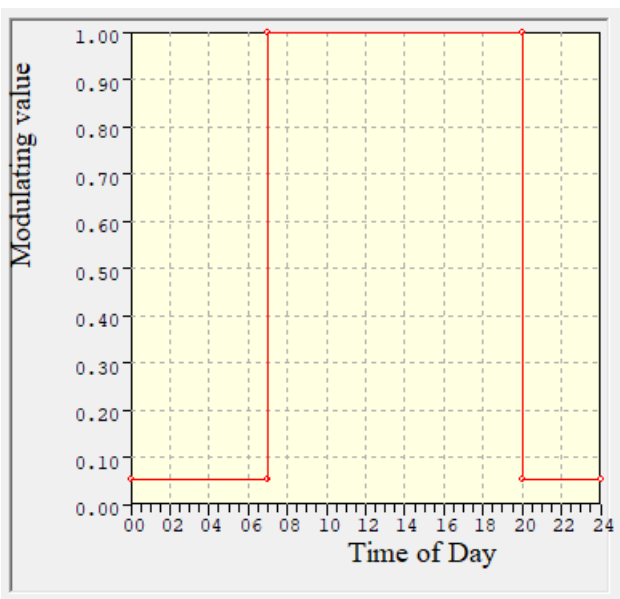
For the purposes of the overheating heating assessment the space is occupied from 07:00 to 19:00 throughout the year including bank holidays in accordance with TM59 guidelines.

Office - Lighting Variation Profile



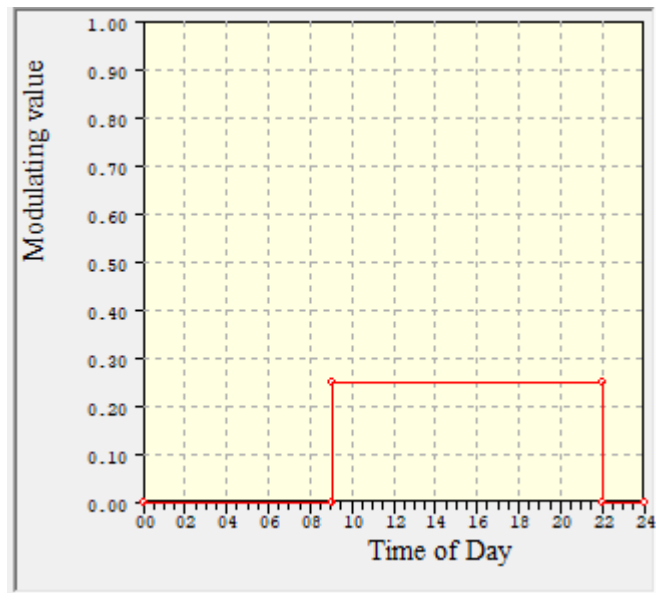
For the purposes of the overheating heating assessment lighting is fully on from 07:00 – 19:00 in accordance with TM59 guidelines.

Office - Equipment Variation Profile



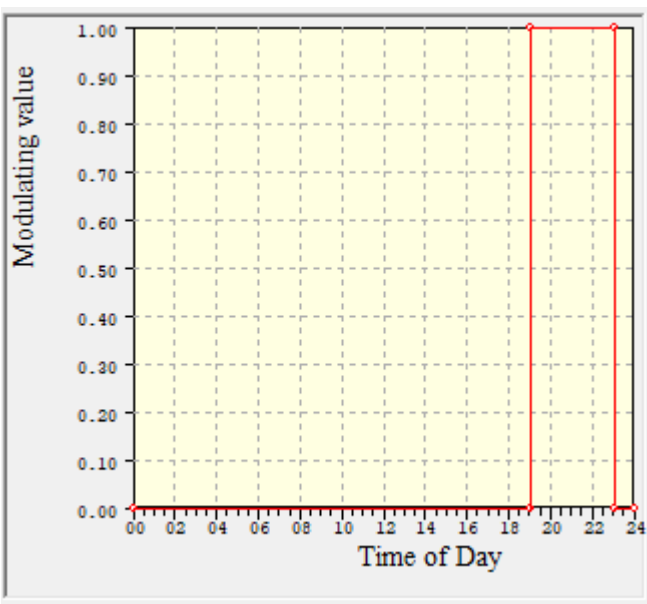
For the purposes of the overheating heating assessment equipment is fully on from 07:00 to 20:00. This profile also considers equipment standby between 20:00 and 07:00 in accordance with TM59 guidelines.

