Volt/VAR Optimization on U.S. distribution lines

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Abstract

Recently, more and more DERs such as PVs and wind turbines which are intermittent resources have been connected to distribution lines around the world. These have made voltage management difficult because voltage goes up and down over a short time due to weather changes. Recently, many distribution companies have been trying to control voltage fluctuation by means of smart grid technologies.

However, many utilities in the U.S. have been trying to control voltage for other reasons. Many U.S. utilities have launched many kinds of smart grid projects, and they have focused on Volt/VAR Optimization (VVO) as well as the installation of smart meters, distribution automation and demand response. VVO has the following objectives; (1) reducing line losses, (2) keeping voltage fluctuating due to DERs within allowable level and (3) reducing peak demand and energy consumption by lowering the voltage level through a method known as Conservation Voltage Reduction (CVR).

In the U.S, CVR is well known as a method of achieving energy efficiency, and many CVR demonstrations have been conducted for decades. However, conventional CVR was previously not cost-effective because there were no economic technologies available to monitor and regulate distribution voltage. These days, smart grid technologies have been extensively developed. Utilities have been able to monitor voltage correctly and regulate voltage flexibly close to real time at a low cost.

There are two VVO/CVR approaches; (1) decentralized control and (2) centralized control. Decentralized control is a conventional method to control exiting equipment such as LTCs (Load Tap Changers), voltage regulators, and capacitor banks independently based on local logic. This method cannot intelligently control voltage, but needs less additional equipment apart from a few of advanced control methods which implement low voltage regulators on the secondary lines of transformers. Centralized control is a method to coordinately control the equipment based on the data from line sensors or smart meters. Communication equipment, sensors and system software are required, but flexible and optimal control can be achieved. Recently, there have been some advanced systems which can also integrate DERs. These systems enable voltage management on distribution lines with a high penetration of DERs.

In Japan, no power company has explored the energy efficiency gains of CVR. However, Japan power companies have also sought new voltage control methods because distribution voltage fluctuation, primarily rising fluctuation, have become a significant issue due to an increase in PVs. Therefore, VVO/CVR technologies in the U.S. could be of a help to accurately monitor voltage, to maintain lower voltage, and to intelligently control voltage.