

# 10<sup>th</sup> International Passive House Conference

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Prepared for the AECB by David Olivier

## ENERGY ADVISORY ASSOCIATES

1 Moores Cottages, Bircher, Leominster, Herefordshire, England, HR6 0AX

T 01568 780868

E [dolivier@energyadvisoryassociates.co.uk](mailto:dolivier@energyadvisoryassociates.co.uk) W [www.energyadvisoryassociates.co.uk](http://www.energyadvisoryassociates.co.uk)

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## Introduction

This conference was attended by about ten delegates from the UK, including three who had attended much earlier conferences in 2000 and 2001. This is only a summary of the main points but the Proceedings are full of further, invaluable information. All costs quoted here assume an exchange rate of 1.50 Eu to £1.

Meeting the Passive House (PH) Standard leads to buildings which consume about *one-eighth to one-tenth* of the energy of a normal German building; see [www.passiv.de](http://www.passiv.de). This involves great efficiency in the use of thermal and electrical energy.

Hanover is a city of 500,000 people. The city government has actively supported such activity since 1996. Some German states which are particularly active today include Lower Saxony, of which Hanover is the capital, North Rhine-Westphalia (NRW) and Rhineland-Palatinate. NRW has had 7 years of government support and there is now a grant of £4,400 for every new PH detached house. The rate for other dwelling types is £3,600 per semi-detached house, £3,200 per row house and £2,600 per flat.

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## A Movement for Change

Starting with the first four Passive Houses in Darmstadt in 1990-91, Germany and Austria now have around 6,000 buildings which meet the PH standard. This is a rough estimate only. Many are reportedly constructed without going through the formalities, possibly to reduce certification costs. We met an Austrian architect who works for a practice with six staff and they now only design PH buildings for their clients.

Germany and Austria have just over 10 school buildings which meet the PH standard and many more are under construction. The city of Frankfurt decided in mid-2005 that *all* new public buildings would now have to meet the standard.

The political support which has developed in Germany was obvious to visitors. A statement we heard at the plenary session put it as follows. By investing in energy-efficient buildings to the PH standard,

which consume less than one-tenth the fuel of conventional buildings, we are not only creating new values but we are creating employment in Germany rather than in the oil- and gas-producing countries.

## New Buildings

### *Introduction*

The first buildings to meet the PH standard were residences, then offices, then schools, then other types. Offices were covered at earlier conferences but not so much at this conference. Nevertheless one project was presented.

### *Domestic*

We visited Kronsberg, a district 8 km from the centre of Hanover which has been developed with 3,000 new dwellings since 1996. One development of dwellings - mostly row houses - was built from 1998 to 2000 and meets the PH standard. The rest of the area meets the earlier Low Energy Standard.

The houses to the PH standard were designed by Factor 10 Architects, Darmstadt and built by Rasch and Partners. The construction is a hybrid of prefabricated timber-frame and precast concrete. The air leakage of all of them was in the range 0.17-0.41 ac/h @ 50 Pa. The average space heating energy use since then has been 12.8 kWh/m<sup>2</sup>yr but the range is 3 to 32, showing the influence of different occupant habits. The construction costs of the houses, 6-8 years ago, were under £650/m<sup>2</sup>. Costs would be similar, were this part of the estate to be built today.

The entire Kronsberg estate is heated by a gas-fired CHP plant. In addition, all the Passive Houses have individual solar hot water systems. We were told that heat distribution losses were 10-20%, making CHP/DH viable at this heat load density although heat-only boilers would probably not be.

We visited a 2,070 m<sup>2</sup> old peoples' home in Hanover, designed for 40 residents and up to 40 staff, which was built in 2003-04. From necessity, it is very close to a busy high-speed railway line. In fact, a train passed while we were being given a guided tour of the building interior, with a rating of about 90 dB, but none of the party of about 40 heard it pass.

The acoustic insulation measures included resting the raft foundation on a special grade of expanded polystyrene developed by BASF, 200 mm thick. The same material, in thicknesses of 250 mm and 350 mm respectively, is used on the walls and on the flat grass-covered roof. The building form was also designed to reflect noise away.

The building structure is of high thermal capacity, for both acoustic *and* energy reasons. Given the proximity of the railway line, it would be unwelcome to have to open windows in the summer. However, in a building of sufficient thermal inertia, the ventilation system can keep the temperature cool in heatwaves as long as it is operated via the bypass and operated preferentially at night.

The ventilation ducts are partly run within the roof insulation. The only duct runs within the volume of the building are risers and exhaust ducts in the bathrooms and supply vents in the living rooms. The risers are mostly concealed within cupboards. The heat exchanger is located in a plant room on the roof which was too small; a larger exchanger would have been more efficient. The heat exchanger used is a model approved for use in hospitals and has zero cross-contamination.

