

Accepted Manuscript

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PII: S0360-1323(17)30257-3

DOI: [10.1016/j.buildenv.2017.06.023](https://doi.org/10.1016/j.buildenv.2017.06.023)

Reference: BAE 4951

To appear in: *Building and Environment*

Received Date: 9 April 2017

Revised Date: 9 June 2017

Accepted Date: 9 June 2017

Please cite this article as: Zaki SA, Hagishima A, Fukami R, Fadhilah N, Development of a model for generating air-conditioner operation schedules in Malaysia, *Building and Environment* (2017), doi: 10.1016/j.buildenv.2017.06.023.

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Development of a model for generating air-conditioner operation schedules in Malaysia

Sheikh Ahmad Zaki^{a,*1}, Aya Hagishima^b, Ryosuke Fukami^b, Nur Fadhilah^a

^a Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia

^b Interdisciplinary Graduate School of Engineering Sciences, Kyushu University, 6-1, Kasuga-Koen, Kasuga-shi, Fukuoka 816-8580, Japan

Abstract

Accurate estimations of the stochastic natures of energy demand for air-conditioner (A/C) use, which are affected by the diverse occupant behaviour, are needed, for the design and operation of residential cogeneration systems and distributed generation systems coupled with renewable energy sources and supply-demand management technologies. However past studies have mainly focused on developed countries, and knowledge of tropical regions, including many emerging countries with large populations, remains limited. We conducted field measurements of occupants' A/C usage behaviour in 38 dwellings in Kuala Lumpur, Malaysia. Measured data were considered as a function of start and end times, duration, and frequency of A/C usage in each dwelling. Analysis showed that A/C events were rare during daytime; however, there was a drastic increase in the frequency of A/C usage at night. Based on this, a simple algorithm to synthesize stochastic time patterns of A/C operation schedules was developed. The validity of the model was demonstrated through comparison with observational data.

Keywords: stochastic model, occupant behaviour, field measurement, air-conditioner usage, dwellings

1. Introduction

It has become increasingly important to implement energy saving and CO₂ emission reduction measures to counteract global warming. The residential sector is one of the main energy consumers, accounting for about 30% of global energy demand [1]; therefore, improving the energy efficiency of residential heating, ventilation, and air-conditioning (A/C) equipment (HVAC) is essential. Renewable energy sources are expected to contribute positively towards a low carbon society; however, due to the dependence of several renewable energy sources (e.g., photovoltaics) on weather conditions, their power generation over time is generally unstable and may not coincide with the pattern of electricity demand, resulting in the need for expensive storage batteries. Accurate estimation of time-series demand for electricity, gas, hot water, and air-conditioning load all of which are strongly influenced by occupant behaviour is important to achieve optimum design at affordable cost.

Over the past decade, there has been substantial research into the characteristics of occupant adaptation behaviours that affect A/C load and energy consumption. For example, Fritsch et al. [2]

* Corresponding author. Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia, Jalan Sultan Yahya Petra, 54100 Kuala Lumpur.

E-mail address: sheikh.kl@utm.my (S.A.Zaki).

Phone: +60322031483

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