The 18th IERE General Meeting and Japan Forum
May 21-24, 2018, Kyoto, Japan

Development of Next-Generation Type of Local Voltage Control Method based on Database of Distribution System Status

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Keywords: *Distribution system, Voltage control, Database, Autonomous control*

Abstract

PVs including rooftop PV and mega solar system have been installed to distribution systems after the operation of Feed-In-Tariff (FIT). Reverse flow from PVs causes voltage deviation from the specified range and degrades power qualities. OLTCs are installed to distribution line in series to control line voltages within the specified range. Line Drop Compensator (LDC) is one of general control methods for OLTCs. LDC controls line voltages based on a reference voltage estimated by passing current and secondary voltage of OLTC. Estimation accuracy of LDC depends on a line-impedance vector as one of setting parameters for LDC. Determination of the line-impedance vector is complicated by diversity power flows due to PVs.

IT-switches and smart meters have been installed to distribution systems to monitor a condition of the distribution system and load demand through a low-speed communication network by distribution system operators. The operators can collect the data containing phase voltages and line currents at IT-switches. These data are difficult for the use of controlling line voltages in real-time since a distribution automatic control system isn't suitable for the distribution system with PVs. The effective operation method for the data regarding distribution system status is necessary.

In this paper, we propose next-generation type of local voltage control method to utilize the database of the distribution system status. This method estimates a confidence interval of the voltage control point based on measured values and the database. The proposed method constructs a database of line voltage of control point corresponding to a passing current and a current phase measured in OLTCs. This method extracts neighbor data corresponding to measured passing currents and current phases from the database. The proposed method calculates a probability density function from the neighbor data to estimate and control the confidence interval.

It was revealed that the rate of inclusion of the actual voltage within the confidence interval was over 90% and the width of the confidence interval was about 3V. We verified that the proposed method reduced the voltage deviation and the switching times by 72% compared with LDC method. These results showed the improvement of voltage control and extension of the instrument life according to the improvement of estimation accuracy by the proposed method.

Revised on February 26, 2018