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Today"s emphasis on implementing energy efficiency programs and limiting peak demand growth has driven renewed interest in the most effective method to implement Smart Grid volt-ampere reactive control, or Smart Grid volt/VAR control, on distribution systems. This includes the implementation of conservation voltage reduction (CVR), in which the system demand is reduced through controlled reduction in operating voltage at customer load points. Effective CVR implementations can typically reduce demand two to four percent.

The benefit of utilizing a dynamic model is that the volt/VAR optimization always uses the "as-operated" state of the network. As outages and system reconfigurations occur, the network maintains proper connectivity of loads, capacitor banks, regulators, and other feeder components. This ensures the determination of the voltage regulator taps, load tap changer taps, and switched capacitor states always uses the present operating configuration of the system.

The savings in deferred generation plants or capacity procurement costs, lower system losses, lower customer energy consumption, and reduced operating and maintenance costs results in model-based volt/VAR optimization having one of the strongest business cases for Smart Grid functionality.

Due to inherent technology limitations, prior volt/VAR control methods--namely local-based controls and one-way centralized radio-controlled systems--did not permit systematic optimization of voltage and VAR controls for maximum effectiveness in loss reduction and CVR demand and energy reduction. Legacy systems also required additional servers and communications infrastructure that did not enable additional Smart Grid functionality such as fault location, self-healing restoration, and comprehensive distribution system monitoring and control.

With the commercialization of model-based volt/VAR optimization, distribution organizations are now able to achieve maximum performance benefits with reductions in demand and energy, real power losses, and operating costs.

In a smart grid, voltage stability and reactive power control are two related and important concepts. The voltage and reactive power control is crucial for improving efficiency and reliability of the power distribution system. In this chapter, we will learn about voltage and reactive power control.

The integration of volt/var control in smart grid results in several benefits like voltage stability, reduced losses in power lines, improved power quality, uninterrupted integration of renewable energy resources, and more.

Volt/VAR Control (VVC) is an important technical concept in modern power system and smart grids. From the basics, we known that voltage is the electrical pressure between two points that forces electric current to flow, while VAR or Reactive Power is a component of electrical power that oscillates between the source and load and responsible for establishing magnetic fields in electrical machines like generators, transformers, induction motors, etc.

In an electrical power system, there are different types of load devices that contain reactive power components such as inductors and capacitors. These load devices put extra strain on the grid by drawing high amount of electric current. This high electric current can result in over-voltage or under-voltage conditions that can heat up and damage the system equipment like transformers, conductors, etc.

Therefore, it is important to control the reactive power flow and the voltage in the system to prevent such undesirable conditions to happen. For this purpose, a technology is involved that manages the voltage levels and reactive power flow through the power system and it is referred to as the Volt/VAR Control (VVC).

In a smart grid, voltage stability and controlled reactive power flow are two important aspects. Therefore, Volt/VAR control is very crucial for the following reasons −

It is a device that consists of a number of static capacitors connected together. The capacitor bank is used in provide reactive power for compensating the reactive power demand, to improve the power factor, and reduce the energy losses.