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Thermal Model Report (Part O)

Carmarthen West

Prepared for:

Lovell Partnerships Ltd

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Disclaimer

Executive Summary

- Dynamic thermal modelling assessment has been developed for Carmarthen West, located in Carmarthen.
- This Overheating assessment has been produced in line with Approved Document O and CIBSE:TM59 criteria.
- The Dynamic thermal modelling for the proposed development has been carried out using IES software, in accordance with ‘CIBSE AM11 Building Energy and Environmental Modelling’.
- The development passes Approved Document O and CIBSE:TM59 criteria with the proposed natural ventilation strategy outlined within this report.
- Window restrictors limiting the opening for security will be required for all easily accessible or ground bedroom windows locations, in accordance with the requirements of Approved Document O, to ensure security. Fixed guarding should be installed to all windows which are less than 1.1m from the floor level.

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1. Introduction

This Thermal Model Report (Part O) has been prepared by Darren Evans Ltd on behalf of Lovell Partnerships Ltd. The Assessment was carried out on a detached building named Carmarthen West.

This Thermal Model Report (Part O) aims to provide guidance on the overheating strategy within the development and ensure that thermal comfort is achieved.

The dynamic simulation model has assessed the circulation areas, bedrooms, lounges, kitchens, bathrooms, and other areas of low transition and takes into consideration the gains associated with adjacent spaces, thermal gain, equipment gains and occupancy gains within the apartments.

The units have been assessed, taking into account the heat transfer and movement of air through all occupied rooms, i.e., bedrooms, living rooms, bathrooms, hallways and all other areas of low transient occupancy.

The analysis has been undertaken using the IES Virtual Environment Version 2025.1.0.0 (VE Compliance 7.0.30.0) using detailed drawings and information supplied by Lovell Partnerships Ltd. The IES interface enabled varying levels of simulation and analysis to be carried out. A model of the development was constructed, and a dynamic simulation was undertaken to understand the internal air temperature of the building during occupancy in line with HM Government Approved Document O: 2021 and CIBSE TM59: 2017.

CIBSE TM52 'The Limits of Thermal Comfort: Avoiding Overheating in European Buildings' was first published in 2013 and is a more rigorous and up to date standard of thermal comfort. Rather than purely focussing on the percentage of hours out of range, TM52 looks at how likely someone is to be "comfortable". Simplistically this is trying to estimate what most people might feel, most of the time.

CIBSE TM59 was released in 2017 as an update for residential areas. It requires, for all domestic living rooms, bedrooms and kitchens, the number of hours during which ΔT is greater than or equal to one degree (K) between May and September shall not be more than 1% of occupied hours. This is also referred to as Criterion 1 in CIBSE TM52. Additionally, between the hours of 10pm and 7am Bedrooms shall not exceed 26 degrees for more than 1% of annual hours. For bedrooms, both of the above statements need to be met. Any room which fails the relevant above criteria is potentially at risk of overheating.

Approved Document O was released in 2021 and took effect on 15 June 2022. All planning applications of residential buildings after 15 June 2022 are required to fulfil the AD-O thermal comfort requirements.

The aim of AD-O is to ensure comfortable indoor conditions by reducing the occurrence of high internal temperatures. Both of the following must be achieved when designing and constructing a building:

a. Limiting unwanted solar gains in summer, and
b. Providing an adequate means of removing excess heat from the indoor environment.

Following guidance from AD-O, compliance can be achieved in either of the following routes:

1. Design Limits under the new Simplified Method, OR
2. Comfort criteria under the dynamic thermal modelling route based on CIBSE TM59

The Simplified Method sets maximum limits on glazing areas and minimum limits on free opening areas for ventilation. These limits depend on the building's dominant orientation, the location in the country (divided into two zones: "high" risk and "moderate" risk), and presence of cross-ventilation (i.e., openings on opposite sides).

While the simplified method does not require modelling, the second method using dynamic thermal modelling tools provide more design flexibility on balancing glazing and shading provision.

In the dynamic analysis, shading from nearby buildings and other external elements such as balconies, overhangs, blinds, louvres etc. can be considered.

The software was used to carry out the simulation at detailed design stage and provides full dynamic thermal analysis, reporting on heating & cooling levels, overheating, air humidity, CO2 concentration and daylighting as well as air movement throughout the building.

Occupancy hours, occupancy density, HVAC operational hours, and internal equipment and installation loads have been based on CIBSE TM59 procedure, while opening profiles have been based on the new approved document O as per below.

1. When a room is occupied during the day (8am to 11pm), openings should be modelled to do all the following:
   a. Start to open when the internal temperature exceeds 22° C.
   b. Be fully open when the internal temperature exceeds 26° C.
   c. Start to close when the internal temperature falls below 26° C.
   d. Be fully closed when the internal temperature falls below 22° C.
2. At night (11pm to 8am), openings should be modelled as fully open if both of the following apply:
   a. The opening is on the first floor or above and not easily accessible.
   b. The internal temperature exceeds 23° C at 11pm.
3. When a ground floor or easily accessible room is unoccupied, both of the following apply:
   a. In the day, windows, patio doors and balcony doors should be modelled as open, if this can be done securely.
   b. At night, windows, patio doors and balcony doors should be modelled as closed.
4. An entrance door should be included, which should be shut all the time.

