Expert Insights

Smarter Power Systems Utilizing Total Solution Technology

Akihiko Yokoyama, Ph.D.

Professor of Department of Advanced Energy
Graduate School of Frontier Sciences, The University of Tokyo

Graduated in electrical engineering from The University of Tokyo in March 1979. Completed master's degree in electrical engineering at the School of Engineering, The University of Tokyo in March 1981. Completed doctorate in electrical engineering at the School of Engineering, The University of Tokyo in March 1984. Appointed Assistant, Department of Electrical Engineering, The University of Tokyo in April 1984. Appointed Lecturer in 1985 and Associate Professor in 1989. Appointed Professor at the School of Engineering, The University of Tokyo in September 2001. Appointed to his current position as Professor, Graduate School of Frontier Sciences, The University of Tokyo in April 2008.
Fellow of The Institute of Electrical Engineers of Japan, Chairman of CIGRE JNC, IEC TC8 JNC, and the Electric Power Safety Subcommittee and Basic Policy Subcommittee on Electricity, Ministry of Economy, Trade and Industry.

The electric power system is currently midway through the electricity market reforms prompted by the Great East Japan Earthquake. The Organization for Cross-regional Coordination of Transmission Operators, JAPAN commenced its activities in April 2015, with deregulation of the retail market to occur from April 2016 and legal unbundling of transmission and generation from 2020. Furthermore, the Long-term Energy Supply and Demand Outlook for 2030 was formulated in July 2015 and includes the installation of a large amount of renewable energy capacity, especially photovoltaic power generation. Given these circumstances, there are concerns about how to maintain security of supply, including such problems as lack of frequency regulation capacity and the generation of excess power, with power systems currently at the stage of undertaking a variety of technical developments and demonstration projects aimed at overcoming these challenges.

At the grid level, new systems are required to deal with functions like the reallocation of base-load capacity between control areas to provide a capacity margin for the thermal power plants used for frequency regulation, and the redistribution via regional interconnections of fluctuations in renewable energy output to areas capable of dealing with them. Within individual areas, meanwhile, the process of managing and controlling supply and demand is becoming increasingly complex, including balancing supply and demand up to the market gate closure (GC) time by the balancing groups created by generators, the supply and demand and frequency adjustment performed by grid operators during the period from GC to actual operation, and trading on the electricity market to enable these adjustments. This calls for the construction of systems that are optimal in both technical and economic terms.

A trend in wider society is the construction of smart systems that use the Internet of things (IoT), big data, and artificial intelligence (AI) to deal promptly, flexibly, effectively, and efficiently with changing circumstances that include advances in technology as well as changes in markets and international trends. In the case of power systems, studies have begun to look at the collection of information from smart meters and home energy management systems (HEMSs) (in the case of households), and phasor measurement units (PMUs) and power system infrastructure (in the case of the grid), and its utilization for purposes such as asset management and maintaining the stability of regional grids. Achieving this requires a common information model (CIM) for information that extends beyond individual control areas, from the grid and from power supply infrastructure. If large amounts of renewable energy capacity is to be installed sustainably and without deteriorating grid stability, it is important to produce a very long-term "grand design" for the transmission and distribution network, and this requires investigations into the installation of innovative technologies, such as superconducting cables or a multi-terminal/self-commutated high-voltage direct current (HVDC) transmission network like that being worked on in Europe and the USA.

This means making the power system smarter. To make the power system more attractive to the students and young engineers who will be responsible for it in the future, I see great potential for further progress being made, with a view to international markets, on the development of solution technologies for the electric power and energy sector, the integration of these systems, and their standardization.