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How to reduce electricity consumption at peak times?
The key to influence consumers
Provision of information and granting economic incentives
Effective automation of electricity saving plans

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Publications selected:
[1] Ida, T. (2009) *Broadband Economics: Lessons from Japa*n, Routledge (Taylor & Francis Group): London.
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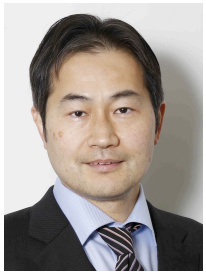

Highlights
- Changing prices of electricity over time are the key to attain “demand response”.
- If left to the consumers, the new electricity pricing scheme would not be widely adopted.
- Surveillance mechanisms to maintain fair market competition are needed.

It is often heard in the news of electric power companies planning to enter the jurisdiction of other companies or making partnerships with mobile operators in order to offer new services or bundle discounts. In the background lies the total liberalization of the retail electricity market scheduled for 2016. It comes a new era when households will be able to freely choose an electric power company according to their life style.

After the earthquake, household awareness of their electricity consumption has changed greatly. After the nuclear power plant accident at the Fukushima No. 1 reactor of the Tokyo Electric Power Company (TEPCO), electricity prices for households have increased nearly 30% due to the rising cost of fuel. Research also shows that the majority of households are willing to change their electric power company if the electricity bill is cheaper. Consumers used to trust electric power companies and did not pay much attention to electricity use, but now they have become sensitive to energy consumption levels.

Every year, the "critical peak" time (daytime midsummer), in which electricity consumption increases the most, is only about 1% of the time (about 9,000 hours) but the power generation cost for this demand peak per year reaches 10-15%. Since power generation costs represent only 60-70% of the operating costs of the electric power companies, it is calculated that if the peak demand is suppressed the electricity bill can be lowered 5-10%.

Electricity prices that change over time utilize the market mechanism by increasing the price at the peak time, when the power generation cost is high, and lowering the price for the off-peak hours. "Demand response" is defined as a mechanism to achieve a more efficient power system by allowing consumers, including households, to participate in the balance between electricity supply and demand. This paper considers the way to promote the realization (social implementation) of demand response in the context of the total power liberalization.

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First, let me explain the mechanism of peak power demand reduction by demand response. The first step for the implementation of demand response is the installation of smart meters (next-generation power meters) to measure the real-time electricity use. The current meters allow power companies to know only the monthly accumulated electricity consumption, and therefore changing electricity prices that reflect the power generation cost cannot be set.

TEPCO has announced plans to install smart meters to all of its customers by 2020. By using the home energy management system (HEMS), consumers can visualize their electrical usage every 30 minutes, and can adopt strategies for power saving.

How much economic effect can be expected from demand response? The Ministry of Economy, Trade and Industry conducted a social experiment of demand response in four regions from 2012 to 2014. At the peak time when the demand and supply of electricity are tight, a power-saving request was issued, and electricity prices increased variously between 50 and 150 yen per kilowatt. Instead, during off-peak hours, the electricity prices were significantly cut, compensating the total budget.

The effect of demand response was found to be large, being able to reduce about 20% of the electricity demand during peak times. Households could achieve electricity costs savings of about 10% by saving electricity use during peak times. By raising the electricity price when the power generation cost is high, the total savings in power generation cost per year nationwide could reach about 10 billion yen. If the reduction in construction costs of future power plants is also incorporated, it is estimated that a wider economic effect of more than 100 billion yen per year could be obtained.

The expected economic effect of demand response is large, but it suffers a major problem. Its diffusion is only marginal. According to the first demand response experiment performed in the world in the U.S. state of California, consumers who chose on their own to participate in the new electricity price scheme represent only 20% of the total subscription rate. The reason is that conservative human psychology may not let consumers adopt a new thing even if it is found to be good. In this manner, the installation of smart meters worth 1 trillion yen could become a useless treasure.

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How can the subscription rate to the new changing prices over time be increased?

Interesting results were obtained from the social experiment carried out in Yokohama City in 2014 (See table).

First, the participation rate in the invitation group by “opt-in” (own choice) was only 16%. The average peak-cut effect of the new price scheme subscribers was 26%. The total peak-cut effect multiplied by the subscription rate was 4%.

Then, the participation rate doubled to 31% in the group that received information about the amount of household's savings expected from the subscription to the new price scheme, based on the actual value of electricity consumption of the previous year. However, since the average peak-cut effect of this group was only 14%, the total peak-cut effect was the same 4%.

Finally, in the group that was granted an incentive fee of 6,000 yen to join the new price scheme as an advance payment of future cost reduction, the subscription rate increased three times, reaching 48%. Although the average peak-cut effect of this group was only 16%, the total peak-cut effect was twice as large at 8%. Thus, it is possible to expand the subscription rate and increase the total peak-cut effect by providing information and granting economic incentives.