Internal doors were included in the analysis and left open in the daytime (9am to 10pm) as described in TM59 document.

The following pages summarise the calculations and results.

2. Thermal Comfort

2.1 Aim

To ensure that appropriate thermal comfort levels are achieved through design, and controls are selected to maintain a thermally comfortable environment for occupants within the buildings.

2.1.1 Assessment Criteria

The following are required to demonstrate compliance with Approved Document O and CIBSE TM59:

Compliance is based on passing both of the following two criteria:

a. **For living rooms, kitchens, and bedrooms:** the number of hours during which ΔT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3 percent of occupied hours. (CIBSE TM52 Criterion 1: Hours of exceedance).

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 fail).

Criteria 2 and 3 of CIBSE TM52 may fail to be met, but both (a) and (b) above **must** be passed for all relevant rooms.

3. Overheating in Buildings

Historically, buildings in the UK and especially dwellings have not particularly suffered from overheating. However, due to the impacts of climate change and the improvements with the UK Building Regulations resulting in better insulated and more airtight buildings, there is a growing body of research that has shown the risk of overheating needs to be accounted for more significantly and considered at the earliest stages of a development.

It is important to consider the risks of overheating within any building from the outset of the design stage. A building which is at risk of overheating can have serious impacts on its inhabitants in a number of important areas such as comfort, productivity, happiness, stress and both mental and physical health.

When inhabitants of a building are exposed to air temperatures of 24-28°C they start to feel discomfort. Extended periods of over 28°C can result in high levels of occupant dissatisfaction. These effects can be of particular concern in vulnerable people, such as the elderly or inhabitants with health conditions.

Buildings constructed with heavier materials will have a higher thermal mass than those built with lightweight materials. A higher thermal mass will result in variations in daily temperature not being reproduced as quickly within the dwelling as the mass of the building absorbs some of the energy during the day before releasing it back into the room at night when temperatures are cooler. A property constructed with lightweight materials is not able to absorb this energy and so more energy is retained during temperature variations which can result in higher temperatures experienced by the occupants. Therefore, the building materials are an important design consideration when assessing overheating risk.

Glazing also plays an important factor in overheating risk. South facing facades receive higher amounts of solar radiation during the day and West facing facades may receive unwanted solar radiation during the evening. The path of the sun and the ability for direct solar radiation to enter the property at various times during the day need to be considered as this can have a significant effect on the risk of a dwelling overheating. Both external and internal shading as well as the properties of the glazing will all affect this risk.

Ventilation within a building is a key variable when assessing the risk of overheating. Air flow can move warm air out of a warm space and move cooler air into that space, but it also has the ability to increase the temperature of a space by bringing in warm air, both of which will impact any risk a space will have to overheat.

The risk of overheating is also impacted by thermal gains experienced from within the building and adjacent spaces. The levels of occupancy and activity of those occupants within a zone, any equipment being used in that space, the amount of lighting and the activity of neighbouring zones will have an impact on the thermal gains experienced by a space and affect its risk of overheating.

4. Project Details

The analysis within this report assesses the risk of overheating within an Affordable Social rented residential building scheme Carmarthen West located in Carmarthen.

Each apartment is containing a Living / Kitchen Spaces, mixutre of Bedrooms (1 to 4) and associated utility areas.

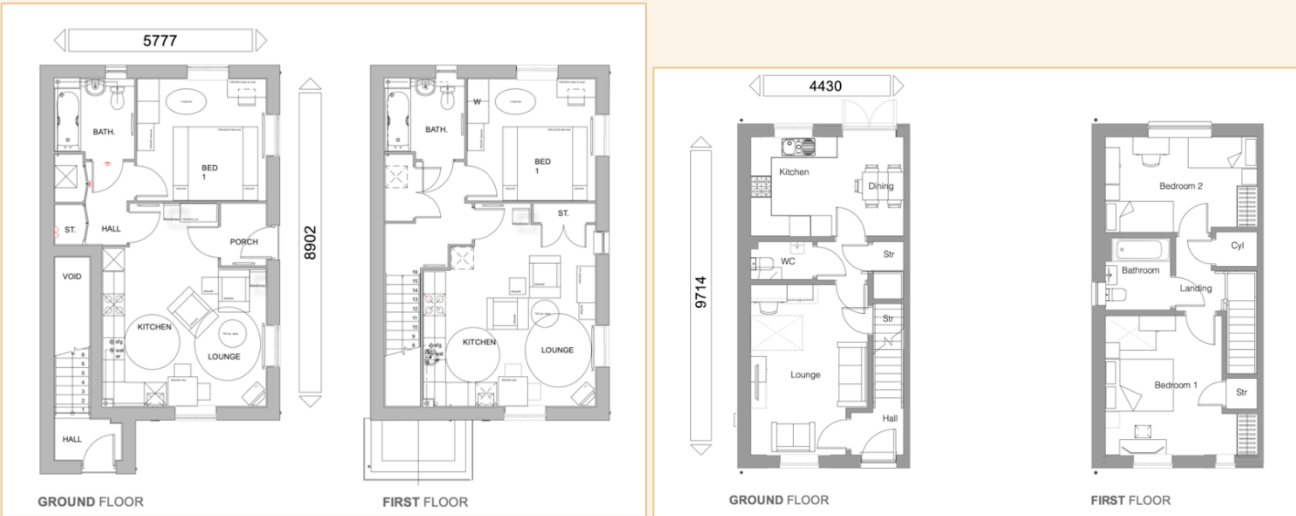

Figure 1: Plan drawings of the 1B2P(left) and the 2B4P (right)

