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DEVELOPMENT OF WEATHER NORMALIZATION PROCESS FOR COMMERCIAL BUILDING ENERGY BENCHMARKING

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ABSTRACT

Recently, IT companies provide building energy benchmarking services based on the presupposition that Energy Use Intensity (EUI, kwh/m^2.yr) is a good indicator of reliable building energy performance. However, EUIs of two buildings can differ if they are built in different climates even though the both buildings' thermal characteristics are identical. In this regard, the authors proposes a weather normalization process for objective building energy benchmarking. For this purpose, the energy data was collected from EnergyPlus simulation for 76 locations, and a 'building energy signature' denoted by EUI* was extracted based on a non-linear regression between outdoor air temperature and EUI. It is found that under various climate conditions EUI* can adequately reflect the building energy characteristics better than the EUI.

1 INTRODUCTION

Although the EUI has been extensively utilized for building energy benchmarking in the Architecture/Engineering/Construction (AEC) industry, it could lead to biased assessment because the EUI can be influenced by climate ((a) in Figure 1). For objective and transparent building energy benchmarking, a weather-normalized indicator is required. With this in mind, the authors propose a weather normalization process in this case study. It is based on the hypothesis that the non-linear relationship between outdoor air temperature and the EUI can be '*uniquely*' defined by each building's thermal characteristics (Figure 1), and this can be defined as a building's '*energy signature*' ((b) in Figure 1). The expected energy use for an entire range of outdoor air temperature can be regarded as a normalized EUI (denoted by EUI*, far right box in Figure 1). The energy data for various climates was collected using EnergyPlus simulation runs, and the energy signature for each building was extracted based on RANSAC.

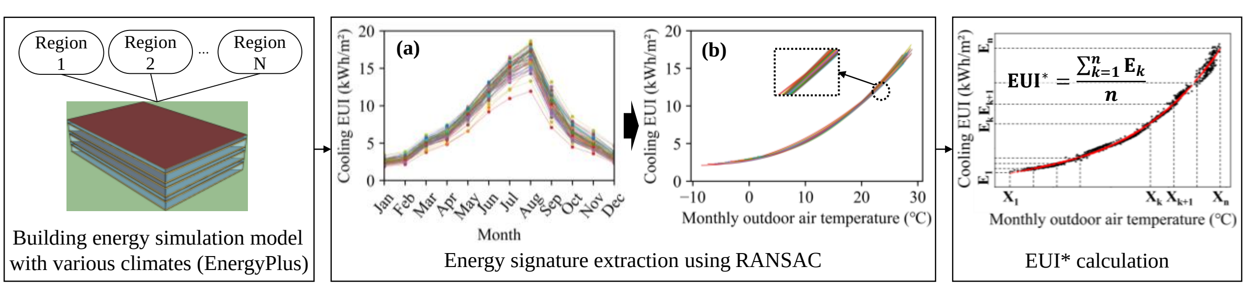

Figure 1: Weather-normaized building energy performance (EUI*).

2 SIMULATION CASES

The reference building developed by the US DOE (a medium-size office located in Atlanta, EnergyPlus) was selected as the baseline model. The authors conducted building energy simulation runs for 380 cases (5 occupant densities × 76 regions). 5 occupant densities linearly vary within the range of 0.161-0.455 person/m^2 (KICT 2016). 76 climate data (South Korea) and monthly cooling energy uses (electricity + gas) were used to find each building's energy signature using RANSAC.

3 RESULTS AND APPLICATION

The results can be summarized as follows:

- It is observed that as occupant density increases from yellow to black, both of the existing EUI and normalized EUI* also increase ((A) and (B) in Figure 2).
- It is noteworthy that the existing EUI increases as mean outdoor air temperature increases, while EUI* would not (red dashed boxes of ((A) and (B) in Figure 2).
- The standard deviations of both the existing EUI and EUI* are 0.6-0.7 and 0.1-0.2 (kwh/m^2), respectively ((C) and (D) in Figure 2). It can be inferred that EUI* can be a reliable candidate for weather-normalized building energy benchmarking.

The proposed weather-normalized building energy benchmarking can contribute to objective assessment of building energy performance, and building energy diagnosis in the AEC industry.

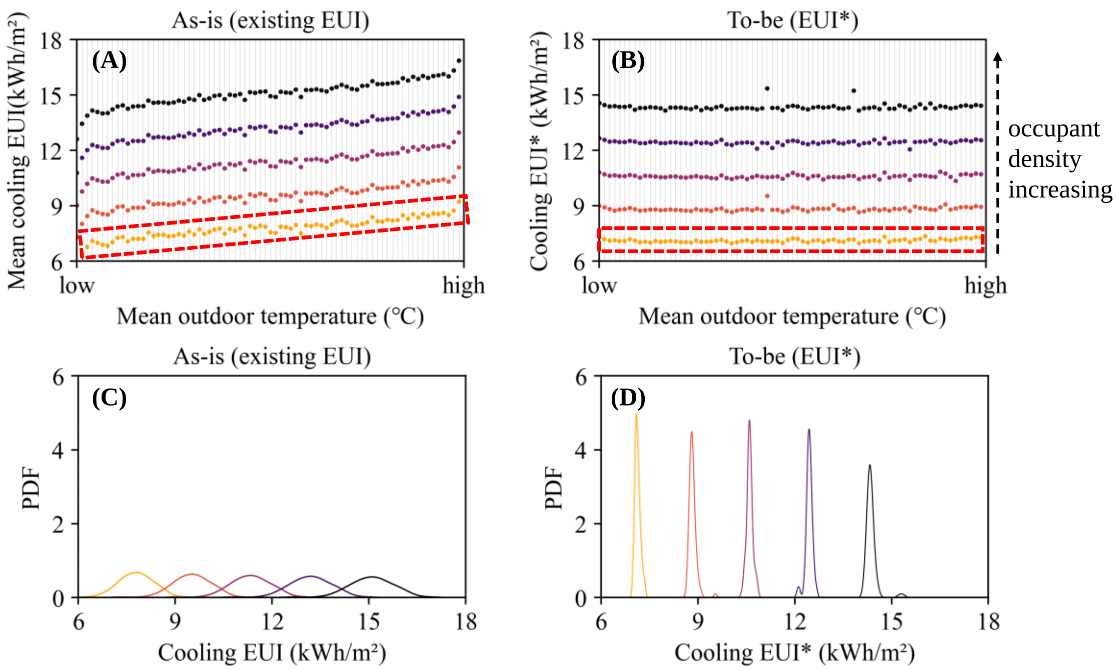

Figure 2: Comparison of building performance assessment between existing EUI and normalized EUI*.

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