Kitchen (2, 3 & 4 bed apartment) - Occupancy Variation Profile



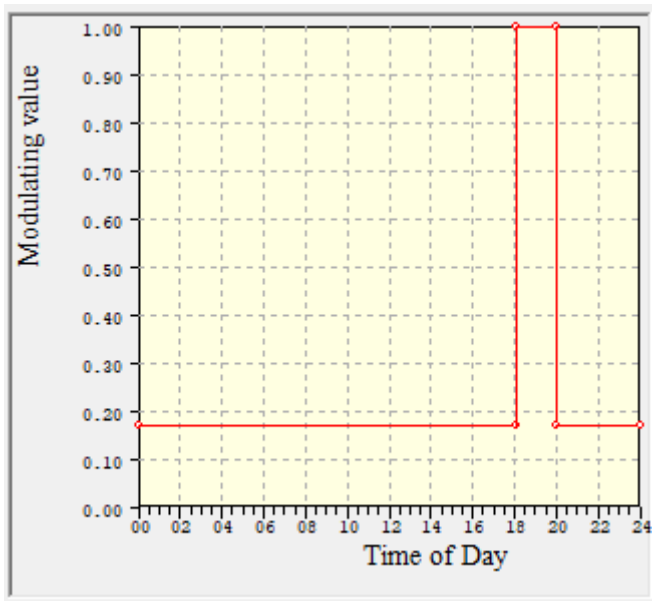
For the purposes of the overheating heating assessment the space is occupied from 09:00 to 22:00 throughout the year including bank holidays in accordance with TM59 guidelines.

Kitchen (2, 3 & 4 bed apartment) - Lighting Variation Profile



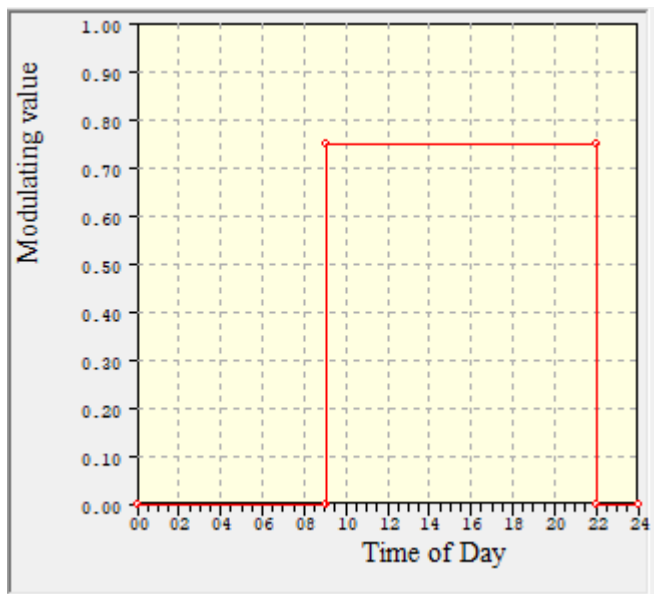
For the purposes of the overheating heating assessment lighting is fully on from 19:00 to 23:00 in accordance with TM59 guidelines.

Kitchen (2, 3 & 4 bed apartment) - Equipment Variation Profile



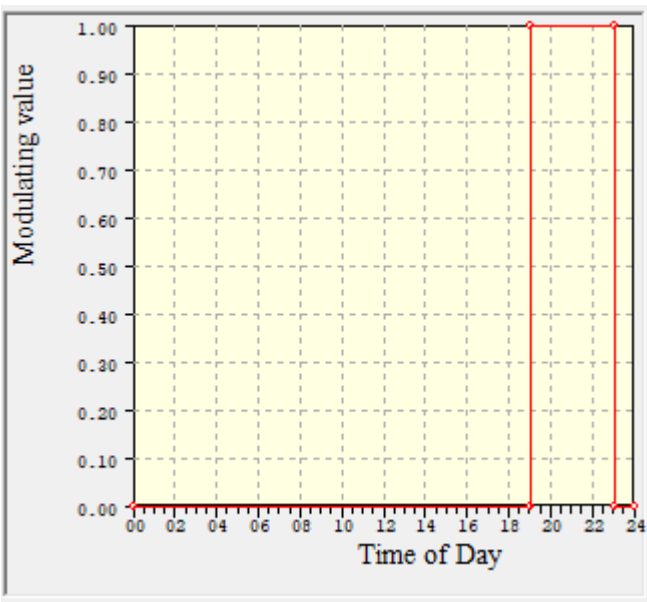
For the purposes of the overheating heating assessment equipment is fully on from 18:00 to 20:00. This profile also considers equipment standby between 20:00 and 18:00 in accordance with TM59 guidelines.