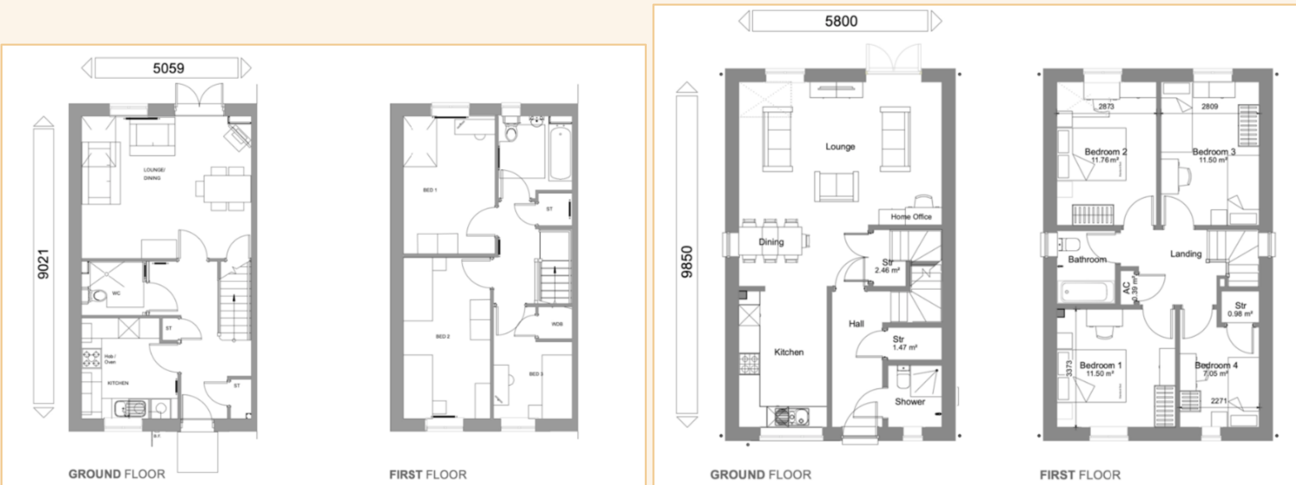

Figure 2: Plan drawings of the 3B5P(left) and the 4B7P (right)

Figure 3: Site Layout Plan of Carmarthen West, Courtesy of The Urbanists

5. Dynamic Simulation Model

IES Virtual Environment, Version 2025.0.0.0, has been used to build a detailed 3D model for the proposed development, as show below. IES VE complies with CIBSE AM11 and Dynamic Simulation Modelling software (DSM) approved by the Ministry of Housing, Communities and Local Government (MCHLG). The modelling geometry was based on the Planning Architectural drawings.

The dynamic simulation models has evaluated all two-storey development, Carmarthen West including all the bedrooms, kitchens / dining/ living areas, bathrooms, and circulation spaces taking into consideration the gains associated with adjacent spaces, thermal gains, equipment gains and occupancy gains.

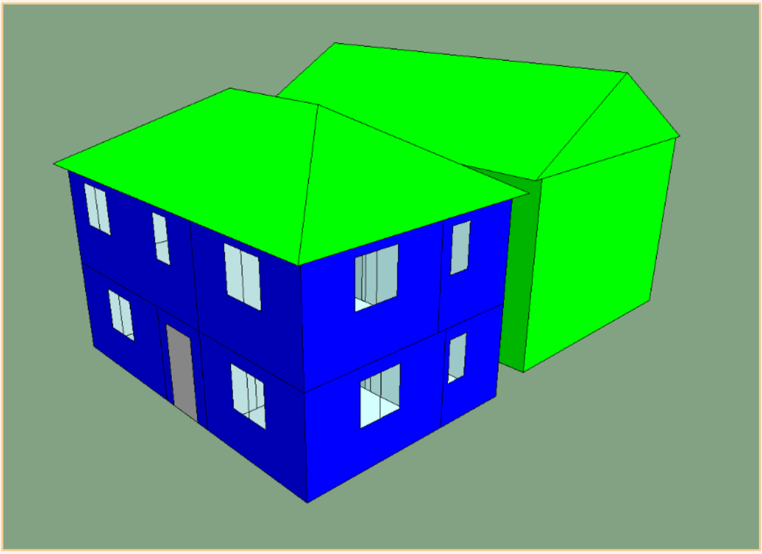

Figure 4: IES Model (3D Model) of the 1B2P house types located in first and second floor.

