Domestic Passivhaus

First to be certified in the UK

The aim of this project by AECB member company, JPW construction was to achieve an autonomous carbon neutral home without comfort loss for the homeowner. The project followed a two step philosophy: (1) reduce energy load and water consumption and (2) to implement on-site renewable energy generation and a carbon neutral auxiliary heat source. John Williamson reports...

The house, called 'Y foel', is a residential 2/3 bedroom private house. As with Canolfan Hyddgen (see seperate article), a hybrid construction was used - an external I-beam timber frame with an internal core of earth block walls (ground floor only), in combination with Welsh slate floor slabs on 60% GGBS (ground granulated blastfurnace slag) in-situ slab. This has produced very stable indoor temperatures.

The project was commissioned to achieve Passivhaus certification. Code for Sustainable Homes (CSH) compliance was not paramount in the brief. We, however, continue to develop CSH and BREEAM compliant supply chains and designs for housing associations and local authorities that enable delivery of Passivhaus certification in the UK and which take into account the unique issues of UK climate and construction practices.

Due to restricted site access, the wall panels were fabricated on the in-situ slab on site and pivoted into position. Pre manufactured I-beam roof trusses were then lifted individually. Although manufacture of the elements on site was time consuming, the erection and sarking process took 2 days. Reducing the number of individual panels also reduced thermal bridging at panel joins. Detailing at junctions of floor joist I-beams can prove labour intensive, but larger, clear spans enabled the potential for flexible internal layouts and future modifications.

Negative psi values, modelled in Therm, assisted in achieving the 15kWh/m^2/pa target. Every junction was treated with this level of attention, as were significant service ducts. Due to the spring water supply, and potential shortages in summer, a dry composting toilet was specified from the beginning. The twin vault system was placed outside of the thermal/air tight envelope to ensure air tightness. Ecological Building Systems, partnered with JPW, to trial taping and membrane systems. Incorporating the membrane within a pre-manufactured off site frame in the future would be favoured to reduce labour costs but its flexibility on site for unforeseen circumstances proved invaluable. The final result was n50 = 0.247 -1 @ 50Pa (Passivhaus Institute requirement is 0.6) Q50 = 0.250m^3/(h.m^2) @ 50Pa (UK measurement).

Breathable paints, in conjunction with hydraulic lime renders, and the MVHR (mechanical ventilation

All images show various views of Y-foel.

Photos courtesy of the author

heat recovery) system have so far demonstrated very comfortable humidity levels. Comparing post occupancy evaluation (POE) with measured data for both Y foel & Hyddgen (see previous article) may well demonstrate how best to achieve comfort parameters with minimal energy use at different points of a 24 hour cycle, depending on usage. Although active systems can respond quickly, flexibility in the fabric to stabilise humidity and temperature levels is predicted, to minimise space heating and cooling loads.

A Drexel & Weiss compact unit was initially considered but due to UK regulatory requirements, the units were not yet available for supply & commissioning. We will be incorporating these in future projects, along with a monitoring program to establish viability regards initial higher capital cost versus quicker installation and lower running costs. Sourcing a low cost auxiliary heat device with low CO_2 emissions and a small footprint, which also supplies the domestic hot water is still a challenge. On this project we used a Drexel & Weiss Aerosilent classic with an RGB - H controller and solenoid activation of 1kW electric towel radiator was specified to create a simple low maintenance system which could be eventually powered by renewable electricity generation in phase 2. This may be on site renewables which have received planning permission or investment in a local community scheme. Silencers on the air handling unit (AHU) eliminated fan noise and additional silencers to prevent crosstalk have proved very successful, in combination with supply, and extract ports designed to eliminate air hiss and enable ease of balancing. The system is not audible (below 25db), which is crucial in a very quiet Passivhaus environment.

A Netec GSHX pre-heat frost protection and pre-heat system was specified in conjunction with the Aerosilent. It is hoped that pre-heating the incoming fresh air, when needed, will achieve optimum efficiency in the cross flow heat exchanger, rather than a simple electric element focused on frost protection only. This should also prove to be more economical and assist the AHU in achieving better heat recovery. The small amount of cooling (approximately 1kW) available from the unit in combination with summer bypass and high fabric 'decrement delay' factors (approximately 12 hours, from use of fibreboard and cellulose) has shown an ability to reduce temperatures significantly.

The potential to close the windows and run such a system on hot nights in noisy external environs with minimal energy use, could prove popular and promote the comfort potential of Passivhaus technology in summer as well as winter. The natural ventilation strategy simulated in PHPP, in combination with a central mass core, has so far been sufficient to maintain comfort levels. SAP was unable to simulate this concept and tended towards an overheating situation, which has not materialised. Due to proposed nature of occupancy – home, office and part time catering business, we have predicted that the auxiliary heat requirement will be minimal and that the direct electrical heating top up from the towel radiator will be rarely used.

Who buys PassivHaus homes?

Does a PassivHaus work for everyone on a personal and energy reduction level and will regulation that may force us to live in them affect the way we perceive the pros and cons?

A survey of a 150 house development in Germany, where planning permission was only granted if a PassivHaus was specified, attempted to address these questions.

Who bought them and why?

51% bought from personal environmental convictions.

16% were encouraged to buy them by their architect.

12% bought them due to location of development.

