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Smart Grids—Core Infrastructure for Low-carbon Societies

Shift from centralized to autonomous, distributed electricity infrastructure

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Summary

- Smart grids—electricity grids that utilize IT to control the flow of electricity—are attracting attention in 2009 as one of the main features of the US economic stimulus package. They are likely indispensable for the mass introduction of renewable electricity sources, whose outputs are heavily impacted by factors such as weather conditions.
- Smart grids can be viewed as an autonomous, distributed electricity infrastructure, in contrast to the current centralized infrastructure. As the makeup of electricity supplies diversifies both in terms of source and location, we anticipate the emergence of a number of areas in the existing electricity infrastructure that will need changing.
- Regarding new demand stemming from the creation of smart grids, our focus is on electricity buffers, which facilitate matching of electricity demand and supply. Specific examples include pumped-storage hydroelectricity and storage cells.
- Just as IT has become an essential element of corporate strategies, we expect green initiatives to be indispensable to corporate strategies going forward. Smart grids can become an integrating energy network allowing more firms to participate in such green initiatives, and so should spur the spread of clean technology.

Japanese report was registered by DIR, so “DIR” used rather than “Daiwa Securities SMBC” in text and charts.

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1. Smart Grids—Integrating Low-carbon Technologies

Hanako Mizuguchi

1.1 Smart Grids Manage Distributed Electricity Generation

Smart grids—electricity grids that utilize IT to control the flow of electricity—are attracting attention in 2009 as one of the main features of the US economic stimulus package. They are likely indispensable for the mass introduction of renewable electricity sources, whose outputs are heavily impacted by factors such as weather conditions. That said, as with CCS (carbon capture and storage: technology to isolate carbon by burying it underground; viewed as key to cutting GHG emissions from coal-fired thermal power plants, etc.), another key technology for creating low-carbon societies, smart grids are still in the trial/research stage, so commercialization will likely take some time.

Still, trials have already started in some regions, including Japan, the US, and Europe. Smart grids require improvements in: (1) links with renewable electricity sources (to create distributed electricity infrastructure); (2) billing and control systems (to efficiently accommodate demand trends); (3) security and reliability (to ensure stable supply). Specifically, it is necessary to control the flow of electricity from both the demand and supply sides using IT.

Standardization of smart grids progressing

Supply-side players (power companies, etc.) already utilize IT technology for controlling electricity flow. However, smart grids are becoming necessary because erstwhile consumers, such as corporations and households, are now becoming suppliers. Specifically, technology is needed to allow power companies to buy excess electricity produced by households/companies using solar cells and other renewables and distribute it over the electricity grid. As a result, control and management technology that has only been used by supply-side players thus far will now likely be introduced for corporations and households as well.

Smart grids are in fact protocol-based grids that transmit electricity and regulate its flow. In the US, efforts are currently underway to standardize the protocols, and the National Institute of Standards and Technology (NIST) is set to announce a standard and roadmap for interoperability in September 2009, based mainly on existing mechanisms (proposals already announced). Major corporate participants in the standardization project are primarily players in the electric power, energy, and IT equipment/service sectors.

Shifting from centralized to distributed electricity infrastructure

Measures to combat global warming are chiefly focused on shifting to a society not dependent on fossil fuels (low-carbon society), so a strategy for a low-carbon society is essentially an energy strategy. Systems for controlling energy are the most important element for maintaining energy security (stable electricity supply with no blackouts or other stoppages). The mass adoption of renewables means these control systems are in need of revision. This could translate into a shift from a highly centralized energy system controlled by the electric utilities (as seen in Japan) to a distributed system in which households and corporations also have the capability to generate, store, and transmit electricity.

1.2 Smart Grids Viewed as Brain to Integrate Low-carbon Technologies in US

Network connecting photovoltaics, electric cars, etc.

One of the reasons smart grids are attracting such attention is their potential as a network to integrate photovoltaics, electric cars (electric vehicles, plug-in hybrids), and other clean technologies that are being promoted under various economic stimulus packages.

The Internet, a network for exchanging information, provides a useful analogy for the workings of smart grids. Information generated on PCs can be stored in memory devices (hard disk drives in case of internal PC memory) and exchanged via the Internet. Routers control these information exchanges. Information can be stored close to or on the PC that generated it (in homes/corporations) or in data centers (via Internet).

For smart grids, electricity would be equivalent to information, electricity sources (such as solar cells) to PCs, storage cells to memory devices, and smart meters to routers. Storage cells can take various forms, such as batteries in electric cars, fuel cells (excess electricity converted into hydrogen), NaS batteries, and pumped-storage hydroelectricity (see 2. Overview of Smart Grids for summary).

