Project Research — Development of a Supply/Demand Infrastructure for Next-generation Electric Power

Evaluation of the Feasibility of Demand Response Suitable for Japan

Background and Objective

The "Demand Response (DR) Program," which utilizes Energy Management Systems (EMS), and its technology development is in progress, has been operated recently in the U.S. The DR program also gathers public attention in Japan, on account of the power supply shortage caused by the Great East Japan Earthquake in the short term and of the secure operation of a utility grid and maintaining appropriate power quality in the medium and long term, which has been performed by the supply side exclusively.

In this project, we analyze and assess the feasibility of the DR program, which is suitable for demand-supply conditions in Japan, through the analyses of acceptability or cost-benefit for electric utilities of a new DR application, such as the secure operation of a utility grid, the efficient use of idle batteries, or load creation when a solar PV is to be introduced on a large scale, along with peak-shaving.

Main results

1 A Study on the Possibility of the Implementation of DR for BEMS-equipped Buildings*

We explored the possible and effective peak-cutting DR control strategies of air conditioning and lighting systems in an actual office building and a shopping center equipped with a Building Energy Management System (BEMS) based on a combination of building energy simulation analysis and on interviews with building facility managers. Each control strategy was evaluated on four-point scales from three different viewpoints: (1) the utility' s benefits, (2) the building owner' s (DR participants') benefits and disadvantages, and (3) controllability by BEMS. The results show that reducing lights in office working areas and sales areas has significant potential for peak load saving and is the highest-rated strategy among all DR control strategies from the three-viewpoint evaluation (Table 1). Although reducing lights was hard to implement before the Great East Japan Earthquake, this seems to have changed to become acceptable to customers.

2 Development of a Load-scheduling Application (OPTLOAD) for Industrial Customers

We developed a load-scheduling application called OPTLOAD for industrial customers, which have several facilities being operated independently of each other (Fig. 1). The OPTLOAD can optimize the operation planning of facilities and can minimize weekly cost consisting of energy charges and labor costs by adjusting each facility' s weekly operation schedule, under the customer's peak demand savings and daily task requirement. The OPTLOAD is applicable to industrial customers that can grasp the electric power demand consumed by each facility.

3 Analysis and Trend Observation of the International Standards Regarding Smart Grid in Customer Domains

We observed the trend of the standard development organizations of customer domains in the U.S. and in European countries regarding international standardization, which has serious influence on the spread of DR in Japan. The conventional OpenADR (Open Automated DR) is collected into late-coming Energy Interoperation (EI), which can respond to a wide range of electricity transactions, and the newest OpenADR2.0 will be announced regarding what was reflected as a part of the EI (Fig. 2). Moreover, OpenADE (Open Automatic Data Exchange), which is a standard for third-party access of energy-use information and which was introduced in the smart meter system investigative commission of the Ministry of Economy, Trade and Industry, is taken over to the "Green Button," which is a standard for providing energy usage information to third parties.

*This is the result of cooperation with Azbil Corporation.

Build-ing	Use	DR Measures	1. Viewpoints of the utility: Peak cutting rate*1	2. Viewpoints of the building owner — Benefits / Disadvantages and barriers: Constraints of building facilities and software	Constraints of operation	Acceptance toward changes in indoor environments	3. Controllability by BEMS	Importance*2
Office buildings	Air conditioning	1. Raising preset temperatures in common-use areas (+1℃, +2℃)	+1℃: 0.17% +2℃: 0.32%	○	○	○	○	C
		2. Raising preset temperatures in office working areas (+1℃, +2℃)	+1℃: 0.69% +2℃: 1.35%	○	○	△	○	C
		3. Reducing the volume of outdoor air (25, 20, 15m^3/[hr･person])	25m^3/[hr･person]: 0.07% 20m^3/[hr･person]: 0.08% 15m^3/[hr･person]: 0.10%	○	○	○	○	C
	Lighting	6. Reducing lights in common-use areas (30%off, 50%off)	−30%: 1.44% −50%: 2.39%	○	○	○	○	C
		7. Reducing lights in office working areas (30%off, 50%off)	−30%: 13.31% −50%: 21.75%	○	○	△	○	−30%: A −50%: B
		8. Turning off unused IT machines (30%off, 50%off)	−30%: 8.63% −50%: 14.23%	×	×	△	×	B
Shopping centers	Air conditioning	1. Reducing the volume of outdoor air (20m^3/[hr･person])	0.14%	○	○	○	○	C
		2. Raising preset temperatures in storeroom (+2℃)	0.04%	×	×	△	×	D
		3. Raising preset temperatures in sales areas, centrally air conditioned (+1℃, +2℃)	+1℃: 0.15% +2℃: 0.36%	○	△	△	○	C
		4. Raising preset temperatures in sales areas, individually air conditioned (+1℃, +2℃)	+1℃: 0.02% +2℃: 0.09%	×	×	△	×	D
	Lighting	6. Reducing lights in storerooms (30%off, 50%off)	−30%: 0.57% −50%: 0.92%	×	×	△	×	D
		7. Reducing lights in sales areas, centrally controlled (30%off, 50%off)	−30%: 15.3% −50%: 25.5%	○	○	△	○	A
		8. Reducing lights in sales areas, individually controlled (30%off, 50%off)		×	×	△	×	B

