



SUSTAINABILITY STATEMENT

41 Beach Road

Emsworth, PO10 7HR

Planning application for a replacement dwelling

June 2023



This document is a statement in support for a planning application for the above development. This sustainability statement has been prepared by Ecospheric Ltd (Architecture, Engineering and Sustainability), on behalf of the applicant, and owner of 41 Beach Road, Mr. M. Hughes.



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The Proposal

Sustainability in the built environment is a complex and wide ranging subject. Liable for more than 40% of anthropogenic greenhouse gas emissions responsible for the climate crisis, the built environment has a lot to answer for and is in **desperate need of viable sustainable solutions**. As the UK takes steps to decarbonise, legislation and guidance rolls out supporting the necessary transition in the construction industry. This is reflected nationally in the NPPF, updated building regulations and Future Homes Standards combined locally with councils' declarations of climate emergency. In May 2019, Havant Borough Council "acknowledged that Havant needs to respond swiftly to the nationally recognised need to reduce harmful carbon emissions".¹

In light of global temperatures already at 1 degree higher than pre-industrial averages and the [Havant Borough Council's aims to reduce carbon emissions to net-zero by 2050](#), a project such as 41 Beach Road would provide a real-world example of how to reduce carbon emissions in a new build property. Currently Havant Borough Council is almost entirely encircled by councils having declared climate emergencies including:

- Portsmouth City Council, (19 March 2019)
- East Hampshire District Council (18 July 2019)
- Arundel Town Council (14 October 2019)
- Arun District Council (13 November 2019)
- Worthing Borough Council (18 July)
- Southampton (18 September 2019)
- Isle of Wight (24 July 2019)

The carbon saving solutions specified for this property would be valuable for a range of building types across the built environment, offering Havant Borough Council the confidence it needs to declare a climate emergency and set down local legislative routes for other construction projects in the area to truly push for decarbonisation.



Ecospheric and OB Architecture have designed a scheme that meets the requirements for Passivhaus certification, with the potential of achieving the **Passivhaus Institut's highest certifiable standard - Passivhaus (PH) Premium**. This has only been certified on a [handful](#) of individual properties around the world to date and [never before in the UK](#) at the time of writing. At the Passivhaus Premium performance standard, the development will not only cover its own operational carbon, but also cover all the carbon embodied in the building fabric and the construction phase. In fact, using only renewables integrated into the proposed development, it will produce **enough energy to power 3 buildings of this scale**. This scale of energy generation presents a valuable addition to the local grid. As such, this project will deliver a **'True' Whole Life Zero Carbon project** making it one of the top most sustainable low carbon buildings in the country.

The design team wishes to reflect the highest standards in architecture and interiors whilst incorporating core sustainability principles. The final product will be functional, healthy, low maintenance accommodation, capable of producing enough energy onsite to power all household and site needs, appliances, lighting, space heating/cooling, domestic hot water and ventilation. Even if we exclude the onsite energy generation this design results in **an 83% reduction in operational carbon footprint** compared to an average UK new build home built to Part L building standards.

¹ Havant Borough Council Climate Change and Environment Strategy, page 4.

<https://cdn.havant.gov.uk/public/documents/Havant%20Borough%20Council%20Climate%20Change%20and%20Environment%20Strategy%202021-2026.pdf>



The team

Ecospheric focus on pioneering eco developments that save carbon and drive technological change. It's not only what excites us, but also offers valuable case studies to progress the field of sustainable construction. Over the last decade we have **helped directly with hundreds of home and business owners** form holistic renovation and development plans collapsing carbon, running costs, whilst improving the comfort and health of their internal environment.

Today, our team and expertise has grown to include our own experimental development firm, with the sole purpose of conceiving of, purchasing and delivering **true pilot projects** across all use classes of the built environment. This development of intellectual property enables us to support architects and developers in delivering specialist eco projects, such as paragraph 80 applications and international award winning certified Passivhaus projects. Indirectly this arsenal of solutions arms designers across the country with the know-how necessary to **decarbonise our national housing stock**. We work hard to keep at the cutting edge of sustainability in the built environment and our integrated approach creates fantastic environments to live and work for years to come.

We specialise in creating extremely efficient buildings, often in highly sensitive locations and are passionate about sharing our knowledge to support the decarbonisation of the built environment. Our last project saw a pair of beautiful Victorian properties in Manchester become the first Enerphit Plus certified houses in Europe, for which we were awarded both the [international Passivhaus award](#) from the PassivHaus Institut in Germany and the [ASBP award](#). The Editor for Passive House Plus Magazine, Jeff Colley, said of the scheme:

"Zetland Road, perhaps the most audaciously ambitious retrofit project of all time."

[Historic England](#) has used this as a **flagship project** and a test case as to what is achievable under the climate heritage banner. Free tours of our projects have been attended by hundreds of architects, planners and engineers and the project has been [featured](#) in over 50 national press outlets.

Our current in-house development program includes the historic restoration and Zero Energy renovation of Lymm Hall, a [grade II* listed manor house](#) with a proposed **5 Passivhaus Premium** new builds in the rear paddock; the [Sorting Office](#) which aims to be the world's first Zero Energy and Zero Waste food hall; and, the conversion of a 300 year old barn complex into off grid group accommodation in the heart of the Yorkshire Dales National Park.



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Sustainability Overview

1. Operational Carbon

Operational carbon refers to the 'in use' impact, typically resulting from building energy performance including thermal and electrical efficiency, hot water and ventilation.

