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Mirata Hosseini, François Tardy, Bruno Lee

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Cooling and heating energy performance of a building with a variety of roof designs; the effects of future weather data in a cold climate

Mirata Hosseini, François Tardy, Bruno Lee

Department of Building, Civil, and Environmental Engineering, Concordia University, Montreal, Canada

Abstract

Building engineers commonly use the Typical Meteorological Year (TMY) weather data for simulation and design purposes. However, the nature of TMY in excluding weather extremes makes them less suitable to investigate the effect of potential climate change on building design as climate change likely increases the frequency and magnitude of those extreme conditions. The current practice of designing buildings has lacked a clear method to incorporate future climate change trends. An approach is used to compare present weather simulation results of a commercial building with varying roof reflectance and insulation thermal resistance parameters with future year-by-year results which are affected by potential climate change. Future weather data for year-by-year simulations is obtained by "morphing" historical weather data with a General Circulation Model (HadCM3). Mean energy consumption and optimal roof configurations are discussed with regards to climate change over the study period, and are compared to results obtained with TMY data. Results show that increased roof solar reflectance always lead to less mean and less variant cooling energy consumption. The study shows the importance of considering possible future climate scenarios and in building energy performance design.

Keywords

Roof design, Weather uncertainty, Climate change, Building energy performance, Morphing, Typical meteorological year (TMY), Actual meteorological year (AMY), Cold climate.

1. Introduction

Over the past decades, literature has indicated that a warming global climate is affecting various human activities ranging from crop production [1] to power plant output [2]. The practice of designing buildings to cope with potential climate change has lacked a clear method to incorporate this trend. Today's buildings are designed to last several decades, and as weather patterns change over time, buildings designed for today's climate may not withstand the potential changes during their useful lives.

Building designers should therefore take future climate predictions into account when assessing building energy performance in the subsequent building design process. Most building energy simulation packages are use weather data which represents a single, typical meteorological year (TMY). The implications of this practice are twofold. a) extreme weather conditions are excluded from the TMY weather data, and the use of TMY data might not be able to reflect future realities since the weather tends to become more extreme under the premise of climate change [3] and b) regardless of the different climate change scenarios, year-to-year changes in the weather might not be adequately captured by a single TMY.

Therefore, even if building engineers today commonly use TMY weather data for design and analysis purposes, such data can not only lead to an under- or overestimation of energy savings, but also does not support future weather modeling.

In this optic, the objective of this research is to:

1. Quantify and systematically demonstrate the effects of future climate changes on energy consumption