

CALDYNE PARK

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

PART FIFTEEN BUILDING ANALYSIS Passivhaus

DD Architects

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Plumpton Pit Stop,
Ditchling Road,
Plumpton
BN7 3AF

SUMMER



WINTER



AUTUMN

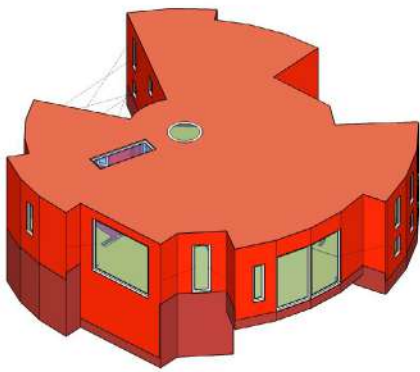


SPRING



PASSIVHAUS ANALYSIS

Design PH Model:
Climate: [UK] - South East England (London Gatwick)
Treated Floor Area: 443.5 m²
Specific Annual Heat Demand (Qh): 11.23 kWh/m²yr
FHLF: 3.18



THE FINAL DESIGN MEETS PASSIVHAUS REQUIREMENTS.

Surface-Area-To-Volume Ratio:

Building Surface Area = 1409.9 m²
Building Volume = 2407.01 m³
S/V = 0.58

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 Requirements.



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 (See Drawing SK61A)	Previous Scheme 1130mm Eaves	New Scheme Full Shading - 5600mm	Final Scheme Works best for Passivhaus (See Drawing SK61A)	Previous Scheme 1200mm Eaves	New Scheme Full Shading - 2000mm	Final Scheme Works best for Passivhaus (See Drawing SK61A)	Previous Scheme 1180mm Eaves	New Scheme Full Shading - 4500mm	Final Scheme Works best for Passivhaus (See Drawing SK61A)
08:00												
10:00												
12:00												
14:00												
16:00												

SOLAR INCIDENCE TESTING & DEVELOPMENT

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 maximising the building’s solar gain (reduced eaves shading) would benefit the dwelling’s energy efficiency (Passivhaus credentials). Therefore, the resulting scheme has no louvres or eaves to reduce window shading and maximise solar radiation. See the simulated figure below:

Solar Heat Gains Analysis (DesignPH):

Treated Floor Area: 443.5 m²
Window Area: 80.95m²
Solar Heat Gain: 4541.25 kWh/a
Q_s: 10.24 kWh/m²a
Specific Annual Heat Demand (Q_h): 11.23 kWh/m²yr

PHOTOVOLTAICS PERFORMANCE

The optimum location, angle and orientation of photovoltaics were also analysed and tested. Utilising innovative Aiko 615W PV panels ensures that only nine panels are required to be installed on the rooftop to provide the dwelling with sufficient energy all year round. These will form part of the dwelling’s solar roof, maximising solar energy generation as the green roof preserves ambient rooftop temperatures, keeping the modules at optimal output. This cooling effect increases panel output by up to 5%.

PVGIS-5 Solar Electricity Generation Simulation:

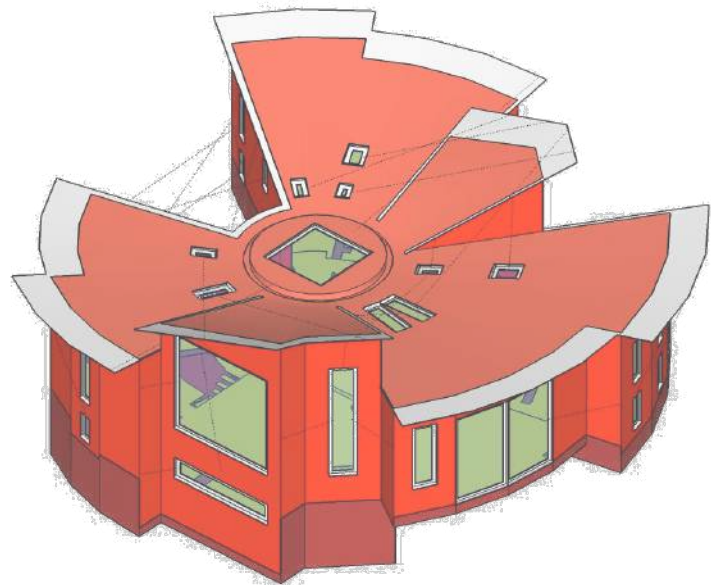
Database Used: PVGIS-SARAH2
Latitude/Longitude: 51.113, -0.113
PV Technology: Crystalline Silicon - (N-Type
ABC module Aiko 615W)
PV Installed: 5.07kWp
Slope Angle: 10°
Azimuth Angle: 15°
System Loss: 14%