Focus areas include smoothing current, decreasing transmission losses, billing/control technologies

On 20 July 2009, the US government announced an increase in stimulus package-based funding for smart grids and its choice of eight trial projects (Chart 1.1). The projects are still at the demonstration/research stages. They have been selected to develop (1) equipment to control and smooth electric current, (2) power lines that reduce transmission losses, such as high-temperature superconductor cables, (3) technology for billing/network control necessary for the shift to distributed electricity generation, and (4) technology to improve the reliability of the electricity grid, including cyber-security. Participants include universities, research institutes, power companies, and firms with energy management technologies.

Model Smart Grid Projects in US (\$ mil)			Chart 1.1
State	Funds	Outline	Project leader
California	8.1	Trial development, demonstration of cutting-edge devices to regulate electric current on grid	Zenergy Power (ZEN LN)
Massachusetts	7.6	Development of 2nd-gen high-temperature superconductor cables to improve reliability, efficiency of energy transmission	American Superconductor (AMSC US)
Nevada	5.7	Reduction of residential electricity demand through researching technologies for distributed generation, detailed energy billing/management by applying cost-benefit analyses, investigating various energy storage design approaches	University of Nevada, Las Vegas
New York	5.6	Development/demonstration of interoperability between energy delivery companies and retail electricity consumers using demand response resources	Consolidated Edison (ED US, power company)
Hawaii	5.5	Research/management of distribution system resources for improved security and reliability, transmission congestion relief, grid support functions	University of Hawaii
Illinois	5.4	Implementation of distributed resources, creation of demand-responsive microgrids in order to achieve optimal energy supplies to individual consumers	Illinois Institute of Technology
Massachusetts	4.8	Development/demonstration of equipment to regulate electric current in order to improve grid stability	American Superconductor (AMSC US)
Colorado	4.8	Research, development, demonstration of coordinated, integrated system of mixed clean energy systems, distributed resources	City of Fort Collins and partner companies
Total	47.7		

Source: The U.S. Department of Energy; compiled by DIR.

Public funding for projects from US Department of Energy

The US Department of Energy (DOE) has announced that it will invest more than \$60 billion in clean energy as part of the economic stimulus measures. The main investment allocations were: \$11 billion for supporting smart grids (including installation of smart meters in 40 million households), \$6.3 billion to support renewable energy and energy efficiency investments by state governments, \$5 billion to support insulation improvements for low-income households, \$4.5 billion to support state government initiatives for energy-efficient construction, and \$2 billion in competitive grants to develop next-generation storage cells.

For reference, we have broken down the Funding Opportunity Announcements released by the DOE up to 23 July 2009 in Chart 1.2. The total funding made available was just over \$22 billion, a bit more than one-third of the \$60 billion for allocation by the DOE. We think roughly one-third of this budget consists of tax breaks, meaning that just over half of the allocated funds have been made available.

Looking at the funding breakdown, \$12 billion has been made available to support renewable energy and energy-efficient construction at the state level (including support for low-income households), \$4 billion has been assigned for the electricity grid, and \$2.4 billion is available for electric vehicle measures, including storage cells. In other words, a lower proportion of the total allocated funds has been made available for smart grids than for state programs and electric vehicles (only around one-third of \$11 billion earmarked for smart grids made available so far). Consequently, we expect further funding opportunities to be announced going forward.

NEDO (New Energy and Industrial Technology Development Organization; Japan) will participate in a large-scale smart grid trial in the southern US. Other participants will be enlisted in September, with some Japanese firms likely involved.

Funding Opportunities Announced by US DOE (\$ mil; as of 23 Jul 09)			Chart 1.2
Field	Funding	Summary	
Total	22,577		
Renewable energy	1,221		
Biomass	658	Research into biofuels refined from algae, enhancement of refueling infrastructure for ethanol blends, integration of biorefinery operations, etc.	
Geothermal	366	Research/development/demonstration projects for advanced geothermal systems, development of systems for collecting/evaluating/classifying data, etc.	
Hydroelectricity	32	Modernization of hydroelectric facilities	
Photovoltaics	75	Promotion of solar energy	
Wind power	69	Trial installations of large turbines, drivetrains, etc.	
Other	21	Development of regional renewable energy sources	
Energy efficiency	11,359		
For states	11,140	Weatherization, installation of energy-efficient appliances, introduction of renewable generation sources, introduction of cogeneration systems, introduction of combined cooling/heating and power systems, etc.	
For industries	219	Combined heat & power systems, local energy systems, energy recovery systems, etc.	
Fossil fuels	2,357		
CCS	1,557	Cultivation of sequestration technology, selection of storage sites, etc.	
Clean coal	800	Clean Coal Power Initiative Round 3	
Electricity grids	4,172		
Smart grids	4,015	Grant program, demonstration projects	
For states	97	Investigation of potential improvements to grid reliability at state level, plans for introduction of smart grids	
Other	60	Evaluation of current state of electricity grid, analysis/plans regarding interoperable electricity transmission	
Transportation	2,918		
Electric cars	2,378	Production of/demonstration projects for high-efficiency batteries/electric motors, etc.	
Trucks	240	Technology development/integration/demonstration for supertrucks, advanced powertrains for light-duty vehicles	
Cars powered by alternative energy	300	Petroleum reduction technology project under clean cities FY09 program	
Construction	150		
Commercial	8	Training programs for building equipment technicians/building operators/energy commissioning agents/auditors, etc.	
Residential	25	Energy Efficient Housing Partnerships	
Materials	75	Cutting-edge energy efficiency technologies	
Lighting	42	LEDs—core technologies/product development/production	
Advanced research	400		

