

PART FIFTEEN

BUILDING ANALYSIS

Passivhaus Design

THE FINAL DESIGN & SPECIFICATION ACHIEVES THE PASSIVHAUS STANDARD!

Building Analysis

Passivhaus Design
Passivhaus Credentials - Part I

CERTIFIED PASSVIHAUS DESIGNER

The Proposals Passivhaus design and specification have been refined in collaboration with the Passivhaus specialist Dr Rachel Mitchell from Greenbox Associates Ltd. They confirmed that this refined design meets and exceeds the criteria for Passivhaus Classic standards in this climate zone. As part of their appointment, they undertook a comprehensive energy statement, in which the building was modelled in the Passive House Planning Package (PHPP) and in specialist thermal bridge modelling software, Flixo.

DESIGN SUMMARY QUOTE:

Extract from the report - *Although the building form appears complex, the proposed design uses a simple and buildable construction method that is free of thermal bridges. All key junctions have been modelled using specialised Flixo thermal-bridge software to verify the robustness of the strategy. Each measured junction shows a negative psi value, confirming that they are thermal bridge free. Additionally, the surface temperature factor (fRsi) has been assessed. A minimum value of 0.70 is generally recommended in cool-temperate climates to reduce surface mould risk; all the measured junctions achieve fRsi values above 0.90, indicating negligible condensation risk and confirming that the dew point lies away from the internal surface of the main structural wall assembly. The location of the wood fibre insulation externally ensures the structure is located on the warm side of the construction and the installation of an effective mechanical ventilation system (MVHR) to extract moisture from the building, further reduces condensation risk.*

The CLT structure provides a robust and durable airtight layer when carefully taped at the joints. Locating the CLT at the internal surface with external insulation, combined with a breather and vapour membrane makes the required airtightness target of <0.6 ACHn50 fully achievable with the specified build-up.

The entrance and bi-fold doors have been redesigned and will now be a combination of glazed side-hung and fixed/openable units, which follows the faceted wall geometry. This allows for simplified detailing for both airtightness and thermal bridges. Using Passivhaus certified windows and doors, such as Norrsken© High-Performance Alu-clad Windows & Doors will assist in achieving a whole-window U-value below 0.85 W/m2K.

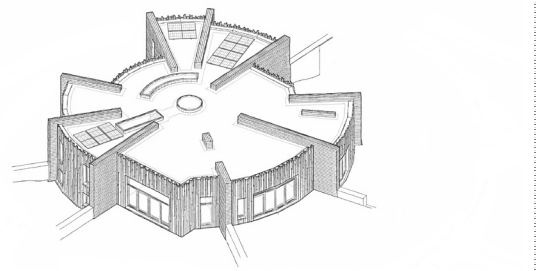
Overheating risk has been managed and under a +2 °C future climate scenario, the proposed building continues to meet Passivhaus requirements and maintains an overheating risk of only 3% (without cooling) and 0% with a minimal cooling input, and therefore remaining below current UK PHT good-practice thresholds. This demonstrates the robustness and long-term resilience of the Passivhaus design.'

CALDYNE PASSIVHAUS – INDICATIVE BUILDING ENVELOPE	
External Wall above ground	0.12 W/m²K 250mm Steico Flex (λ =0.036)
External wall below ground	0.14 W/m2K 200 mm EPS/XPS (λ 0.035)
Roof	0.12 W/m²K 200mm Polyfoam roof board (λ = 0.033)
Floor	0.13 W/m²K 200mm Structural EPS (λ 0.035)
Air tightness	Less than 0.6 Ach@50Pa
Triple Glazing	Whole window U value (installed) less than 0.85 W/m²K
Reduced thermal bridges	Thermal bridge free design

Table 2 Summary of building envelope

Extracts From Energy Statement by Greenbox Associates Ltd.

Passive House-Verification



Building: Caldnye Park
Street: Off Wallage Lane
Postcode/City: RH10 Crawley
Province/Country: West Sussex GB-Vereinigtes Königreich
Building type: 1-Freestanding single family house
Climate data set: GB0003a-London Gatwick, Altitude corrected
Climate zone: 3: Cool-temperate Altitude of location: 115 m

Home owner / Client: Caldnye Ltd
Street:
Postcode/City:
Province/Country: GB-Vereinigtes Königreich

Mechanical engineer:
Street:
Postcode/City:
Province/Country:

Certification:
Street:
Postcode/City:
Province/Country:

Year of construction:	2026	Interior temperature winter [°C]:	20.0	Interior temp. summer [°C]:	25.0
No. of dwelling units:	1	Internal heat gains (IHG) winter [W/m²]:	2.2	IHG summer [W/m²]:	2.2
No. of occupants:	3.5	Specific heat capacity [Wh/K per m² TFA]:	100	Mechanical cooling:	

