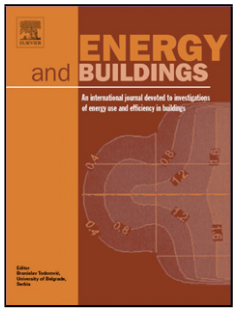

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Quantifying electrical energy savings in offices through installing daylight responsive control systems in hot climates

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Abstract

Lighting is considered as one of the most important issues in reducing energy consumption of a building. It is estimated that electrical lighting consumes 25-40 percent of the total electrical energy in a typical commercial building in the United States. Over the last three decades, there has been a growing concern about reducing energy consumption associated with artificial lightings. Daylighting could be considered as a cost-effective alternative to artificial lighting which not only reduces the demands for electrical energy, but also provides occupants with a pleasant, attractive, and a healthy indoor environment. Through installing sensors and controllers, daylighting is able to reduce and even eliminates the use of artificial lighting needed to deliver sufficient illuminance levels in an office. Present study is a simulation based research that investigates the impacts of various types of daylighting controllers on enhancing total and lighting electrical energy consumption of office buildings located in hot climates. Effects of Dimming (5%, 10%, and 20% light), On/Off, and Stepped control systems are evaluated in this study. E-Quest is used as the energy simulation tool to calculate and compare electrical and lighting energy consumption. In order to assess the effects of daylight control systems in humid and arid hot climates, Miami, Phoenix, and Houston, located in ASHRAE 90.1 climate zones of 1, 2b, and 2a respectively, have been chosen as three locations for the prototype building. The prototype building is a four-story open office building measuring 18m wide x 36 m long x 15 m high oriented along east-west axis. The window to wall ratio of 20, 40, 60 and 90 percent in all directions are assessed. Windows consist of horizontal shading in all façades as well as blinds in those of East and West. Results of this study demonstrate that in all studied cities installing daylighting controllers in office buildings significantly reduces electrical energy consumption of the building particularly that of lighting.

Keywords: Daylight responsive control systems; Lighting, Electrical energy savings; Cooling energy; Hot climates

1. Introduction

In the past decades, there has been a growing concern regarding energy consumption of buildings and its environmental impacts such as carbon emission, Urban Heat Island effects, and global warming. Around 19 percent of total national energy use and 46 percent of building primary energy in the United States consume in commercial sector [1]. Based on 2012 Commercial Buildings Energy Consumption Survey (CBECS 2012) released in 2016 [2], it is estimated that artificial lighting accounts for 10 percent of total energy and 17 percent of electrical energy