Source: The U.S. Department of Energy; compiled by DIR.

Smart grids also key research field in Europe

The EU proposed digital electricity meters as one method for improving energy efficiency in 2006, and the introduction of smart meters and pilot projects has already started in the UK, Germany, Italy, and other nations. Smart meters have also been positioned as a European Industrial Initiative in the EU's Strategic Energy Technology (SET) plan, which outlines a long-term framework for technological development in Europe (Chart 1.3). According to media reports, fiscal support for the SET plan should be announced in Sep-Oct 2009.

Priority European Industrial Initiatives		Chart 1.3
Initiative	Target	
Wind power	Projects involving large turbines/generation systems. Focus on offshore installations.	
Solar power	Demonstrations aimed at commercialization of large-scale photovoltaics/collector-based solar thermal generation	
Bio-energy	Raising competitiveness of 2nd-gen biofuels	
CCS	Demonstration projects aimed at commercialization of CO ₂ capture/transport/storage technologies in order to reduce GHG emissions from fossil fuel power plants	
Electricity grid	Development of smart electricity grid (incl. storage cells) to integrate diverse renewable energy sources on large scale	
Nuclear power	Technological development for 4th-gen nuclear systems, trial initiatives to maintain competitiveness of European nuclear fission technology/solve waste management issues	

Source: Various materials; compiled by DIR.

South Korea leading way in Asia

Furthermore, in July 2009, the Major Economies Forum on Energy and Climate (MEF), an American initiative, decided to assign a lead country to each cutting-edge clean tech field. These lead countries are required to present an action plan and roadmap for these fields at the meeting scheduled in November. South Korea and Italy were named as the lead countries for smart grids, while Japan is the leader for clean coal.

South Korea plans to construct a nationwide smart grid by 2030, and some expect the nation to undertake joint trial projects with the US from 2010. Apparently companies from both nations, including LS Industrial Systems and Korea Electric Power from South Korea and Google and IBM from the US, participated in a joint smart grid investment forum. Amid such movements, Japan appears a minor player in the smart grid field.

1.3 Large-scale Introduction of Renewables a Prerequisite

Mass adoption of photovoltaics likely to spur introduction of smart grids

Smart grids have garnered little attention in Japan until now. The main reason for this is likely that the existing infrastructure has been sufficient while installation of renewables has remained at low levels. According to government materials, the electricity grid could accommodate around 13 million kW of photovoltaic generation capacity (just under 10 times current levels) if some output restrictions are set. However, the government has set a goal of increasing photovoltaic capacity twentyfold by 2020 (capacity was 1.4 million kW in FY05), suggesting that Japan will need to introduce a smart grid in the near future.

Where are the first smart grids likely to be built? Globally, there is a strong correlation between the countries with the largest number of smart grid projects (US, Germany, Australia, Spain; Chart 1.4, left), and the top-ranked nations in terms of installation of photovoltaic capacity in 2008 (Spain, Germany, US; Chart 1.5, left). The breakdown of smart grid projects in the US by state shows that states that are aggressively introducing renewables, such as California, Texas, and Florida, are taking the lead (Chart 1.4, right). This tallies with our assertion that renewables and other electricity sources that do not generate steady outputs (necessitating capability to smooth output over electricity grid) are a prerequisite for smart grids. The first job for most projects is switching over to smart meters,

