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www.elsevier.com/locate/jobe

PII: S2352-7102(18)30149-9
DOI: https://doi.org/10.1016/j.jobe.2018.05.013
Reference: JOBE490

To appear in: *Journal of Building Engineering*

Received date: 8 February 2018
Revised date: 5 May 2018
Accepted date: 11 May 2018

Cite this article as: KC Rajan, H.B. Rijal, M. Shukuya and K. Yoshida, An in-situ study on occupants' behaviors for adaptive thermal comfort in a Japanese HEMS condominium, *Journal of Building Engineering,* https://doi.org/10.1016/j.jobe.2018.05.013

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Keywords: HEMS, Indoor environment, Thermal comfort, Thermal responses, Adaptive behaviors, Clothing, Window opening

Abstract

We conducted a series of survey on occupants' behaviors for adaptive thermal comfort together with indoor air temperature measurement in a condominium equipped with Home Energy Management System (HEMS), from November 2015 to October 2016, in which 17,026 votes were collected. The data was categorized into Free Running (FR), Cooling (CL) and Heating (HT) mode and were analyzed thoroughly. The results showed that the indoor air temperature was highly correlated with outdoor air temperature in FR mode. In CL mode the mean indoor air temperature was 27.3℃, which was close to the recommended air temperature for summer in Japan equal to 28℃. In HT mode it was found that indoor air temperature was maintained around 20℃. Similar indoor air temperature was also observed in FR mode during winter. The occupants' thermal sensation votes were most likely for neutral. The mean clothing insulation was 0.43 clo in summer and 0.89 clo in winter. The occupants' behaviors in this condominium for clothing insulation adjustment were found to be quite similar to those in detached houses found in previous studies. The occupants seemed adapting to the indoor thermal environment by window-opening behaviors to adjust thermal comfort during summer. The use of fan was found to increase as the indoor air temperature increased. The occupants were found to take these passive means along with the use of air conditioning unit for cooling. Mechanical heating was used only for a limited period for the condition of outdoor air temperature being low.

1. Introduction

We are facing the need for reducing energy use in both existing and new buildings over the next 30 years by 50-90% [1]. Therefore, seeking an effective way for energy management is the challenge not only for developing countries but also for developed countries. Even in developed countries like Japan, the increasing aging population has resulted in the increase of residential energy use [2]. Electricity generation has shifted away from nuclear-fission based towards natural-gas based after Fukushima disaster, so that Japan has become increasingly reliant on generating electricity using imported liquefied natural gas. This has caused the increase of electricity price in Japan [3]. Higher electricity costs will have an adverse impact on Japan's international competitiveness in the manufacturing sector. Therefore, Japanese government's policy is to reduce of the electricity use by 17% in 2030 [4].