DEMAND RESPONSE ASSESSMENT AND STRATEGY PLANNING FOR THE CONDOMINIUM RESIDENTIAL SECTOR IN JAPAN

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ABSTRACT

Dealing with peak electricity demand has always challenged electric power companies. Recent shrinkage of electricity supply capacity due to the nuclear accident in Fukushima, Japan, as well as growing electricity demand under extreme weather conditions threaten a shutdown of the electricity grid in the Kanto region of Japan. Demand response (DR) is one solution that reduces electricity consumption during those "tight" periods by 1) using incentives to solicit electricity consumers to cut consumption, or 2) raising real-time electricity prices.

The residential sector has become the new target for improving energy efficiency, and this research estimates the potential electricity demand reduction at peak hours based on ten minute interval historical electricity consumption data for Japanese households from July 2012 to September 2012 with 94 samples. A DR solution is considered where every electricity consumer in each house is assumed to i) leave the house, ii) cut consumption indoors, or iii) take no action in response to a predicted peak demand. The consumption levels reducible by actions i) and ii) are estimated, and simulations are run based on scenarios with different percentages of residents that take one of the three options. Of the three scenarios considered, the scenario "Medium Participation" highlights the most realistic level of DR outcome where 40% of residents in the house leave the house and 30% of the residents decide to reduce consumption indoors. This scenario is thought to be an 'achievable' level of DR outcomes, and our estimations show that, on average, the household electricity demand peak could be reduced by 28.6%. If the total demand peak for the residential sector in

TEPCO service areas could be reduced by 28.6%, then the peak reduction would be equivalent to the electricity supply capacity of 4 and one quarter of nuclear reactors.

Furthermore, living patterns of the households and their relationship with family structure is investigated, to answer the questions such as ‘Who consumes electricity during peak demand?’ or ‘What are the characteristics of those residents?’ The results of that investigation provide evidence that ties to recommendations aimed at designing effective DR programs for the residential sector. We first identified 4 representative living patterns based on the hours of resident occupancy. We found that on a daily basis, in an average of 46% of the households at least one household member remains in the house and consumes electricity during the day time. We identify this group of households to be a major potential contributor to DR programs. We then looked into the distribution of different family structures that characterize this group and found that nearly 70% of the households are couples living with their children.

These findings enable us to recommend actions plans for policy makers and grid operators. We then describe a number of suggestions that would help households in each of the categories to contribute towards DR. We also suggest how businesses could engage in this project by motivating families that are inside the house during peak demand hours to participate in DR programs. Because, we identified that the majority of the households in Kashiwa-no-ha that consume electricity during peak demand hours are families living with children, our proposals emphasize the importance of providing services to motivate these families to leave their houses during times of peak demand. The findings and recommendations stated in this research should help policy makers and grid operators to design more effective DR programs.

Key words: Demand Response, Residential Sector