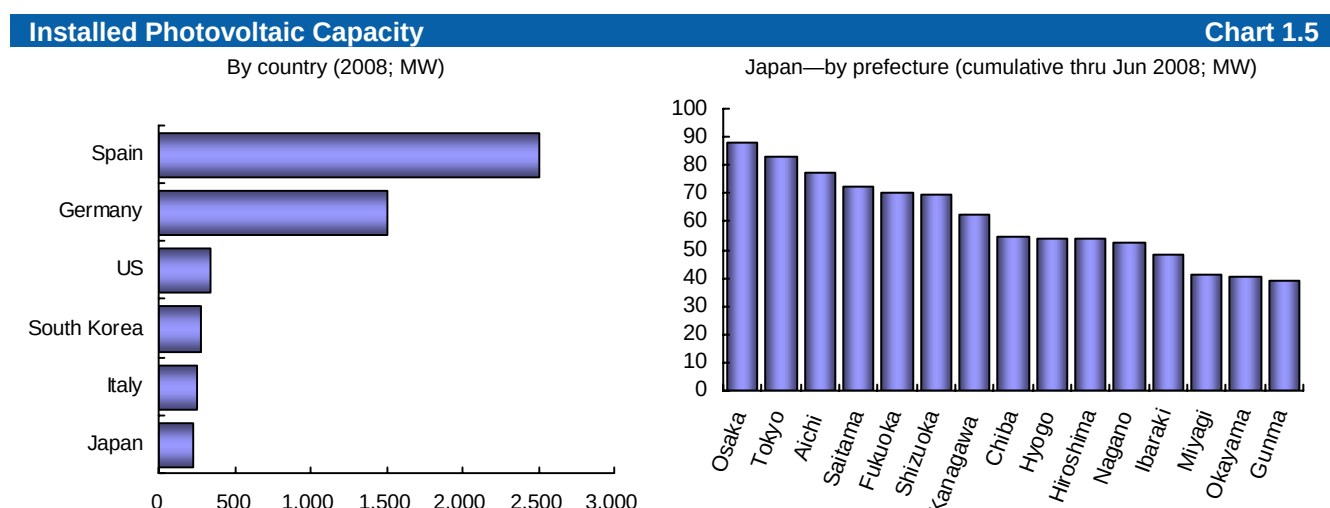
which likely means their scale will be defined by the number of households equipped with such meters (i.e., can transmit, receive electricity).

Smart Grid/Meter Projects (left—by country; right—by US state)								Chart 1.4	
Country	Smart grids (total)	Projects	AMIs (total)	Projects	State	Smart grids (total)	Projects	AMIs (total)	Projects
US	11	8	46	28	Total	11	8	46	28
Germany	1	0	10	2	California	2	2	5	5
Australia	1	1	7	1	Texas	1	0	4	3
Spain	1	1	1	1	Florida	1	1	2	1
Canada	0	0	9	7	Indiana	1	1	2	1
Finland	0	0	7	7	Maryland	1	1	2	0
Sweden	0	0	6	6	Tennessee	1	1	2	2
New Zealand	0	0	4	3	Colorado	1	1	1	0
Denmark	0	0	4	4	Oklahoma	1	1	1	1
UK	0	0	3	1	Washington	1	0	1	0
					Illinois	1	0	0	0

Source: Smart Metering Project Map by the Energy Retail Association in the UK; compiled by DIR.

Notes: 1) AMI: Advanced meter infrastructure (IT-based automatic meter reading system).

2) Totals include trials, pilot schemes as well as projects.



Source: The European Photovoltaic Industry Association (EPIA); compiled by DIR.

Source: Japan Photovoltaic Energy Association (JPEA); compiled by DIR.

In Japan, smart grids will likely be necessary in regions with significant photovoltaic capacity, as home solar panel installation can turn households into net electricity suppliers (i.e., distributed electricity infrastructure). For reference, we have shown the 15 prefectures with the highest photovoltaic capacities on the right side of Chart 1.5. There is significant capacity in the three major urban prefectures (Tokyo, Osaka, Aichi), particularly in Osaka.

According to media reports, trial projects are also proceeding in Japan. Kansai Electric Power will hold a trial in cooperation with Sharp and Sakai City, while a trial led by Tokyo Institute of Technology, with cooperation from Tokyo Electric Power, Toshiba, Hitachi, Mitsubishi Electric, Fuji Electric, Meidensha, and Kandenko, is scheduled to start in FY10. In addition, Kyushu Electric Power and Okinawa Electric Power will apparently hold trials on outlying islands from autumn 2009 with government backing. As with projects in the US, the Japanese trials include an array of participants, such as power companies, universities, research institutes, and firms with energy management technologies.

1.4 Plugging Storage Cells, Smart Home Appliances into Grid

Notably, electric cars are often included in model plans for smart grids as a form of electricity storage. Other envisaged storage devices include fuel cells, NaS cells, and pumped-storage hydroelectricity. As with smart grids, the spread of these storage devices, along with photovoltaics, electric vehicles, and heat pumps, is being fueled government support, as these technologies are viewed as vital components of national anti-global warming policies. Model plans also reach into individual homes to incorporate TVs, air conditioners, and other appliances. This is because smart appliances, which can be remotely operated and automatically monitored/controlled, are becoming a realistic possibility.