Living room (2, 3 & 4 bed apartment) & Lounge – Occupancy Variation Profile



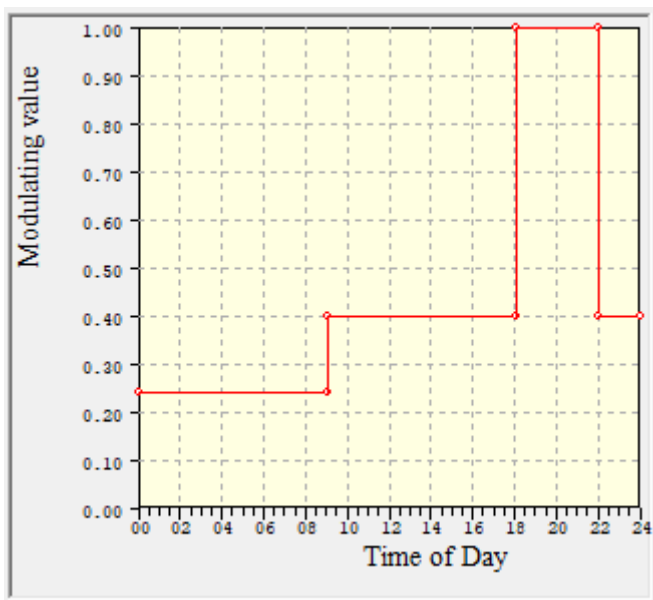
For the purposes of the overheating heating assessment the space is occupied from 09:00 to 22:00 throughout the year including bank holidays in accordance with TM59 guidelines.

Living room (2, 3 & 4 bed apartment) & Lounge – Lighting Variation Profile



For the purposes of the overheating heating assessment lighting is fully on from 19:00 to 23:00 in accordance with TM59 guidelines.

Living room (2, 3 & 4 bed apartment) & Lounge – Equipment Variation Profile



For the purposes of the overheating heating assessment equipment is on a varying usage from 09:00 to 22:00. This profile also considers equipment standby between 22:00 and 09:00 in accordance with TM59 guidelines.

