First Passivhaus offices to be certified in the UK

Low energy should equal low carbon, yes, but enhanced comfort levels are what John Williamson of AECB member company, JPW, believes will be a very important factor that helps to encourage the adoption of the Passivhaus standard in the UK. Certainly, lower running costs will encourage a wider interest, particularly among the public and commercial sector. This is borne out in the project featured here ...

Canolfan Hyddgen is a Welsh Assembly/Powys County Council funded scheme. All parties were well aware that gas prices were due to rise by 40% in the winter of 2007 and this played a big part in the design decisions for the build. It is a building used for multiple tenants and occupancy; a school, night classes, adult learners, meeting rooms and a drop in centre and council sevice point.

Via property rationalisation they wished to reduce energy consumption, fuel bills and overheads. They also wanted to maximise revenue through design and a management strategy for a new multiple tenancy and community use building. All parties wished to address their carbon management programme and explore reducing its CO_2 footprint via the Passivhaus concept. A potential reduction in space heating of 85% caught the clients' attention and sold the project. Powys County Council (PCC) has targets for CO_2 reduction of 30% by 2012 and 50% by 2017 with potential cumulative carbon saving of 39,000t and a financial saving of £7.8m over the next 5 years.

The client brief was thus to achieve at least BREEAM Excellent and Passivhaus certification simultaneously. Combining elements which satisfied the wider sustainable scope of BREEAM, but did not impinge on the energy saving potential of Passivhaus was challenging within the time scale but achieved through a dedicated and integrated design team working under an NEC3 contract. Canolfan Hyddgen subsequently achieved - 84.4% Excellent (highest to date in Wales) - and won the Welsh BREEAM 2009 awards for offices.

As director ofJPW, based in mid Wales, we focus on low energy buildings and now Passivhaus. Our philosophy is "always to reduce energy consumption and associated CO_2 emissions first, and then apply appropriate renewable technology to achieve carbon neutrality, if viable". We consult on and build low energy and carbon neutral buildings. Our most recent focus has been the design/build and renovation using Passivhaus methods in the UK. We decided to concentrate on Passivhaus design because we were impressed by the cohesive approach of the system and how years of monitoring had been incorporated to develop the Passivhaus Planning Package (PHPP) tool for calculating performance. It has only been available in English since 2004 and JPW adopted it as a central design and prediction tool in 2005. We welcomed the upgrade in 2007, which allowed for more detailed calculation of non domestic buildings. Although the use of TAS (thermal analysis simulation software) level 5 dynamic simulation for such projects has shown interesting correlations with PHPP 2007, the current EPC (energy performance certificates) outputs and domestic SAP (standard assessment procedure) predictions have shown cause for concern.

Canolfan Hyddgen began in August 2007. The residential 2/3 bedroom new build private Passivhaus project – Y Foel, (see following article) was started prior to this and provided the supply chains and knowledge ready to deliver the ambitious build time required for Canolfan Hyddgen's funding schedule.

Design, build and monitoring

JPW has sourced its Passivhaus components from within the UK wherever possible, although some specialist goods are from abroad if not available locally. A major issue appears to be that councils are locked into framework agreements involving the more conventional technologies because their maintenance teams and procurement officers are reluctant or unable to change suppliers quickly. In a rapidly changing world of environmental legislative requirements this area therefore needs to be addressed. PCC recognised this and worked hard with JPW to enable the use of innovative technology products and specialist subcontractors.

Certainly, working the Passivhaus concept into and alongside established UK schemes such as CSH, BREEAM and AECB standards, as well as the UK Building Regulations, has proved time consuming but will hopefully bear fruit and demonstrate that better buildings have resulted. However, a simpler approach, avoiding duplication of calculations would allow more time for good design and on site supervision to ensure air permeability targets. JPW used the opportunity to combine BREEAM with Passivhaus principles, (the first time this has been done in the UK on a non domestic new build office project).

Creating 2 sets of data, (simulated and reference), for input into PHPP2007 and TAS proved time consuming but informative and did influence the design, particularly in relation to the calculation of summer overheating. Although Mid Wales experiences quite a mild climate, solar gain values tend to be lower than other parts of the UK. This meant high insulation values and large solar glazing areas had to be maintained. This enhanced

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natural daylighting levels but also had the potential for summer overheating. In the end it was internal gains from framework and IT equipment which was highlighted as the real overheating issue. To compensate, the lighting design was pushed below 10W/m^2 with extensive daylight balancing controls.

We adopted a hybrid approach of a central masonry core with an external solid timber frame and I-beam cassette roof. We incorporated the Proclima air tightness/ breathable membrane system into the timber frame which, together with on-site management practices, ensured a pleasing and compliant permeability result: n50 = 0.249 -1 @ 50Pa (Passivhaus Institute requirement is 0.6) Q50 = 0.37m^3/(h.m^2) @ 50Pa (UK measurement).

One of the greatest challenges was coming up with unique thermal bridge free junction details, which the timber frame supplier could guarantee and the Passivhaus Institute would accept. The 'buildability' of such details was important to convince and develop a dialogue with the supplier and erection team. The importance and responsibility of achieving these junctions, whilst ensuring airtightness continuity, was passed onto the site team and then on again to the M&E contractors to ensure a holistic result.