Smart grid trials likely in environmental model cities

The Japanese government has designated 13 cities as environmental model cities to undertake projects to promote a low-carbon society. Ten of these model cities, including Yokohama, have included renewable energy and eco-cars in their project plans (Chart 1.6). Of these cities, we expect Yokohama, Toyota, and Miyakojima, which have plans for photovoltaics and electric car projects, to consider the introduction of smart grids particularly seriously. In fact, Miyakojima City has been chosen as one of the sites for the Agency for Natural Resources and Energy's smart grid trial, to be held from autumn 2009.

Projects to Promote Low-carbon Society (000)			Chart 1.6
Model city	Population	Outline	
Yokohama	3,640	Photovoltaics, electric cars	
Kyoto	1,470	Residential photovoltaics	
Kitakyushu	990	Photovoltaics, thermal solar, wind power, storage cells	
Sakai	840	Megasolar, large fuel cells	
Toyota	420	Solar panels, eco-cars	
Obihiro	170	Photovoltaics	
Iida	110	Solar panels	
Miyakojima	55	Photovoltaics, wind power, bio-ethanol, eco-cars	
Minamata	30	Introduction of alternative energy sources	
Yusuhara	5	Wind power	

Source: Government materials; compiled by DIR.

Energy networks connected by smart grids

Since the IT revolution, IT has formed an essential part of corporate strategies. In the same way, we think the current green industrial revolution will make green initiatives an indispensable element of company strategies going forward.

The Japanese government's planned feed-in tariff scheme (from FY10) should spur the spread of photovoltaics. The government announced its medium-term goals for combating global warming in June, which included lifting the country's photovoltaic capacity twentyfold by 2020. The Democratic Party of Japan (DPJ) has a far more ambitious agenda for cutting GHG emissions, calling for a 25% cut vs. 1990 levels, vs. the Liberal Democratic Party's (LDP) target of an 8% reduction (15% reduction vs. 2005 levels). In publicly released materials outlining its medium-term target, the DPJ indicated that its plans include hiking photovoltaic capacity 55-fold from current levels. If policies to achieve this stricter goal are introduced, the adoption of technologies aimed at a low-carbon society should proceed faster.

Smart grids can become an integrating energy network allowing more firms participate in green initiatives, and so should spur the spread of clean technology.

2. Overview of Smart Grids

Hiroyasu Sato

2.1 Distributed and Autonomous Systems

Power distribution in smart grids differs from conventional systems

Chart 2.1 illustrates the difference between smart grids and conventional power generation/distribution networks. In conventional power grids, electricity flows one way from the supplier (power station) to the customer (factory, household, etc.), with voltage being stepped down as it is transmitted over the grid to users. The centralized control of supply ensures an efficient system.

However, power generation comes in an increasingly wide range of forms these days. Solar and wind power in particular have become a force to be reckoned with, especially when environmental concerns are considered. These renewable energy systems allow households and businesses to be both energy clients and suppliers, making an agile, bilateral exchange of power essential for the grid. The current infrastructure, which has undergone efficiency improvements based on the assumption of one-way traffic, needs a facelift to ensure an optimal, autonomous system allowing power to be routed in multiple directions.

To work, such systems need (1) the proper infrastructure for two-way transmissions and (2) buffers to facilitate the management of supply and demand.

A two-way transmission of information is bound to be increasingly necessary, as the decentralized approach to power generation will make it harder to strike a balance between supply and demand. Accurate tracking of demand on a real-time basis will be essential for an autonomous system. This has piqued the interest of a number of major IT players in the US (noticeably Cisco Systems), which have announced plans to make forays into the smart grid, seeing infrastructure needs on this front as a golden business opportunity. The firms likely hope that the network link-ups needed in a smart grid to tie together households in some form or another will drive up data traffic, boosting demand for their products.

Changing Forms of Power Supply		Chart 2.1
	Current system	Smart grids
Characteristics	Centralized Centrally managed power supply Producer and distributor are the same One-way supply of energy Hefty capex due to concentration of equipment	Decentralized Autonomous power supply Producers and distributors are different Power secured through discretionary transactions Decentralization of equipment spreads capex burden

Source: Compiled by DIR.

2.2 US IT Majors Eyeing Smart Meters

Spotlight in US on smart meters

The smart grid has IT majors chomping at the bit chiefly because the network link-ups of households could generate demand on par with what currently exists with the Internet.

For example, Cisco announced plans to participate in a smart grid project in Miami, Florida, estimating that replacement purchases will generate \$20 billion in annual sales of network equipment over the next five years. This project, sponsored by Florida Power & Lighting, aims to install more than one million wireless smart meters to keep track of demand on a real-time basis. Cisco plans to provide the infrastructure equipment necessary to efficiently manage the network of smart meters tying together power clients. The smart grid network proposed by Cisco will use Internet-like protocols but will not be directly connected to the Internet. Its intent here is to use the existing infrastructure to keep costs low while enhancing security levels.

