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Centre for the Built Environment

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Introduction to Passivhaus

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Briefing Paper 04

adapt part of the Adapt Low Carbon Group

Introduction

This briefing paper is written as an introduction to the Passivhaus standard as part of the dissemination for the Norwich Research Park (NRP) Enterprise Centre, which is aiming for Passivhaus standard certification.

What is Passivhaus

Thermal comfort and energy efficiency are the two main aims of Passivhaus. A Passivhaus may be defined as a building in which a comfortable internal temperature is achieved solely by heating or cooling the fresh air that is introduced in order to meet the occupants' ventilation requirements.

Passivhaus standard can be used for both domestic and non-domestic buildings.

The benefit of designing a particular building to the Passivhaus standard includes high indoor air quality, highly energy efficient and hence lowering fuel bills, smaller (and potentially cheaper) heating system and potential scope for renewable energy systems.

The history of Passivhaus

The current Passivhaus concept was developed in year 1988 by Professor Bo Adamson and Dr Wolfgang Feist, about the same time as when the increase of low energy buildings started and where there is a legal requirement to have energy standard for new building in Denmark and Sweden.
Elements necessary for reducing building energy consumption includes thick insulation, minimum thermal bridging, excellent air tightness, insulated glazing and the use mechanical ventilation and heat recovery system (MVHR). Passivhaus concept is not new, in fact it was developed based on this energy efficiency principal.

Passivhaus principles

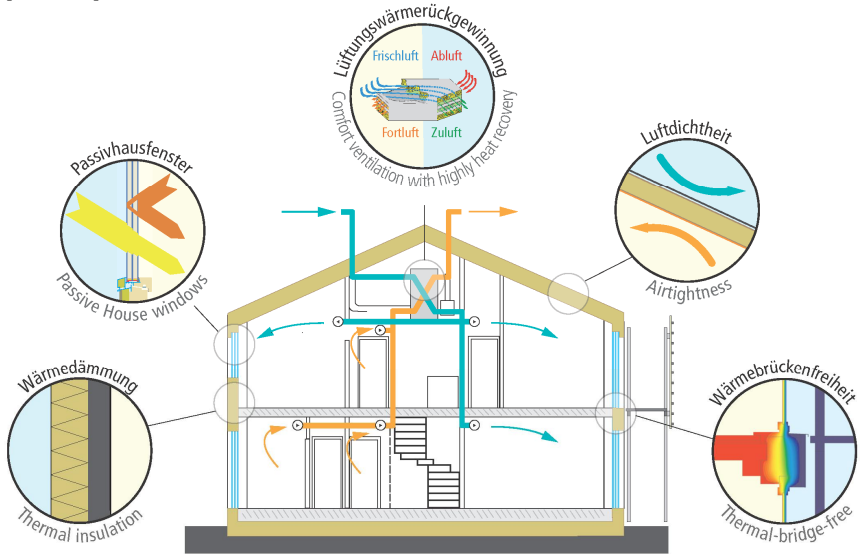

Figure 1 Passivhaus schematic diagram courtesy of the Passivhaus Institute (http://www.passiv.de/_images/02/02_grundprinzipien.png)

The reduction of the heating demand to the point where a traditional heating system is no longer required means that the typical features of Passivhaus buildings are:

- Super-insulated (with all external building elements achieving **U-Value**[1] of 0.15 W/m^{2}K or better)
- Minimized thermal bridging to less than 0.01W/mK (ideally eliminate any thermal bridging)
- Extremely airtight building envelope (any uncontrolled leakage through gaps must be smaller than 0.6 of the total house volume per hour during a test with a negative pressure/excess pressure of 50 Pascal[2]).
- Mechanical ventilation with heat recovery (MVHR)
- Triple-glazed windows, largely south oriented (with the glazing together with the window frame not exceeding a U-value of 0.8 W/m^{2}K and **g-values**[3] of around 50%)
- High thermal comfort

[1] U value (W/m^{2}K) is a measurement of the rate of heat loss through a material. This means that the lower the U Value figure is, the less heat will escape.

[2] Please note that the units use in Passivhaus (ACH) differ to that use in the UK Building Regulations which is in m^3/m^{2}h and hence the figure must not be compared directly like for like.

[3] g-value is a measurement of total solar transmittance, proportion of the solar energy available for the room

Examples of Passivhaus projects in the UK
Wimbish, Norfolk

Figure 2 Wimbish Development in Norfolk (left). Picture taken by Mark Baigent.

Wimbish development consists of 14 affordable housing units for Hastoe Housing Association. It was designed by Parsons + Whittley Architects to achieve both Passivhaus certification and Code for Sustainable Homes Level 4. The design team also include Inbuilt (Passivhaus design consultant), Robinsons Associates (M&E Engineers), Bramall Construction Ltd (Keepmoat) as the Contractor, Richard Jackson PLC (Structural Engineer) and Davis Langdon (Employers Agent).

