Understanding power system conditions based on cross-regional power system operations and renewable power sources increasingly connected to power systems

Masamoto Tatematsu
Senior Research Associate, Research Department, Japan Electric Power Information Center
Tokyo, Japan

Keywords: *PMU (Phasor Measurement Unit), power system conditions, cross-regional power system, renewable power source*

Abstract

In Japan, cross-regional power system operations will continue to be developed and renewable power sources such as wind and PV will be increasingly connected to power systems. Therefore, in Japan there will be 1) clustered locations of power sources and 2) a decrease of inertia and synchronizing power in the power systems.

When these clustered locations of power sources occur in Japan, Japan has a longitudinal power system, and the distance between the power source and the load will lengthen. In addition, the transmittable output power will decrease and power system instability may occur. There are two frequencies (50Hz and 60Hz) utilized in Japan. For the 60Hz system in Japan, the power normally flows from the western area (Kyushu and Chugoku) to the eastern area (Kansai and Chubu). When the clustered locations of power sources occur, more power flows from the western area to the eastern area, and the phase angle between the western area and the eastern area will be wider. This can cause power system instability. Therefore, as the cross-regional power system operations in the 60Hz system of Japan develop, there will be an increased need for understanding of the phase angle between the western area and the eastern area. Therefore, the phase angle should be measured in real time, and the power system conditions should be fully understood.

When renewable energy sources are increasingly connected to a power system, the percentage of synchronous generators in the power system will decrease, and a decrease of inertia and synchronizing power will also occur. The reason is that the power system in Japan is not synchronously interconnected to neighboring countries.

Consequently, the following three problems will occur. These are 1) power system instability, 2) increased frequency fluctuations, and 3) decreased short circuit currents (increased voltage fluctuations and harmonic distortions). Based on these three potential problems, the frequency, power, voltage and harmonic distortion should also be measured in real time, and the power system conditions should be fully understood.

To understand the phase angle, frequency, power, voltage and harmonic distortion, PMUs (Phasor Measurement Unit) need to be utilized. The multiple PMUs can obtain the measurement data time-synchronously and precisely. The PMUs are installed in the U.S. and U.K. power systems, and they are also installed in some electric power facilities in Japan. When the PMUs are installed in all the main substations of the 60Hz system in Japan, and they are utilized for measuring the phase angle, frequency, power, voltage and harmonic distortion in real time, the power system conditions can be understood and evaluated through the PMUs' data. For example, if the phase angle is ever wider, and the power system stability decreases, the proper measures can be immediately taken such as fewer clustered locations of power sources. Through this method, the power system stability and quality can be maintained.