***RESIDENTIAL RESPONSE TO CRITICAL PEAK EVENTS OF ELECTRICITY: A GREEN MOUNTAIN POWER EXPERIENCE***

Seth Blumsack, Penn State University, 814-863-7597, sethb@psu.edu

Paul Hines, University of Vermont, 802-656-9960, paul.hines@uvm.edu

Suman Gautam, Penn State University, 214-542-6697, sig5203@psu.edu

Overview

When electricity demand is at or near peak, the short-run and long-run costs of meeting incremental peak demands can rise quickly. Large amount of generating capacity has to be kept in reserve in order to supply electricity during the high demand periods. At the same time, transmission and distribution systems need to be able to accommodate the peak electricity demands resulting in higher investment costs. Introducing time-varying pricing can help electric utilities provide customers with incentives to reduce or shift consumption during peak periods, lowering short-run generation costs and reducing the need for some long-run peak-driven investments. This paper reports on a “critical peak” pricing experiment run by Green Mountain Power (GMP) in Central Vermont. The experiment was designed as a set of randomized control trials where customers were given different rate structures and information on their electricity consumption, and exposed to a number of declared “critical peak events” during which retail electric rates would increase substantially relative to non-critical time periods. Based on analysis of customer response during the first year of the study, we found that customers did respond to higher rates during critical peak periods, although the response magnitude varied depending on the type of critical peak rate to which customers were exposed.

Methods

Green Mountain Power (GMP) launched the pilot study during summers of 2012 and 2013 with the help of two time-based emergency DR programs – critical peak pricing (CPP) and critical peak rebate (CPR) – coupled with the in-home display (IHD) equipment that provided real-time feedback on household-level electricity usage. CPP charges very high pre-determined electricity price during the critical event period. CPR provides incentives to participants for reducing consumption below a determined baseline. IHD allows a two-way communication between customers and electricity grid showing information on real-time electricity consumption and critical peak events. The 3735 single-home residents of Rutland area are separated into six treatment groups and two control groups resulting into 17 million hourly load observation for the first year of the study.

The paper’s primary interest is to estimate the impact of different treatment rates and information system in real-time electricity usage. We create a panel dataset combing hourly electricity load, critical peak event information, weather variables, and participant specific characteristics. We use difference-in-difference regression approach starting with randomized control treatment (RCT) analysis followed by randomized encouragement design (RED). The paper also conducts persistence analysis to analyze customers’ responses within different time periods of the critical peak event, specifically within critical peak event hours, event-to-event analysis, and inter-year analysis. Furthermore, the paper also estimates the impact of real time electricity feedback system on energy consumption. Customers equipped with the IHD technology can look at their real time electricity usage and can adjust their consumption pattern.

Results

The econometric analysis of first year’s data suggests that both CPR and CPP treatments have statistically significant impact on peak load during the critical peak events of the fall 2012. The results show that CPR rate reduces peak load usage by 6.5 – 6.8 percent whereas the impact of CPP treatment rate is larger. The decrease in electricity consumption by CPP rate participants is between 5.9 and 14.7 percent during the critical peak events.The persistence analysis suggest that participants respond consistently during the called emergency demand response hours. Similarly, the energy consumption analysis predicts that the information system technology reduces the monthly electricity load by 5.3 to 6.2 percent. Further analysis will be conducted after we receive the second year electricity usage data.

Conclusion

The results from the first-year analysis show that incentive based demand response programs have statistically significant impact in reducing peak load in the range of 5.9 – 14.7 percent during event hours. However, we cannot conclude that the customers’ savings from peak load reduction will be sufficient to pay for the cost of DR programs without considering the energy savings during non-event hours. The results suggest that participants with IHDs show larger responses during non-event hours than customers facing similar electricity rates but are not equipped with the IHDs. Further analysis needs would incorporate the savings for GMP by avoiding the cost of electricity system upgrades due to the potential peak load reductions.

References

Albadi M. H.and El-Saadany E.F. A summary of demand response in electricity markets. *Electric Power Systems Research.* 78. 1989 – 1996.

Faruqui, A. 2010. Fostering economic demand response in the Midwest ISO. *Energy*. 35. 1544 – 1552.

Herter, K. and S. Wayland. 2010. Residential response to critical-peak pricing of electricity: California evidence. *Energy.* 35. 1561 – 1567.

King, Chris S. and S. Chatterjee. 2003. Predicting California Demand Response: How do Customer React to Hourly Prices? *Public Utility Fortnightly*. 27 – 32. *available at* <http://www.americanenergyinstitutes.org/research/CaDemandResponse.pdf>