Another big-name in the IT sector, Google, has also expressed interest in smart grids. Its offering on this front is the *PowerMeter*, software aiming to help users manage detailed energy use. When installed on smart meters, *PowerMeter* allows consumers to confirm energy use on a real-time basis for each device using energy. It also allows remote control of equipment. The control of the energy use of a household's individual devices can help users keep a lid on utility bills, especially when rates differ by the time of day. There is a variety of ways a consumer could make use of information on how much power consumer electronic devices are using.

Example of Smart Meter in US

Chart 2.2



Source: Wikipedia; compiled by DIR.

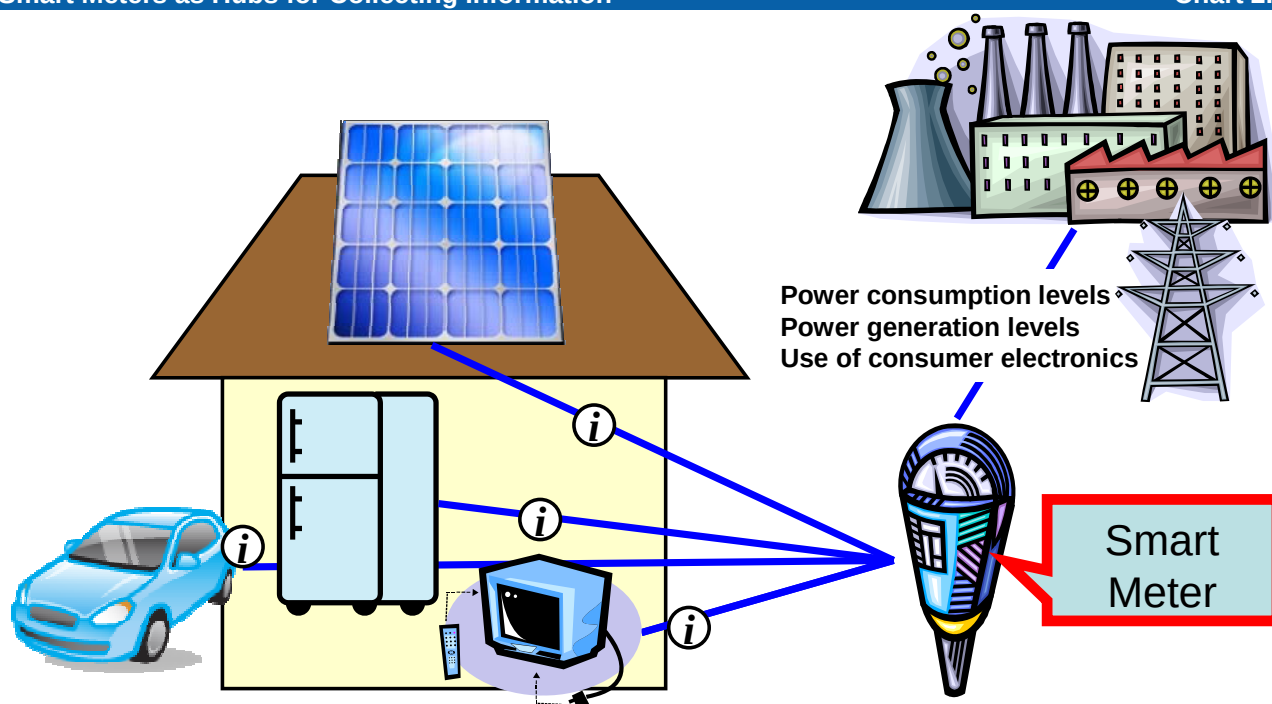
US Internet firms have their sights on aggregation of household information

There are plans underway in the US to promote the spread of smart meters as a hub for acquiring a variety of household information with an aim to curb CO₂ emissions and improve the efficiency of energy management. A number of IT firms want to have a hand in the development of the infrastructure needed to distribute and manage such information. This has fomented strong expectations in the industry, somewhat akin to what we saw at the dawn of the Internet.

Compared to the US, interest in smart meters in Japan is relatively low. In terms of keeping track of power client information, Japan is several steps ahead of other regions and the approach by domestic IT firms is very different from that in the US. In contrast to the US, where smart meter expectations seem overheated, the focus of discussions in Japan appears to be on the value of smart meters as a hub for ascertaining information on the use of consumer electronics in general households.

Smart Meters as Hubs for Collecting Information

Chart 2.3



Source: Various materials; compiled by DIR.

