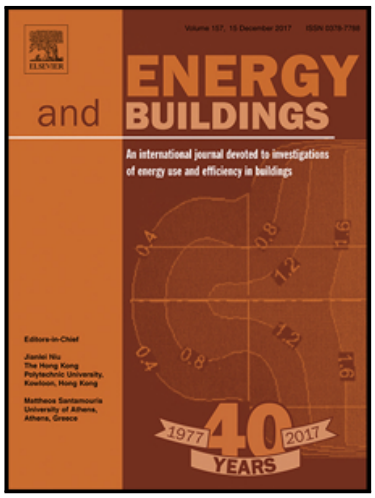

Modelling and simulating occupant behaviour on air conditioning in residential buildings

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Modelling and simulating occupant behaviour on air conditioning in residential buildings

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Abstract: Occupant behaviour on air conditioning directly influences building energy consumption. Current building energy simulation typically assumes that occupants operate air conditioners ideally ignoring the stochastic characteristic of occupant behaviour, which leads to a large deviation of predicted energy performance from real consumption. This paper proposed a methodology framework for modelling occupants' stochastic behaviour on air conditioning. This method combined measured data, statistical analysis and logistic regression to derive stochastic behaviour models that give the probability of when and above which temperature occupants may turn on air conditioning, at what temperature they may set and when they may turn off air conditioning. The behaviour models developed in this paper were further incorporated in widely used building simulation engine—EnergyPlus. The accuracy of the developed simulation model was validated against field measurement. Using this model, the cooling energy performance was simulated and compared with results from building energy standard based settings. The result shows that simulation using settings according to building energy standard over-predicts cooling load and total cooling energy requirements by 113% and 5.6 times respectively, which are very large discrepancies and may lead to a misunderstanding of energy savings potential of energy efficiency measures. The methodology developed in this paper has generality and can be extended and applied in other buildings for constructing behaviour models of air conditioning. The limitations of the current research as well as future research works were also discussed.

Keywords: Occupant behaviour, air conditioning, logistic regression, behaviour model, energy performance

1. Introduction

With the improvement of living standards, residential buildings in China consume more cooling and heating energy compared to 10 years ago[1]. To reduce building energy consumption, China implemented mandatory building energy standards for new residential buildings [2]. These standards require a significant thermal improvement of building envelope such as external walls[3], roof[4], windows and shades [5] compared to non-energy efficient buildings built in 1980s[6, 7]. These building energy standards require building designers or architects to simulate the energy performance of designed buildings and only those buildings whose energy saving performance meets design standard are allowed to be built. Thus the accuracy of simulation results is critical to achieve an energy efficient building.

Currently, DOE-2 simulation engine (developed by US LBNL) [8] is used in China to predict building energy performance since this tool was used in the compliance of these building energy