Yearly PV Energy Production: 4779.15 kWh
Yearly in-plane irradiation: 1176.08kWh/m²
Yearly-to-yearly Variability: 152.13 kWh



1. Previous Scheme:

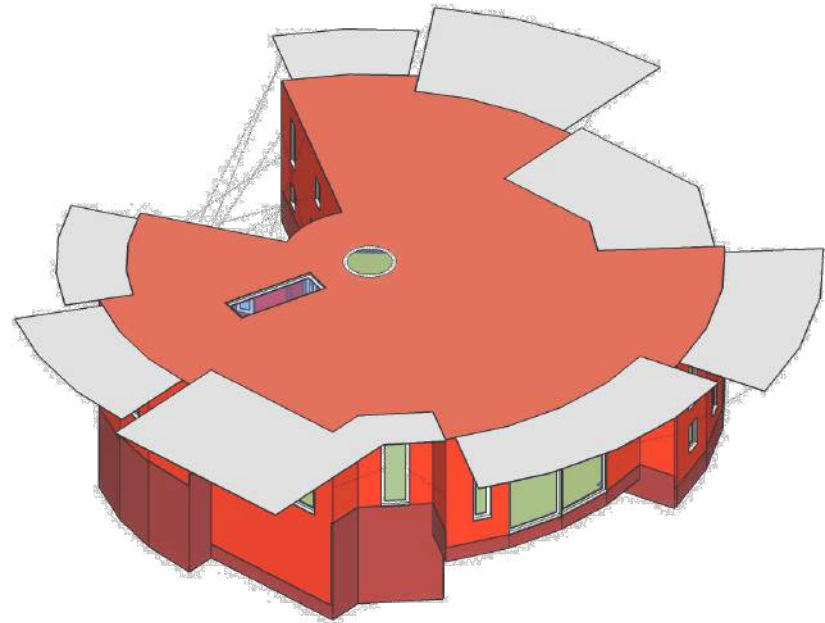
Design PH Analysis:	
Climate	London Gatwick
Treated Floor Area	429.88 m ²
Annual Heat Demand	4974.89 kWh/a
Window Area	102.27 m ²
Solar Heat Gains (Qs)	13.04 kWh/m ² a
Specific Annual Heat Demand (Qh)	11.57
FHLF	3.32



The proposal presented to the design review panel.
(11/07/23)

2. New Scheme Iteration 1:
(Eaves to provide full solar shading)

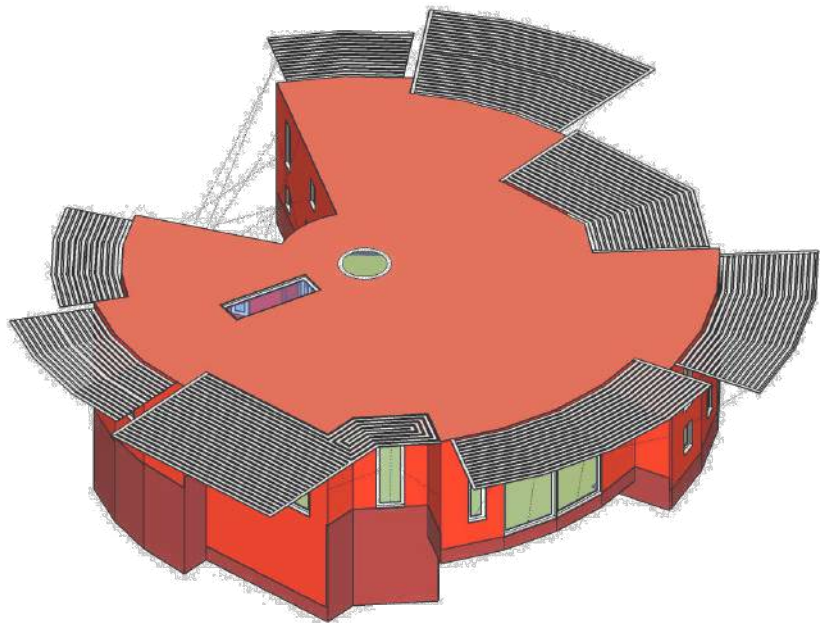
Design PH Analysis:	
Climate	London Gatwick
Treated Floor Area	443.48 m ²
Annual Heat Demand	5620.39 kWh/a
Window Area	80.95 m ²
Solar Heat Gains (Qs)	8.45 kWh/m ² a
Specific Annual Heat Demand (Qh)	12.67
FHLF	3.18



The increased solar shading has increased the annual heat demand, reducing the dwellings Passivhaus effectiveness/qualities.