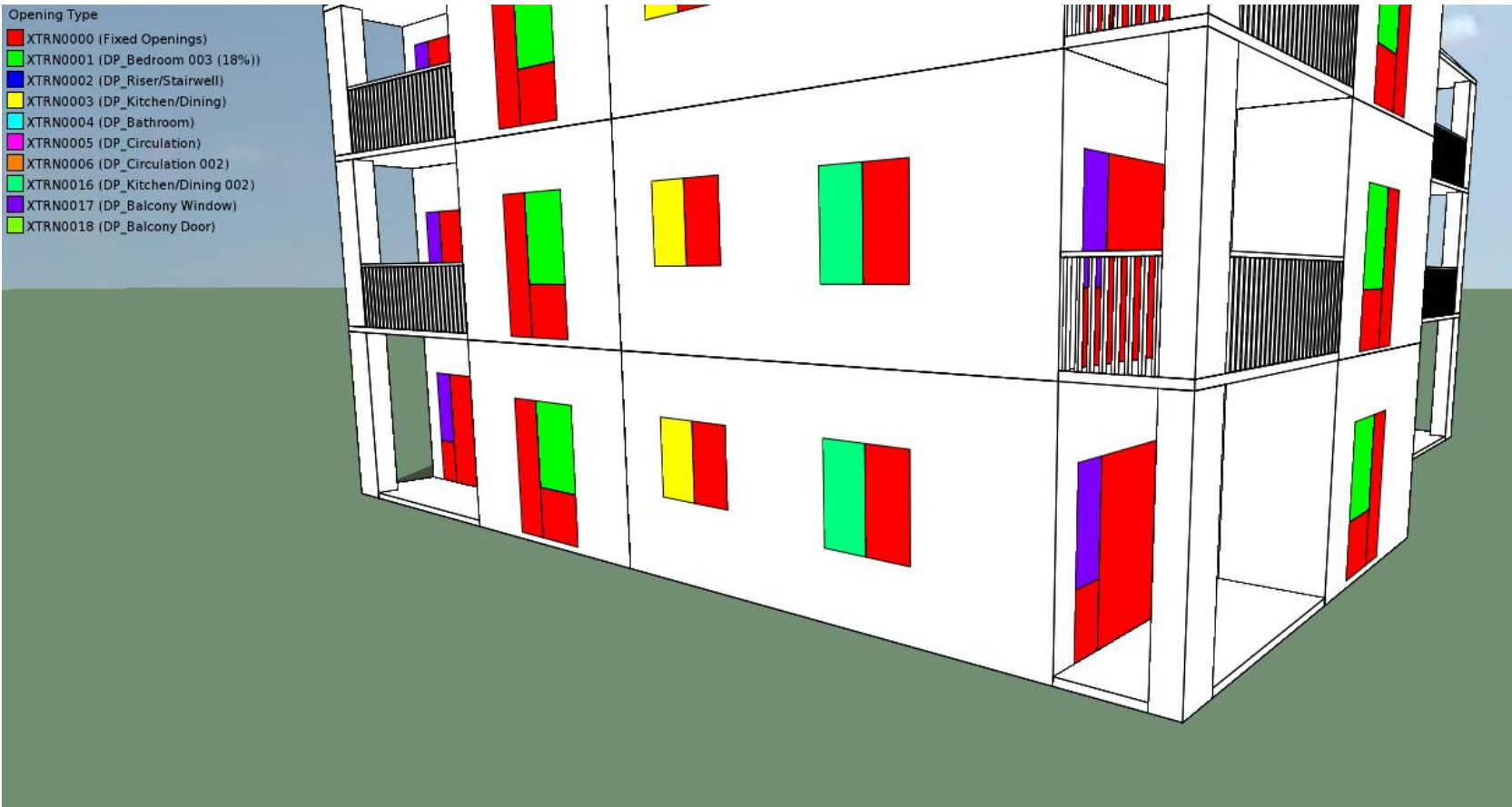
Appendix D

Natural Ventilation Strategy

SCH30A 1B2P Apartments (Common Access)

Opening Description	Opening Type	Min. Physical Free Area (m2)	Min. Throw Distance (mm) beyond building face	Colour	Opening Times
Fixed	N/A	0	0		Fixed
Bedroom 003	Custom/sharp orifice	0.09	100		Open fully during the day from 09:00 - 22:00 if internal air temperature >22° C and wind speed is < 13 m/s. Window is closed during the night from 22:00 - 09:00.
Kitchen/Dining	Custom/sharp orifice	0.06	100		Open fully during the day from 09:00 - 22:00 if internal air temperature >22° C and wind speed is < 13 m/s. Window is closed during the night from 22:00 - 09:00.
Kitchen/Dining 002	Custom/sharp orifice	0.06	100		Open fully during the day from 09:00 - 22:00 if internal air temperature >22° C and wind speed is < 13 m/s. Window is closed during the night from 22:00 - 09:00.
Balcony Window	Custom/sharp orifice	0.07	100		Open fully throughout the day and night when internal air temperature > 22° C and wind speed is <13 m/s.