Procurement was one of the main challenges in this project. To combine client's preference for Design and Build contracts to reduce risk, yet ensure a reasonable level of post contract control, Parsons+Whittley designed a scheme to Stage F before tender and were retained by the client to oversee the execution of works. Other challenges include the placing of insulation and air tightness on site as well as designing and installation of MVHR on site. All these aspects required a cultural shift for the UK construction industry and it is a tribute to the project team that all of the problems were collaboratively resolved which resulted in a successful end project.

Key lessons learnt include:

- To design a cost effective Passivhaus that is capable of construction without the need to source new materials or master new and challenging techniques.
- To develop a soft landings approach to occupation; within affordable housing the tenants are unlikely to be knowledgeable Passivhaus enthusiasts.
- To identify early tenancy nominations, allowing the design team to work with the occupants before, during and after occupation, this has proved an invaluable learning experience for the project team as well as the tenants.

Based on the Post Occupancy Evaluation (POE) funded by TSB, the 2/3 bed houses use approximately 2,500 kWh of gas per annum, which equates to a gas bill of around £150 per year (for both space heating and domestic hot water. They have also scored the highest ever residential BUS scores for satisfaction and comfort.

Ditchingham, Norfolk

Figure 3 (Top left) Ditchingham Development (picture courtesy of Abi Dennington-Price). (Top right) Passivhaus plaque and South Norfolk Council Design Award 2012 (picture courtesy of Jennifer Hardi)

Following the successful Wimbish development, Hastoe Housing Association has once again appointed Parsons+Whittley Architects and Bramall Construction as the contractor to developed their second Passivhaus development in Ditchingham, Norfolk. This scheme of 14 homes are set in Ditchingham Conservation Area adjacent to the Tayler and Green properties which were an innovative 'post-modern' practice producing post war rural housing in SW Norfolk and of which has been subsequently listed for special protection. This makes the scheme unique for Passivhaus as it demonstrates how the methodology can work within a rigid planning framework, within a conservation area and adjacent to important listed buildings. The lessons learnt from Wimbish development are being replicated in this development, the first step on the way of making the methodology a mainstream option for those wanting comfortable living environments with low fuel bills. The Ditchingham Scheme was completed in September 2012. It has also received South Norfolk Design Awards 2012. They have proved that overcoming the challenges associated with developing homes for local people, in sensitive rural areas, can go hand in hand with cutting edge techniques. Early monitoring indicates that the dwellings are performing exceptionally well. The first five months fuel bill for a 2 bed mid-terrace between August and December was less than £50 with an average temperature of 21.9 degrees internally.

Funding and business support for East of England SMEs

As a condition of the European Regional Development funding awarded for the Norwich Research Park (NRP) Enterprise Centre, the Centre for the Built Environment (a Centre that draws upon a cluster of expertise within and outside UEA and is responsible for delivery of ERDF outputs and, through Adapt Commercial, the provision of low carbon consultancy services) will provide free business support. This support will be delivered through a series of bespoke CPD accredited seminars, webinars and other support showcasing the design, build and post-occupancy of the building. As part of the ERDF funding, SMEs in the East of England are eligible for up to 12 hours support free of charge. Non SMEs will be charged £30 plus VAT per half day session. The seminars are CPD accredited and suitable for architects, contractors, planners, M & E consultants and other built environment professionals. The seminars will be delivered by a combination of professionals working on the Exemplar Low Carbon Building, other built environment specialists and CBE consultants and will have a maximum capacity of 15 people per session. Events include topics such as Passivhaus, BREEAM, Building Information Modelling (BIM), Ventilation and many more.

Below is the list of our February and March events. Otherwise, for our latest events, please visit our website: www.adaptcbe.co.uk/CBE/events.

February

Events	Date	Time	Location
Meet the founder of Passivhaus: Wolfgang Feist talk at the University of East Anglia	Tuesday 5th February 2013	17:00-19:30	Thomas Paine Building, University of East Anglia, Norwich
Ventilation in Passivhaus and low carbon buildings	Wednesday 6th February 2013	09:00-13.30	Bidwells, Bidwell House, Cambridge
Designing and delivering Passivhaus Low Carbon Buildings 1	Wednesday 13th February 2013	09:15-16:00	Bidwells, Saxon House, Chelmsford
Embodied carbon, Passivhaus and low carbon building 1	Wednseday 20th February 2013	11:00-15:00	Renewables House, BRE Innovation Park, Watford
Building Information Modelling (BIM) for Passivhaus and Low Carbon Buildings	Wednesday 27th February 2013	09:00-13.30	Bidwells, Bidwell House, Cambridge

March

Events	Date	Time	Location
Biodiversity and Green Roofs in Passivhaus and Low Carbon Buildings	Wednesday 13th March 2013	08:30-13.30	NRP Innovation Centre, Norwich
Embodied Carbon, Passivhaus and Low Carbon Buildings 1	Wednesday 20th March 2013	09:00-13:30	Cambridge, venue to be confirmed
Designing and delivering Passivhaus and Low Carbon Buildings 2	Wednesday 20th March 2013	09:15-16:00	Bidwells, Saxon House, Chelmsford
The use of timber in the construction of Passivhaus and Low Carbon Buildings	Wednesday 27th March 2013	08:30-13:30	Cambridge, venue to be confirmed

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