1.1. Standards

The Passivhaus approach is an internationally recognised standard for the design and construction of low energy buildings. Having operated for over 30 years, with 60,000 such buildings erected and with scientific evidence demonstrating minimal performance gap, it is truly accepted as the world's most effective performance standard. The Passivhaus standard is based on an advanced thermal modelling software, Passivhaus Planning Package (PHPP), a comprehensive building physics engine and calculation toolset developed by the International **Passivhaus Institute of Germany** (PHI). The functionality of this software has been expanded through advanced modelling plugins to include embodied carbon calculation and whole building optimisation tools. In preparation for the full planning application, Ecospheric has produced a comprehensive thermal, carbon and daylighting analysis using PHPP, Dynamic Simulation Modelling (DSM) and the associated advanced tool sets, resulting in a highly optimised proposed design and fabric specification, that is properly considered and the resulting performance specification can be **trusted**.

With the results obtained from the modelling process the design team are confident we can deliver not only a **Zero Energy and Zero Carbon dwelling** but also **Passivhaus Premium Certification** (a **UK first certification** at the time of writing).

An exact definition for what is meant by 'Carbon Neutral' or 'Zero Carbon' is a constant source of debate. A strong argument put forward by John Palmer of the Passivhaus Trust, clearly demonstrates why **SAP** based, BRE specified definitions clearly avoid the hard realities of 'True Zero Carbon'; avoiding large energy demands such as unregulated energy (any energy demands that do not fall under lighting, heating, hot water), ignoring elements such as, basic household appliances, cooking, spa/swimming pools and relies upon averaged climate datasets with many assumptions made to speed up the modelling. All this results in large performance gaps averaging **40% greater energy consumption** in reality and **in some cases over 200%**, putting our national carbon targets at risk. Conversely **PHPP** has been shown to range between 0-10% performance gap, **typically less than 5%**.



There are many buildings with many claims out there; few attempt to define scientifically what aspects of Energy and Carbon are included. The following list covers all of the standards, certifications and claims that the proposed dwelling intends to achieve in prioritised order of increasing difficulty, with associated definitions:

- **NZEB or Zero Energy** - The EU definition of NZEB is 'The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby'. [UK Government approved](#) SAP based definition accounting for predicted energy generated on site in kWh and predicted energy consumption in kWh performing a net calculation on a 1 for 1 basis i.e. building demand of 10,000kWh excluding unregulated energy and grid based energy wastage offset by a predicted annual site energy generation of 10,000kWh, all based on a simplified thermal model (SAP). *Note: this is not a certification and there is no official body tasked with defining or overseeing the process of calculation.*
- **Zero Carbon** - UK Government approved SAP based definition accounting for predicted CO₂e emissions associated with building offset against predicted carbon saved through installed onsite generation in kg CO₂e, on a net calculation basis. This excludes unregulated energy (anything plugged in within the dwelling) and grid based energy wastage, and also does not account for the high carbon energy associated with the grid use, to balance supply for the site. All figures are calculated using SAP, a simplified thermal model. *Note: this is not a certification and there is no official body tasked with defining or overseeing the process of calculation.*
- **Passivhaus Classic Certified** - Passivhaus is the most scientifically ratified internationally recognised standard and is very much focused on building performance. When it comes to the combined operational energy predictions of a building; considering the building services, thermal comfort, hygiene, and thermal bridging, its proven track record is unsurpassed. At a Classic certification level a Passivhaus will require ~90% less energy for space heating when compared to a typical new build. In real terms, John Palmer has shown that a certified classic Passivhaus is closer to true zero carbon performance than the SAP based standard.
- **'True' NZEB or Zero Energy** - As per the SAP definition of Zero Energy, only modelled using PHPP and including both unregulated energy and grid based inefficiencies.
- **Passivhaus Plus Certified** - As per Classic with a further reduction in energy consumption levels and combined with onsite renewable generation typically better than a True Zero Energy performance standard and roughly comparable to a True Zero Carbon standard. This includes the rigorous Passivhaus certification process where the resultant buildings will have less than 10% performance gap.
- **'True' Zero Carbon** - As per the SAP definition of Zero Carbon, only modelled using PHPP and including both unregulated energy, grid based inefficiencies and grid carbon factor for imported energy.
- **'True' Zero Carbon site** - As per 'True Zero Carbon', however includes the whole site demand. All external lighting, EV chargers, outbuildings, external pumps etc.
- **Passivhaus Premium Certified** - As per Plus certification, with yet further reduction in energy consumption levels and combined with massive onsite renewable generation typically equivalent to three times the total main building energy consumption.
- **'True' Whole Life Zero Carbon project** - Coupling a dramatic drop in lifetime carbon achieved through extreme building performance and careful building material selection with the provision of large scale renewable energy generation to offset the total project carbon over a 60 year operational lifetime (which of course the building may last much longer than).



1.2. Passive Design

Energy efficiency has been central to the design of the proposed dwelling at 41 Beach Road from the outset and in line with the project team's pursuit of this aim, they engaged with a Design Review Panel process, which provided advisory recommendations for ensuring the best possible design quality. The panel's main objective was to offer impartial and knowledgeable advice to the design team on the quality and suitability of the design proposal. Comprising a group of professionals with expertise in diverse design areas such as architecture, urban planning, landscape design and engineering, the design review panel evaluated the proposed design for 41 Beach Road.

One of the panel's principal recommendations was to demonstrate the commitment to low energy design and sustainability by "set[ting] a meaningful quantitative target for CO₂ emissions of the building as well as a clear path to demonstrably achieving the set level." The panel suggested a process of iterative energy modelling using dynamic simulation modelling and pursuance of an "industry recognised metric, such as Passivhaus". Ecospheric was brought in to optimise the energy performance and sustainability of the proposed design by employing a passive design process which includes dynamic simulation modelling, ensuring that the proposed dwelling at 41 Beach Road is targeting achievements in every category of sustainability and is aiming above and beyond typical national standards.