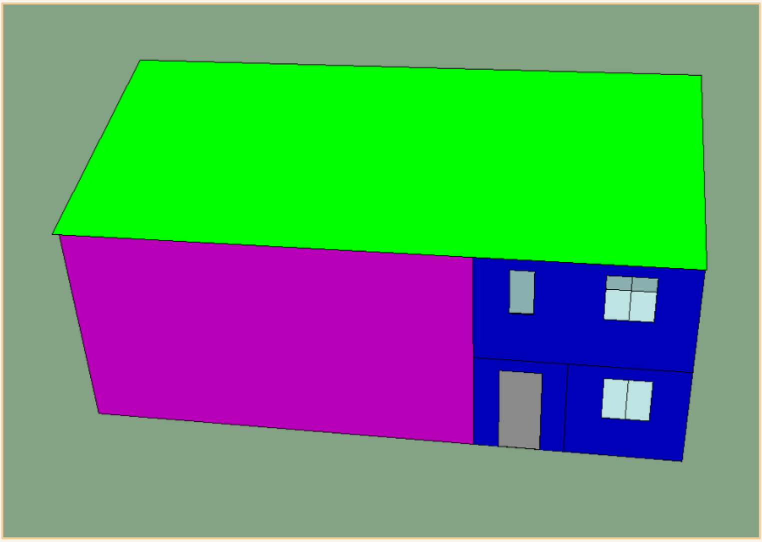

Figure 5: IES Model (3D Model) of the 2B4P house type.

The ApacheSim Engine within the IES Software was used to calculate the Operative Temperature for each room for every hour of the Design Summer Year. The internal gains, occupancy hours, occupancy density, HVAC operational hours, and internal equipment and installation loads have been based on the CIBSE TM59 Document.

The results from the software give an indication of the predicted environmental conditions based on both weather data and the predicted operational strategy of the building. The simulation run on the software returns simulated internal temperatures. However, these simulated results may differ from the actual internal air temperatures due to a variety of factors. Change in zone function, change in equipment and/ or occupancy, degradation of building materials, occupant behaviour, changes in opening management, and climate change effects can all result in differences form the calculated model.

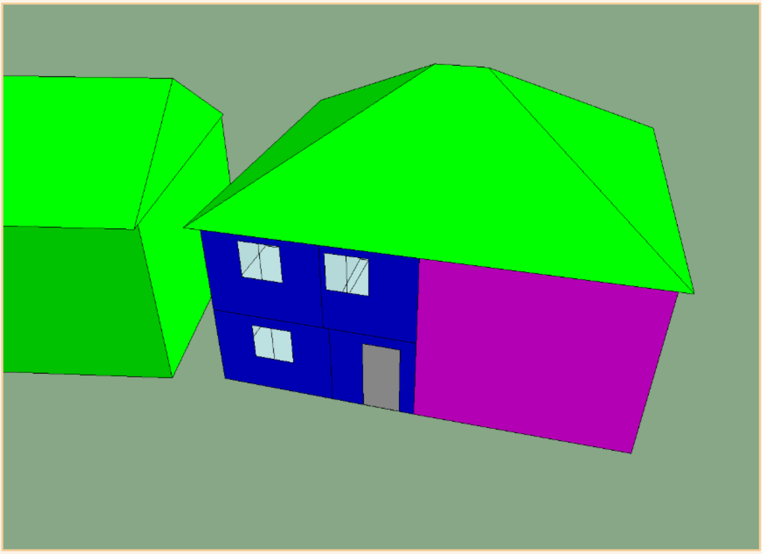

Figure 6: IES Model (3D Model) of the 1B2P house types located in first and second floor.

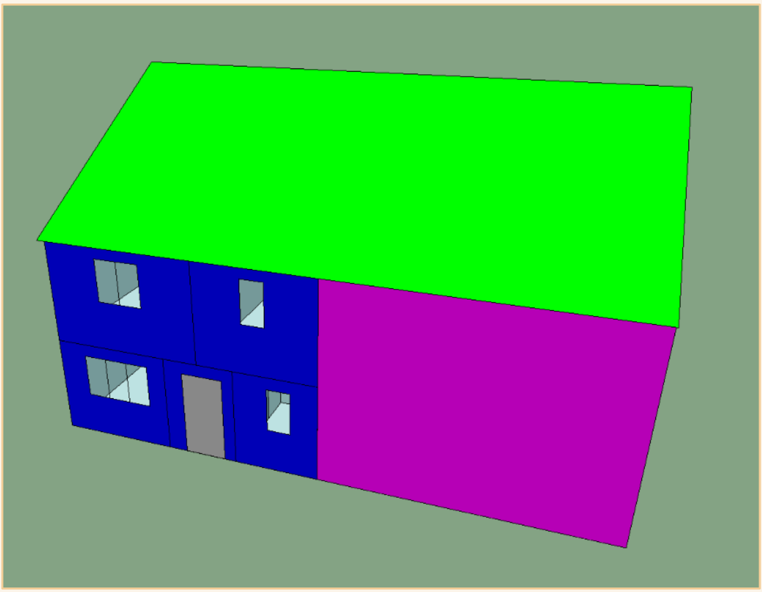

Figure 7: IES Model (3D Model) of the 2B4P house type.