The heating system is separated from the ventilation system, so that all rooms have a small radiator. This choice was made for psychological reasons. The residents would all have come from normal German dwellings, where radiators were both necessary and expected, so the designers aimed to provide them with the same appearance as far as possible.

The heating comes from a 60 kW gas condensing boiler in a separate and much smaller plant room on the ground floor. This boiler size is normally used to heat a large detached house. 20 kW of it is devoted to space heating and 40 kW to water heating.

Heat is also recovered from the lift and used for heating. There is a solar water heating system on the roof. The measured space heating energy is 12 kWh/m<sup>2</sup>yr, at a mean internal temperature of between 22 and 23°C.

In PH dwellings, the recommended rate of fresh air intake, via the mechanical ventilation and heat recovery (MVHR) system, has been steadily reduced. The advice is now to provide no more than 25 m<sup>3</sup> per hour and person (7 litres/sec.cap). Any more than this makes the indoor air too dry for optimum comfort over the period from November to March. In severely cold weather, the indoor relative humidity can dip below 30% (with an outside RH of 80-90%). User surveys have borne this out.

Odours are not a problem at this flow rate, even in health care buildings, provided that the MVHR system is properly-adjusted and -balanced. This advice was all implemented in the above building. The extra cost of building it to the PH standard was £20,000, that is some £10 per m<sup>2</sup> or 1% above the normal German cost allowance.

#### *Non-Domestic*

Germany's first PH school, totalling 13,350 m<sup>2</sup>, was constructed in Waldshut in Baden-Wurtemberg in 2003. Design began in 2000. There was some grant aid from the federal government.

It has worked quite well, although even the young adult occupants wanted the internal temperature maintained at 22°C, not the 20°C which is assumed in Germany. The measured space heating energy at this temperature was 180,000 kWh/yr. The calculated usage had been 110,000 kWh/yr at an internal temperature of 20°C, so this makes a huge difference in low-energy

buildings. The heat itself comes from a CHP system.

The CO<sub>2</sub> concentration has always been below 1500 ppm, and usually below 1000 ppm. The measured level of heat recovery on the ventilation air has been 75%, which seemed rather low.

The summer performance has been good. Using the ventilation system correctly; i.e, it is turned on selectively at night in heatwaves, using a bypass, the peak internal air temperature can be kept at about 21°C on hot days when it peaks at 35°C outside. After a long heatwave, though, the peak midday internal temperature may eventually reach 26°C, at which point the users would rather have open windows even if this causes the air temperature to rise further.

The entire building is of high thermal capacity. The floors and the roof are reinforced concrete slabs and the walls are of plastered calcium silicate blockwork, with the insulation situated outside the mass. Some of the floors have hollow cores, which are used as part of the MVHR system, but there was no mention of the Swedish Termodeck<sup>R</sup>. The high thermal capacity is regarded as essential in non-domestic construction which meets the PH standard, with the peak temperatures in lightweight buildings being several K higher.

The measured CO<sub>2</sub> concentrations have consistently been lower in PH schools with MVHR than they have in older schools with "natural ventilation", which some Germans call "window ventilation". The concentration rarely exceeds 1000 ppm, whereas in older schools it always rises above 1500 ppm and sometimes goes over 3000 ppm. This alone provides strong grounds for adopting the PH standard, since staff or student performance is badly affected at such high CO<sub>2</sub> concentrations.

We visited a large sports hall in Hanover which was recently built to the PH standard. The external walls are of cavity construction, with a brick outer leaf, but they have a 350 mm aerated block inner leaf. This was done in order to restrict the cavity width to 150 mm, which is the maximum width permitted in Germany. The cavity is fully filled with mineral

fibre.

Although the heating of this hall is combined with the ventilation, the validity of this approach was questioned by several delegates, who felt that in a building with such high ceilings the warm air would tend to rise to the roof rather than warm the whole space. In reality, the problem is minimal. The monitoring of two previous PH sports halls in Munich and Heidelberg has confirmed that the approach of combining heat and ventilation remains valid and that “conventional wisdom” no longer applies to highly-insulated, airtight buildings

Details of a PH owner-occupied office in Rhineland, with a floor area of 11,250 m<sup>2</sup>, were presented by the developer. He said that the PH standard is still something of a political football since many peoples’ business is still selling coal, gas or oil (there are not many selling nuclear, since the German political consensus is already in favour of a phaseout, but this is not yet true of fossil fuels).

The project’s air leakage was 0.12 ac/h at 50 Pascals! The construction cost was £630 per m<sup>2</sup>, this being treated floor area which excludes circulation space and communal areas. The energy bills for the whole block are £23,000/yr or £2.10/m<sup>2</sup> at present German energy prices. These are around 2.5 p/kWh for gas and 12 p/kWh for electricity.