Ecotect software was used to simulate and calculate natural daylighting requirements, diffuse daylighting was balanced with glare reduction measures to ensure monitors and interactive white boards in the computer suites were still effective and eyestrain was not increased due to reflections and direct sunlight on learning mediums. By using an access corridor and break out space between the south facing glazing and IT suites and offices the design allowed for low angle winter solar gain to enter and be retained within the thermal envelope, without blinding IT users and students. The use of such individual internal blinds satisfied the BREAAM requirement, along with a view to the outside from within 7 metres of any desk. The extra attention given to this aspect of the project has resulted in positive feed back from regular staff and tutors who have experienced less eye strain and head aches and enjoyed more control over lighting levels in their workspaces.

The internal mass played a significant role and was highlighted when simulated in TAS. In conjunction with night-time (secure) cooling through the ventilation system (summer bypass in-place) compliant summer time temperatures were achieved. This system was favoured by the client above additional active cooling which was used in Y foel. In-use monitoring should highlight the benefits and limitations of the different approaches.

Various views of Canolfan Hyddgen showing the heavyweight floor construction, the mechanical heating and ventilating equipment, the office spaces and the reception area.

All photos by the author.

A decentralised ventilation system incorporating 5 Drexel & Weiss Aerobusiness Units with timer and PIR controls was favoured due to the multiple and varied occupancy. Rooms not occupied run at level 1 ventilation levels with no artificial lighting. Level 2 provides adequate fresh air and a level 3 automated and manual boost control allows for occupant control. A simplified BEMs (building energy management) system control board, linked to county hall, allows local key holders and caretakers to manage the building, under instruction, thus avoiding expensive and CO_2 intensive travelling by maintenance teams across Wales' largest county. Timers for IT sockets and external lighting and instantaneous 15 litres DHW water heaters, at point of use in combination with very low flow taps, have dramatically reduced primary energy and standby losses. Aux space heating is supplied by a 10kW low Nox gas boiler, the heat being distributed by radiators with TRV and more accurate thermostats and zone control. A robust delivery system was preferred by the client and has shown very good efficiency, heating the whole building very easily through Wales' coldest winter for 30 years.

The project is being monitored using a remote access monitoring system with guidance from the Passivhaus Institute (PHI) to extract useful data to analyse the performance of certified Passivhaus projects in the UK Climate. We hope a study of simulated, actual weather data, SAP, EPC outputs and PHPP will assist in the design of future projects and inform the current debate. It will also assist the client to assess their billing and management strategy. JPW would welcome an AECB lead in creating a standard monitoring formula to aid this process.

Economies of scale and the supply chain

Extra build costs to achieve the Passivhaus standards in the Netherlands were be about 8-12% higher, due to few projects. Similar costs are likely to be experienced initially in the UK. We have experienced high import and 'unfamiliarity' costs (contractors unfamiliar and inexperienced with the level of detailing and technologies required either double their normal tender price or just did not tender at all). German and Austrian experience has shown that the initial 10% increase in costs soon reduced to between 0 - 4%, as the supply chain of components/ materials improved and the network of contractors and architects increased their confidence in the concept.

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Further research into the analysis of costs, BREEAM score and associated CO_2 reduction is ongoing and will be enhanced by the current 12 month monitoring programme.

John Williamson

Design Team

Client - PCC

Architect - JPW

Project Management - Powys County Council (PCC) and JPW

Contractor - C. Sneade Ltd

M&E design - JPW, Drexel & Weiss, Flare Wales Consultants

M&E contractors - Flare Wales, EOM

BREEAM Assessor - GBSPM

Architectural particulars

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

South pitched roof U-value - 0.12W/m^{2}K

Wall U-value - 0.16W/m^{2}K

North pitch roof U-value - 0.11W/m^{2}K

Internorm windows and doors

Alwitra living roof

Warmcel insulation - installeed by Pen-y-Coed

Proclima air tightness system

Appliances and lightings

5 Drexel & Weiss Aerobusiness Units

Decentralised ventilation system. Timer and PIR controlled.

Secure night time cooling strategy

BEMs system

Timers for IT sockets, DHW heaters and external lighting

T5 lighting and daylight balancing throughout

Domestic hot water

Localised 15-30 litre instantaneous electric water heaters at point of use

Low flow spray taps, toilets and waterless urinals - GBS

Renewables

1st phase integrated in roof 7kW PV array - Dulas

2nd phase proposed 20kW near site wind turbine to provide carbon neutrality - Dulas (awaiting outcome of carbon neutral consultation)

Aux space heating energy

Ultra low Nox 10kW gas boiler

Electricity

Low energy computers and monitors

Build process

MMC external timber frame with GGBS (ground granulated blastfurnace slag) and reclaimed and recyceled masonry internal core

Air permeability

n50 = 0.249 -1 @ 50Pa (Passivhaus Institute requirement is 0.6)

Q50 = 0.37m^3/(h.m^2) @ 50Pa (UK measurement)

Spec and costs

Canolfan Hyddgen - 410m^2

Basic building - £1537/m^2

including PV's and green roof - £1721/m^2

including PV's, green roof and canopy - £1784/m^2

Interestingly the BRE & Faithful & Gould report, dated Sept 2008, stated the benchmark for secondary schools of 3116m^2, to meet Part L2 Building Regs cost £1711m^2 and the addition to meet BREEAM Excellent £1789 to £1858m^2

Passivhaus facts and figures

PassvHaus construction methods can be masonry or timber frame. In Germany there is roughly a mix of 70% masonry, 15% concrete and 15% timber. In Austria it tends to be around 80% timber frame and 20% concrete and masonry. Successful Passivhaus designs have been adapted to traditional regional construction practices, vernacular styles and localised specific climate requirements. However, energy services, such as cooling or dehumidification, could be of greater importance than heating in some regions.

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