Preface

Transition and Challenge of Stable Electric Power Supply

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Approximately 140 years have passed since the king of inventors Thomas Edison launched its electric power business, and during that time, after the DC and AC debate with Nicola Tesla [Westinghouse Electric & Manufacturing Company (Company name at that time)], the Alternating Current won over the technology of converting to high voltages for long-distance transport, and the present large-scale AC power transport networks have been established. On the other hand, advances in power electronics technology have made it possible to handle various frequencies freely, including direct current, and direct current technology has penetrated into AC-based power systems. In particular, natural energy systems such as solar and wind energy generation are power generation systems that are not originally related to commercial-frequency 50 Hz or 60 Hz, and it can be said that the value of DC power transmission is increasing in this respect as well. Direct current transmission interconnection is also expected to strengthen the interconnected transmission network for nationwide natural energy interchange.

The power transportation network has become huge by strengthening the interconnection until now, and efficiency improvement and reliability upgrading have been attempted. At the same time, after experienced several large-scale power outage caused by spread of an accident, each time the power supply measures have been strengthened and related technologies have become more sophisticated. On the other hand, with the emergence of global environmental problems, energy conservation and low environmental load have become important keywords. With the increase of natural energy power generation and power electronics equipment in the electric power system, new problems are emerging. For example, as the amount of solar power generation increases during clear daytime in the AC system, the proportion of thermal power generation, which has been playing a role of keeping the frequency constant by balancing the demand and supply, decreases, resulting in a sharp drop in the supply-demand balancing capacity from both sides of increasing variation power sources and decreasing demand-supply balancing power sources. In addition, the stability of the synchronous machine is becoming weaker when disturbances occur due to the drop of the synchronizing power, which is the function of self-stability originally possessed by the synchronous machine, and the lowering of the inertial power possessed by the rotating equipment. The troublesome point of this problem is that it is difficult to see the drop of stability under normal operation, which may cause an unexpectedly large effect once a large disturbance occurs. Though the blackout in Hokkaido is still fresh in our minds, the drop of synchronization and inertia power must also become an important issue that cannot be overlooked in future. In addition, the so-called duck curve problem, in which thermal power generation must be launched abruptly for supply-demand balancing with the rapid decline in solar power generation from the evening, suggests that an increase in natural energy does not lead to a simple reduction in environmental impact.

While uncertainty is increasing rapidly due to the diversity of such power sources and equipment, the widespread use of electric vehicles has increased the number of storage elements connected to the grid, for example, in terms of power storage, which was the biggest weakness in the operation of power systems. Simply, as seen in Vehicle to Home, even if the power supply is disrupted due to an interruption in the power grid, the power supply from electric vehicles allows for the continual use of electricity, thus increasing each reliability. If it is possible to consider the adjustment of the charging time as well as the discharge, it is certain that it can also greatly contribute to the adjustment of the supply-demand balance.

While the increase in the number of power electronics equipment causes a decrease in the synchronization and inertia power as it is, it is also possible to add a function to support a stable supply of electric power when the flexibility of the control of the power electronics equipment is actively used. Various studies have been carried out on this under the name of Grid Forming Inverter. It is also easy to form an operation system to reduce the loss because the power electronics equipment can be controlled flexibly in response to changes in the surrounding conditions. The appropriate information acquisition and control combined with the Internet of things (IoT) technique has enabled re-

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alization of multiple functions which greatly contribute to energy conservation of various systems and improvement of stability and reliability of electric power supplies. In addition to the progress of electric power control technology with power electronics equipment, it is certain that what previously thought impossible will be converted to common sense through the establishment of the environment in which anyone can inexpensively use a highly reliable, large-capacity communication technology with simultaneous, multiple connections like 5G, as well as high-performance information processing and information tracing technology.

I believe that if Edison had acquired the modern technology environment and made various assertions, the aspects of the electric power system would have been quite different, and this reminds me of the importance of creating innovation through new encounters between people in different fields and between technology and technology.

Fuji Electric

Innovating Energy Technology