An Analysis of Potential Demand Shaving in Japanese Office and Retail Buildings by Demand Responsive Strategies and Technologies

Background

Demand response (DR) programs have been already introduced into a part of US power market and are recognized as a useful tool to improve reliability of power system and curb price spikes in wholesale electricity market. Rapid advances in information communication technologies are expected to make the demand response easier and cheaper to introduce into the power system in the near future.

Objectives

The purpose of this study is to explore the possibility of demand response programs and technologies in Japanese power system. To this end, we first studied what kinds of demand response strategies and technologies are applicable to the Japanese power system, and then analyzed load impact quantitatively when a couple of demand responsive technologies were applied to office buildings and retail stores in the Tokyo Electric Power Co. (TEPCO) service area.

Principal Results

1. Demand responsive strategies and technologies for commercial sector

First, we identified possible thirty five DR strategies and technologies based on surveys of earlier studies on DR strategies in US commercial buildings and reports on energy efficiency options in Japanese commercial buildings. We classified these DR strategies into three categories as follows:

(1) Demand shaving

During a DR period, electricity usage is reduced by lowering output level from building facility or changing building facility operation. Global Temperature Adjustment (GTA) in space cooling and zone switching of lights are primary DR strategies to shed load, because lighting and space cooling demand dominate peak-time electricity demand of commercial buildings.

(2) Demand shift

Electricity usage during a DR period is made to shift out of a DR period by changing operation of building facilities, e.g. re-scheduling operation of thermal storage air conditioner, re-scheduling operation of battery system, pre-chilling goods in refrigerated warehouse, shifting industrial processes to off-peak time and so on.

(3) Peak-time power generation

Surplus capacity of customer owned on-site generator during a DR period is utilized to generate power and reduce purchased electricity from the grid. An economy hotel owned cogeneration system could be an example of this strategy.

2. Technological potential of DR demand shaving in Japanese office and retail buildings

We estimated technological potential of demand shaving in office and retail buildings in the Tokyo Electric Power Co.(TEPCO) service area by three kinds of DR strategies: (a) Global Temperature Adjustment, in which space cooling temperature for an entire building is increased from 26.2 degree C to 28 degree C, (b) Zone switching, in which lights of common spaces, perimeter zones and stockrooms are turned off, (c) Discharging attached battery of computing appliances, in which built-in batteries of notebook computers and UPS of server systems are discharged during a DR period. The DR period analyzed was set to be 13:00-16:00 on summer weekday in FY2020. Office and retail building segments were divided into three and four subcategories respectively, and technological potential of DR demand shaving was estimated considering differences in load characteristics and building facility ownerships among and within the building segments.

Table 1 shows the estimated demand shaving potential of three DR strategies for office buildings and retail stores in FY2020. The GTA strategy has a potential reduction of 753MW, zone switching strategy has a potential of about 417MW, and discharging the attached battery of computing appliances has a potential of 120MW, totaling a load reduction of 1290MW. This means that, a demand shaving of about 1290MW could be technologically achievable in FY2020 if every office building and retail store adopts the supposed demand shaving and shifting options. The estimated demand shaving of about 1290MW is about 25% of the projected reserve of TEPCO, 5130MW in FY2020. That implies that demand response for commercial building sector, if fully utilized, could have the potential to give a considerable reserve capacity to generation reserve on the supply side in Japan.

Future Developments

As a next step, we will study the market potential of demand response strategies and techniques considering the cost benefit and customer acceptance of DR programs. Finally, we will evaluate DR programs in Japanese power system.

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Reference

M. Takahashi, H. Asano and N. Yamaguchi 2009, “An Analysis of Potential Demand Shaving in Japanese Commercial Building Sector by Demand Responsive Strategies and Technologies”, CRIEPI Report Y08034 (in Japanese)

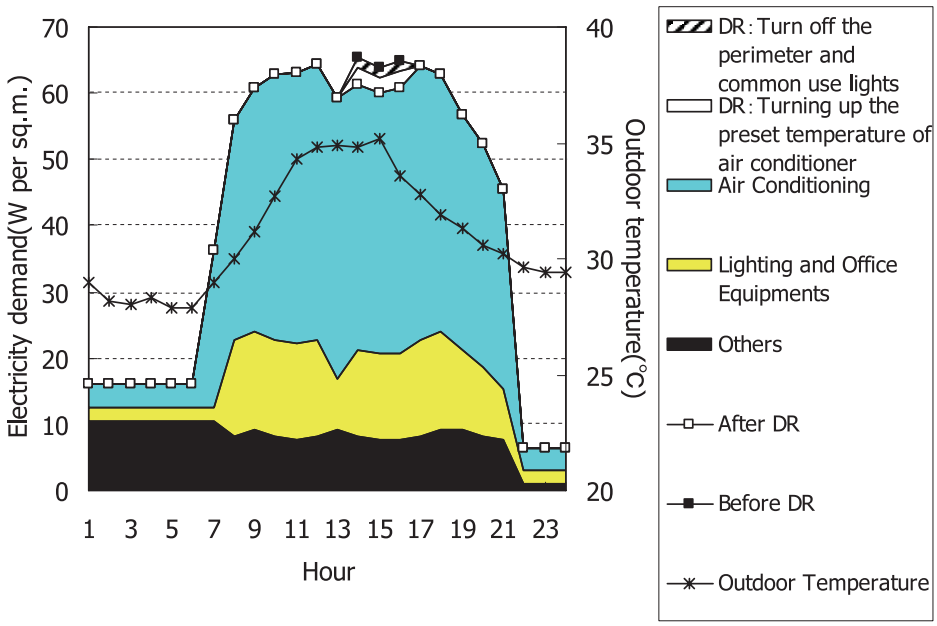

Fig.1 Hourly electricity demand curve and shaved demand of an analyzed small-sized office building with decentralized air conditioners

Table 1 Estimated technological potential of demand shaving by space cooling, lighting and computing appliances DR strategies in office buildings and retail stores in TEPCO, FY2020

	Office Building	Retail Store
(1)Global Temperature Adjustment, Increase temperature for an entire building, from 26.2 to 28 degree C	350	403
(2)Zone switching, Turn off lights of common spaces, perimeter zones and stockrooms	303	114
(3)Discharging attached battery of computing appliances	120	
Total	1290	