Feasibility of Demand Response Suitable for Japan

Background and Objective

Recently, various attempts to utilize Demand Response (DR), such as encouraging peak shaving or load shift of electricity demand by electricity rate, have commenced as a form of experimental critical peak price by electric utilities or demonstration projects of smart communities. However, knowledge of participation rate for DR program, the amount of load shaving, or the degree of customers' response to rate change has not been sufficiently accumulated.

In this project, we assess the feasibility of DR as a new application for securing grid stability as well as peak shaving from a viewpoint of acceptability and cost benefit. We also supply useful information for electric utilities such as the possible variation in rates or service and global optimization of energy utilization including renewable energy.

Main results

1 Development of a support tool for detecting workers active in DR actions

A tool for obtaining information on confirmation of DR notices to workers in office buildings has been developed. In order to verify the effectiveness of this tool, we conducted an experiment in an actual small office building with around 30 workers (Fig. 1). In the experiment, confirmation time was measured and interview surveys were executed for 3 workers who confirmed DR notice. The experiment result demonstrates that confirmation behavior of workers observed by this tool has a consistency with concern about DR actions (Fig. 2) (Y13016).

2 A study on possibility of fast demand response in Japanese power systems

High penetration of intermittent renewable energy could require enhancements of power balancing capability in the development and operation of Japanese power systems. This study examined the possibility of fast DR as a supplier of ancillary services mitigating such grid balancing challenges and summarized the merits and demerits of fast DR. The merits are enhancements of power balancing capability and creation of cost-reduction opportunity of ancillary services. The demerits are influences on productivity in the customers' production process when a DR event is called. Uncertainty of power balancing capability from fast DR resources is also an issue. The study also explored the possibility of implementation of fast DR for four industrial and commercial segments and showed that waterworks, sewerage works and refrigerated warehouses could be potential DR segments due to having time-unvarying electricity demand all day and night throughout the year, as well as having load shifting experiences. Air conditioning of buildings might also be a potential DR segment due to using a large amount of electricity, though unlike the above three segments, this varies hourly, daily and seasonally (Table 1) (Y13030).

3 Issues in cost-benefit analyses of smart metering in Europe

We investigated methodological issues in the cost-benefit analysis of smart metering in Europe and evaluated the results. Many European countries indicate that the net benefit is positive (Table 2). It is important to recognize, however, that these analyses often look at the benefit to society at large, and that the impact of uncertainty in the benefit of energy savings is particularly large. There may be some non-monetary benefits that are only assessed qualitatively, though such benefits are considered to be small at the moment (Y13022).

4 Issues of estimating costs and benefits of Smart Grid projects in Japan based on the analysis of the U.S. and Europe

Cost-benefit analysis is important to the development of Smart Grid (SG) projects. We explored the methodologies of cost-benefit analysis that made progress in the U.S. and Europe. We found that the basic framework of the approach proposed by the Electric Power Research Institute (EPRI) is applicable to a great variety of SG projects. The European Commission (EC) established a guideline for conducting analysis in Europe which is mainly composed of EPRI's approach. However, the EC modified the approach to cater specifically to European standards. Furthermore, the EC demonstrated their guideline on an actual SG project. Based on our assessment, we found some needs for modification of the EPRI's approach, for example, appropriately formulating the monetary benefits in our SG project, if it were to be applied in Japan (Y13019).

