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Emerging Smart Grid in Japan
Time from Technological Testing to Successful Social Implementation

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Publications selected:
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Power shortage suddenly occurred after the March 11th earthquake. In response to this, the social expectations to the smart grid (the next generation transmission network) have been growing. By utilizing information and communication technologies, the next generation energy system effectively eliminates the gap between supply and demand of power, and can contribute to reducing greenhouse gas emissions.

Originally, Japan required a smart grid in order to maintain the quality of electricity while it promoted the introduction of renewable energy as part of the measures against global warming. The smart grid is needed since the power grid is connected to solar and wind power generators whose energy supply tends to be unstable depending on the weather.

On the other hand, the introduction of a smart grid in the United States was discussed as part of measures to curb the electricity demand in response to a serious power shortage caused by institutional reform failure in California. The objective consisted on reducing the variation between power consumption and total power generation during peak hours by the use of smart meters that assign different power consumption rates according to the hour of the day.

While the United States and Japan began to consider implementing the smart grid because of different circumstances, nowadays both countries are facing the same direction and should try to kill two birds with one stone; that is by restraining power demand while promoting energy conservation and renewable energy. In Japan, the Ministry of Economy, Trade and Industry (METI) set up the “project for social implementation of next generation energy”. In the United States, the Obama administration, under the slogan of a Green New Deal, intends to promote the development and dissemination of a smart grid.

In this article, I explore the current status and issues of the smart grid in Japan and the United States, which are shifting to a new stage of commercial demonstration of a social system implementation.

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The smart grid consists of home appliances equipped with a sensor function connected to the power grid, which automatically adjusts the power supply and demand, to achieve energy saving and cost reduction.

The following economic impacts are expected from the smart grid. 1) It controls in real time the power consumption of the household by shifting electricity demand during peak hours to off-peak hours and thus reducing the payment of the demand side and the generation cost of the supply side. 2) It raises environmental awareness on the demand side, through the "visualization" by consumers of their own power consumption. 3) It facilitates the introduction of renewable energy and contributes to the solution of global environmental problems by raising the awareness of energy saving.

Following, the general case of a consumer household will be explained. Smart meters that can measure hourly electricity consumption will be set up in each household. In addition, the sequential introduction of a Home Energy Management System (HEMS) with a two-way exchange of information will offer energy-saving advice or will automatically control appliances such as air conditioner temperature, among others.

The above may be combined with electricity rates that reflect a tight supply and demand of power by dividing the power tariffs into daytime and nighttime or by having critical peak-time prices in summer, several times the normal charge. In addition, if solar power generators are installed, then most of the household power consumption may be covered with the home self-generation, and in some cases extra revenue could be obtained due to the sale of unused electricity. Electric vehicles and hybrid vehicles, expected to spread as ecological cars, can be plugged in to a smart house to be charged with the spare home electricity or, in contrary, the vehicles extra energy can charge electrical batteries or power generators. In this way, new generation vehicles can become excellent house batteries.

If these smart homes and smart buildings can match supply and demand of energy, then local production for local consumption of energy may be possible in each region. Even if large-scale renewable energy is also connected to the power grid, the impact can be reduced considerably. As a result, the current power supply system, based on mass power generation in remote areas and subsequent long-distance power transmission might need a fundamental revision.

From April 2010, METI and the Council for Next Generation Energy and Social Systems launched four demonstration projects of social systems. Yokohama City in Kanagawa Prefecture, Toyota City in Aichi Prefecture, Kansai Science City in Kyoto Prefecture and Kitakyushu City in Kyushu Prefecture were selected as demonstration areas for "smart communities" (see table). Each project pursuits specific goals with different scale for each region.

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On the other hand, what is about the progress in the United States? A famous preceding example is the social demonstration of dynamic electricity rates in Washington D.C., introduced by Professor Frank Wolak of Stanford University. In this experiment,

approximately 1,300 randomly selected households were arbitrarily assigned a wide variety of dynamic electricity rates and their performance was compared with flat-rate households. This experiment has a high academic significance since the true policy effect was measured without bias. The Stanford team demonstrated that dynamic electricity rates have a demand-control policy effect, and they also point out that the effect is greater in low-income households in particular.

Currently, with the support to more than 10 power companies of the smart grid adoption fund under the jurisdiction of the Ministry of Energy, the Obama administration is validating the policy effects of varying electricity rates, the information provided by HEMS and the education on energy conservation and environmental protection.

The author is currently enrolled as a visiting researcher at University of California, Berkeley and Lawrence Berkeley National Laboratory of the United States Department of Energy, and accordingly has the opportunity to discuss about the United States smart grid policy with U.S. experts. If you compare the social demonstration between the United States and Japan, the Japanese society appears more advanced than the United States in that it promptly incorporates state-of-the-art technology such as the introduction of solar power for households, and connection to the home of plug-in hybrid cars, among others.

But there are pitfalls. In Japan, the blurred distinction between technological demonstration success and social demonstration conditional on this success means that there is a small number of samples or insufficient number of agents for policy effects comparison. Also, it does not matter how good the technology is, if the effect of its policies cannot be correctly measured, because it could end up as a castle in the air.

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First we were struck by the earthquake and then the following power crisis. We are faced with a problem that we have never experienced before. The smart grid does not only solve the mere problem of how to promote renewable energy while restraining power demand, it is also the key to solve the bigger problem of how to design energy systems of the 21st century.

Since the stability of the power supply system in Japan is considered to be the best in the world, electric power companies were reluctant to introduce costly smart meters and renewable energy that could increase power instability. Unfortunately, after the earthquake this attitude has been in vain. Power companies should put in place promptly smart meters across the country and should also undertake the use of fluctuating electricity prices.

This is a chance for manufacturing companies involved in the development of next generation automobiles and HEMS. The smart grid policy of the United States is trying to switch from policies to curb demand by use of smart meters to higher value-added measures such as energy-creation and environmental protection policies. In the near future, there is a potential for the widespread diffusion of next-generation automobiles and high-performance consumer electronic products related to the use of a smart grid.

Japanese manufacturers should cooperate without delay with overseas players and participate in the creation of international standards. “All Japan” type of ideas have unnecessarily created a counterattack from overseas markets and can lead to a “Galapagos

effect" (isolation) of Japan's technologies.

In addition, it is expected that most future business opportunities will be in emerging markets where the dilemma between economic growth and environmental protection is more pronounced. At that time, the technicians' ego to sell only the best products should be discarded and a plausible diffusion strategy might involve the provision of goods with some degree of good quality at a low price.

For emerging countries, an initiative to export the entire smart grid system will be required. It is necessary to correctly measure the effect of policies through social demonstration, and to propose a concrete solution of the social dilemma faced by countries.

Four "smart community" social experiments in Japan

Kansai Science City, Kyoto Prefecture (Kansai Electric Power, Omron, etc.) Introduction of an integrated energy-saving community by the use of a smart tap targeted to newly constructed houses.	**Yokohama City, Kanagawa Prefecture** (Toshiba, Tokyo Electric Power, etc.) Measurement of the combined effect of the installation of electricity price fluctuation system (HEMS) and solar power generators targeted up to 4000 households.
Kitakyushu City, Fukuoka Prefecture (Nippon Steel, Fuji Electric, etc.) Measurement of household demand response of apartment buildings that offer varying electricity rates.	**Toyota City, Aichi Prefecture** (Toyota, Chubu Electric Power, etc.) Pursuit of new energy-saving methods by introducing plug-in hybrid vehicles targeted to newly constructed smart homes