How to minimise space heating to dwellings in Wales, UK through the use of exhaust air source heat pumps: results of a post-occupancy monitoring study in Bargoed, UK

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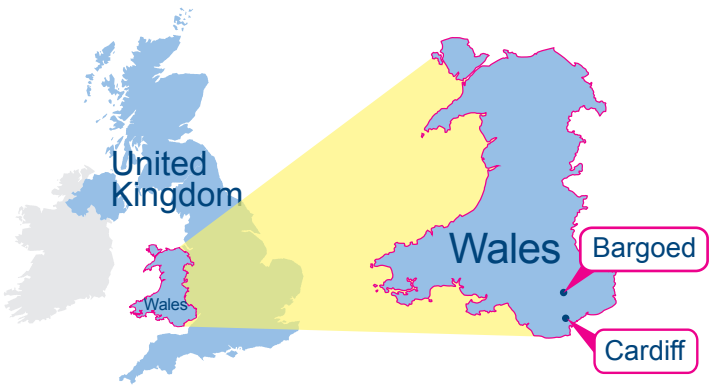
1. Introduction

This poster presents a summary of a live case study, in Bargoed, Wales, UK. The monitoring methodology and results are investigating the comfort conditions, energy use and carbon dioxide emissions when exhaust-air-source-heat-pumps (EASHP) providing space and water heating are used in dwellings in Bargoed. The study commenced in July 2010 and has been undertaken in collaboration with United Welsh and the Ecological Built Environment Research & Enterprise (EBERE) group from the Cardiff School of Art & Design at the University of Wales Institute Cardiff, UK. United Welsh is a not for profit housing association created in 1980. They develop and regenerate new and existing communities across South Wales and currently own over 4300 homes.



2. Background to case study

The case study for the physical monitoring is a family house (for two adults and up to three children) on a residential development known as 'Park Crescent' in Bargoed, Wales, UK (Fig 1 and Fig2); which was completed in early 2009. Park Crescent is on a latitude and longitude of 51.7 and 3.2 degrees respectively and at an altitude of 220 meters. The heating strategy for each dwelling was designed to trial the use of one EASHP per dwelling and with roof mounted solar hot water panels. Each EASHP works on two cycles: air-to-water for space heating, which involves extracting air from two internal rooms (kitchen and bathroom) and water-to-water for domestic hot water [1].

Figure 1: Park Crescent residential development site

Figure 2: As built elevation of case study

The aim of the research programme was to investigate the development of a monitoring protocol for United Welsh, which could be used to test the environmental performance, energy consumption and occupancy behavior and occupant attitudes at recently completed residential general needs dwellings. The key research questions are discussed in more detail in the paper id: 1653631.

3. Monitoring Methodology

The monitoring methodology adopted to investigate and test the research aim and questions included physical monitoring of the exterior climate (Fig 3), internal conditions (Fig 4) and energy consumption; and social monitoring which included interviews with a range of occupants at Park Crescent. Further details of the monitoring equipment used can be found in the paper id: 1653631.