## Existing Buildings

Germany has moved rapidly to retrofitting old buildings to the PH standard - or nearly that level. We visited many such projects. Typically, they are inner-city homes facing directly onto the pavement, with solid 440 mm brick walls, built around 1900. The current verdict is that if these structures are externally-insulated, one can expect to reach the Passiv Haus Standard, or a Factor 10 improvement. If they have protected facades (a rough equivalent of a UK Grade II listing) and can only be internally-insulated, the practical limit is usually to bring them up to

Germany’s earlier Low Energy Standard - roughly a Factor 4 improvement. The marginal cost, over and above normal renovation, was given as £60-100 per m<sup>2</sup> floor area for a full Passive House renovation.

One of the earliest such projects was a block of 108 flats in Ludwigshafen, Rhineland. This block was externally-insulated with 250 mm of Neopor<sup>R</sup> expanded polystyrene on the solid walls (as developed by BASF) and the whole block was brought up to the PH standard. The air leakage of the block was brought down from about 5 - normal for Germany for *old* buildings, although considered good in the UK for *new* buildings - to 0.45 ac/h @ 50 Pa. The heating system of the refurbished block is a gas-fired CHP system, reducing primary energy by about 30% compared to separate generation of heat and electricity.

This renovation project was viewed as an alternative to demolition and total replacement of the original flats, and the cost was £750 per m<sup>2</sup>. This makes it as expensive as new domestic sector construction, which in Germany costs about £700 per m<sup>2</sup> including VAT (i.e. about the same as when we last visited a PH conference in 2001).

Non-domestic buildings are also being brought up to the PH standard. Schools were discussed, including one built in Frankfurt in 1959 whose oil consumption was reduced from 45,000 to 9,000 litres/year (480,000 to 95,000 kWh/yr).

## Other Countries

Apart from Germany and Austria themselves, the largest numbers of PH buildings so far are in Switzerland, Belgium and Denmark, followed by the Netherlands, Sweden, the Czech Republic and Belarus. The Swiss federal government has set up a different standard -fairly similar to Passive House - called “MINERGIE P”. Smaller numbers of PH buildings are built or underway in Norway, Finland, the USA, Canada and other European countries. There were conference delegates from Korea and

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China, and there were 10 participants from France.

A paper by a Swiss delegate described a zero emissions block of flats which is being developed in Winterthur. It has already received support from institutional investors. The paper showed that the project is commercially viable at normal market rents (about £600/month for a roughly 100 m<sup>2</sup>, two-bedroom flat).

The situation in the Netherlands seems to have similarities to the UK. Most new dwellings are speculative or social housing - self-build is fairly rare (only 7% of new dwelling construction). The overcost to meet the PH standard is greater than it is in Germany, since fewer projects have been built. On a very small starter home selling for £100,000 (building, plus land, plus profit) the PH standard adds an extra £8,000 to £12,000.

In neighbouring Belgium (the Flanders region), where most houses *are* built by or for a particular owner, takeup of the PH standard has been considerably more rapid. This seems noteworthy.

A Danish delegate informed us that predictions of energy use made by their national approved software have been found to be somewhat inaccurate, versus the PHI's own PHPP. The Danish software under-predicts energy use. He presented a new foundation design for low-rise masonry housing, which gives improved energy performance at a somewhat lower cost. He suggested that under present policy - the permitted energy use of a new dwelling is to be reduced by 25% every five years for the indefinite future - all new Danish buildings will have to meet the PH standard by about 2020.

There are no certified PH buildings in the UK, although a house is under construction in south Wales and there are 5-10 at design or construction stage in England or Wales which meet the similar AECB Gold Standard. This standard, (originally developed from the PH standard) is virtually the same as PH on the thermal envelope aspects but is stricter than PH as regards electricity use. It also imposes a limit to CO2 emissions, not just to primary

energy use. All are self-build dwellings; i.e., the market sector which led the PH field in Germany and Austria.

There appear to be three PH certified projects built or underway in Ireland. The owner of one said that it had been tested and did not quite meet the Passiv Haus air leakage limit. So further action would be needed to rectify this. Note that, due to the windy climate of the UK and Ireland, air leakage losses are potentially as high as or higher than a Passive House in Germany, despite our slightly milder winter temperatures.

## Conclusions

Germany is reducing its CO2 emissions and, from what we heard at the conference, this trend is led by reductions in energy use by the buildings sector. The UK situation is different, since our CO2 emissions are *not falling*. Because the general level of UK understanding of energy efficiency in buildings remains so low, the UK would do well to take serious note of the policies which have been adopted - and have worked - in Germany.

*For more details on the AECB Gold Standard see:*

<http://www.aecb.net/energyinbuildings.php#background>.