Elevation 1

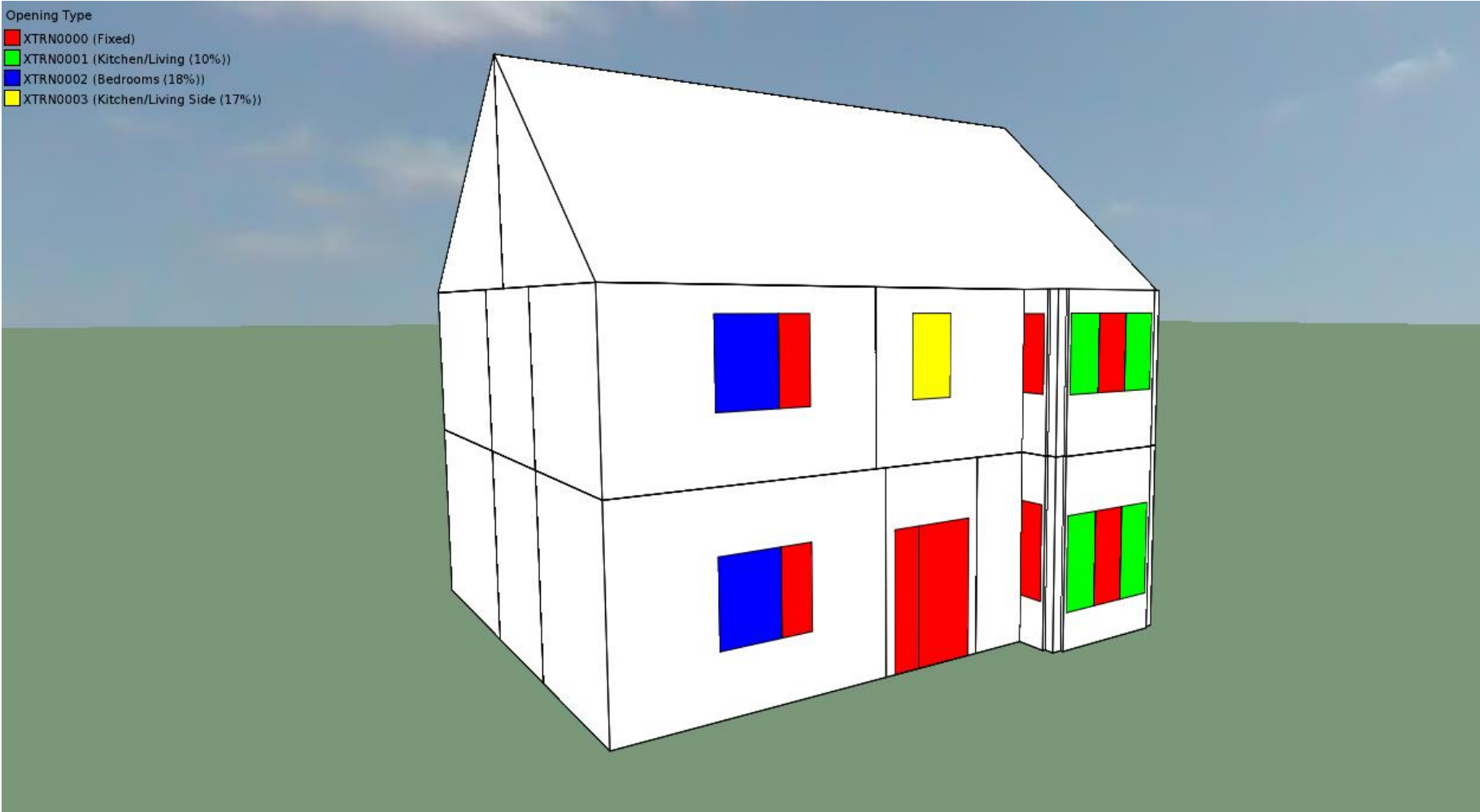


The exact position and type of opening can be adjusted provided the effective free areas are achieved as detailed in the table above, considering any internal or external restrictions as detailed in CIBSE AM10

Opening Description	Opening Type	Min. Physical Free Area (m2)	Min. Throw Distance (mm) beyond building face	Colour	Opening Times
Fixed	N/A	0	0		Fixed
GF Kitchen/Living	Custom/sharp orifice	0.06	300		Open fully during the day from 09:00 - 22:00 if internal air temperature >22° C and wind speed is < 13 m/s. Window is closed during the night from 22:00 - 09:00.
GF Bedrooms	Custom/sharp orifice	0.09	300		Open fully throughout the day and night when internal air temperature > 22° C and wind speed is <13 m/s.
GF Kitchen/Living Side	Custom/sharp orifice	0.07	300		Open fully during the day from 09:00 - 22:00 if internal air temperature >22° C and wind speed is < 13 m/s. Window is closed during the night from 22:00 - 09:00.

SCH21A 2B3P Apartments (Walk Up)

