EPRI DATA ANALYTICS CASE

Optimal Placement of Dist. Capacitor Banks in Conjunction with Controllable Smart Inverters

The Data Challenge

The determination of the optimal size and location of a distribution capacitor bank has long been an issue facing distribution utilities. If managed correctly, these assets have lasting positive impacts of voltage support, loss reduction, system capacity, and power factor correction on the distribution grid as well as the transmission grid. They also support the generation fleet. Common placement and sizing strategies rely on manual processes and the knowledge of the planning engineer about the circuit configuration, present and historical reactive measurements of the study circuit, future load growth and reactive power requirements, and planned additions of distributed energy resources (DER). The reactive capabilities of some controllable DER must be taken into account in order to maintain a desirable power factor using the least costly and fewest number of resources. A non-optimal placement and sizing of capacitor bank and their co-operations with the reactive support capabilities of utility-controlled DER may lead to a less-than-desirable grid performance and could adversely affect the utility financial performance.

Solution Overview

Enhanced planning algorithms and/or applications must be developed to assist with the optimal placement and sizing of new distribution capacitor banks. With the complexities of a modern grid that is becoming increasingly integrated, the analysis must account for the reactive capabilities of smart inverters that exist today and in the near future. As a result, the algorithms and applications must be able to perform numerous simulations to account for most of the possible interactions of the newly placed distribution capacitors, fixed and/or switched banks, with other smart grid devices and their reactive resources to ensure optimal grid performance.

Potential Methods for Solving the Problem

A standalone placement and sizing algorithm or algorithms embedded in a power-flow analysis application or planning tool would need to determine the optimal location of capacitor banks. The application would need access to the circuit topology, historical loading information, historical DER real and reactive power output as well as reserve reactive power capability, potential load and DER growth on the circuit, and dispatch costs by type of capacitance device. After solving for the location and size of the first capacitor bank, the application or planning tool would need to solve for the location and size of each viable capacitor bank. Once all viable locations have been evaluated, the power factor correction and voltage-support capabilities of each should be ranked to determine which location provides the greatest impacts.

The proposed method should be expanded to include multiple installations of capacitor banks to determine an optimal device configuration and an acceptable cost-benefit ratio. One approach would be to place the capacitor banks sequentially, meaning to place the first capacitor bank and the subsequent ones one after the other so that the location of the previously placed device is set before evaluating the next one. An alternate approach would be to place the capacitor banks, two or more, simultaneously. The second approach is more complex and would require more computation time but would likely produce the optimal solution and provide the greatest reliability impact. With each approach and simulation, the ability to control the reactive support of smart inverters and the cost to do so should be evaluated.

Available Data Sets

The data sets highlighted in the following figure are available in the EPRI Data Repository to solve this data analytics case.