The Passivhaus Premium is a certification level within the Passivhaus standard that requires buildings to meet extremely high energy efficiency and comfort standards. In fact this is arguably the world's highest performance standard given the extreme renewable generation coupled with the extreme conservation of energy targets. In order to achieve **Passivhaus Premium Certification** and to integrate the wider ranging sustainability aims, Ecospheric have supported OB Architecture in optimising building performance through optioneering passive design techniques (see image right) and 'Fabric First' improvements such as glazing optimisation, and by accommodating modern methods of construction (MMC) for the floor and internal structure. MCC is endorsed by the NPPF and the [national model design code](#) which encourages local councils to provide support for and embrace modern methods of construction.

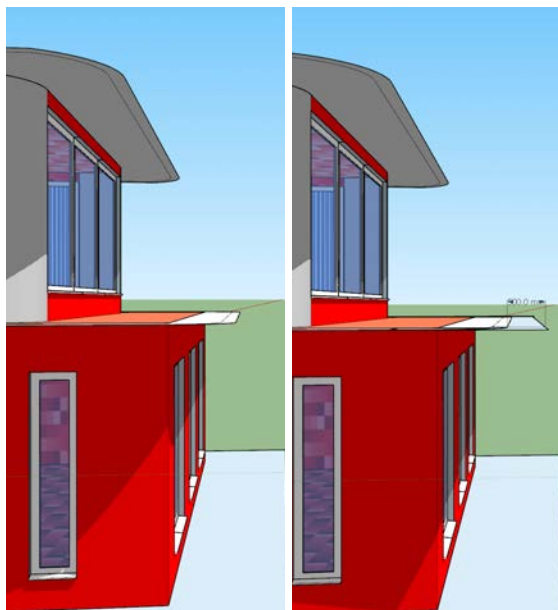
The passive design hierarchy primarily focuses on passive cooling using design, then passive cooling systems such as automatic opening rooflights and shutters, and finally a reversible heat pump driven by renewables. The use of a reversible heat pump driven heating system that delivers heat via the ventilation system also allows for active cooling to further reduce the chance of overheating potential as well as covering a future warming climate. Alternative roof massing was explored but it was found that pitched options reduced the renewable generation capacity, preventing the necessary threshold for PH premium certification levels.

The glazing performance enhancement was necessary to reduce the space heating demand and overheating potential. The images below are example exports from the DSM software and show examples of the glazing optimisation process undertaken. Through an iterative process of modelling the proposed options and liaising with the client, we were able to reduce the innate frequency of overheating from 35% (ie. more than 4 months of the year) down to 1% (or 4 days a year), well within national overheating standards.

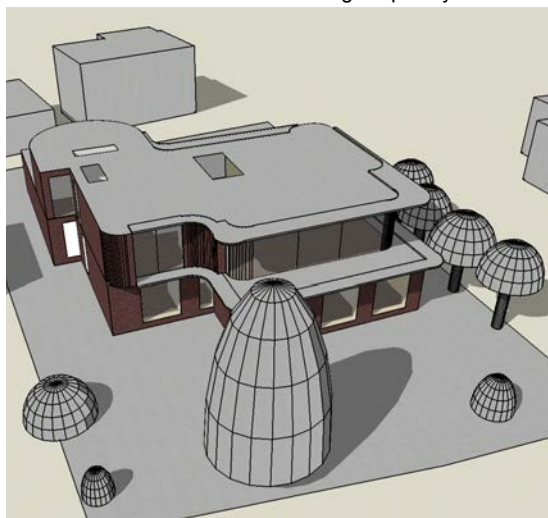
A good Passivhaus design is based on:

-  **Free heat in winter** from solar gains with predominant façades facing south and limited overshadowing
-  **Simple building form** for the warm spaces with a low exposed surface area
-  High levels of **insulation**
-  An extremely **airtight** building fabric
-  Significantly reduced **thermal bridges**
-  High performance **triple glazed windows** with window proportions that are based on orientation
-  Opening windows for **natural purge ventilation**, with the ability to cross ventilate
-  Efficient **background mechanical ventilation with heat recovery (MVHR)**
-  Accurately predicted energy use modelling using the Passive House Planning Package (**PHPP**).





Option-5 Increase shading on the south by 500mm
~26% reduction in overheating frequency



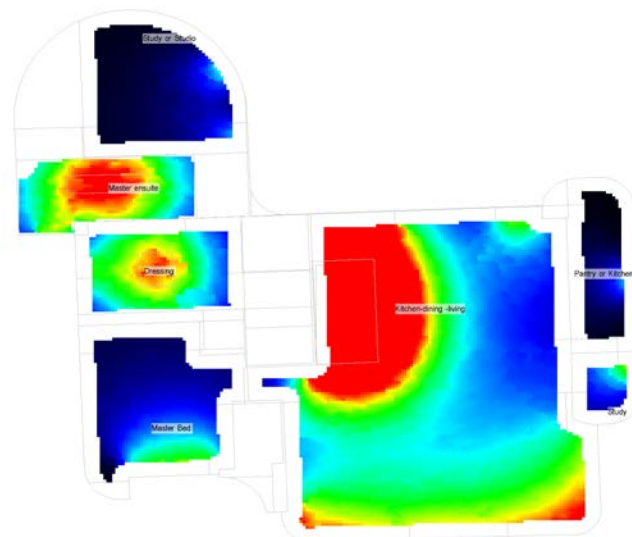
Daylight Optimisation - Glazing is typically both 6 times worse performing per m^2 of opaque fabric and 6 times more expensive. It also acts as the primary cause of overheating. Each of these negative characteristics need optimising against daylighting and framing principal views. Design Builder Dynamic Simulation Model (DSM) is capable of optimising the building on a room by room basis enabling the design team to minimise the glazing proportion whilst satisfying the RIBA standards for daylighting. The inherent massing design of the proposed dwelling aims to take advantage of passive solar gains in the colder months whilst reducing overheating potential through the adoption of solar shading optimised using PHPP and Design Builder DSM with specifically designed window reveals and roof overhang.