Elevation 1

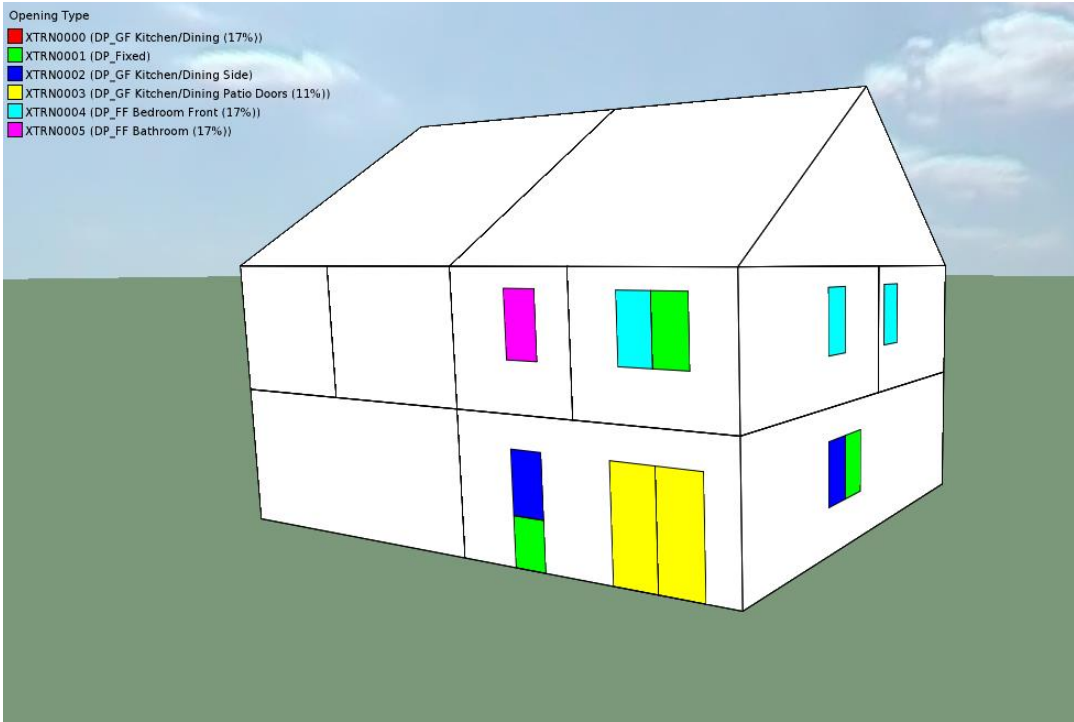
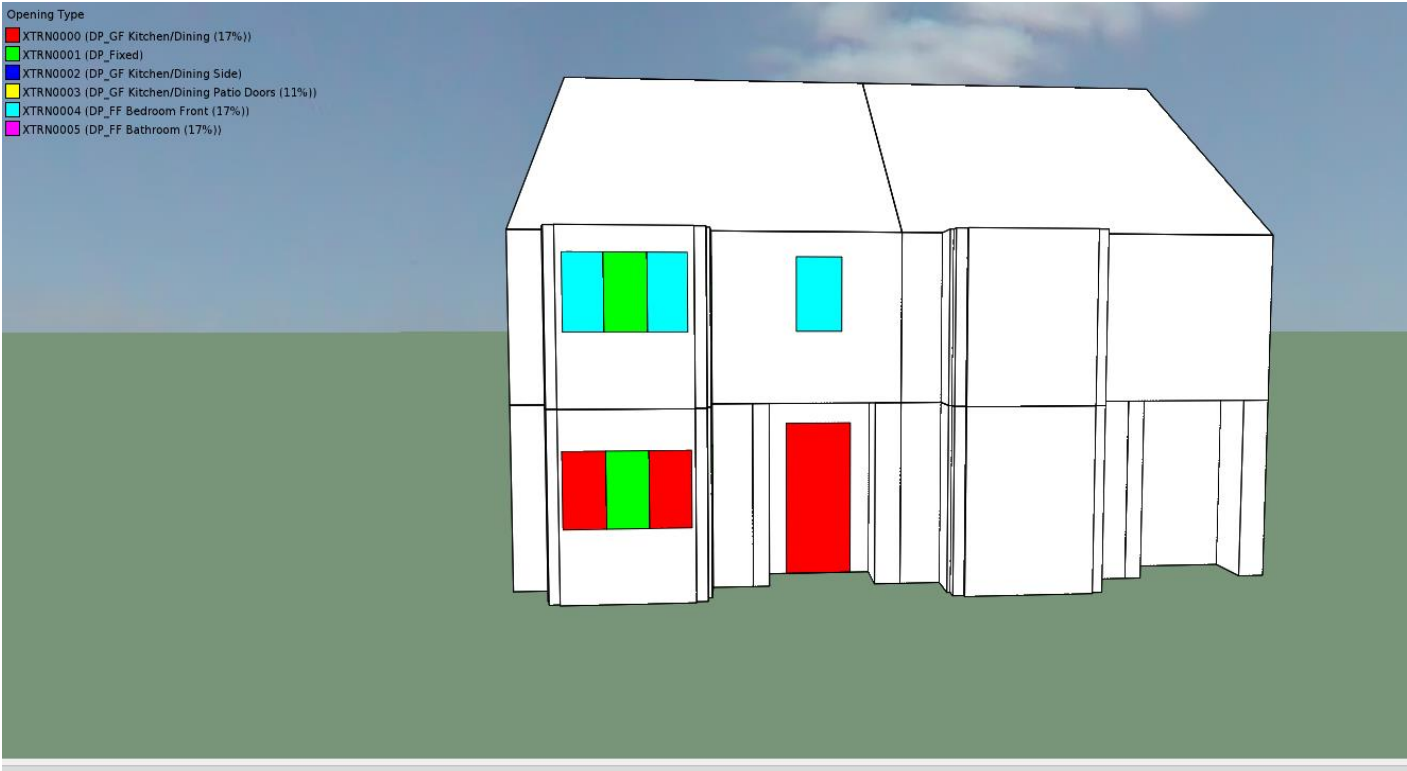


The exact position and type of opening can be adjusted provided the effective free areas are achieved as detailed in the table above, considering any internal or external restrictions as detailed in CIBSE AM10