In the previous “convoy-style” regulation system, there were low incentives towards favorable strategies by electric power companies, and consequently economic efficiency was undermined. Hopefully, total liberalization will encourage electric power companies to compete, offer new services and aid in the implementation of demand response.

There are still a number of challenges. First, it is the relationship between the existing and the new electric power companies. The existing electric power companies have a vertically integrated system that includes power generation, transmission and retail distribution. In contrast, new entrant companies are often specialized only in power generation or retail. Competition failure may arise due to asymmetric access to power transmission and distribution networks that are necessary to deliver electricity to consumers. Appropriate regulation is vital to ensure the fair usage of transmission and distribution networks.

On the other hand, existing electric power companies must comply with the universal service obligation to supply electricity to all consumers in a universally fair way. If a certain burden of obligation is not imposed on the new electricity companies as well, excessive “cream skimming” of the best customers may occur. Guiding the liberalization process of the power industry is difficult, and mechanisms that allow constant market monitoring of the maintenance of fair competition are a must.

Secondly, there is a need for mechanisms that encourage new innovations driven by liberalization and competition. The demand response is said to be “manual” when consumers save electricity by reacting on their own to changing electricity prices. Electricity saving during hot summer days, when consumers' foreheads sweat, imposes a big psychological burden on the demand side.

If big data of electricity consumption were analyzed by artificial intelligence and power-saving behaviors could be pre-programmed, it would be possible to automatically formulate an optimum electrical consumption plan without imposing extra psychological burden to consumers. This is called “automatic” demand response. By making partnerships with consumer electronics manufacturers, electric power companies should develop

services that took into account consumers' perspectives, and then demand response could switch from manual to automatic.

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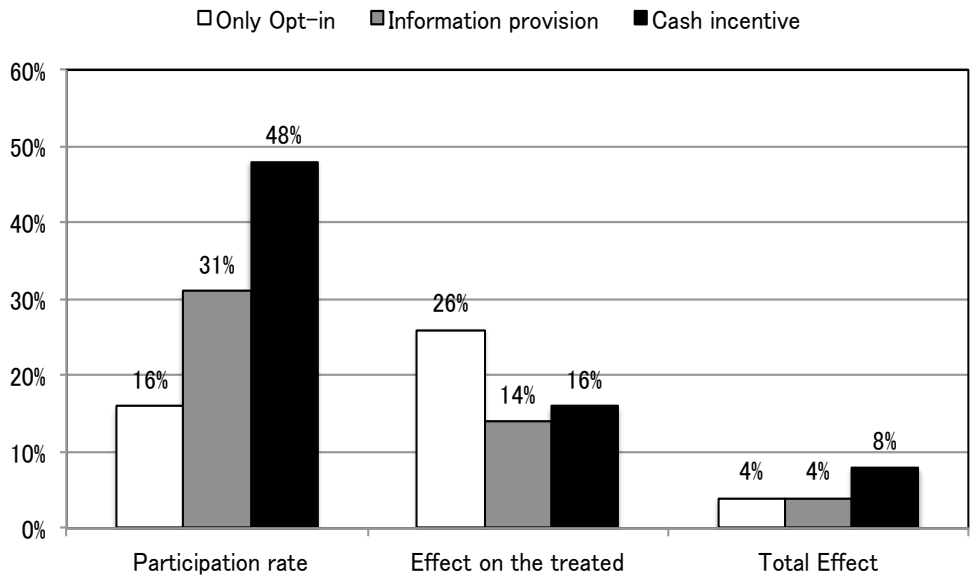
Japan has been suffering a long electricity crisis after the earthquake, but it has a chance, through the implementation of demand response, to solve some energy and environmental problems for the first time in the world. It would also be a good lesson to other countries facing the same energy and environmental issues such as Southeast Asian countries, where an increase in population and economic growth are advancing rapidly.

In the wake of the total liberalization of the electric power industry, the government, academia, and industry should unite, sometimes competing and sometimes cooperating to show Japan's underlying strength to the world. If Japan's demand response is recognized worldwide, infrastructure export of the smart grid (next-generation power networks) could become a growth strategy. Since the foundation of smarter systems lies in information and communications technologies (ICT), smarter applications will spread from energy to health care. Ahead of the electric power system revolution, service innovations of the whole lifestyle (smart life) can also be previewed.

Effect of the Yokohama social experiment



Opt-in participation rate ×Subscribers' effect of new prices = Total effect of new prices
Joint research with Makoto Tanaka at the National Graduate Institute for Policy Studies and Koichiro Ito at Chicago University.