Detailed overheating and TM59 analysis - For Passivhaus certification the frequency of overheating must be less than 10%. This is defined as the number of days per year that the internal temperature is predicted to exceed 25°C . This is still in excess of 1 month per year, so we try to target less than 5% which 3% was achieved. After further refinement of building orientation, glazing, shading (including roof overhang and reveals) and fabric U-values the final overheating figure settled on just 1.4%. This was ratified with the model passing the requirements of the CIBSE TM59 analysis.

Thermal bridge reduced design - When undergoing PassivHaus certification, stringent control measures are applied to manage thermal bridging effectively. The PassivHaus Institute (PHI) has set a threshold of $0.01 \text{ W/m}^2\text{K}$, below which there is considered to be no thermal bridging. If a proposed junction lacks sufficient evidence from manufacturer information or previously modelled details to prove thermal bridging performance below this figure, THERM modelling is necessary. If the junction returns a Psi value $>0.01 \text{ W/m}^2\text{K}$, it is classified as a thermal bridge and must be included in the PHPP model to account for the additional heat loss it causes.

There are two key limits associated with thermal bridges. The first limit relates to the overall space heating demand, and the threshold of $15 \text{ kWh/m}^2\text{a}$ varies based on the inherent building performance. If the thermal bridges are particularly problematic or contribute significantly to heat loss, they may deplete the contingency and cause the property to fail in meeting the required thresholds. The second limit pertains to individual thermal bridges being so severe that they cause internal minimum surface temperatures to drop below the condensation threshold, resulting in failure on hygiene grounds.

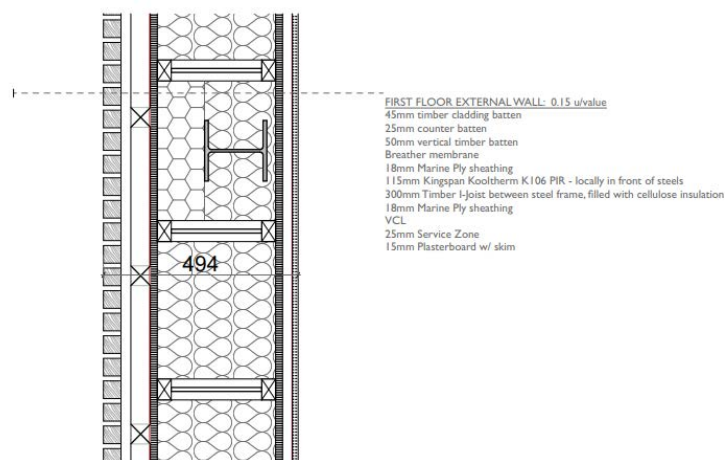
Although the detailed design stage has not yet been completed, as we have not progressed to RIBA stage 4, it is evident that the thermal break solutions, along with the thermal bridge allowance already incorporated into the proposed PHPP model and the remaining contingency before breaching the certification threshold, provide clear evidence that this building is poised for certification. With our extensive experience in certifying PassivHaus buildings, we hold great confidence in this building's certification potential.



1.3. Building Fabric

This section defines the exact thermal properties for each of the main construction elements and compares them against standard Part L performance levels. The following table is an extract from PHPP defining what has been allowed for within the model, with Part L requirements for comparison.

- **Windows and Doors** - Aluminium-clad (marine grade finish) triple glazed timber systems offer optimum thermal insulation. All glazed elements in the property have been calculated to achieve between 0.5 - 1.0 W/m²K, which gives a **38-69 % improved performance** over building regulations requirements. With a Class 4 airtightness at 600 Pa (the equivalent of a hurricane) this system achieves the highest classification of airtightness. To ensure this performance in reality the proposed glazing systems utilise ironmongery with 4D adjustment, allowing 4 separate axes for enhanced commissioning within the building after installation and for long term realignment to ensure airtightness performance is retained.
- **Roof** - Ecospheric have a history of working with lightweight carbon sequestering timber based materials and the recommended domestic structural solution is the I-Joist system. With incredibly low embodied carbon and the highest performance for the thickness of all the organic methods, I-Joist is the ideal material for construction of the world's highest performance standard. High levels of insulation are proposed, achieving a U-value of 0.127 W/m²K or better, a **21 % improvement** on building regulations criteria. All structural timber used in the development will be sourced from sustainably managed forests under the FSC or PEFC standards.
- **Walls and Superstructure** - Wall structures will employ the use of reused and recycled steel offering carbon reductions on standard new build steel frame structures. Walls will be constructed of Poroton clay blocks which are a modern insulating clay block designed to achieve a u-Value of 0.153 W/m²K, which is a **41 % improvement** on building regulations specification. External wall finishes will include locally sourced set pebbles to reference the waterfront location.

