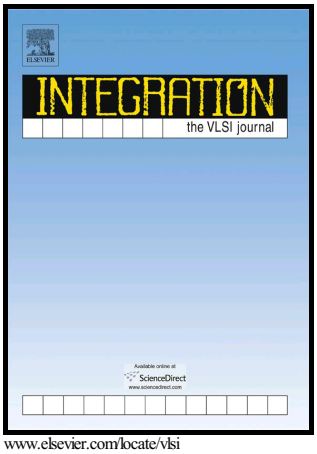

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An Optimal Energy Co-Scheduling Framework for Smart Buildings

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Abstract

The Heating, Ventilation and Air Conditioning (HVAC) system accounts for nearly half of the energy consumption of a typical building. Additionally, the need for HVAC changes over hours and days as does the electric energy price. Level of comfort of the building occupants is, however, a primary concern, which tends to overwrite pricing. Dynamic HVAC control under a dynamic energy pricing model while meeting an acceptable level of occupants' comfort is thus critical to achieving energy efficiency in buildings in a sustainable manner. Finally, there is the possibility that the building is equipped with some renewable sources of power such as solar panels mounted on the rooftop. The presence of Hybrid Electrical Energy Storage (HEES) system in a target building would enable peak power shaving by adopting a suitable charging and discharging schedule for each Electrical Energy Storage (EES) element, while simultaneously meeting building energy efficiency and user comfort requirements. Achieving this goal requires detailed information (or predictions) about the amount of local power generation from the renewable source plus the power consumption load of the building.

This paper addresses the co-scheduling problem of HVAC control and HEES system management to achieve energy-efficient smart buildings, while also accounting for the degradation of the battery state-of-health during charging and discharging operations (which in turn determines the amortized cost of owning and utilizing a battery storage system). A time-of-use dynamic pricing scenario is assumed and various energy loss components are considered, including power dissipation in the power conversion circuitry, the rate capacity effect in the batteries, and the self-discharge in the super-capacitor. A global optimization framework targeting the entire billing cycle is presented and an adaptive co-scheduling algorithm is provided to dynamically update the optimal HVAC air flow control and the HEES system management in each time

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