2.3 Buffer for Managing Power Supply and Demand Needed

Buffer needed for efficient supply and demand controls

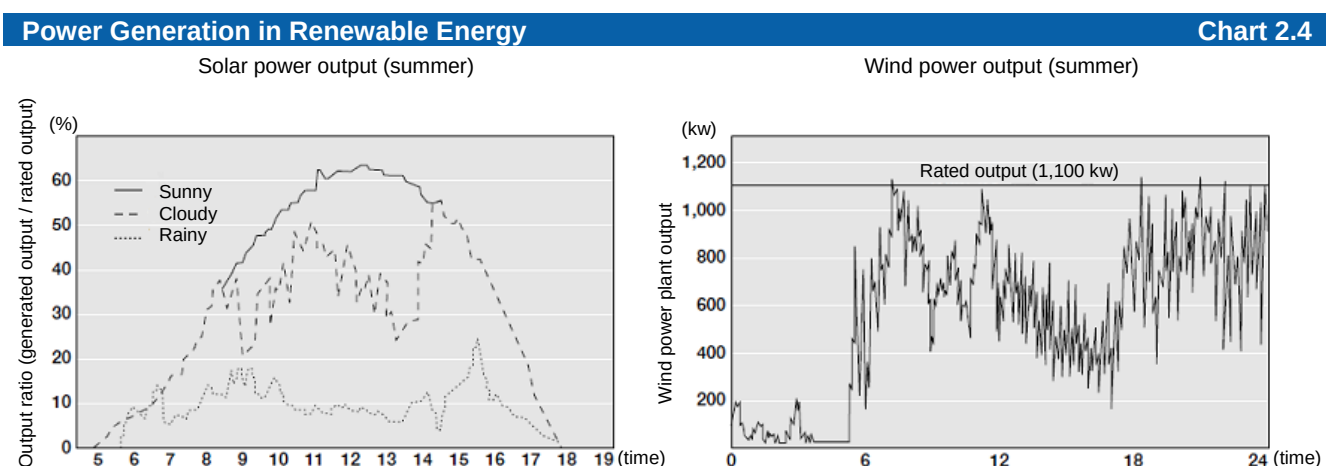
A buffer is needed to ensure an efficient balance of power supply and demand because power generation based on renewable energy can be unstable.

In the current mainstay system, where power generation is centralized at large power plants, the supplier manages the grid since it fine-tunes supply. However, as shown in Chart 2.4, power generation levels can fluctuate widely with renewable energy. Linking such volatile systems to the grid without any buffer can make management extremely difficult, as conventional controls would no longer work when there is widespread use of solar or wind power systems.

The problem is easier to picture if we compare the power grid to water pipes. If the water supply came directly from a waterfall, where the quantity of water produced can vary widely in a short period of time, users might have too much water when they don't need it or not enough when they do. However, if a storage tank (with spigot) was provided to preserve a set level of water from the waterfall, users would be better able to use only the amount of water they need. This same concept could be applied to power.

Continuing with this analogy, the current system is comparable to a carefully managed river that households can directly access. However, a large number of users (themselves minor suppliers) are trying to divert water from new sources to the river, complicating the management of demand. To ensure better controls, these new water flows to the river should go through a tank. In a power grid, one candidate for such a buffer would be batteries, which can store power temporarily.

However, it is not enough to just add more batteries to the system, as cost effectiveness, and thus the efficiency of the control system, will hinge on where the buffers are provided. This is also critical when we consider smart grids from the perspective of industrial development or economic stimulus packages.



Source: Federation of Electric Power Companies (FEPC); compiled by DIR.

