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ROLE OF SIMULATION TOOL IN NATIONAL BUILDIG ENERGY RATING SYSTEM

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ABSTRACT

In this paper, the authors present a simulation case study to show how sensitivity analysis can be beneficially used for objective building performance assessment. The case study was made by comparing the existing *prescriptive* building energy rating system (weights-based) in South Korea with a new sensitivity-based performance rating (can be regarded as *performance-based*). For this purpose, a surrogate model of EnergyPlus, one of the most advanced dynamic simulation tools, was developed and then used for Sobol analysis. By substituting sensitivity indices for the weights, the existing system was improved from R^2 of 0.06% (existing) to R^2 of 89.3% (new) between the rating score and EnergyPlus simulation results.

1 INTRODUCTION

Building simulation tools enable energy performance analysis of building design(s) and thus can be beneficially used for a national building energy rating system (Malkawi and Augenbroe, 2004). In South Korea, the existing building energy rating system uses two weights (credit, point) for calculating a final score called Energy Performance Index (EPI). It has been widely acknowledged that the final EPI score is not strongly proportional to the Energy Use Intensity (kWh/m^2·yr) thus is regarded as a prescriptive approach. Another building energy rating approach in South Korea is called ECO2 that was simplified and customized from ISO 13790 and DIN V 18599. In contrast to EPI, the ECO2 program calculates EUI. One of the issues in the building energy rating in South Korea is *lack of objectivity and transparency*. In other words, the EPI score and calculated EUI from ECO2 do not seem to be relevant to actual EUI or simulated EUI from EnergyPlus. Therefore, in this study, the authors propose a new approach for improving EPI and ECO2. As illustrated in Figure 1, a reference model was selected and a surrogate model was developed. Then, the sensitivity indices obtained from a global sensitivity analysis (SOBOL) were introduced into the EPI rating system as well as ECO2 rating.

2 SIMULATION MODEL

The target building is a reference building developed by US DOE, a medium three-story office building located in Inchon, South Korea (50m deep, 33.4m wide, and 11.9 high, WWR:33.01%). To reduce computation time, a surrogate model was developed using Artificial Neural Network (ANN). To make two weights more proportionate to EUI, SOBOL and polynomial regression analyses were conducted as shown in Figure 1 and the results are tabulated in Table 1.

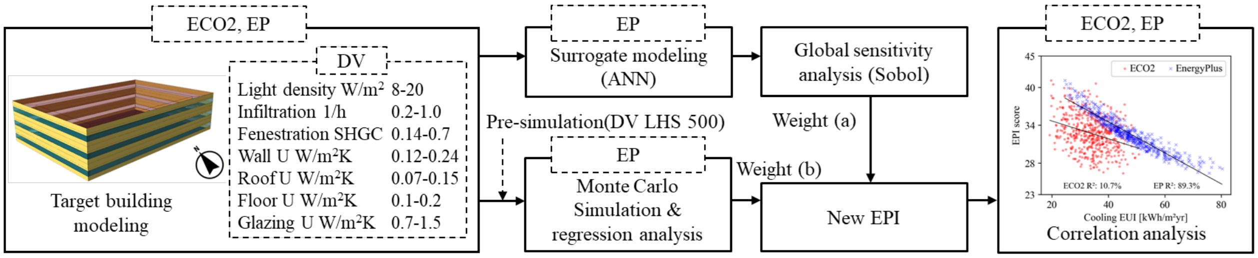


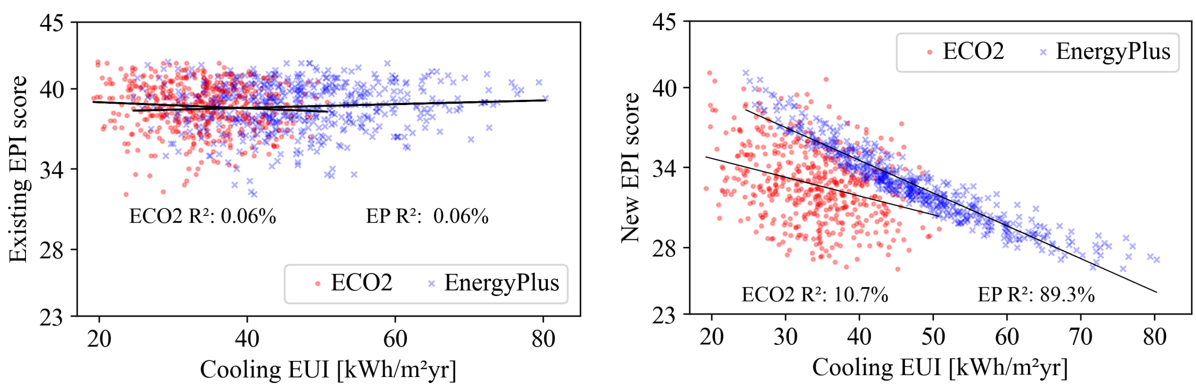
Figure 1 : Simulation-based building rating system (DV: design variable, EP: EnergyPlus, LHS: Latin Hypercube Sampling).

3 RESULTS AND CONCLUSION

500 random building were generated and assessed using the existing EPI, the new EPI (w/ improved two weights), the ECO2 calculation and EnergyPlus calculation (Figure 2). Red and blue points in Figure 2 represent 500 buildings. As shown in Figure 2, the new EPI (a simple, straightforward rating method based on two weights) is good enough compared to EnergyPlus Simulation results (R^2_{EP}:89.3%). It can be inferred that the new simple straightforward EPI method can be a good surrogate to the existing ECO2 calculation (ISO 13790-based tool) (R^2_{ECO2}:10.7%) because of the sensitivity and regression analyses and EnergyPlus simulation model.

Table 1 : proposed EPI rating system.

Design variable	**Sensitivity**	**Weight (a)**	**Weight (b)**
Exterior Wall U value	0.0460	1.82	$0.6723(\text{Wall U})^2+0.38(\text{Wall U})+0.466$
Roof U value	0.0020	0.01	4.9723(Roof U) + 0.246488
Floor U value	0.0001	0.00	-
Infiltration	0.3520	15.1	$0.6605(\text{Inf})^3-0.6832(\text{Inf})^2+0.5062(\text{Inf})+0.5155$
Fenestration SHGC	0.3500	15.0	$0.000009(\text{SHGC})^2-0.007(\text{SHGC})+1.085$
Light density	0.2570	11.0	-0.3333(Light density) +1.2666



(a) Existing (b) New

Figure 2 : Comparison between existing EPI, new EPI and EUI.

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