Specific building characteristics with reference to the treated floor area						
	Treated floor area m²	560.0			Alternative criteria	Fulfilled? ²
Space heating	Heating demand kWh/(m²a)	13	≤	15	-	Yes
	Heating load W/m²	9	≤	-	10	
Space cooling	Cooling & dehum. demand kWh/(m²a)	-	≤	-	-	-
	Frequency of overheating (> 25 °C) %	0.00	≤	10		Yes
	Frequency of excessively high humidity (> 12 g/kg) %	0	≤	20		Yes
Airtightness	Pressurisation test result n ₅₀ 1/h	0.6	≤	0.6		Yes
Non-renewable Primary Energy (PE)	PE demand kWh/(m²a)	33	≤	-		-
Primary Energy Renewable (PER)	PER demand kWh/(m²a)	28	≤	60	60	Yes
	Renew. energy generation (in rel. to projected building footprint area) kWh/(m²a)	15	≥	-	-	

² Empty field: data missing; '-': No requirement

² Empty field: data missing; -: No requirement

I confirm that the values given here have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification.

Task: 1-Design First name: Rachel Surname: Mitchell Certificate-ID: Issued on: City:

Passive House Classic? Yes

Signature:

Extracts From Energy Statement by Greenbox Associates Ltd.

DD Architects

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Land at Caldnye Park,
Turners Hill Rd,
West Sussex
RH10 4NB

Plumpton Pit Stop,
Ditchling Road,
Plumpton
BN7 3AF

Building Analysis

Passivhaus Design
Passivhaus Credentials - Part 2

DETAILS	DRAWING	THERMAL BRIDGE CALCULATION	FRSI VALUE	ISOTHERMS
Detail SK 05 Parapet		-0.075 W/mK	0.924	
Detail 03 SK53 ground floor to wall below ground Detail 04SK 53 ground floor to wall below ground		-0.035W/mK	0.932	
Inverted corner to internal wall		-0.082 W/mK	0.973	

Extracts From Energy Statement by Greenbox Associates Ltd.

INDICATIVE BUILDING ENVELOPE	
Floor U value	0.13 W/m²K
External Wall U value	0.12 W/m²K
Roof U value	0.12 W/m²K
High levels of air tightness	Less than 0.6 ach @50
Triple glazed windows	Whole window U value less than 0.85W/m²K
Reduced thermal bridges	Minimised
Mechanical ventilation with heat recovery	With high efficiency levels
Overheating risk	Minimised

Extracts From Energy Statement by Greenbox Associates Ltd.

POTENTIAL ENERGY DEMAND/ GENERATION	
Space heating demand	13 kWh/m²/year
Space heating Load	9 W/m²
Energy Generation	15 kWh/m2/year
Primary Energy Demand	28 kWh/m²/year

Table 6 Summary of Passivhaus Design and estimated energy outputs

CLIMATE CHANGE - OVERHEATING - FUTURE CLIMATE (+2°C)

As we refined the Passivhaus design, we wanted to account for rising global temperatures in the proposal to ensure the design and specification could still meet Passivhaus requirements. Therefore, the building design (including heating, cooling, and ventilation strategy) has been developed for both the current climate and future climate conditions at +2 °C.

In the current climate, the design has a 0% frequency of overheating (>25 °C), and without any future adaptations would only have a 3% frequency of overheating in the future climate conditions (+2 °C), which is still below the UK Passivhaus good practice. The overheating analysis shows that, in the current climate, summer conditions are most of the time well controlled through ventilation, without the need for cooling.

However, there may be future periods of hotter weather, which could lead to less comfortable conditions, so the ability for occasional cooling is beneficial and will reduce the risk of retrofitting air conditioning. Therefore, we designed and specified the combined utilisation of the GSHP and underfloor pipework to also run in cooling mode, an effective way to maintain cooler floor temperatures in the building during periods of high external temperatures, with no additional plant cost. Combined with the production of cooler air via the MVHR system, which can be an effective part of a night ventilation strategy. These measures will work in harmony with the passive measures already specified to manage overheating.

CALDYNE PARK OVERHEATING RISK ASSESSMENT				
	Current climate	Future climate (+2°C)	Future climate (+2°C)+ cooling	
	Number of hours internal temperatures are predicted to be above 25°C	0 %	3%	0%
	Passivhaus Maximum	10%	10%	10%
	Passivhaus Good Practice	5%	5%	5%
	Passivhaus Best Practice	2%	2%	2%
	Cooling load (Passivhaus Maximum 15 kWh/m²/year)	-	-	1 kWh/m²/year

Table 5. Overheating risk assessment outputs from PHPP
Extracts From Energy Statement by Greenbox Associates Ltd.

