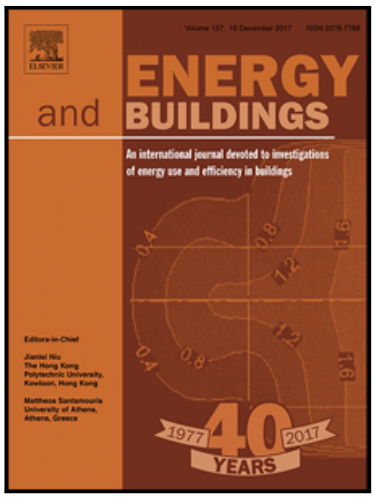

Evaluating the influence of building fabric, services and occupant related factors on the actual performance of low energy social housing dwellings in UK

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Evaluating the influence of building fabric, services and occupant related factors on the actual performance of low energy social housing dwellings in UK

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Abstract

This paper empirically investigates the influence of building fabric, services and occupant related factors on actual energy use of six case study dwellings, located in three new low energy social housing developments in UK, covering a variety of built forms and construction systems (timber frame, hempcrete, steel-frame). Physical monitoring of indoor environment and window-opening is cross-related with building fabric and systems' performance, and qualitative data gathered through occupant surveys, review of control interfaces and handover guidance, to understand the causes of the gap between modelled and measured energy use. Actual energy use is found to exceed design expectations by a factor of three, questioning the need for whole-house mechanical ventilation heat recovery (MVHR) systems at measured air permeability rates of 6m³/(h.m²) against the design target of 3m³/(h.m²). Lack of proper commissioning of MVHR and heating systems, combined with inadequate user comprehension about their operation and control leads to occupant 'misuse' wherein systems are de-activated, thereby negatively affecting indoor air quality. This is confounded by occupant factors related to higher demand temperatures, unexpected opening of windows during winters due to under-performance of MVHR combined with habitual behaviours, and over-use of heating systems to compensate for higher than expected air permeability.

Key words: social housing; energy; environment; building performance evaluation; occupant behaviour

Introduction

In the UK, as with other European countries, about 27% of all carbon dioxide (CO_2) emissions are related to energy use in housing (DCLG, 2009; EU, 2011; HMG, 2008). The housing market has seen an exponential development of policy culminating in energy certificates, in line with the EU Energy Performance of Building Directive (EU, 2010), the Code for Sustainable Homes (CSH) assessment, and a series of other regulations aiming to improve the energy performance of houses and reduce their carbon emissions.

Despite this, many low carbon solutions are untested, creating a gap between 'expected' (modelled) and 'in-use' (measured or actual) energy performance. The result is that even new low carbon housing is using up to five times the energy predicted by models (Monahan and Gemmell, 2011; Thompson and Bootland, 2011). Although research has revealed that the physical building characteristics, performance of systems and occupant behaviour all play a significant role in determining actual energy use in buildings (Sharpe and Shearer, 2013; Gupta et al., 2013, Huebner et al., 2015; Jones and Lomas 2015; Gram-Hanssen,