2.4 Buffer Candidates: Pumped-storage Hydroelectricity, Large-capacity Batteries

Pumped-storage power generation, batteries could be good buffers

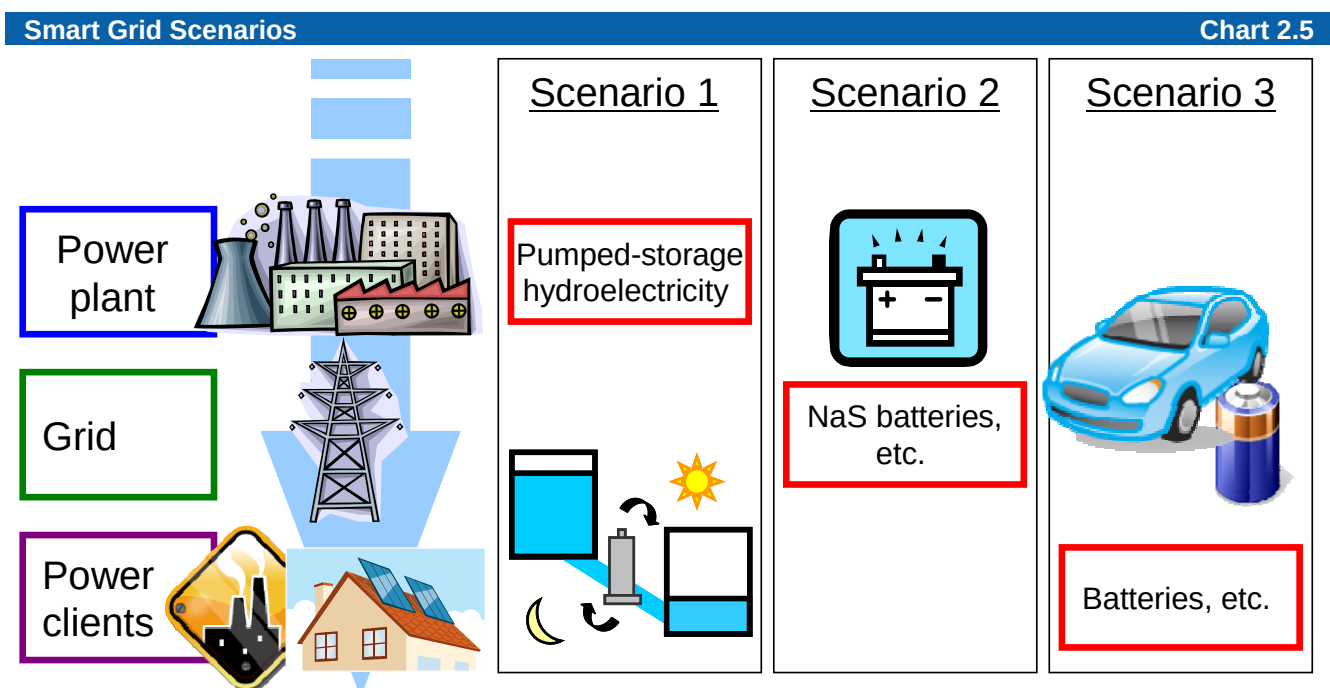
The power grid has several layers. When it leaves its source (power stations), power generally ranges from 275 kV to 500 kV. Substations are used to step down the voltage to 154 kV, with power carried over power lines at 66 kV. From there, power is transmitted over 6.6 kV distribution lines to utility poles, where the voltage is further lowered to 100/200 V for delivery to households.

Based on this multi-layered architecture, we envision three scenarios for positioning buffer spots.

The first scenario assumes the grid uses pumped-storage hydroelectricity as an alternative to large-scale batteries. Solar power is used to offset shortages and power generated by wind power overnight is used to pump water into reservoirs, which can then be used for hydroelectricity during the day, when more power is needed.

In the second scenario, a large-scale battery system is deployed in the power grid to store power generated by the wide range of small-scale suppliers. The best and most realistic solution at this juncture would likely be the NaS (sodium-sulfur) battery, given its high energy density, long life cycle, and compact structure. The scenario assumes a direct connection to the grid as well as parallel installation of the batteries at solar generation plants and wind farms.

In the final scenario, mid-sized batteries are installed at households and other small-scale power clients and suppliers. Although dedicated batteries are the likely candidates here, consumers could also use batteries of electric cars or hybrids.



Source: Compiled by DIR.

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Attention

This cover letter is an unofficial translation. The official document is in Japanese.

Inspected for Advertising, etc. Content

Notification Items Regarding Advertising etc.
(Notification items pursuant to Article 37 of the Financial Instruments and Exchange Law)

If you decide to enter into a business arrangement with our company based on the information described in materials presented along with this cover letter, we ask you to pay close attention to the following items.

- In addition to the purchase price of a financial instrument, our company will collect a trading commission* for each transaction as agreed beforehand with you. Since commissions may be included in the purchase price or may not be charged for certain transactions, we recommend that you confirm the commission for each transaction.
- In some cases, our company also may charge a maximum of ¥ 2 million (including tax) per year as a standing proxy fee for our deposit of your securities, if you are a non-resident.
- For derivative and margin transactions etc., our company may require collateral or margin requirements in accordance with an agreement made beforehand with you. Ordinarily in such cases, the amount of the transaction will be in excess of the required collateral or margin requirements.
- There is a risk that you will incur losses on your transactions due to changes in the market price of financial instruments based on fluctuations in interest rates, exchange rates, stock prices, real estate prices, commodity prices, and others. In addition, depending on the content of the transaction, the loss could exceed the amount of the collateral or margin requirements.
- There may be a difference between bid price etc. and ask price etc. of OTC derivatives handled by our company.
- Before engaging in any trading, please thoroughly confirm accounting and tax treatments regarding your trading in financial instruments with such experts as certified public accountants.

* The amount of the trading commission cannot be stated here in advance because it will be determined between our company and you based on current market conditions and the content of each transaction etc.

When making an actual transaction, please be sure to carefully read the materials presented to you prior to the execution of agreement, and to take responsibility for your own decisions regarding the signing of the agreement with our company.

Corporate Name: Daiwa Securities SMBC Co. Ltd.
Financial instruments firm: chief of Kanto
Local Finance Bureau (Kin-sho) No.109
Memberships: Japan Securities Dealers Association
Financial Futures Association of Japan