Passive House-Verification FUTURE CLIMATE (+2°C)

Building: Caldine Park + 2C summer temperature with cooling
Street: Off Wallage Lane
Postcode/City: RH10 Crawley
Province/Country: West Sussex GB-Vereinigtes Königreich
Building type: 1-Freestanding single family house
Climate data set: GB0003a-London Gatwick, Altitude corrected, +2K summer corr
Climate zone: 3: Cool-temperate Altitude of location: 115 m

Home owner / Client: Caldine Ltd
Street:
Postcode/City:
Province/Country: GB-Vereinigtes Königreich

Mechanical engineer:
Street:
Postcode/City:
Province/Country:

Certification:
Street:
Postcode/City:
Province/Country:

Architecture: DD Architects
Street:
Postcode/City:
Province/Country: GB-Vereinigtes Königreich

Energy consultancy: Greenbox Associates Ltd
Street:
Postcode/City: PO4 9QH Southsea
Province/Country: GB-Vereinigtes Königreich

Year of construction: 2026
No. of dwelling units: 1
No. of occupants: 3.5

Interior temperature winter [°C]: 20.0
Internal heat gains (IHG) winter [W/m²]: 2.2
Specific heat capacity [Wh/K per m² TFA]: 100

Interior temp. summer [°C]: 25.0
IHG summer [W/m²]: 2.2
Mechanical cooling: x

Specific building characteristics with reference to the treated floor area						
	Treated floor area m²	560.0			Alternative criteria	Fulfilled?²
Space heating	Heating demand kWh/(m²a)	13	≤	15	-	Yes
	Heating load W/m²	9	≤	-	10	
Space cooling	Cooling & dehum. demand kWh/(m²a)	1	≤	15		Yes
	Frequency of overheating (> 25 °C) %	-	≤	-		-
	Frequency of excessively high humidity (> 12 g/kg) %	0	≤	10		Yes
Airtightness	Pressurisation test result n50 1/h	0.6	≤	0.6		Yes
Non-renewable Primary Energy (PE)	PE demand kWh/(m²a)	34	≤	-		-
Primary Energy Renewable (PER)	PER demand kWh/(m²a)	28	≤	60	60	Yes
	Renew. energy generation (in rel. to projected building footprint area) kWh/(m²a)	15	≥	-	-	
² Empty field: data missing; '-': No requirement						
I confirm that the values given here have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification.						Passive House Classic? Yes
Task:	First name:	Surname:		Signature:		
1-Design	Rachel	Mitchell				
Certificate-ID	Issued on:		City:			

Extracts From Energy Statement by Greenbox Associates Ltd.

Summer Solstice 06/20	1. Living Room			2. Dinning Room			3. Dinning Room Side Door			4. Entrance Hall Window		
	Previous Scheme 1390mm Eaves	New Scheme Full Shading - 3500mm	Final Scheme Works best for Passivhaus	Previous Scheme 1130mm Eaves	New Scheme Full Shading - 5600mm	Final Scheme Works best for Passivhaus	Previous Scheme 1200mm Eaves	New Scheme Full Shading - 2000mm	Final Scheme Works best for Passivhaus	Previous Scheme 1180mm Eaves	New Scheme Full Shading - 4500mm	Final Scheme Works best for Passivhaus
08:00												
10:00												
12:00												
14:00												
16:00												

SOLAR INCIDENCE & SOLAR GAIN

During the redevelopment of the external form, the solar incidence was extensively analysed and tested to evaluate solar shading and optimum photovoltaic performance. The eaves shading of the last scheme (presented to the DRP on 11/07/23) was initially investigated, and then a series of forms were analysed, exploring the optimal eaves and no eaves.

After extensive physical and digital analysis, it was clear that a balance between maximising the building's solar gain and overheating mitigation was critical. Increasing the solar gain benefited the dwelling's energy efficiency. The resulting scheme has no louvres or eaves but has utilised passive overheating risk mitigation, such as:

- Reducing heat coming into the building - The glazing percentage has been calculated as 17% of the treated floor area which is within the good practice guidance of designing to under 20% of floor area.
- External passive shading to windows from new nearby deciduous tree planting and surrounding existing woodland
- Solar control glass (low g glass) to reduce solar gain in summer.
- All hot water pipework to be fully insulated to reduce internal gains in summer.
- Floors and Walls below ground are concrete and provide thermal mass within the building .
- Ceiling heights vary between 3m and 3.5m.
- The building is designed to have cross-ventilation (opening windows on both sides) where possible and openable roof lights to allow air flow through the dwelling.
- Secure window opening for night ventilation.
- MVHR units to have a summer bypass to turn off heat recovery in summer

SURFACE-AREA-TO-VOLUME RATIO:

Building Surface Area = 1480.1 m²
Building Volume = 2913.7 m³
S/V = 0.51

The surface-area-to-volume ratio 'suggests' that a building with a small surface area compared to its volume will be more energy efficient. However, the S/V is an inaccurate and ineffective indicator of this buildings thermal behaviour as the S/V ratio does not consider other external environment factors that influence heat transfer of buildings with complex plans, such as 1. The temperature of ground, air or snow with which the building envelope is in contact; 2. The direction and speed of winds blowing at the building; And 3. Solar radiation incident on the building.

In order to compare the different options of building shape, especially for buildings with complex plans, one would have to resort to simulation by an advanced computer software - Hence the use of Design PH, which confirms that the design meets Passivhaus Classic Requirements. This has been corroborated by Dr Rachel Mitchell - Greenbox Associates Ltd - the third party certified passivhaus specialist.