*1 The peak cutting rate is estimated through the use of the ESUM v5 building energy simulation tool.
*2 A = Most important (high peak cutting rate, little disadvantages and barriers, controllable by BEMS); B = Important (high peak cutting rate, substantial disadvantages and barriers); C = Less important (low peak cutting rate, little disadvantages and barriers); D = Out of consideration (low peak cutting rate, substantial disadvantages and barriers)

Table 1: Assessment of the importance of load-saving DR methods

Source: Kurosaki, et.al. A Study on the Possibility of the Implementation of a Demand Response Program for BEMS-equipped Buildings (No. 2): Results and Problems of Method, Proceedings of the 28th Conference on Energy, Economy, and Environment, Japan Society of Energy and Resources, pp. 165-168, 2012.

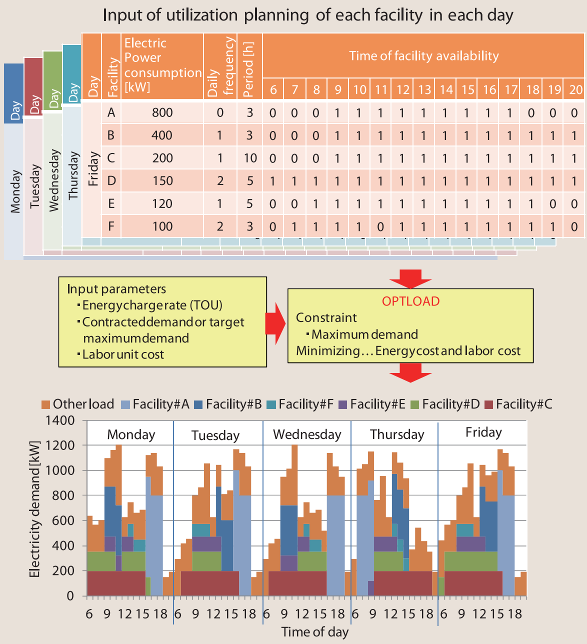
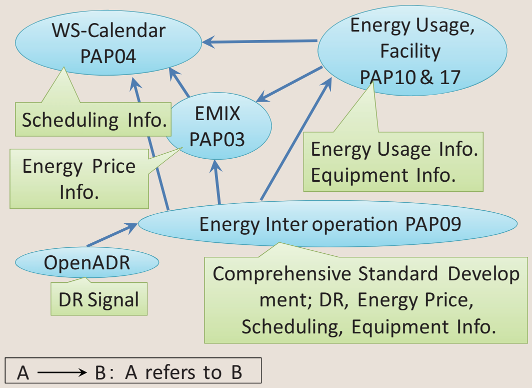


Fig. 1: Calculation flow of the OPTLOAD load-scheduling application



PAP (Priority Action Plan):
A form of technology-focused efforts initiated by the Smart Grid Interoperability Panel (SGIP) of the National Institute of Standards and Technology (NIST). PAPs address specific standards-related gaps and issues for which resolution is most urgently needed.

Fig. 2: Relationship between OpenADR and the relative standards

Energy Interoperation (EI) refers to WS-Calendar, Energy Usage, Facility, and EMIX. OpenADR2.0, which is the newest DR standard and which will be released in a few days, has been the standard that refers to a part of the EI and the apparatus certification procedure, etc., with reference to a part of the EI.

Source: Yamaguchi et al. A Role of OpenADE in Customer Services, The Institute of Electrical Engineers of Japan, PFC-12-003, 2012, revised.