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DEMAND-SHIFTING USING MODEL-ASSISTED CONTROL

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ABSTRACT Increasing energy demand and more strict environmental regulations have enabled the transition from traditional electric grids, in which centralized power plants directly transmit energy to consumers, to smart electrical grids where the existing power grid is enhanced by distributed, small-scale renewables-based energy generation systems. The use of renewables into the grid inserts uncertainty to the system, due to their stochastic output profile which strongly depends on local weather conditions and their inability to cover the total electric demand at peak demand periods. One of the most common and effective methods for tackling the peak demand period problem in buildings is the use of electricity tariffs with Time-Of-Use charges, which are based on higher energy rates during high demand periods, in order to encourage electricity load shifting from peak-demand periods to periods with lower demand. In the present work, we assume that a day-ahead notification on a (hypothetical) tariff plan is provided, and the Building Energy Management System is requested to adapt to the new setting. A photovoltaic panel is assumed available, but there is no energy storage and selling-back energy to the grid is not allowed. This way, the controller is forced to operate the actuating components of the building during the production of renewable energy, while saving energy the remaining time. A model-assisted control design methodology, utilizing a stochastic optimization algorithm and weather and occupancy predictions, is used to produce a control strategy which exploits the energy produced by the photovoltaic panel, to minimize the cooling cost of a building, for a given summer day, while maintaining user comfort at acceptable levels. The proposed approach results to substantial cost reductions when compared – for a hypothetical tariff scheme – to a widely-used, static rule-based control scheme.