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Abstract

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Voltage Control Method for Distribution System Equipment and PCS for PV

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Abstract

In recent years, the penetration of renewable energy systems such as photovoltaics (PV) has progressed rapidly in Japan's distribution system. The government provides assistance to install PV by purchasing surplus generated electricity and implementing a feed-in tariff (FIT) system since 2009. Under the FIT scheme, if a renewable energy producer requests an electric utility to sign a contract to purchase electricity at a fixed price and for a long-term period guaranteed by the government, the electric utility is obligated to accept this request. Purchase at a fixed price for amounts less than 10 kW is guaranteed for 10 years from the start of the program. The consumer expired this program will appear since 2019.

Japan's distribution system includes voltage management equipment such as load ratio control transformers (LRTs) and step voltage regulators (SVRs). Because their outputs are weather-dependent, voltage control assumes more importance and proves to be a complex problem. To this end, the collaborative control method is considered for the distribution system equipment and power conditioning sub-system (PCS). The PCS suppresses voltage rise when the output voltage deviates from the upper limit. This function consists of normal operation, reactive power output, and output suppression. In a distribution system including a PCS equipped with this function, deviation from the upper limit of the distribution line voltage can be avoided, but the generated power may be suppressed.

One solution to this problem is to extend the waiting time limit of the voltage rise suppression function by considering coordination with an SVR. Typically, the waiting time limit of the SVR is set to about 1min at a minimum. By setting the operating time limit of the PCS to longer than 1min, the SVR can first optimize the voltage and reduce the amount of output suppression using the PCS voltage rise suppression function. However, voltage control performance is degraded by extending the operating time of the PCS. Thus, a method without a waiting time limit is considered to be effective in reactive power control, wherein the power generation opportunity loss does not occur in the voltage rise suppression function.

In this study, we developed a voltage rise suppression function for a power conditioning sub-system that can cooperate with a step voltage regulator as well as cope well with a short cycle output fluctuation. The simulation results confirmed that the proposed method is effective.