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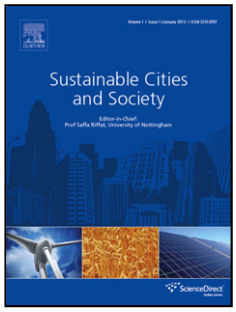

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Dynamic programming and genetic algorithms to control an HVAC system: maximizing thermal comfort and minimizing cost with PV production and storage

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Abstract

Finding the optimal balance between electricity demand and production constrained to economic and comfort variables requires intelligent decision and control. This article addresses the formulation of three models that optimize control of a heating, ventilation and air conditioning (HVAC) system in an experimental room, which are coupled with two thermal models of the indoor temperature. Electricity is supplied by the grid and a photovoltaic system with batteries. The primary objective is to maximize users comfort while minimizing cost constrained to: thermal comfort; variable electricity price; and available electricity in batteries that are charged by a PV system. Three models are developed: (i) dynamic programming with simplified thermal model (STM), (ii) genetic algorithm with STM, and (iii) genetic algorithm with EnergyPlus.

The genetic algorithm model that uses EnergyPlus to simulate indoor temperature generally achieves higher convergence to the optimal value, which also is the one that uses more electricity from the PV system to operate the HVAC. The dynamic programming performs better than the genetic algorithm (both coupled with STM). However, it is limited by the fact that uses STM, which is a less accurate model to simulate indoor temperature especially because it is not considering thermal inertia.

Keywords: Energy efficiency, optimization, thermal comfort, PV production, storage, demand response, genetic algorithm, dynamic programming.

1. Introduction

The global surface temperature of the Earth has been increasing at unprecedented rates according to different world scientific bodies, ranking 2016 as the warmest year so far [1]. Despite these alarming figures, there is still evidence in the literature supporting that these effects are still reversible or at least can be reasonably mitigated if

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[1] *Abbreviations:* **ASHRAE 55**, American Society of Heating, Refrigerating and Air Conditioning Engineers; **AC**, air conditioner; **BEMS**, building energy management system; **COP**, coefficient of performance; **DR**, demand response; **DP**, dynamic programming; **EB**, Energy Box; **EP**, Energy Plus; **FC**, fan coil; **GA**, Genetic Algorithm; **HVAC**, heating, ventilation and air conditioning; **IEA**, International Energy Agency; **ISO**, International Organization for Standardization; **PMV**, predicted mean value; **PN**, Portuguese norm; **PPD**, prediction of percentage of discomfort; **PV**, photo-voltaic; **RCCTE**, Regulamento das Caracterstticas de Comportamento Trmico de Edifcios; **RSECE**, Regulamento dos Sistemas Energticos e de Climatização de Edifcios; **STM**, simplified thermal model