Figure 3: Davis Vantage Pro 2 weather station

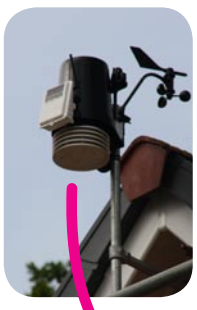
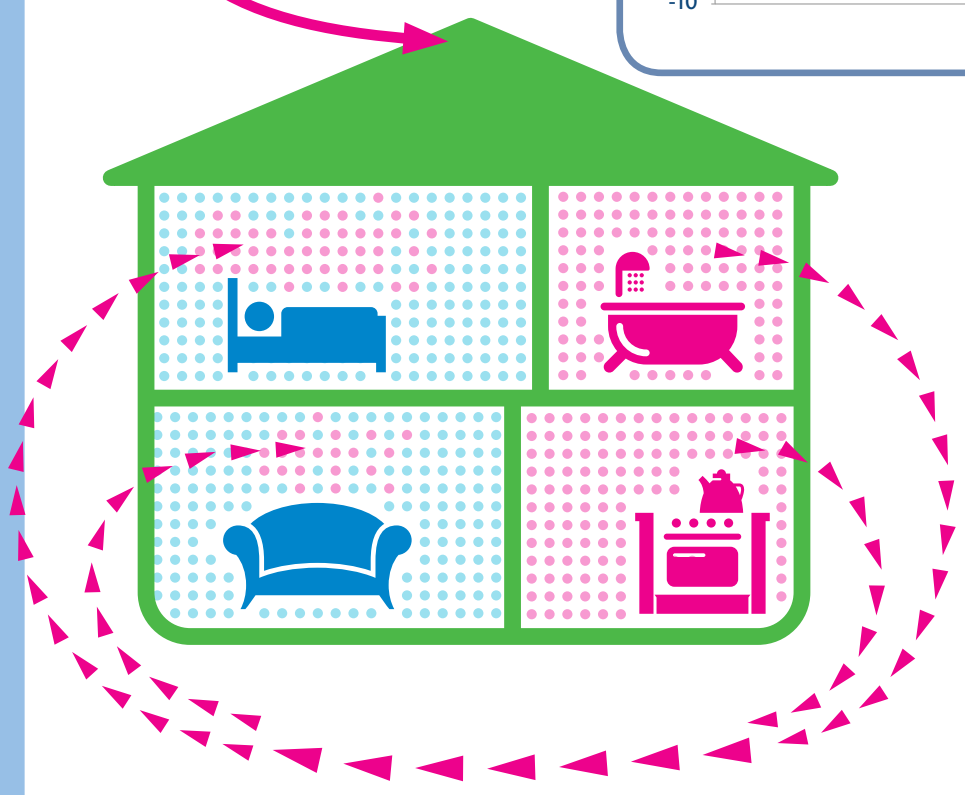
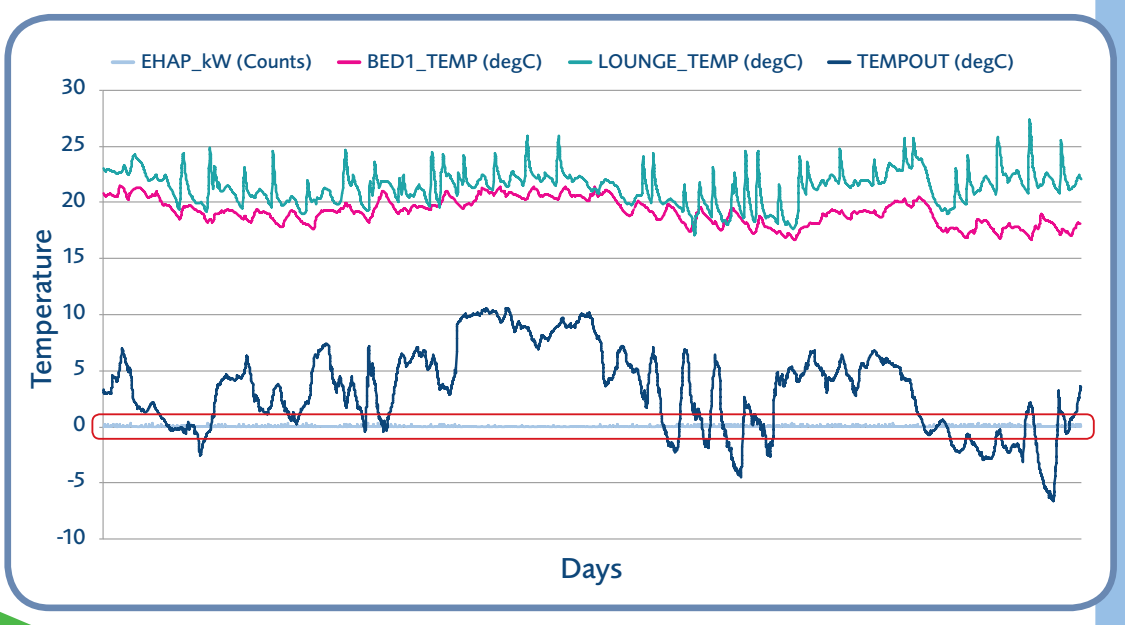


Figure 4: Spydaq sensor for monitoring air temperature & relative humidity (wirelessly) and fenestration position (wired)



4. Physical monitoring results – winter & spring 2011

Figure 5: Physical Monitoring Results for January 2011 - Lounge & Bedroom air Temperature Vs Exterior Temperature; and Power consumption of the EASHP (Y axis: °C; X axis: days 1st to 31st January 2011)



During January 2011:

- The lounge temperature exceeded **23°C** on almost everyday
- Only **175.58kWh** of energy was used for the EASHP
- The total monthly energy cost for the EASHP was only **£22.85=€26.20**
- The total monthly CO_2 emissions for the EASHP was only **95.73kg** CO_2 per unit

5. Discussion of results

- 2010 was on average the coldest year since 1986 and the winter period was the coldest since at least 1970; mean temperatures for January 2011 were somewhat below the 1971 to 2000 average, especially over parts of the UK, including Wales [2].
- The winter design temperature range for *living rooms* in the UK as recommended by the Chartered Institute of Building Services Engineers (CIBSE) is 22 to 23°C [3].
- Fig 5 illustrates that on almost every day of January 2011 the lounge interior air temperature exceeds 23°C & the highest temperature is 27.4°C (the green line). The lounge temperature is below the minimum comfort temperature of 18°C, on only two days. By contrast the exterior air temperature has a maximum and minimum of 10.3 °C and -6.3°C, which is a 16°C temperature range.
- The winter design temperature range for *bedrooms* in the UK is 17 to 19°C. Fig 5 illustrates (the red line) that on several occasions (15 in total) during January 2011 the interior air temperature in the bedroom exceeds 20°C and the highest temperature is 21.2°C. The bedroom temperature is below the minimum comfort temperature of 18°C on 15 days and the coldest temperature is 16.8°C.
- Because of the internal temperatures being well within recommended comfort ranges during a very cold January (by UK standards) it was anticipated that the power consumption, the associated energy costs and the CO_2 emissions would be excessively high in relation to the usage of the EASHP. However, this is not the case as indicated by the results in Fig 5 (blue line just above the '0' unit on the y axis, within the red band) it is almost negligible. The total power consumption for space and water heating for the EASHP was only **175.58kWh**, a total monthly cost of **£22.85** (unit cost of £0.13 per kWh) and only **95.73 Kg CO_2e** per unit emissions.

6. Conclusion and Future Work

The poster has demonstrated that in January 2011, following one of the coldest years (2010) and winter periods in the UK since the 1970s, and by minimal intervention by occupants, the energy use for space and water heating provided by an EASHP for a family of two adults and three children in a dwelling has been a nominal 176 kWh, at a cost of just under £23.00 (approximate 27 Euros) and led to CO_2 emissions of just 95.73 Kg CO_2e per unit. Future publications will indicate a more in-depth analysis of the physical monitoring and also the social monitoring.

References

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