APPLICATION AND VERIFICATION OF ENERGY BASELINE ESTIMATION METHOD BY SIMULATION

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ABSTRACT

A rational method to estimate the energy baseline of a building is indispensable in performing such as retro commissioning, on going commissioning and ESCO (Energy Service Company) projects. Usually a statistical regression method is used to estimate a baseline. But the limitation of this method is that it cannot evaluate the effect of changes in operational conditions such as HVAC system and occupancy schedule, room temperatures, amount of fresh air intake in HVAC systems, weather conditions, etc. by which energy use is affected. In these cases an estimation method based on simulation would be a good option. However, few studies are found about verification of the method based on experiments using a real building. Therefore we carried out an experiment for changes of room air temperatures and the fresh air intake volume in a real building and verified the accuracy of the baseline estimation method developed in our previous study. The results show that the model can estimate the baseline change with acceptable accuracy.

KEYWORDS

energy use baseline, retro commissioning, ESCO, air-condtioning load simulation

INTRODUCTION

When we introduce energy conservation measures to estimate how much energy is reduced is a key issue. The difficulty of estimating it is on the fact that energy consumption is related to various operational conditions such as weather, occupancy, room air temperature set point, HVAC system operation, etc. which change with time and sometimes by user needs or by chance. If we can measure the reduction directly it is easy but it is not possible because post-retrofit energy usage is measurable but pre-retrofit energy use after retrofitting is not measurable. Therefore we need to estimate the pre-retrofit energy use under specific operational conditions based on a model. This is defined as an adjusted energy baseline.

The U.S. Department of Energy proposed four options to estimate the adjusted energy baseline. These are Options A, B, C and D which are explained in the International Performance Measurement and Verification Protocol (IPMVP 2002). In Japan, it is used in most ESCO projects. Option C is a method to estimate the energy baseline by statistical linear regression. Option D is a method to estimate the energy baseline by simulation. Although it requires much information and manpower, it can estimate the baseline with operational condition changes; for example, changes in weather, occupancy and equipment operation. Option D is theoretically considered more accurate than Option C. This method is important in baseline estimation because operational condition changes occur very often in usual.

We developed a method of Option D type (Miyata and Yoshida, et. al 2006). The model has two sub-modules: a heating and cooling load calculation module and an energy consumption estimation module, which consists of the models of energy consuming equipment in a building. In this study the applicability of the first sub-model is investigated by carrying out an experiment of changing room air temperatures and fresh air intake volume intentionally using a real building.

THE BASELINE ESTIMATION MODEL

Figure 1 shows an outline of the energy baseline estimation model (Miyata and Yoshida, et. al 2006). Air-conditioning load estimation is performed using ACSES developed by the authors. The load calculation is carried out by the following equations that are based on the response factor method (Yoshida, et. al 1994).

$$Q_{b,n} = Q_{T,n} - Q_{R,n} + c_a V_{oa,n}(h_{o,n} - h_{r,n}) \qquad (1)$$

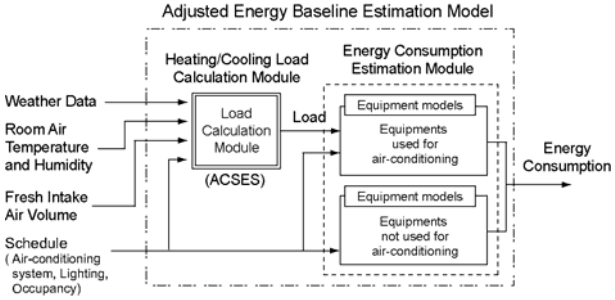

Figure 1 Adjusted energy baseline model