THE ENVIRONMENT

A key aim of this project is to provide an outstanding example of a rural house and it is hard to see how an outstanding piece of architecture can be anything other than highly energy efficient. Passivhaus is a measurable, reliable way in which high levels of comfort and efficiency can be demonstrated at design stage and ultimately carried through to construction and use.

The climate crisis has highlighted our need to drastically cut carbon emissions with buildings being a major contributor. The clients are deeply committed to doing their part and, like the design team, believe that all new dwellings should be designed to minimise their energy consumption and therefore CO^2 emissions. Passivhaus is often considered as the exemplar standard for producing high performance buildings which are not only extremely energy efficient but also comfortable to live in. Passivhaus is a fabric first approach, so energy requirements are minimised by the building fabric being very highly insulated and built to very high levels of air tightness. Orientation and window size and placement are key to success, as is a mechanical heat recovery ventilation MVHR system which ensures that little heat is lost through ventilation. This results in an exceptionally healthy, comfortable environment. There are several criteria that need to be met, some are comfort based and others relate to energy efficiency, these are summarised in the table overleaf.

At design stage a detailed computer model of the proposed scheme was created to assess the design in energy terms. This involves entering information on the efficiency of the external envelope, the size and orientation of windows, the climate, shading, the ventilation and heating systems and the size of the building allowing very complex energy assessments to be completed. The output from this demonstrates whether the design is capable of being a certified passivhaus.

The proposal is capable of meeting the strict criteria of a passivhaus with a heating load of 10w/m^2, 0% risk of overheating and risk of excessive humidity and a primary energy requirement of just 45kwh/m^2 per year. These figures are considerably lower than a similar sized dwelling built to current Building Regulations standards.

Operational carbon, the carbon produced by running the heating, lighting and hot water, is also a key consideration. By its nature the proposal requires very little heating, so the design team have concentrated on minimising the energy requirements of the production of domestic hot water and lighting/ consumer electronics. This has been done by including an air source heat pump to produce hot water and by installing 100% low energy lighting and a solar PV array to produce the majority of the energy requirements on site.

CRITERION (For Passivhaus Classic standard)	LIMITING VALUE	COMFORT & HEALTH RELATED	ENERGY RELATED
Airtightness (as built tested)	0.6 air changes per hour @50Pa	X	X
Internal Surface Temperatures	>17ºC at all times	X	
Summer overheating	No more than 10% of the year >25ºC. The UK guideline for this limit is 5% with a best practice target of 0%*	X	
Ventilation Air (as built tested)	30m³ of fresh air per person per hour	X	
Ventilation System Noise	<25dBa in living and sleeping areas	X	X
Heating Demand Heating Load (One or other of these criteria has to be met)	<15 kWh/m².year or <10 W/m².year		X
Primary Energy	135 kWh/m².year		X
Or ... Primary Energy Renewable	<60 kWh/m².year		X

Primary Passivhaus Criteria, Passivhaus Trust



Benifits of PassivHaus
(Palmer et al., (2021) *PASSIVHAUS BENIFITS. Passivhaus Trust* , p.7)

Due to the fabric first approach, the form of construction has been carefully integrated into the design with a specific construction system in mind. PH15 are a specialist British company based in Devon who design and supply very highly insulated, airtight timber frames. Their approach is to supply all the components to construct the frame in pre-cut frame components. This differs from most timber frame constructions in the UK where off-site construction results in panels being brought to site on trucks which are then lifted into position with a crane. Instead, accurately cut components (studs, rafters, joists etc.) will be delivered and stored in a local farm shed with only the material required that day being transported to site in the applicants own much smaller vehicles, across farmland rather than the local road network. The PH15 system has been very carefully designed with the UK construction industry in mind and offers a fast and simple construction method ensuring the high levels of insulation and airtightness are easily achieved by local builders. The system is carpenterled and is highly suited to the use of apprentice carpenters who are more than capable of assembling the system. This approach makes the construction more socially sustainable bringing new skills to local tradespeople. The system has been designed specifically to minimise embodied energy and the company states their system produces just 21kgCO2e/m^2 where conventional cavity wall (how the vast majority of UK housing is constructed) produces 75kgCO2e/m^2.

Not only is the structure made from sustainable materials, but the insulation is also made from natural materials with a combination of blown cellulose fibre, wood fibre and sheep's wool used.



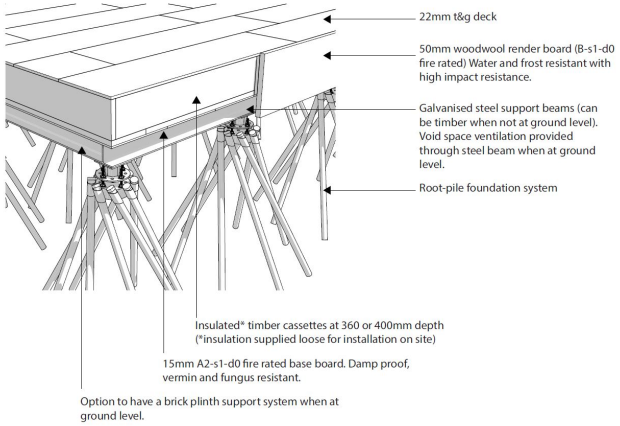








The light touch approach that the client requested is further evident in the choice of a zero concrete foundation system. Most buildings in the UK use vast amounts of carbon rich concrete in their foundations and ground floor constructions. The proposal at Clackersbrook Barn is to use a radial pile foundation system, small diameter magnesium alloy steel poles individually driven into the ground by handheld compressor driven air hammers in splayed cone orientations. These micro piles do not disrupt ground water movement and can be used close to trees without significant damage. Their specified design life is more than 100 years and the system is fully removable and recyclable. This allows the floor structure to be timber greatly reducing embodied energy and reducing the risk of cold bridges which can have huge impacts on energy efficiency.



