

Demand response programs are currently being proposed as a solution to deal with issues related to peak demand and to improve the operation of the electric power system. In the demand response paradigm, electric utilities provide incentives and benefits to private consumers as a compensation for their flexibility in the timing of their electricity consumption. In this paper, a dynamic energy management framework, based on highly resolved energy consumption models, is used to simulate automated residential demand response. The models estimate the residential demand using a novel bottom-up approach that quantifies consumer energy use behavior, thus providing an accurate estimation of the actual amount of controllable resources. The optimal schedule of all of the controllable appliances, including plug-in electric vehicles, is found by minimizing consumer electricity-related expenditures. Recently, time-varying electricity rate plans have been proposed by electric utilities as an incentive to their customers with the objective of re-shaping the aggregate demand. Large-scale simulations are performed to analyze and quantitatively assess the impact of demand response programs using different electricity price structures. Results show that simple time-varying electricity price structures, coupled with large-scale adoption of automated energy management systems, might create pronounced rebound peaks in the aggregate residential demand. To cope with the rebound peaks created by the synchronization of the individual residential demands, innovative electricity price structures-called Multi-TOU and Multi-CPP-are proposed.