Opening Description	Opening Type	Min. Physical Free Area (m2)	Min. Throw Distance (mm) beyond building face	Colour	Opening Times
Fixed	N/A	0	0		Fixed
GF Kitchen/Dining Front	Custom/sharp orifice	0.06	100		Open fully during the day from 09:00 - 22:00 if internal air temperature >22° C and wind speed is < 13 m/s. Window is closed during the night from 22:00 - 09:00.
GF Kitchen/Dining Side	Custom/sharp orifice	0.07	100		Open fully during the day from 09:00 - 22:00 if internal air temperature >22° C and wind speed is < 13 m/s. Window is closed during the night from 22:00 - 09:00.
GF Kitchen/Dining Rear	Custom/sharp orifice	0.09	100		Open fully during the day from 09:00 - 22:00 if internal air temperature >22° C and wind speed is < 13 m/s. Window is closed during the night from 22:00 - 09:00.
FF Bedroom Front	Custom/sharp orifice	0.07	100		Open fully throughout the day and night when internal air temperature > 22° C and wind speed is <13 m/s.
FF Bedroom Front 002	Custom/sharp orifice	0.07	100		Open fully throughout the day and night when internal air temperature > 22° C and wind speed is <13 m/s.

SCH35 2B4P House

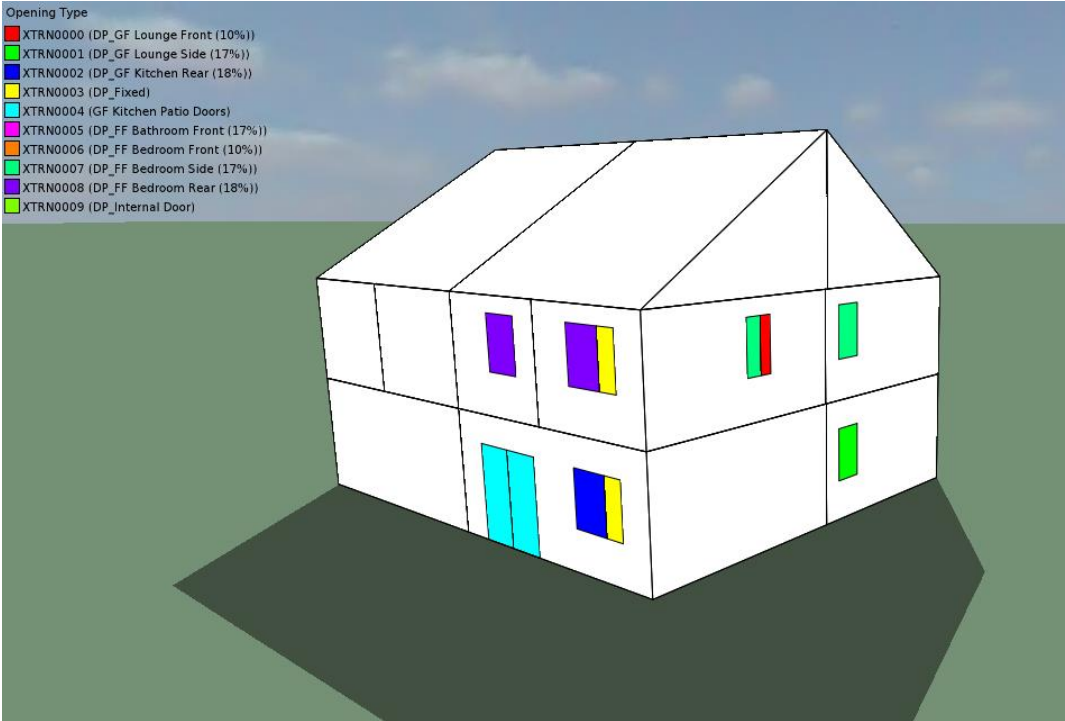
Elevation 1



The exact position and type of opening can be adjusted provided the effective free areas are achieved as detailed in the table above, considering any internal or external restrictions as detailed in CIBSE AM10

Opening Description	Opening Type	Min. Physical Free Area (m2)	Min. Throw Distance (mm) beyond building face	Colour	Opening Times
Fixed	N/A	0	0		Fixed
GF Lounge Front	Custom/sharp orifice	0.06	100		Open fully during the day from 09:00 - 22:00 if internal air temperature >22° C and wind speed is < 13 m/s. Window is closed during the night from 22:00 - 09:00.
GF Lounge Side	Custom/sharp orifice	0.07	100		Open fully during the day from 09:00 - 22:00 if internal air temperature >22° C and wind speed is < 13 m/s. Window is closed during the night from 22:00 - 09:00.
GF Kitchen Rear	Custom/sharp orifice	0.09	100		Open fully during the day from 09:00 - 22:00 if internal air temperature >22° C and wind speed is < 13 m/s. Window is closed during the night from 22:00 - 09:00.
GF Kitchen Patio Doors	Custom/sharp orifice	0.09	100		Open fully during the day from 09:00 - 22:00 if internal air temperature >22° C and wind speed is < 13 m/s. Window is closed during the night from 22:00 - 09:00.
FF Bedroom Front	Custom/sharp orifice	0.06	100		Open fully throughout the day and night when internal air temperature > 22° C and wind speed is <13 m/s.
FF Bathroom Front	Custom/sharp orifice	0.07	100		Open fully throughout the day and night when internal air temperature > 22° C and wind speed is <13 m/s.
FF Bedroom Side	Custom/sharp orifice	0.07	100		Open fully throughout the day and night when internal air temperature > 22° C and wind speed is <13 m/s.
FF Bedroom Rear	Custom/sharp orifice	0.09	100		Open fully throughout the day and night when internal air temperature > 22° C and wind speed is <13 m/s.

