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Smart and Healthy within the 2-degree Limit

Post Occupancy Analysis of nZEB implementation via the PH standard

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ABSTRACT: Building regulations are currently under development across Europe in advance of the implementation of the nearly Zero Energy Buildings (nZEB) standard at national member state level. However, when revising the national building regulations to improve energy efficiency, few examples exist of the monitored performance of such dwellings, making informed decision-making difficult. This paper reports on the monitored performance of nZEB compliant dwellings which were built to the Passive House (PH) Standard. It finds that the PH bedroom CO2 concentrations are significantly better than in houses built to the current building regulations which use natural ventilation.
KEYWORDS: IAQ, CO2, Passive House, nZEB, Cardon Dioxide

1. INTRODUCTION

In the Republic of Ireland, regulations are being prepared to define nearly Zero Energy Buildings (nZEB) (1,2,3) which will come into effect for all dwellings completed after 31st Dec 2020.

An ongoing project provides monitoring data gathered from both low-energy Passive House (PH) dwellings (seven of which are nZEB compliant) and from dwellings complying with the current building regulations from both Northern Ireland (NI) and the Republic of Ireland (RoI) (fig 1).

Figure 1: Location of Monitored Dwellings on the island of Ireland, Europe

Given the similarities in the nZEB and Passive House (PH) standards (4) and the cost effectiveness of the PH methodology in meeting the nZEB standard (5), it is likely that the PH standard is a viable route to meet the nZEB standard. Therefore this study affords an opportunity to compare the recorded performance of the potential future nZEB building stock with that which is currently being constructed, facilitating evidence-based policy-making.

Data is presented on the Indoor Air Quality (IAQ) by considering the proxy of carbon dioxide (CO2) concentrations for 19 dwellings (Ireland – 11 of which are Passive Houses, and 8 of which are built to the prevailing minimum building regulations) which are being monitored over a full year as part of the study of 27 dwellings on the island of (see Figure 1).

2. METHOD

Data was analysed for the living rooms, kitchens and master bedrooms for the period September 2016 to September 2017 in Irish homes and supplements an analysis which has previously been carried out in Northern Irish homes e.g. (6).

Metrics gathered at five-minute intervals for the dwellings by the "Netatmo" monitoring equipment include: occupancy profile; indoor air temperature; indoor relative humidity; indoor carbon dioxide concentrations; outdoor temperature; outdoor relative humidity; barometric pressure and energy consumption, similar to studies which have been carried out in the UK (7,8). An analysis of the CO_2 concentrations indicated higher concentrations in bedrooms. Therefore further analysis was carried out to assess CO_2 concentrations during occupied periods in bedrooms for one day for all monitored dwellings. This bedroom data is the focus of this short paper.

The PH dwellings all use Mechanical Heat Recovery and Ventilation (MVHR), while all the dwellings constructed to the minimum building regulations use natural ventilation (apart from OWBR3 which uses positive input ventilation). All but two PH bedrooms (OWPA3, OWPA 6) and 2 houses constructed to the minimum building regulations (OWBR 7, 9) had dual occupancy.

3. RESULTS

3.1 Indoor Air Quality

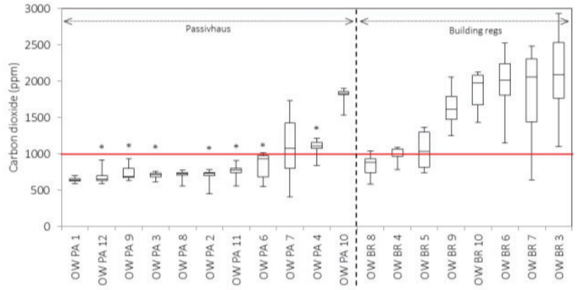

Figure 2 Midsummers day Bedroom night time CO_2 levels

Figure 2 above shows the minimum, first quartile, median, interquartile range, third quartile and maximum CO_2 levels in the bedrooms of 11 of the PH and eight of the houses constructed to the minimum building regulations over a seven-hour period from 00:00 to 7 AM, 21/06/17 (or if 2017 data was not available, 21/06/16). Both the values and range of the CO_2 concentrations are generally lower in the houses constructed to the PH Standard.

Figure 3 compares the bedroom CO_2 levels from 00:00 to 07:00 averaged over all dwellings in the PH group and the minimum Building Regulations group. For the passive houses, the average CO_2 concentration increases from 720 ppm at midnight to 930 ppm at 7 AM. The average CO_2 concentrations in the dwellings with natural ventilation increase from 1170 ppm at midnight to 1750 ppm at 5 AM, and remain above 1700 PPM for the remainder of the monitoring period.

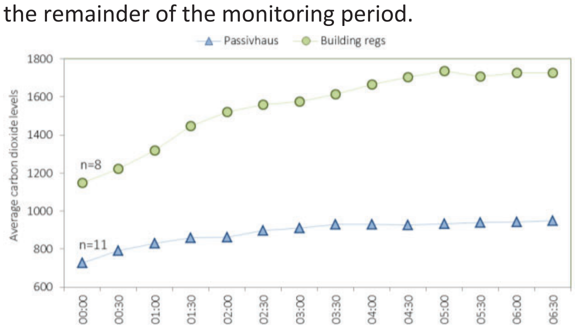

Figure 3 Midsummers day average night time bedroom CO_2

4. CONCLUSION

The results demonstrate that the average CO_2 concentrations in the bedrooms of the dwellings constructed to the PH standard were significantly lower than that of bedrooms constructed to the minimum building regulations. This may be explained by the presence of MVHR systems in PH homes, particularly in light of previous research indicating poor performance of natural ventilation strategies in contemporary housing (9). As demonstrated by closer analysis of individual case study homes (*e.g.* OWPA10), care must be taken to ensure ventilation systems are performing as designed in airtight homes to ensure adequate air change rates, and the provision of healthy indoor environments.

This study emphasises the need to consider indoor air and environmental quality, especially in bedrooms, where people spend a considerable portion of each day in an enclosed space. Moreover, air quality in bedrooms should receive particular attention when reviewing national building regulations.

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