6. Modelling Input Data

6.1 Architectural Drawings

The drawing detailed in Table 1 has been used to build the geometry of the units and undertake the overheating analysis in IES-VE.

Table 1: Architectural Drawings

Drawings Name	Format	Date Received
2511 - URB-XX-XX-EL-UD-001 - Housetype 1B2P	DWG	Oct 2025
2511 - URB-XX-XX-EL-UD-002 - Housetype 2B4P	DWG	Oct 2025
2511 - URB-XX-XX-EL-UD-003 - Housetype 3B5P	DWG	Oct 2025
2511 - URB-XX-XX-EL-UD-005 - Housetype 4B7P	DWG	Oct 2025
2511 - URB-XX-XX-DR-UD-001E - Site Layout	DWG	Oct 2025
2511 - Lovell Housetype Drawings Master	DWG	Oct 2025

Weather Data

CIBSE weather data, specific to the site, is used for the calculation. In line with CIBSE Guide A, Approved Document O and CIBSE TM59 the Design Summer Year weather dataset closest to the site has been used for the overheating risk assessment. The guidance in TM59 suggests using the DSY1 (design summer year) file most appropriate for the site location for the 2020s, high emissions, 50% percentile scenario. In this case the closest appropriate Design Summer Year weather data to the site used is the **Cardiff_DSY1_2020High50_.epw**.

6.2 Building Specifications

Table 2: Building Fabric

Element	Details
External Walls	U-value of 0.18 W/m2K
Internal Walls	U-value of 1.78 W/m2K
Exposed Floor	U-value of 0.11 W/m2K
Roof - Plan	U-value of 0.09 W/m2K
Solid Door	U-value of 1.2 W/m2K
External Windows	U-value of 1.2 W/m2K, g-value of 0.38
Glazed Doors	U-value of 1.3 W/m2K, g-value of 0.38
Air permeability	4.0 m3/h.m2 @ 50Pa

6.2.1 Occupancy Density and Operational Hours

The model has been developed in accordance with CIBSE TM59 guidance. Details regarding occupancy density and occupancy hours have been sourced from the Part O profiles, which are fixed and cannot be modified.

6.2.2 Acoustic Restrictions

There are no acoustic restrictions on site.

6.2.3 Site Security

Carmarthen West development is a mix of two-storey residential buildings. However, there will be easily accessible rooms located on the on the ground floor. Part O defines easily accessible rooms as follows:

- A window or doorway, any part of which is within 2m vertically of an accessible level surface, such as the ground or basement level, or an access boundary.
- A window within 2m vertically of a flat or sloping roof (with a pitch of less than 30 degrees) that is within 3.5m of ground level.

Spaces located on the ground floor are classified as easily accessible under Approved Document O, which restricts the ability to open windows at night.

6.2.4 Window and Door Openings

- Side hung windows on the are set to open outwards up to 40 degrees during day and nighttime.
- Top hung windows on are set to open outwards up to 40 degrees during day and nighttime.
- Entrance doors are set as shut at all times.
- Balcony Sliding doors are assumed to open during day and closed nighttime.
- Internal doors have been set as open during daytime only to allow for cross ventilation through the spaces.

Table 3: Glazing Specification

Window Reference	Maximum openable angle
Side Hung Windows	GF:90 degrees, FF:40 degrees
Internal Doors	90 degrees