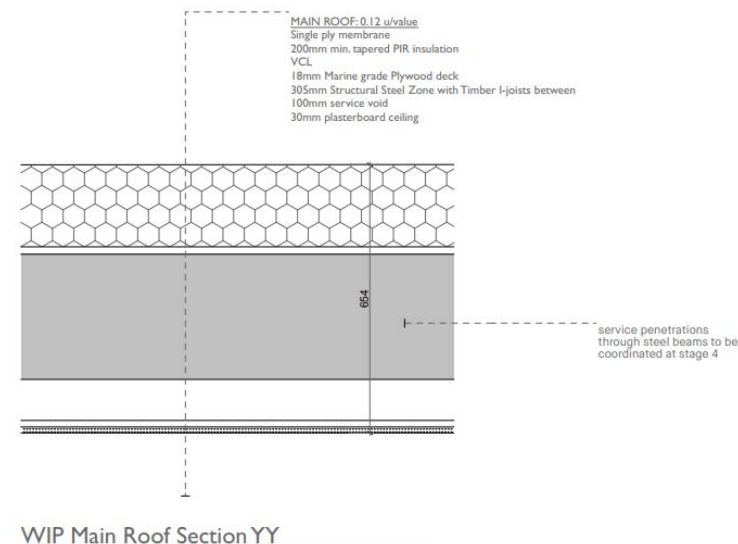


WIP First Floor External Wall Plan Detail

The opaque fabric detailing has resulted in installation Psi values of less than ~0.01 W/mK - so minor as to be classed as thermal bridge free and ignored by the PH certification process.

- **Floor and foundations** - A precast Filigran concrete slab system offers an MMC solution for the efficient use of materials. High performance PIR will be used to insulate the floors to a u-value of 0.151, making a **16% improvement** on building regulations.

Summary	U-value	
Area group	[W/(m ² K)]	
Treated floor area	Creek Cottage	Part L
North windows	0.798	1.6
East windows	0.820	1.6
South windows	0.896	1.6
West windows	0.920	1.6
Horizontal windows	0.560	1.6
External wall - ambient	0.153	0.26
Roof / ceiling - ambient	0.127	0.16
Floor slab / basement ceiling	0.151	0.18



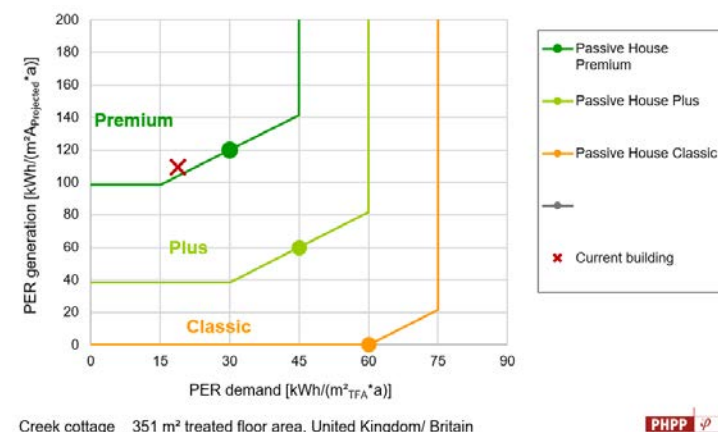
WIP Main Roof Section YY



1.4. Renewable Energy Generation

PV, or photovoltaic, panels can play a critical role in the certification of the Passivhaus Premium building standard. The Passivhaus Premium standard is a certification level within the Passivhaus standard that mandates buildings to adhere to extremely rigorous energy efficiency and comfort standards through the utilisation of passive design techniques as outlined earlier in this document. Moreover, the standard requires a large amount of renewable energy generation, which typically equates to around three times the amount of energy needed to power the building, effectively producing a small-scale renewable energy generation facility for the local power grid (see graph to right).

Owing to the flat roof typology a larger area of solar PV panels maximises energy generation from renewable solar sources. As part of the output from the massing studies the roof shape, orientation and respective position on the site have been optimised, and combined with specific generation and mounting technologies to produce as large as possible building mounted array. This process was strictly necessary in order to accommodate the large number of panels required for PH Premium certification. 151 m² of solar PV mounted on the roof will produce a peak power output of approx **32 kW** (8 times the size of a typical domestic array) and will **generate an estimated 24,000 kWh/a** of electricity. This is more than three times the energy required to power the house, and allows for certification as a Passivhaus Premium.

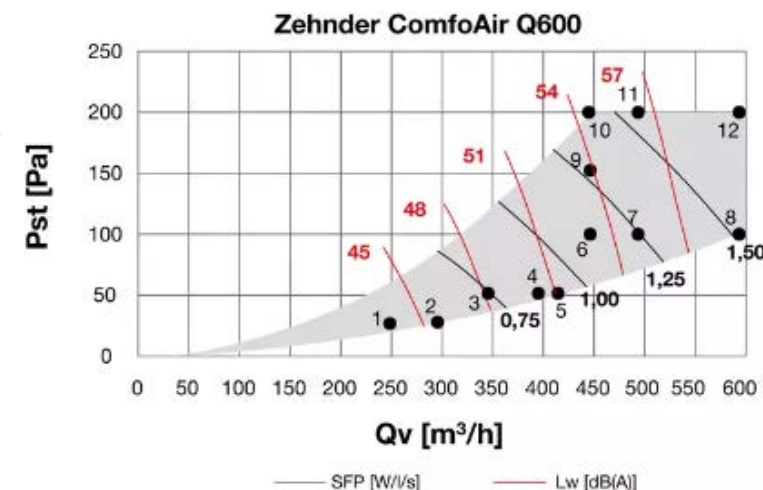


1.5. Appliances, Mechanical, Electrical and Plumbing

Mechanical Ventilation with Heat Recovery (MVHR) - Renewably driven heat recovery ventilation solutions are to be applied throughout the dwelling to achieve a 90% total heat recovery efficiency. This is the single biggest energy saving strategy alongside airtightness. The long term health of both the building and occupants depend upon this ventilation solution. A Zehnder Comfoair Q600 offers a nominal flow rate of 360m³/hr @ 60% output (optimal for cost, acoustics and specific fan power) suited to the proposal for 41 Beach Road.

A detailed design has been completed with a single device satisfying air flow for 8 supply points and 13 extract points, to conform to building regs.

