

Technotalk

Global Approach to Sustainability Achieved through Electric Power Transmission & Distribution Technology



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Several factors including increasing international demand for electric power brought about by economic growth and measures adopted by various countries aimed at preventing global warming are behind a growing interest not only in power generation but also in transmission and distribution technologies. In April 2011, Hitachi, Ltd. established its new Transmission & Distribution Systems Division in response to demands for electric power transmission and distribution technologies that deliver new value, such as long-distance cross-border transmission system and power system stabilizing solutions that support the wider adoption of renewable energy. By strengthening coordination with other power system equipment and solutions within Hitachi that help maintain a reliable supply of electric power and delivering these in a way that suits the needs of different communities, Hitachi will contribute to creating a sustainable society by responding to the growing global demand for power transmission and distribution technologies.

Wide-area Interconnection Supported by High Voltage Direct Current Transmission and Power System Stabilization

Yasaka: Because of factors such as the increasing international demand for electric power and greater use of renewable energy, there is a growing interest not only in power generation but also in transmission and distribution technologies. The environment in which transmission and distribution businesses operate is also changing, particularly in Japan where significant changes in awareness and policy have occurred following the Great East Japan Earthquake.

Okada: Hitachi City in Ibaraki Prefecture where I live was one of the places hit by the disaster and I experienced the loss of essential services such as electricity, gas, and water. I imagine that going through this experience has increased many people's awareness of electricity.

Nishioka: The planned power outages and summer power restrictions implemented in the area supplied by The Tokyo Electric Power Co., Inc. highlighted, like never before, the importance of energy conservation and the provision of electric power during disasters.

Omori: Japan is the only country in the world that operates two separate power grids with different frequencies, and there has been debate about the need for a greater wide-area power interconnection capacity. The Great East Japan Earthquake has increased motivation to reduce the risks associated with natural disasters by strengthening interconnections between the 50-Hz and 60-Hz grids and between Hokkaido and the Mainland of Japan. Wide-area interconnection capabilities, such as the supply of electric power over long distances or between grids with different frequencies, are provided by infrastructure including frequency converter and HVDC (high voltage direct current) transmission equipment. Nine such systems are in operation at six sites in Japan. Hitachi has been supplying equipment to all of these systems since the 1970s and is the market leader with the largest share of this sector in Japan.

Yasaka: What are the latest technology trends?

Omori: Both frequency conversion and HVDC transmission are based on AC (alternating current)/DC converter technology. Converters can be broadly divided into those that use self-commutated and line-commutated conversion. Line-commutated converters fitted with thyristor valves are capable of being scaled up to large capacities and have been the most widely used type in the past. The most recent technology, however, involves self-commutated converters that use IGBTs (insulated gate bipolar transistors) or similar devices. These converters feature high-speed and flexible control, and with future

technical advances that are expected to allow larger capacities and higher voltages, we are focusing our efforts on the development of this technology. In particular, HVDC transmission has low transmission losses and is in growing demand overseas. Emerging economies and elsewhere recognize the potential of HVDC transmission for use in long-distance transmission lines.

Okada: A common observation throughout the world is that the places where resources are located are often distant from the places where electric power is required. For this reason, attention is being directed toward new types of electric power generation and transmission that can adjust the resource/energy balance both within individual countries and across borders. Examples include "gas to wire" or "coal to wire" power generation, whereby resources such as natural gas or coal are mined from the ground and converted into electricity for transmission to the distantly located demand, and "wind to wire," whereby electricity is sent from offshore wind farms. We believe that the use of HVDC transmission required in these distribution systems has huge potential.

Omori: As the grid becomes larger, the impact of any problems also becomes greater. This makes power system stabilization systems that can prevent wide-area outages extremely important. Hitachi is helping to ensure the stability of the electricity grid through advanced control techniques, for instance, our online TSC (transient stability control) system runs a continuous simulation of power system stability and reacts instantaneously to restore stability in the event of a fault.

Use of IT for More Advanced Power Transmission & Distribution System

Yasaka: The growing adoption of renewable energy is one of the key changes taking place in the global environment in which we operate our electric power transmission and distribution business. In Japan, interest in this area has grown even further since the Great East Japan Earthquake.

Okada: In May, I attended an international conference held by the International Council on Large Electric Systems (CIGRE) where a major topic of discussion concerned the best mix of power sources to suit each country's circumstances. Having a diversity of power sources is important for a wide range of reasons including supply security, environmental protection, economics, and safety improvement.

Nishioka: A number of challenges must be resolved if renewable energy is to be more widely adopted. The output of photovoltaic and wind power, in particular, varies with the weather conditions and the overall grid becomes less stable the more such power sources are connected, because of greater frequency and voltage fluctuations caused by unpredictable

disturbances to the supply and demand balance. While thermal power plants such as gas turbines can do a good job of frequency adjustment, repeated sudden changes in output comes at the cost of poorer power generation efficiency. A similar adjustment mechanism is a pumped storage hydro power plant, and adopting adjustable-speed operation and increasing the adjustment capacity of such plants will be essential, as will other measures such as large-capacity electrical and heat storage systems.