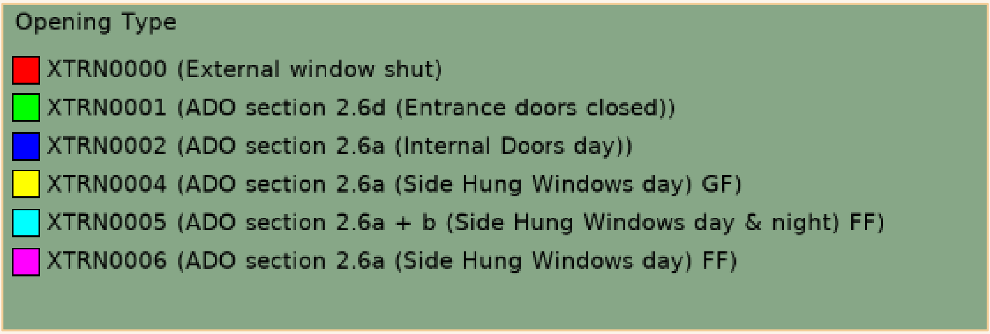

Figure 8: Legend showing Opening Types

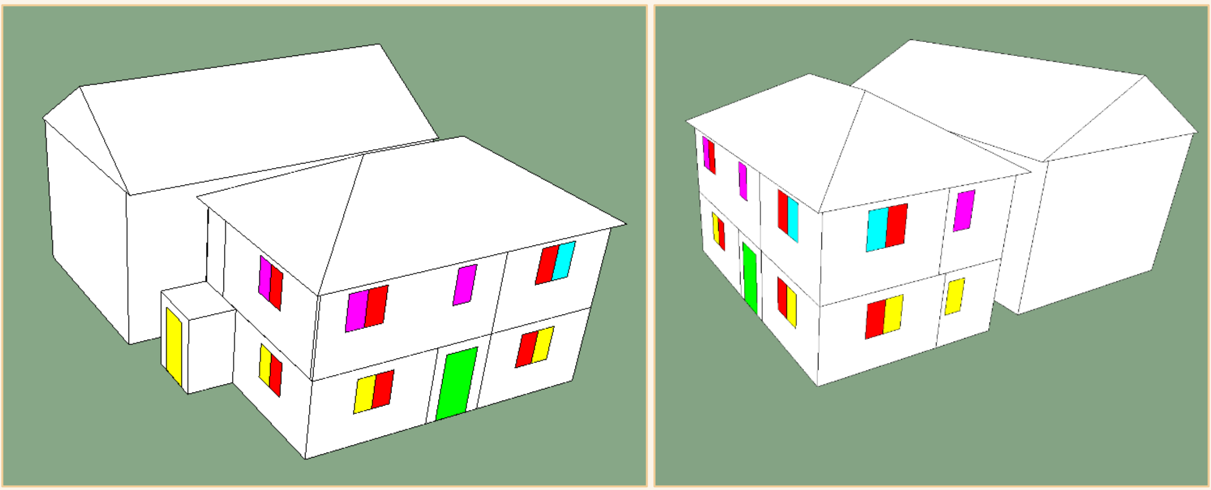

Figure 9: 3D Images showing Opening Types in 1B2P

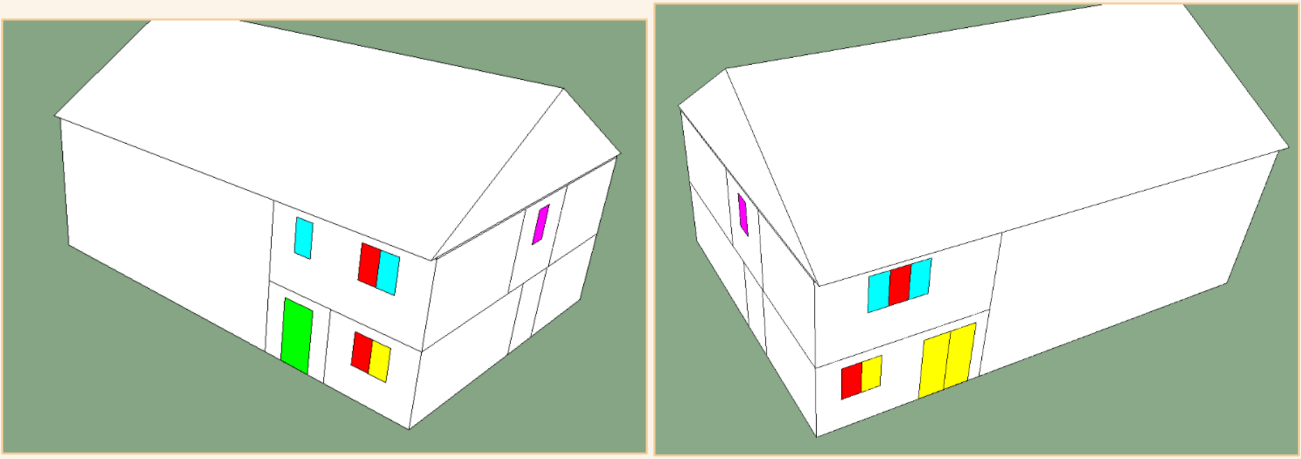

Figure 10: 3D Images showing Opening Types in 2B4P

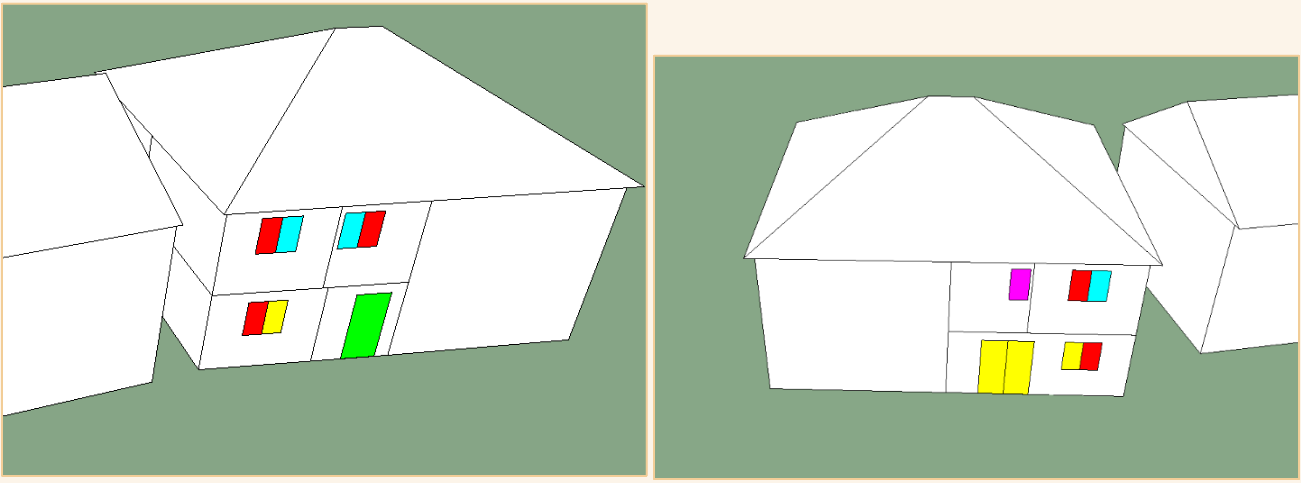

Figure 11: 3D Images showing Opening Types in 3B5P

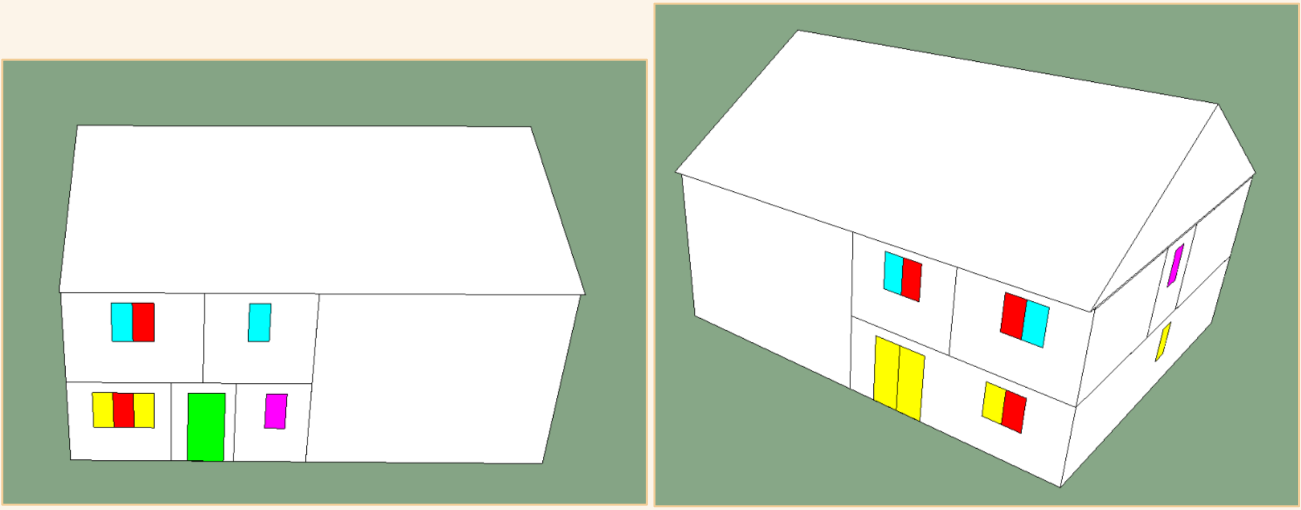

Figure 12: 3D Images showing Opening Types in 4B7P

6.3 External Shading

External horizontal shading has been modelled as per Architectural drawings.

6.4 Mechanical Ventilation & Cooling

The dwellings have been designed to minimise overheating risk through a natural ventilation strategy. This is achieved via cross-ventilation, enabled by openings on opposing façades, manually operated side-hung windows, and internal doors that allow occupants to adjust airflow.

Due to the effectiveness of this passive approach, no mechanical ventilation or active cooling systems are required to maintain acceptable thermal comfort and indoor air quality under normal conditions.

An exception applies to the bedrooms, where security considerations necessitate that the windows remain restricted during the entire day. As a result, natural ventilation cannot be maintained in these spaces especially during nighttime 22:00 and 07:00. An extract fan in each bedroom will assist maintaining the desired thermal comfort and eliminate any overheating risk.

In accordance with design ventilation standards, the extract fan will be sized to deliver 13 litres per second (l/s) per person, resulting in a total required extract rate of 26 l/s for a double-occupancy bedroom and 13l/s for a single bedroom.

Table 4: Extract Ventilation Flow Rates

Space Type	Extract Ventilation Flow Rate (l/s)
Double Bedroom	26
Single Bedroom	13

7. Results

The results displayed in this section are the outcome of the thermal model assessment, which utilises the design specification, assumptions and details that have been outlined in the previous sections.

In accordance with CIBSE requirements only 'occupied rooms' need to be assessed. Areas with a low transient occupancy (WCs, Bathrooms, Circulation spaces and stores etc.) are exempt from the requirements. Additionally, following the guidance in CIBSE: TM59, the bathrooms and circulations areas are included in the calculation but are not required to pass the criteria.