Picture	Component name	Manufacturer	Country	Air flow range from... /m ³ /h	To... /m ³ /h	Heat re-cov-ery rate	Specific elec-tric power/Wh/m ³	Effi-ciency ratio	Hu-mid-ity re-cov-ery	Sound level of unit/dB(A)	Climate zones
	ComfoAir Q600 HRV, Comfort Vent Q600 HRV	Zehnder Group Nederland B.V.	NL	70	460	87%	0.24	0.7	0%	50.9	Cool, temperate



Heat Pump (HP) technology - In order to achieve the performance standard of PassivHaus Premium a heat pump is required to greatly reduce the remaining space heating and DHW demands. Modern air source HP technologies have the ability to reduce direct electrical demand for domestic hot water and space heating by over 2/3rds. We are still underway with a detailed analysis comparing Ground Source (GSHP) and Air Source (ASHP) technologies. The current proposal intends to include a 7kW [aroTHERM plus Air-to-water heat pump](#). This ASHPs will supply space heating, domestic hot water and are reversible so able to provide cooling loads. In order to deliver the bulk of both space heating and cooling the proposal is to utilise 2 No. Zehnder comfoposts which act as a water to air heat exchanger capable of heating and cooling the building via the MVHR system.



Domestic Hot Water (DHW) - New DHW purging technologies developed by Ecospheric and Mixergy enable the proposed dwelling to adopt a truly low temperature distribution system maintaining hot water at just 45°C without any risk of Legionellas. This allows for a single main hot water store to provide all the household DHW and space heating demand. Careful design of pipe diameters are used to maximise flow rate whilst maintaining delays to taps to below recommended levels, removing the need for energy intensive circulation loops. This greatly simplifies the plant set up and reduces future maintenance. Additionally, Mixergy tanks adopt a world first thermocline control, further halving the DHW energy consumption through the careful management of the temperature profile of the stored hot water. Mixergy have also recently released control technologies that enable the tank to control the ASHP. Thanks to the large PV array on the roof excess generated energy can be used for PV divert via heat pump when energy supply outweighs demand, excess energy from the large roof mounted solar PV array will be diverted to generate hot water via the heat pump for optimal efficiency.

Space Heating and Cooling - For heating and cooling an innovative 'Climalevel' solution will utilise a combination of a high efficiency heat pump, underfloor heating, thermal mass storage and tempered air circulation. This innovative methodology reduces running costs and visual impact on the building, removing the need for traditional radiator networks entirely. This is made possible with the low space heating demand achieved with the Passivhaus approach resulting in a call to heat occurring on less than 30 days of the year. The Climalevel system used for delivering tempered air throughout the building is also capable of distributing chill potential to allow occupants to manage instances of overheating, including for future climate warming scenarios into the next century.

Energy Management - In order to maximise self usage of the renewable energy produced on the building a combination of divert technologies will be employed. At any point during the day when the PV array generation exceeds the baseline household demand the excess energy will be diverted to on-site Tesla batteries, DHW production, and Electric Vehicle charging. In this way onsite energy generation will completely satisfy all household energy consumption with enough spare energy to charge 10,000 EV miles. Thus also meeting personal transportation energy demands.

Shower Waste Water Heat Recovery (WWHRS) - Waste water heat recovery is a methodology of recovering waste heat lost down the drain when showering, reducing energy demand for showers by typically over 60%. Specification of the latest Powerpipe technology is taking heat recovery further than ever before with the best recovery rate (65+%) and a custom design utilising whole house shower water heat recovery.

Household Appliances - Under the new EU energy rating scale, products that were once classified as A+++ in 2020, are now likely rated B or C. A++ is now classified as D or E, and A+ will find themselves F or G rated. A+ or better appliances throughout the site are all designed to run from the onsite generated renewable energy. All appliances on the proposed dwelling will achieve an E level or better, equivalent to A++ on the previous classification scale. Better ratings will be achieved in some classes of appliance. These performance figures are used and will be checked as part of the PH certification process.

Lighting - High performance LED's with greater than 75 Lumens per Watt efficiency are specified throughout. No non-LED lighting technologies are specified. Coupled with optimised daylighting study the usage requirements for artificial lighting has also been reduced.



3. Health, comfort, maintenance and resilience

3.1. Building and occupant health

Air quality is a complex subject with a number of variables impacting occupants' health. Gaining control over Relative Humidity (RH) results in improved resilience over the following pathogens/conditions: Bacteria, virus, fungus, mites, rhinitis, asthma, eczema/dermatitis, respiratory infections, chemical interactions and ozone production. CO₂ impacts mental concentration and can lead to headaches. Particulate matter, radon and volatile organic compounds (VOC's) impact the respiratory system with increased prevalence of cancer. The key methods to ensure top air quality are as follows and will be incorporated into the design of the proposed dwelling:

1. Create an airtight fabric (PH standard achieves 0.6ach) and filter all incoming air (H7 filters on the MVHR)
2. Provide a controlled rate of air flow based upon RH in all rooms in the building (MVHR has supply air brought to all habitable rooms and extracts from all wet spaces ensuring adequate air flow in connecting spaces)
3. Minimise the presence of VOC's through the specification of natural building materials, fixtures and furnishings where appropriate
4. Specification of lime based finishes in order to mop up (sequester) excess CO₂ and VOC's with antimicrobial surfaces for the ultimate in hygienic interiors

3.2. Occupant comfort and avoidance of overheating

Comfort is a complex and often personal science impacted by five main physical variables, air quality, air temperature, internal surface temperatures (irradiative effects), draughts (internal air speed) and floor finish conductivity. Four of the five elements are tightly controlled by the Passivhaus standard and further enhanced with additional modelling, low conductivity floor finishes, graphene enhanced lime based finishes and VOC free inbuilt furnishing. In addition, a careful shading design passively reduces overheating whilst maximising free heat for performance. Analysis was carried out checking building comfort against a future warming climate showing that comfort is maintained without active cooling requirements up to the 2050's.