3. New Scheme Iteration 2:
(Louvres to provide full solar shading)

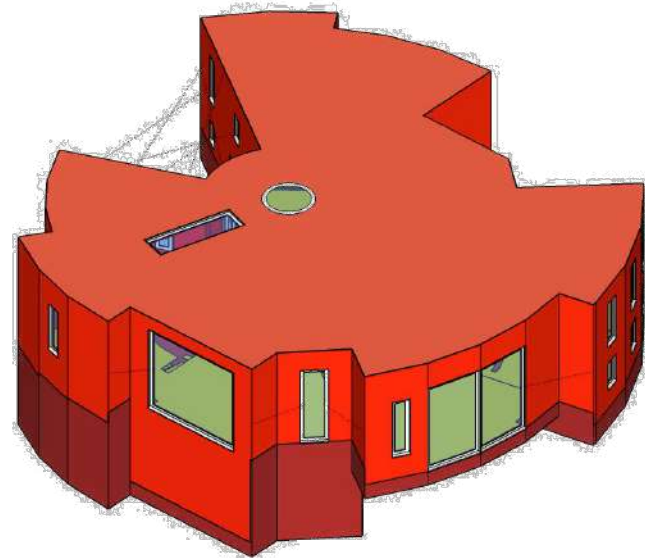
Design PH Analysis:	
Climate	London Gatwick
Treated Floor Area	443.48 m ²
Annual Heat Demand	8099.72 kWh/a
Window Area	80.95 m ²
Solar Heat Gains (Qs)	2.29 kWh/m ² a
Specific Annual Heat Demand (Qh)	18.26
FHLF	3.18



Again, the increased solar shading has increased the annual heat demand, reducing the dwellings Passivhaus effectiveness/qualities.

4. Final Scheme:

Design PH Analysis:	
Climate	London Gatwick
Treated Floor Area	443.48 m ²
Annual Heat Demand	4979.06 kWh/a
Window Area	80.95 m ²
Solar Heat Gains (Qs)	10.24 kWh/m ² a
Specific Annual Heat Demand (Qh)	11.23
FHLF	3.18



The removal of the eaves has reduced the dwellings annual heat demand [the lowest out of these tests], reducing the operational carbon and improving Passivhaus qualities. Other techniques are also proposed in response to potential solar gain overheating such as thermal massing and MVHR.

PASSIVHAUS ANALYSIS

Alongside the solar incidence analysis (previous page), a series of Passivhaus simulations (DesignPH Software) were investigated to explore the implications on the Passivhaus credentials of the dwelling (four example iterations on the left). This analysis revealed that a certain amount of solar gain is essential to efficiently (and sustainably) meet the dwelling's Passivhaus qualities.

The analysis resulted in a final scheme that has been carefully orientated and designed to ensure that the dwelling receives sufficient solar heat gain but does not exceed the dwelling's annual heat demand, preventing overheating issues.

Additionally, the final proposal implements a series of design choices that will mitigate overheating during peak temperatures (summer):

1. Thermal Massing:

The building has a high area of exposed thermal mass, which will help maintain the dwelling's internal temperature by averaging out day-night (diurnal) extremes. The thermal mass acts as a thermal battery that absorbs the solar heat and re-radiates the warmth back into the home throughout the night.

2. Ceiling Height & Passive Ventilation:

The project's integration of high internal floor-to-ceiling heights and 360-degree mechanical openings will increase the stratification of the interior air movement.

3. Vegetation:

The dwelling is surrounded by an abundance of vegetation that will provide cooling through the evaporation of water collecting on the leaves and soil. A single tree absorbs as much as 600,000 Btu (British thermal unit) of solar radiation daily and evaporates water into the air.

4. High Performance Glazing:

The dwelling will integrate high-performance glazing (Passivhaus), reducing thermal transmittance. Additionally, the glazing will incorporate low-e coatings (solar control glass) that reduce the long-wave solar radiation transmitted from the outside to the inside.

5. Highly Insulated Envelope:

The building's highly insulated envelope (Passivhaus) will also prevent the transmission of indirect solar gains, further reducing the risk of overheating.

6. Mechanical Heat Recovery Ventilation (MVHR):

The solar gains are mitigated due to the well-insulated and high-performing design (Passivhaus); the MVHR system will support the dwelling's cooler internal temperature by deflecting the heat of the incoming air to the outside and recovering cold to the inside. Additionally, the cross ventilation and MVHR create a highly effective ventilation system that can purge heat gains.