Following a year of homebuyer monitoring, it transpired that the space heating demand was very similar for all types of occupants. The house design limited energy consumption and resulting CO_2. However: 51% who bought due to personal environmental convictions had a much lower primary energy - a higher level of energy awareness. The project was still considered a success when 88% of occupants stated they would buy a PassivHaus again.

Dedicated low flow domestic hot water devices and appliances are currently personal choices. In the crusade to reduce primary energy, technology and design may not succeed alone without changes in personal decisions and habits. Energy reduction without loss of comfort will no doubt become a much wider debate and challenge.

If an individual PassivHaus can reduce the energy load considerably how can we make the best of the concept when applied to communities and larger developments?

Carbon neutrality was built into a development called Kronsberg' in Hannover. Individuals bought $1200 euro shares in a local wind farm which was tagged onto the purchase cost. It caused no impediment in the take up of the houses. The greater efficiencies from larger renewables, reduced maintenance issues for home owners and any spikes or excessive individual CO_2 production from primary energy across the development was absorbed or offset via renewable generation. Would this approach create more satisfied occupants who can afford to live close to carbon neutrality without even knowing it?

A cold larder was requested by the clients and is semi submerged on the north elevation, It is also outside the thermal envelope. Stepping down into the larder from inside the building meant the inclusion of a thermally and air tight door, which added cost but has proved successful. The larder has hovered between 10 and 13^{0}C. Ventilation through the larder is currently natural and controlled manually to avoid internal condensation and maintain temperature ranges.

Both this project and the one described in the previous article, appear to be exceeding expectations so far in terms of energy use and comfort levels. The monitoring programme will hopefully reveal where we have over-engineered and where we could simplify and reduce cost further. Success appears to be in the pedigree of

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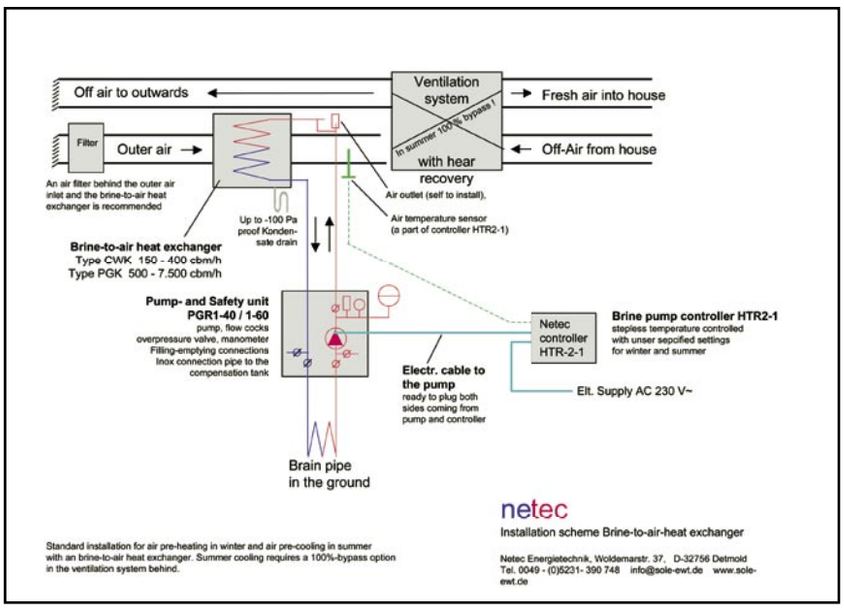

the prediction tools and products used and the on-site execution of details and commissioning of systems. Taking these assumptions forward into upcoming renovation projects will be the next challenge.

If we have learnt anything from the projects, it's been the value of design and building with a view to focusing on the actual, not theoretical energy saving, which united all involved. JPW would like to thank its clients for allowing them to put this Passivhaus mantra into practice.

John Williamson

Design team

Client - private client

Architect - JPW

Contractor -JPW

M&E design, Installation and commissioning – JPW & Drexel & Weiss

Architectural particulars

1 1/2 storeys traditional Welsh cottage and a replacement dwelling. Old meets new strategy with planning authority. Smaller sash windows combined with larger areas of fixed glazing to maximise solar gain and natural daylighting.

Building fabric - insulation, glazing/windows, thermal bridging and solar design

Nordan N-tech windows

Pro Clima air tightness and breathable membrane system

Wall - timber Steico I-beams with blown cellulose insulation installed by Pen-y-Coed

Unger Diffutherm fibre board system (rendered and weather boarded with locally sourced larch cladding)

Roof – timber I-beam with blown cellulose insulation and fibre board sarking and reclaimed Welsh slates

Floor – In situ concrete GGBS slab on EPS

Ibstock earth blocks, HL 3.5 render and Earthborn paints

Appliances and lighting

100% low energy lighting

Ventilation and heating - Drexel & Weiss Aerosilent classic

RGB - H Controller with solenoid activation of 1kW electric towel radiator if needed

Pre-heat and active cooling. Netec GSHX frost protection and pre heat system (controller HTR 2-1, pump PGR1-40, F7 filter water/air HX CWK 250F, 100m collector 25mm Dia PE80 SDR 11)

Services

Planning permission for 2kW PV tracker array and a 5kW wind turbine are in place and could be implemented as a 2nd stage after 1 year of monitoring to establish energy profile if the client wishes

Hot water - Grant solar hot water system 4m^2 panel, Heatrae 200lt tank & pump station and electric immersion

Auxilary Energy - electricity

Air permeability - n50 = 0.247 -1 @ 50Pa (Passivhaus Institute requirement is 0.6)

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