A Dynamic Controller for Residential Energy Management at the Intersection of Occupant Thermal Comfort and Dynamic Electricity Price

Mostafa Meimand[1] and Farrokh Jazizadeh[2]

[1] Dept. of Civil and Environmental Engineering, Virginia Tech, 315B Patton Hall, 750 Drillfield Dr., Blacksburg, VA 24061. E-mail: mostafaem@vt.edu
[2] Dept. of Civil and Environmental Engineering, Virginia Tech, 200 Patton Hall, 750 Drillfield Dr., Blacksburg, VA 24061 (corresponding author). E-mail: jazizade@vt.edu

ABSTRACT

HVAC systems account for 50% of buildings' energy use and could play a critical role in energy management in buildings both for energy-saving, and demand-side management to reduce peak energy use. According to contextual demands of occupants, efficient control of HVAC systems could result in peak energy shaving and decreased energy costs in demand response programs. Accordingly, in this paper, we have introduced an agent-based model consisting of three agents: human agent, thermostat agent, and utility agent. In this model, the thermostat agent receives the real-time electricity price from the utility agent and aggregates thermal comfort profiles of the occupants from human agents. By considering these inputs, the thermostat agent employs a predictive model of a house and calculates the next setpoint of the HVAC system on energy cost and occupants comfort. Then, the thermostat agent signals the suggested setpoint to the thermostat of the building at each time step. For evaluating the proposed controller's performance, the electricity price profile from ERCOT, which supplies the state of Texas, is used as a signal from the utility agent. Realistic thermal comfort data were used to simulate the thermal preference of occupants represented as human agents. The evaluation was carried out in a co-simulation using a Python and EnergyPlus model of a residential unit. Our results show that the proposed controller reduces the peak energy by 5.5% to 10% and increases occupants' thermal satisfaction up to 12%. The main contribution of this paper is developing an agent-based model that humans, as the main stakeholders of the buildings, play a role in controlling HVAC systems for peak reduction and energy saving.