SCH37 3B5P House
Elevation 1

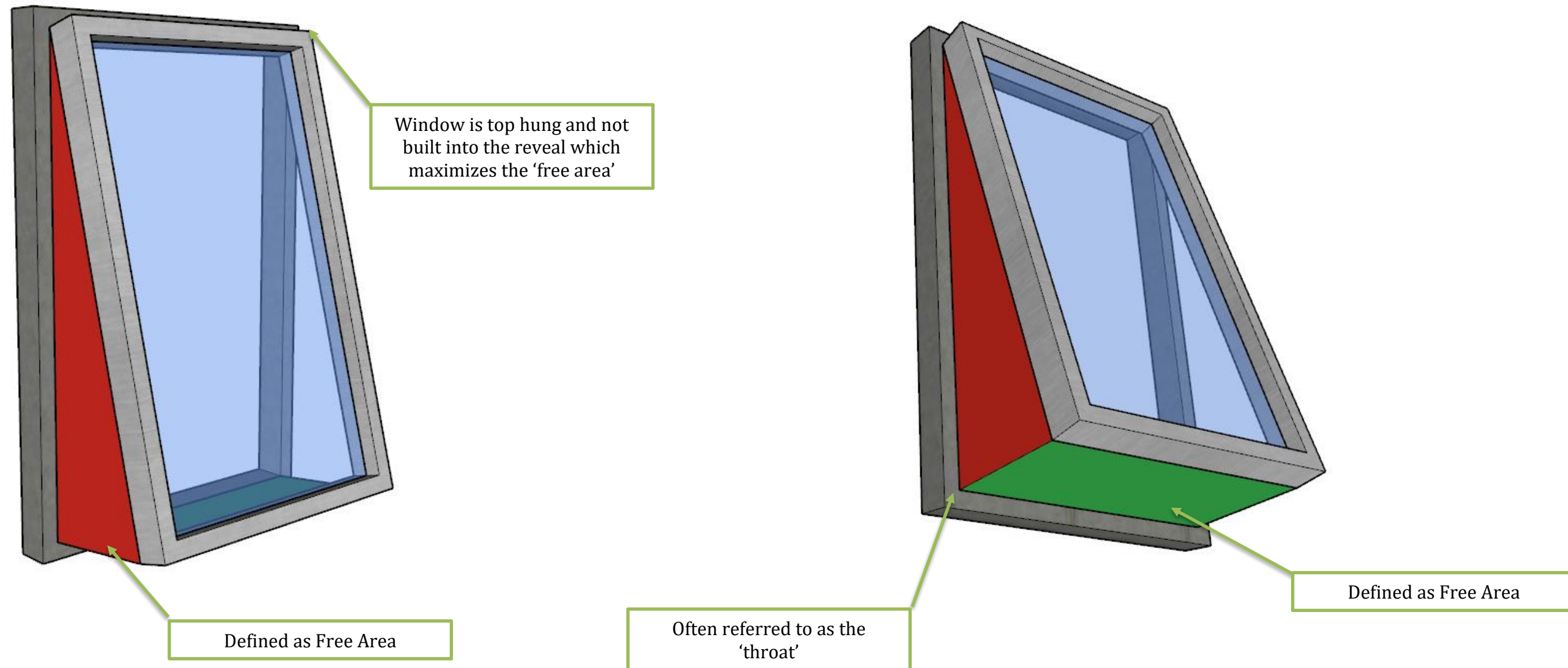


The exact position and type of opening can be adjusted provided the effective free areas are achieved as detailed in the table above, considering any internal or external restrictions as detailed in CIBSE AM10

Appendix D

Effective Opening Area Calculation Guidance

Calculating Effective 'Free Area' for Openings



The graphics above have been developed to represent the way in which 'effective free area' for window openings has been calculated. Throughout this report the value is expressed within Appendix B as a m^2 value.

The image above shows a typical top hung window as an example. There are lots of different window types available and each calculation method differs, but this should provide an idea for the non-technical user.

There are plenty of papers and research articles surrounding this topic. CIBSE Application Manual 10 is what we have used as a basis for our calculations.