Detailed overheating and CIBSE TM59 analysis - For Passivhaus certification the frequency of overheating must be less than 10% as modelled by PHPP. This is defined as the number of days per year that the internal temperature is predicted to exceed 25°C. The 10% limit is still in excess of 1 month per year, so we try to target less than 5%. As PH certification is desired for this project we have completed an overheating and future climate analysis within PHPP software. This shows a very low current overheating potential of just 1.4%, well below the Passivhaus certification limit of 10%. This tool, however, is limited to a whole building basis, potentially resulting in overheating individual rooms. As such a CIBSE TM59 detailed overheating analysis was performed using a Dynamic Simulation Model alongside a detailed daylighting and wider thermal analysis. This model supported an optioneering process whereby it is possible to trial a large number of technology and design decisions and analyse the impact. This approach led to a refinement of glazing, shading (including roof overhang, reveals, automated shutters and rooflight opening) and fabric U-values. The following tables show the results exported from the TM59 analysis highlighting a pass in all the principal habitable rooms.

Present (2020s):

Criteria for predominantly naturally ventilated homes

Block	Zone	Criterion A (%)	Criterion B (hr)	Pass/Fail
First Floor	KitchenDiningLiving	0.14	N/A	Pass
First Floor	MasterBed	0.00	1.50	Pass
First Floor	PantryOrKitchen	0.00	N/A	Pass
Ground Floor	Bed1	0.00	0.00	Pass
Ground Floor	Bed2	0.00	0.00	Pass
Ground Floor	Bed3	0.00	0.00	Pass
Ground Floor	Snug	0.00	N/A	Pass

Compliance is based on passing both Criterion A and Criterion B.

(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.



Future(2050s):

Criteria for predominantly naturally ventilated homes

Block	Zone	Criterion A (%)	Criterion B (hr)	Pass/Fail
FirstFloor	KtchnXdrngXlvng	1.08	N/A	Pass
FirstFloor	MasterBed	0.25	16.17	Pass
FirstFloor	PantryOrKitchen	0.83	N/A	Pass
GroundFloor	Bed1	0.00	4.50	Pass
GroundFloor	Bed2	0.05	7.33	Pass
GroundFloor	Bed3	0.00	6.50	Pass
GroundFloor	Snug	0.12	N/A	Pass

(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 10pm-7am shall not exceed 26°C for more than 1% of annual hours.

This degree of analysis and optimisation **demonstrates this property's resilience to overheating**. Multiple design strategies and systems have been employed to mitigate instances of overheating, including automatic opening roof lights and shutters and reversible heat pump.

3.3. Ongoing affordability

The sustainability of living in the UK is at risk due to the ongoing stability of energy and resource costs. With energy prices having doubled in recent years, reducing demand and dependence is the most effective solution. By employing an extreme conservation of energy strategy in the design of 41 Beach Road, native energy costs have been significantly reduced. The same house built to Part L notional standards without heat pumps would have an annual gas and electricity cost of £2700 (noting this would be considerably more if a typical all electric property was specified where no gas was used), but with the proposed Passivhaus construction and a heat pump the cost has been reduced to just £1800, a saving of 33%. This reduction is solely due to conservation of energy strategies and does not account for any additional savings or earnings from the PV array. The entire site is designed as fully electric to make the most of future grid decarbonisation including personal transportation. With the all electric systems and generation potential of the proposed development, the homeowners are estimated to have a **conservative net income of £5000** from their house after energy and maintenance bills.

3.4. Site and building resilience

Due to the site being partially located within Tidal Flood Zones 2 and 3, first floor levels have been raised to reduce flood risk to low, and when projected for the impact of climate change flood risk is still considered acceptable according to the flood risk assessment (FRA) prepared by Aegaea. The drive for high airtightness in Passivhaus certified buildings leads to a reduction of fabric penetrations, and the use of mechanical ventilation avoids the need for air bricks, while windows and doors will be of the highest airtightness, thus exceeding the recommendations of the FRA.

Additionally 100% sustainable urban drainage systems (SUDs) have been designed in place of hard standing and oversized soakaways handling all roof areas for a future climate. With **2800 litres of dedicated rainwater harvesting and storage**, all external water use and potential future potable systems would reduce dependency on the local water supplies. The house has been redesigned to accommodate full disabled access including a lift to the first floor. In addition, rooms suited for offices have also been included in response to increased home working. Embodying 'Lifetime homes' principles within the design with a focus on flexibility for family archetypes and assisted and accessible living arrangements this helps avoid unnecessary building work in the future.



4. Green infrastructure, Landscaping and external air quality

Urban greening/infrastructure and its intrinsic link to wellbeing and climate adaptation, attracts considerable attention across all national built environment documentation, with a focus on the intimate connection between quality housing, green spaces and our wider quality of life.

4.1. Site Biodiversity

The biodiversity of green spaces surrounding the building will be enhanced through the planting of native trees, hedgerows, and shrubs such as hawthorn. Wetland areas and ponds are known to increase biodiversity and attract less common species, recent studies are also showing that ponds can act as better carbon sinks than woodland. A sunken rain garden on site will allow for the collection of storm water from the property but will also collect storm run-off from Beach Road, therefore reducing pressure on the sewage system and lowering the chance of overflow. All of this helps to protect the neighbouring Site of Special Scientific Interest and the Protection Area for the harbour from man made pollution, while increasing biodiversity through native wetland planting, and increasing carbon sequestration. Bat and bird boxes will also be incorporated into the site to provide habitat for these locally nesting species and a sensitive lighting scheme will mitigate any impacts on foraging and commuting bats.