Also, connecting large numbers of distributed power sources such as residential photovoltaic power generation systems to the edge of the grid has the potential to make voltage adjustment difficult. Along with var compensators and voltage regulators, dealing with this difficulty will require incorporation into the electricity distribution grid of next-generation distribution automation systems with energy management functions.

Omori: The main type of var compensator is the STATCOM (static synchronous compensator) which, like HVDC transmission, utilizes the fast response of IGBTs to achieve a high level of control performance. To help ensure a reliable supply of electric power, Hitachi has developed a STATCOM that uses our own proprietary control method.

Yasaka: In addition to the development of such equipment, the move toward greater use of renewable energy is starting to show up in other areas, such as the installation of additional pole-mounted transformers or the replacing of these with low-loss amorphous transformers. In response to these changes, our intention is to help build an electricity distribution system that places less of a burden on the environment through activities such as technology development and the supply of products.

Nishioka: Another idea behind smart grids is to utilize IT (information technology) to deepen coordination between demand and supply and also to induce demand to maintain the balance of supply and demand on the grid, by storing power produced during times of high photovoltaic generation, for example.

Omori: Making greater use of renewable energy will require not only the expansion of power generation capacity but also the use of IT for energy management, as you noted earlier. Because EMSs (energy management systems) with control functions installed in districts, buildings, homes, and other consumer sites will become important along with more advanced distribution automation systems, we are directing our efforts toward development through smart grid and smart city demonstration trials, as well as participation in actual projects. These electric power transmission and distribution systems involve the fusion of technologies from different fields, namely, power, information and control, and telecommunication systems, and I believe that one of

Hitachi's strengths is that we have all of these technologies within the group.

Okada: Work is also being done on using IT to achieve more advanced operation of the high voltage part of the grid. In the USA, progress is being made on increasing substation intelligence by using sensors and other IT to maintain the safety and integrity of aging substations. I visited an old substation built in 1957 that had been upgraded with intelligent functions. I found myself wondering why we couldn't apply the excellent preventive maintenance techniques and philosophies we have in Japan to this intelligent substation concept and supply them globally.

Solutions Compatible with Standardization that Suit Local Needs

Yasaka: What contribution can Hitachi make to the ongoing international growth in electricity demand in the field of electric power transmission and distribution?

Nishioka: Dealing with standardization is a prerequisite for playing an active role in the global market. While there are considerable differences between how standards are viewed in Japan and the rest of the world, it is something that requires an urgent response. Meanwhile, it is also important that we think about how we can deliver solutions and take account of local needs given that these needs may go beyond the scope of standardized technologies and other standards.

Yasaka: Hitachi is starting to strengthen its response to international standardization. Mr. Okada, having played an active part in international standardization committees, what sort of things do you believe we should be doing?

Okada: Although standardization is on going in many different ways such as through the International Electrotechnical Commission (IEC), in fact it is the activities of international associations, like CIGRE, that are important. These associations provide a forum for discussing matters such as what actually needs to be standardized. Having Japanese engineers take an active role in these international associations is essential to the development of any global business. For example, that the international standard for ultra-high voltage transmission was set at 1,100 kV, based on Japan's UHV (ultra-high voltage) standard, was due to vendors playing an active role at CIGRE under the leadership of Japanese power companies. I would like to see more examples of this.

Omori: The high quality of electric power in Japan is underpinned by power electronics and such technologies as power system protection, monitoring, and control systems. I believe that these technologies for ensuring a reliable supply of electric power can play a role in emerging nations, including in measures

for preventing power outages.

Okada: Certainly, Japan's high-quality electric power transmission and distribution technology is widely recognized around the world. However, electricity infrastructures in different countries each have their own histories and circumstances, and are subject to their own economic constraints. The era in which we could participate in the global market through an export-based business model is over. Instead, we must adopt an approach where we listen carefully to the circumstances and requirements of each economy and offer solutions that are rooted in their specific regions. Additionally we need to pursue overseas operations forthrightly and devise projects that are closely tied to the local region. I see this as being one of our roles and a shortcut to active participation in

overseas markets.

Yasaka: For technologies and other solutions with a high level of value to be implemented in only the Japanese domestic market would be a waste. Would it not be better to take what is good about the Japanese approach, including technology reliability and meticulous services, and apply it globally? We have established our new Transmission & Distribution Systems Division to bring together and strengthen the technologies and solutions associated with electric power distribution that Hitachi has built up over time so that we can support social innovation internationally. We intend to take a locally based view of what we can do and contribute to the creation of a sustainable society in the field of electric power transmission and distribution.

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