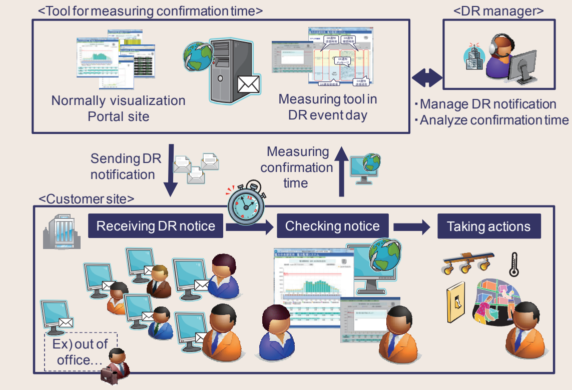
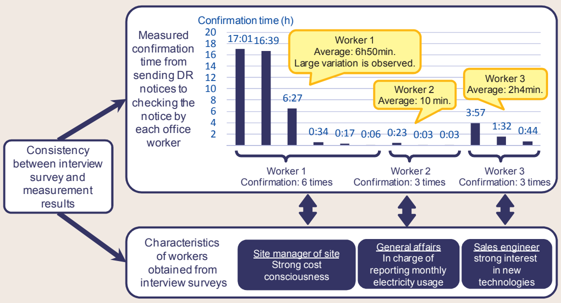


Fig. 1: Conceptual diagram of developed tool for detecting workers active in DR actions



- During this experiment, 9 DR events are issued.
- 6 other workers did not confirm the DR notice.

Fig. 2: Confirmation time from sending to viewing DR notices

Table 1: Possibility of fast DR for four potential and commercial customers

Waterworks, sewerage works and refrigerated warehouses each have an annual averaged load demand of approx. 300 MW in the supply area of Tohoku and Tokyo electric power companies, while air conditioning in buildings has a time-varying load demand, e.g. 7900 MW on summer weekdays and 1600 MW on spring and autumn weekends.

		Water work	Sewerage work	Refrigerated warehouse	Air conditioning in buildings
Time period for fast DR	Season	All year	All year	All year	Summer and winter
	Day	Everyday	Days when amount of sewerage is small	Everyday	Everyday, though weekday has a big DR potential
	Hour	24 hours	24 hours	24 hours	Business hours
Direction of demand change by Fast DR		Demand reduction and creation	Demand reduction only	Demand reduction and creation	Demand reduction and creation
Fast DR techniques		Control of pumps for water supply and delivery	Shut-off of pumps for lifting sewerage, Time shift of sewerage treatment	Control of refrigerators	Control of air conditioners and heat production sources

Table 2: Status of cost-benefit analysis and roll-out of smart meters in Europe

In Germany, a cost-benefit analysis indicated that smart meter roll-out is not cost-effective, even considering customer benefits. In the UK, an analysis suggested that although the benefit from smart meters for distribution network operator alone is not enough to justify the investment, the societal benefit of smart meters outweighs the cost.

Cost benefit analysis		Status of roll-out		Country
Yes / No	Net benefit	Roll-out decision	Status	
Yes	Positive	Yes	Progress	Austria, Denmark, Finland, etc. (4 countries)
			Preparation	France, UK, the Netherlands, Norway, etc. (8 countries)
	Negative	Limited roll-out	Preparation	Germany
		No	Preparation	Belgium, Czech
		Mandate monthly reading *	Complete	Sweden
No	(N.A.)	Yes	Complete	Italy
			Progress	Spain

* No formal decision to roll-out smart meters but monthly meter reading requires actual smart meters to be installed.

Table 3: Main results of cost-benefit analysis for Smart Grid projects in the U.S. and Europe

	Findings	Suggestions
Conditions in the U.S. and Europe	●Clarified the concept, cost - benefit, and the methodological approach by EPRI ●Adopted EPRI's approach as a guideline for conducting analysis in Europe by EC ●Based on EPRI's approach, applied the approach to an actual SG project, InovGrid in Portugal, and verified by EC *	→ Acquisition of the detailed cost-effectiveness in various SG projects → EPRI's approach spreading to countries other than the U.S. → Applicability of EPRI's approach to actual SG projects
Development in Japan	●There is not much difference in SG concepts between countries ●There are differences in the asset formation, operation and the technology between countries ●The ideas of Smart Community/City are similar to that of SG	→ Applicability of the idea of cost-benefits analysis and the framework based on EPRI's approach to SG projects in Japan → The necessity for improvement of the details of EPRI's approach based on actual conditions in Japan → Application of EPRI's approach to the cost -benefit analysis in Smart Community/ City

* Selected as a case study suitable for Europe