The criteria set in TM59/ AD-O thermal comfort are as follows:

- **Naturally ventilated rooms - criterion (a)**

  Criterion (a) states that for living rooms, kitchens and bedrooms, the number of hours during which ΔT is greater than or equal to 1K from May to September (or November to March for southern hemisphere locations) shall not exceed 3% of occupied hours

- **Naturally ventilated rooms – criterion (b)**

  Criterion (b) states that the operative temperature of the bedrooms from 22:00-07:00 shall not exceed 26°C for more than 1% of annual hours (33 hours is therefore recorded as a fail). Any rooms that are not bedrooms are therefore not assessed, hence the corresponding N/A values.

- **Communal corridors**

  CIBSE TM59 states that whilst there is no mandatory target for communal corridors, if an operative temperature of 28°C is exceeded for more than 3% of annual hours, then this should be identified as a significant risk within the TM59 overheating report.

As shown in the tables below, all assessed rooms within all units pass the TM59/ AD-O thermal comfort criteria with the strategy outlined in this report (for full calculations please refer to Appendix A).

Table 5: Results of TM59 Assessment

Area Reference	Criteria a (%Hrs Top-Tmax>=1K) Limit = 3%	Criterion b Total hours between 22:00- 07:00 > 26° Limit = 32 hours	Pass/Fail
1B2P GF KLD	0.4	N/A	Pass
1B2P GF Bed 1	0.3	11	Pass
1B2P FF KLD	1.4	N/A	Pass
1B2P FF Bed 1	0.7	23	Pass
3B5P FF Bed 1	0.0	21	Pass
3B5P FF Bed 2	0.2	28	Pass
3B5P FF Bed 3	0.5	32	Pass

Area Reference	Criteria a (%Hrs Top-Tmax>=1K) Limit = 3%	Criterion b Total hours between 22:00- 07:00 > 26° Limit = 32 hours	Pass/Fail
3B5P GF LD	0.3	N/A	Pass
3B5P GF Kitchen	0.5	N/A	Pass
4B7P FF Bed 3	0.1	6	Pass
4B7P FF Bed 2	0.1	6	Pass
4B7P FF Bed 4	0.0	6	Pass
4B7P FF Bed 1	0.0	6	Pass
4B7P GF KLD	0.2	18	Pass
2B4P GF KD	0.3	N/A	Pass
2B4P GF Louge	0.3	N/A	Pass
2B4P FF Bed 1	0.0	13	Pass
2B4P FF Bed 2	0.0	7	Pass

Table 6: Results of ADO Assessment for transition areas

Area Reference	No. hours >28°C	% Annual hours >28°C	Overheating Risk
1B2P FF Hall/stairs	0	0.0	No
1B2P GF Hall	10	0.1	No
1B2P FF Landing	28	0.3	No
3B5P FF Landing	9	0.1	No
3B5P GF Hall	10	0.1	No
4B7P FF Landing	0	0.0	No
2B4P GF porch/stairs	9	0.1	No
2B4P GF Hall	10	0.1	No
2B4P FF Landing	2	0.0	No

8. Conclusion

A Thermal modelling assessment has been carried out on the proposed development at Carmarthen West, Ryde, using IES software in accordance with Approved Document O: 2021, CIBSE TM59:2017 Design Methodology for the assessment of overheating risk in homes and CIBSE TM52:2013 The Limits of Thermal Comfort: Avoiding Overheating in European Buildings.

The analyses have been undertaken using the IES Virtual Environment Version 2025.1.0.0 (VE Compliance 7.0.30.0), which is an integrated system of building design and simulation software tools. The IES interface enabled varying levels of simulation and analysis to be carried out. A model of the two-storey developments was constructed, and dynamic simulations undertaken to understand the internal air temperature of the apartments during occupancy and ensure compliance with Part O.

Ground-floor bedrooms are considered easily accessible; therefore, windows should not be left open at night for security reasons. This constraint has been reflected in the ventilation strategy. In contrast, first-floor bedrooms may remain open during both day and night when fitted with compliant restrictors. Where ventilation openings pose a risk of falling, fixed guarding with a maximum 100 mm gap shall be provided up to a minimum height of 1.1 m above floor level, in accordance with Approved Document K. Consequently, and to ensure adequate ventilation performance under these conditions, all bedrooms will be provided with mechanical extract fans delivering a minimum continuous extract rate of 13 L/s between 22:00 and 07:00.

Following initial results, the implemented natural ventilation strategy outlined within Section 6, was proven sufficient to relieve the heat in all assessed rooms within the development.

Kitchen/dining/living areas comply with the criterion (a) of TM59. Additionally, all bedrooms which within the dwellings comply with criterion (a) and criterion (b) and they are not deemed to be at risk of overheating during the warmest summer months with the natural ventilation strategy outlined in this report.

The modelling and analysis of the proposed Carmarthen West development has demonstrated that both the buildings design and ventilations strategy meet AD-O & TM59 requirements in all occupied spaces.

The results outlined in this report show that the building can provide a comfortable indoor environment for the building users and delivers thermal comfort levels in all the occupied spaces in accordance with the criteria set out in AD-O & TM59.

Darren Evans

Build a Net Zero future

Join us in creating a more
sustainable built environment –
spaces where people and planet can thrive

Let's chat

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