4.2. Green Infrastructure

Current national policy looks to 'Avoid areas at risk of flooding and is resilient and responsive to the impacts of climate change. As such, the proposed dwelling intends for all hard standing to have a SUDS solution specified, adopting SUDScape technology or similar. This solution will ensure full water penetration and percolation is designed in. This offers partial flood protection and more importantly in combination will protect the subground (up hill) sections of the property. Visually speaking, there will be minimum impact, and yet the parking requirements will be satisfied. This SUDs technology is biological by nature and contains [geotextiles](#) that form an active layer capable of degrading any potential oil spills caused by the vehicular access, permanently protecting the site from contamination.

4.3. Transport

The site of 41 Beach Road is located in the small town of Emsworth, which is close to the built up areas of Portsmouth and Chichester, both of which are easily reached by bus or train, connections for which are less than a 10 and a 20 minute walk respectively from the site. To further increase clean mobility cycle storage encourages the use of further active travel with the Dover to Cornwall National Cycle Network route 2 within 2 minutes cycle and Havant town centre a 12 minute cycle, making sustainable commuting a viable option. 41 Beach Road is in close proximity to the M27 and the A3 providing good connections for road travel. The proposed onsite Electric Vehicle charging facilities and parking provision of 2 spaces with additional indoor parking, facilitates the transition to electric vehicles for the home owners and their guests.

The proposal is to **set aside a pair of visitor parking spaces each with their own Tesla Destination chargers** powered in part by excess solar energy. These chargers will be capable of charging any EV with a standard Type 2 charge port, not just Tesla vehicles. This proposal will significantly enhance the local EV charging network, facilitating the transition to electric vehicles, but also do so with **direct renewable energy**, a clear statement of the future of domestic development.

5. Waste and Resources

5.1. Water-Saving Technologies

All new taps will be flow restricted (5L/m for bathrooms) and aerated and low flush (4/2.6L) dual flush toilets. New showers will be flow restricted (9L/m) and aerated. These technologies should result in a considerable reduction in typical water usage. Rainwater collection and use across the site will greatly reduce the need for potable water use for external activities.

Portsmouth Water encourage developers to construct properties which promote the efficient use of water.



Where qualifying developments can be proven to be constructed to use 100 litres per person per day, or less, many utilities companies will provide a reduced rate against the Water Infrastructure Charge (as published in their charges scheme).

Using a calculator that follows the methodology set out in Appendix A "Water Efficiency Calculator for New Dwellings" of the Building Regulations Approved Document G, to calculate the level of water consumption for new dwellings, it has been shown that the building in the proposed development will satisfy requirements for approval as a low water usage development and therefore qualify for a reduced rate against the Water Infrastructure Charge.

The following table covers the overview of the results from the calculator.

Installation Type	Unit of Measure	Capacity/Flow rate (1)	Use Factor (2)	Fixed use (litres/person/day) (3)	Litres/person/day = [(1)x(2)] + (3) (4)
WC (single flush)	Flush Volume (litres)		4.42	0.00	0
WC (dual flush)	Full flush Volume (litres)	4	1.46	0.00	5.84
	Part flush Volume (litres)	2.6	2.96	0.00	7.70
WC (multiple fittings)	Average effective flushing Volume (litres)		4.42	0.00	0
Taps (excluding kitchen/utility room taps)	Flow rate (litres/min)	5.00	1.58	1.58	9.48
Bath (where shower also present)	Capacity to overflow(litres)	150.00	0.11	0.00	16.50
Shower (where bath also present)	Flow Rate(litres / minute)	9.00	4.37	0.00	39.33
Bath Only	Capacity to overflow(litres)		0.50	0.00	0
Shower Only	Flow Rate (litres/minute)		5.60	0.00	0
Kitchen/Utility room sink taps	Flow rate (litres/minute)	5.00	0.44	10.36	12.56
Washing Machine	(Litres/kg dry load)	4.67	2.1	0.00	9.81
Dishwasher	(Litres/place setting)	0.60	3.6	0.00	2.16
Waste disposal unit	(Litres/use)	☐ Present	3.08	0.00	0
Water Softener	(Litres/person/day)		1.00	0.00	0
	(5)	Total Calculated use (litres/person/day) =SUM(column 4)			103.38
	(6)	Contribution from greywater (litres/person/day)			0
	(7)	Contribution from rainwater (litres/person/day)			0
	(8)	Normalisation factor			0.91
	(9)	Total internal water consumption = [(5)-(6)-(7)]x(8) (litres/person/day)			94.08
	(10)	External water use			5.0
	(11)	Total water consumption (Building Regulation 17.K) = (9)+(10)(litres/person/day)			99.1



5.2. Construction Waste Minimisation Strategy

One of the key sustainability drivers associated with this project centres on waste minimisation.

There are three key approaches to reduce the impact of waste:

1. Waste minimisation
2. Reuse/convert/recycle where possible
3. Use organic/natural, non-toxic and biodegradable materials with low embodied carbon where appropriate
4. Circular Economy - Design for reversibility and reuse

This approach can be applied to a number of functions where waste is generated:

- Construction - including labourers or external contractors bringing waste on site
- Material manufacture
- Material delivery and packaging
- Post occupancy - Ongoing maintenance and building occupation
- End of life

Conclusion

This project will see newly developed technologies and strategies brought into practice, offering an exemplary case study for the future of the built environment. This family home will offer a future-proofed and net-zero carbon dwelling, a fitting development in this area of significant ecological value, delivering a **'True' Whole Life Zero Carbon project** making it one of the top most sustainable low carbon buildings in the country. As such, it is hoped that the Council will support and approve the application so that work on this important and exciting new project can commence.

