

Uncertainty Analysis of Hybrid Ventilation Potential Investigation for Small to Medium Commercial Buildings

Jianli Chen, Godfried Augenbroe, and Xinyi Song, PhD.
Georgia Institute of Technology
Atlanta, Georgia

Commercial Buildings have long been recognized as one of the major energy consumers in our society. Among this high energy consumption, approximately half of the energy is spent on air conditioning of building zones. Accompanying with the benefits such as stable indoor environment, the low thermal satisfaction rate of occupants in air-conditioned building has been constantly reported by large surveys from different parties. Meanwhile, health problems such as sick building syndrome also occur much more frequently in air conditioning building due to the possible insufficient ventilation. As a combination of both air conditioning and natural ventilation, hybrid ventilation is a promising strategy to save energy while maintaining sufficient thermal comfort in commercial buildings. Understanding its benefits could definitely help advocate it to public. However, currently, almost all the hybrid ventilation potential investigations are based on deterministic simulation results without fully taking into account the possible variations of buildings properties and its micro-environments. These could all give rise to discrepancies and bias in the outcomes. The information from only deterministic simulations is also not sufficient to provide a good view of possible variations of hybrid ventilation performance.

To promote hybrid ventilation strategy, the first and foremost step is to investigate the hybrid ventilation potential in different US climate zones. Considering the existing insufficiency and possible inaccuracy in the potential investigation of hybrid ventilation, the objective of this paper is to conduct a more thorough investigation of the hybrid ventilation potential in different US climate zones utilizing uncertainty analysis. In order to apply a thorough uncertainty analysis for hybrid ventilation potential investigation, different levels of uncertainties in building simulation are discussed first. Then, more specifically, the uncertainties spring from meteorology (e.g. possible weather change), building microclimate (e.g. urban heat island effect, local wind speed, ground reflectance), building properties and operations (building material, building convection, electric equipment, lighting consumption, occupancy etc.) are quantified either based on measurement of difference between our simulation model and high-fidelity model or reliable data from literature and public databases. A prototypical small to medium size building is then selected as our baseline building. At last, a workbench is developed to automate the process of applying uncertainty analysis on this prototypical building in the hybrid potential investigation.

Currently, the uncertainty analysis for hybrid ventilation potential investigation has been applied in 4 different climate zones in US. The preliminary result shows that the energy saving could range from 10% to 50% under different scenarios. The climate zone with highest potential for hybrid ventilation is 3C (marine). Firstly, this research has presented quantification of different levels of uncertainties in building simulations, which could be applicable to other building simulation scenarios in the future. Also, by taking these possible variations of scenarios into account, this research provides more informative and comprehensive hybrid ventilation potential investigations across different climate zones in US. It could serve as a reference if others intend to invest in hybrid ventilation building in the future.

Keywords: Hybrid Ventilation, Uncertainty Analysis