Smart grids (Part 3 (I))

Most smart grids are created by adding information and communication technology (ICT) to existing power networks. Given the lack of a universally accepted definition of what constitutes a smart grid, it's difficult to say exactly where a smart grid stops. One view is to base its scope on who owns the assets, so that a smart grid extends only as far as the assets owned by the distributor. However, this simplistic definition may exclude many items that are key contributors to, or drivers for, a smart grid. So those technologies that sit on the network and the second covers those that are more peripheral but play an important role in any smart grid.

Core Smart Grid Technologies

Active Network Management (ANM)

Active network management (ANM) is a collective term for the technologies that put enhanced network monitoring and intelligence into the network to automatically manage functions such as voltage control, fault levels and network restoration. Optimising the network through ANM also offers a smart grid distributor the ability to connect more *distributed generation (DG)*, potentially a relatively inexpensive way to reinforce the network. An essential part of ANM is a fast and reliable communication infrastructure between substations on the network and the central *distribution management system (DMS)*, a suite of application software that supports the operation of electric systems.

Automatic Voltage Control

The voltage across an electrical network changes depending on where consumers are connected and how much electricity they use. The higher the consumption, the greater the voltage drop between substation and consumer. Distribution systems are typically designed to let voltage levels vary within acceptable limits as consumer load varies – voltage levels approach the statutory minimum when loads are greatest and statutory maximum when loads are at a minimum. Consumers complain when they don't get enough voltage whilst high voltage levels can result in unnecessary energy losses. *Automatic voltage control (AVC)* is about putting intelligence into the substations to monitor voltage levels within the Low Voltage (LV) network and automatically adjust controls to maintain the voltage level within preset limits. AVC can improve both the efficiency and power quality of the distribution network. AVCs are going to have to get smarter as not all cope well with the reverse power flow that can arise when distributed generation is connected to the network.

Dynamic Line Rating (DLR)

The conventional approach to network planning and operation is to operate distribution lines within static or, at best, seasonal rating limits. But, in truth, the maximum current an overhead line can carry safely is an ever-changing value affected by prevailing weather conditions. *Dynamic line rating (DLR)* is about squeezing more capacity out of existing network infrastructure through real-time monitoring. For example, strong winds provide cooling that increases line capacity. By measuring line parameters and weather conditions, DLR can determine the capacity of a section of the network at any given moment and use that information to help the network function at peak performance.

Intelligent Electronic Device (IED)

Smart grids need smart tools, and an intelligent electronic device (IED) combines substation protection, control, power quality recording and measurement capability in a single device.

Phasor Measurement Unit (PMU)

Referred to as a power system's 'health meter', a *phasor measurement unit (PMU)* samples voltage and current many times a second at a given location on the network, giving the distributor a near real time view of the power system's behaviour. If traditional Supervisory Control And Data Acquisition (SCADA) systems can be said to provide an X-ray of the network, PMUs provide an MRI scan.

Reactive Power Compensation

Reactive power is one of those concepts that nonelectrical engineers struggle with, but in a nutshell it can be described like this: Some connections to the network just consume power; some, such as a large motor, have the annoying habit of storing up energy supplied to them for a part of the energy cycle, then letting go of it later in the cycle. This reactive power cycle means more power on the network, requiring greater capacity in the cables and increased losses. *Reactive power compensation* is the injection or absorption of this reactive power to control voltage and increase available capacity.