RAISING THE STANDARDS OF DESIGN IN RURAL AREAS

A key part to Paragraph 80 of the NPPF is that new dwellings in the countryside should be *truly outstanding, reflecting the highest standards in architecture, and would help to raise standards of design more generally in rural areas*'. This frequently results in paragraph 80 houses being exceedingly expensive: both in design and construction costs and way outside of the means of the vast majority of rural people. This scheme has been specifically designed to keep construction costs at a sensible level, far more in line with average construction costs, whilst still providing an outstanding piece of architecture.

An essential part of the client's brief was for the proposal to have minimal environmental impact and to show that this can be done within a relatively small budget. Passivhaus allows the design to be assessed from the very beginning of the project and the performance gap between how the building is predicted to behave at design stage and how the completed building actually behaves is very small. This differs greatly from other energy standards. This, together with keeping the size of the dwelling no greater than normal' farmhouse will ensure affordability.

Passivhaus construction is becoming more common, but it is still unusual and still deemed to be innovative. This really shouldn't be the case and if the UK is to meet its climate targets it should become the standard way buildings are designed and constructed. The latest version of the NPPF removes the word innovative' from paragraph 80 although it is not difficult to argue that outstanding architecture should still be innovative.

The proposed form of construction has been chosen in part because it is not only highly environmentally sustainable, but also socially sustainable. The system has been designed to ensure that it is 'UK tradesperson friendly'. This ensures that the incredibly high standards required for passivhaus can be achieved by local builders, not specialists. This will ensure that the quality of rural design and construction will be improved more generally by passing on experience.

The scheme is fairly isolated with only filtered views of the site from the footpath to the east so its impact on the public and passes by will be limited. However, it is inevitable that these glimpsed views will pique some peoples interest resulting in them looking further into the project. It is intended that a case study of the completed scheme will be registered with the Passive house trust allowing members of the public, construction professionals and planning officers the ability to learn more about the project via passivhousetrust.org.uk.

Details of the scheme, form of construction and progress on site will also be published on the PKA Architects website. This will include tracking the construction progress providing a detailed record of how high quality, energy efficient dwellings can be constructed in an environmentally conscience and efficient way. In this respect it would provide a template for affordable rural housing, particularly accessable to self builders.









ENHANCEMENTS

ENHANCING IMMEDIATE SETTING AND SENSITIVE TO DEFINING CHARACTERSITICS OF LOCAL AREA

The immediate setting of the house is the woodland glade, so it was of vital importance to the client for the proposal to be sensitive to the landscape. Therefore, the design of the house has been completed alongside a carefully considered and subtle landscape plan and aims to improve the biodiversity on site.

BIODIVERSITY ENHANCEMENTS

As can be seen within the accompanying ecology report the dwelling has been specifically designed to have low impact on the existing wildlife on the site. Of course, a new dwelling will always have some impact but in this instance the design has been influenced by the desire to protect wildlife from the outset. The site is flanked north and south with woodland and a 10m buffer to the woodland to both North and South has been incorporated to ensure that the proposal has minimal impact on the woods and its natural occupants by virtue of both effect on tree roots and light spill affecting wildlife. Careful consideration has been given to the fenestration and external lighting to ensure negligible effect on nocturnal animals from light spill at night. Even with all the lights on and with all curtains open in complete darkness the proposal will only cast a light spill of 0.5lux on the neighbouring woodland. This equates to approximately the light from a full moon. This level of caution has shown the client and design teams desire to design a dwelling that has the absolute minimum impact and is *sensitive to the defining characteristics of the local area*'.

LANDSCAPE ENHANCEMENTS

The residential garden curtilage is deliberately to be kept very tight to the dwelling with minimal manicured domestic formal areas and these will be screened by the well-established horseshoe of trees to the North East of the house. The remainder of the immediate landscape will be herb-rich meadow helping to improve biodiversity and to help merge the building into the wider landscape. Biodiversity will be further improved by reinforcing the tree planting and the inclusion of a mixed native hedge providing subtle enclosure to the site.





CONCLUSION

We believe this proposal fully satisfies the criteria for a Paragraph 80 house, raising the standards of design in rural areas, both in terms of the quality of architecture and in relation to the ecological enhancements and the significant improvements proposed by the landscaping design and careful treatment of the site. The scheme takes a poor piece of neglected land and intends to create a truly outstanding, unique, affordable, site specific and very low energy dwelling in a sensitively conceived landscape setting, the two working in harmony within the woodland context.

The scheme includes carefully considered environmental benefits not only in the way the house has been designed but also in the subtle landscaping proposals improving biodiversity and nestling the house into its woodland glade setting. The addition of tree reinforcement along the southwestern boundary gives a greater sense of the woodland glade and filters views into the site from the public footpath. The scheme also includes significant off-site tree planting to the general benefit of the local environment.

The carefully designed, low energy, visually discrete new dwelling will contribute to the quality of the rural area and raises the quality of rural design generally by demonstrating that quality, environmentally conscience design is possible without spending the millions generally spent on Paragraph 80 houses.