Reliably estimating the impact of a new control strategy in a building

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Conventional measurement and verification (M&V) methods for whole-building energy savings estimation are both time-consuming and unreliable, especially when non-routine events occur during the M&V process. Those events are unrelated to the proposed intervention strategy but have substaintial impacts on the building energy consumption. In this study, we argue that for switchable interventions (e.g. most of the control retrofits) can benefit from random sampling where the analyst randomly decide which strategy (i.e. baseline or intervention) to implement each day. We tested the novel randomized M&V method on a large public dataset which covers multiple climate zones and types of commercial buildings. We applied a virtual chilled water supply temperature reset based on outdoor weather as a control retrofit intervention. Our study shows that the new M&V method can estimate the savings accurately much quicker than the conventional method and most importantly, the estimation results are much more robust compared to the conventional method when non-routine events are present.

# 1 Introduction

## 1.1 Background

### 1.1.1 Conventional M&V

### 1.1.2 Randomized (rapid) M&V

### 1.1.3 Non-routine events

## 1.2 Literature review

## 1.3 Objectives

The objectives of this paper include:

1. Demonstrate the implementation of the proposed randomized rapid M&V method using a public available dataset. We ensured the reproducibility of the M&V method by making the analysis code open source including randomized schedule generation, sequential statistical analysis, energy modeling and normalized saving calculation. Using the available open resources, building analysts should be able to seamlessly integrate and apply them in their own M&V projects.
2. Compare the energy saving estimation accuracy between the conventional and the randomized method. In particular, this study extends the comparison to large samples of buildings of various types and across multiple climate zones.
3. Verify the superior robustness of the randomized method over the conventional method. By using the realistic measurements from real-world buildings, which contains various sources of noises, could largely reflect the challenges that a building analyst would be facing in any real project. Particularly, as we will demonstrate in the following sections, non-routine events (i.e. ‘noises’ in the measurements) have less impact in the energy saving estimation when the analyst uses the randomized approach.

# 2 Method

As mentioned, this study leverages a large public dataset to demonstrate the energy saving estimation results of a novel M&V method inspired by other scientific research fields. We outlined the methodology of the study in figure and outlined several key steps in this section.

## 2.1 Data filtering process

### 2.1.1 ‘Tidy’ dataset - buildings with the same two-year electricity usage

### 2.1.2 ‘Messy’ dataset - buildings with reasonable change

## 2.2 Control intervention - chilled water supply temperature reset

## 2.3 Building Energy modeling

# 3 Results

## 3.1 Randomized M&V results

### 3.1.1 Saving estimation accuracy comparison (‘tidy’ dataset results)

### 3.1.2 Required estimation time

### 3.1.3 Continue sampling results

## 3.2 Influence of non-routine events

### 3.2.1 Example non-routine event: occupancy change

### 3.2.2 Saving estimation accuracy comparison (‘messy’ dataset results)

# 4 Discussion

# 5 Conclusion

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