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Procedia Engineering 205 (2017) 716–723

Procedia Engineering

www.elsevier.com/locate/procedia

10th International Symposium on Heating, Ventilation and Air Conditioning, ISHVAC2017, 19-22 October 2017, Jinan, China

Study on Building Energy Load Prediction Based on Monitoring Data

Zhuling Zheng[a,c],Zhi Zhuang[b,*],Zhiwei Lian[a],Yao Yu[d]

[a] *Shanghai Jiao Tong University, Shanghai, 200240, China*
[b] *Tongji University, Shanghai, 200092, China*
[c] *Shanghai Research Institute of Building Sciences, Shanghai, 200032, China*
[d] *North Dakota State University, Fargo, 58102, USA*

Abstract

Energy planning is important for development areas in need of new energy distribution systems. However, the current energy planning still lacks effective data support and necessary assessment, and the energy load is usually overestimated by using the static load index meth-od or dynamic building energy load simulation, which leads to big equipment capacity at the design stage and high energy consumption during the operation stage. There is an urgent need to use real data to support the energy load estimation for energy planning. In this paper, a new model is described that produces heating and cooling load profiles for building categories based on monitoring data. The method is based on simultaneous metered delivered energy on hourly basis as well as background information of the metered buildings. The five-parameter model considering the relationships between energy and mean outside temperature were developed. The electricity consumption data routinely collected from over fifty campus buildings was selected for case study. The proposed model is used to estimate the energy loads for the selected campus region for case study, which are proven accurate with the difference of less than 5% of the monitoring result. This study provides a new procedure to estimate heating and cooling load for energy planning for community energy planning.

Peer-review under responsibility of the scientific committee of the 10th International Symposium on Heating, Ventilation and Air Conditioning.

Keywords: Community energy planning; Energy load profile; Monitoring data

* Corresponding author. Tel.: +86-21-65980778; fax: +86-21-65981002.
E-mail address: zhuangzhi@tongji.edu.cn

1877-7058
Peer-review under responsibility of the scientific committee of the 10th International Symposium on Heating, Ventilation and Air Conditioning.
10.1016/j.proeng.2017.09.894

1. Introduction

Energy planning is extremely important for developing areas in China, which are in need of new energy distribution systems. The current energy planning, however, still lacks effective data support and necessary assessment, and building energy loads are usually overestimated due to the use of the static load index method or dynamic building energy load simulation, which may lead to oversized equipment capacities at the design stage and higher energy consumption during the system operation [1,2]. Therefore, there is an urgent need to use real data to justify the energy load estimation for effective energy planning. In addition, the Chinese central government released a document in 2007 to initiate a task regarding the construction of an energy efficiency supervision system for non-domestic and campus buildings. To respond to this call, by now more than 5,000 non-domestic buildings and 50 universities have finished the real-time monitoring of electricity consumption. Yet these data have not been effectively utilized for the improvement of energy planning and/or other similar purposes.

In order to achieve the most economical, environmental, and optimal energy supply system, it is especially important to accurately estimate the peak loads and the corresponding load pro-files of the buildings located in the areas in question. This paper describes a novel method for use to estimate cooling and heating load profiles of a given building category based on the basic condition and information of a building and its monitoring data that are on an hourly basis and were obtained through measuring its electricity use. Load profiles for specified building categories are developed through statistical regression analyses of the metered data.

2. Building energy data monitoring and collection

Statistical analyses of the district heating and cooling loads were performed to develop a method for estimating load profiles for various building categories. In this study, the campus buildings in Shanghai, China were taken for a case study. The research team has already con-ducted a wide survey on 16 typical universities including almost 200 buildings with many building types, such as administrative office, classroom, research building, library and dormitory [3,4]. Buildings with different functions have distinct characteristics. Fig.1 illustrates the ratio of different building types in terms of building areas (a) and energy consumption (b) in a specified university. As shown in this figure, research buildings are the most important building type in a university and account for 28% and 24% respectively in terms of building areas and energy consumption. Therefore, in this study, nine research buildings are chosen as samples to verify the developed method for heating and cooling load pre-dictions for the purpose of optimizing energy planning. This proposed method can also be used to guide load predictions for other buildings.

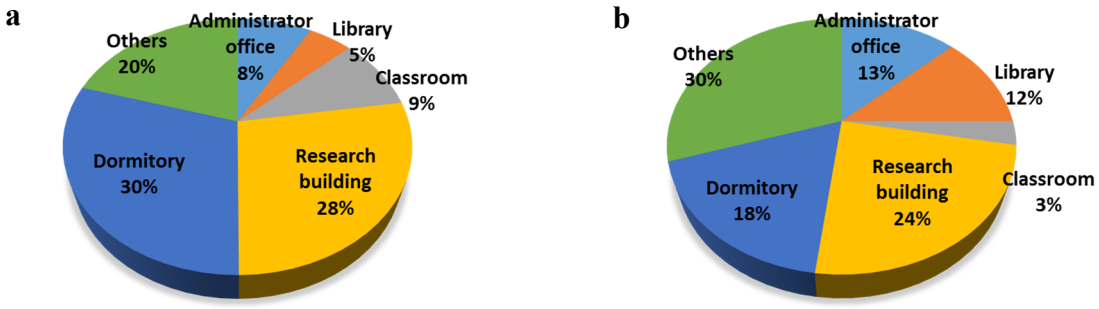

Fig. 1. Composition of building areas and energy consumption for one university (a) building area; (b) energy composition.

3. Building load modelling method

The proposed method for estimating heating and cooling load profiles is described in Fig.2.

Three different building categories are divided, including office buildings, library and re-search buildings. All the buildings used only electricity for space heating and cooling, lighting, computers, etc. A typical week is divided into