Smart Power Control

The operational complexities of large interconnected power system are increasing with power network expansion and multi energy source connectivity including RES. The matter of great concern for such a dynamical fast growing network has been the regulation of voltage and frequency in tight band as per CERC regulation. Since the expansion of overall system is a continuous process, especially with present focus worldwide on renewable energy integration with Grid along with market operations provision, the Grid parameter's maintenance has now become a major challenge for Grid Security. It is known that Indian power network is operating as "One Nation One Grid One Frequency" from Dec 31, 2013; the sensitivity to any minor change locally may be viewed by the global network at large due to interactive features of various components such as generators, transmission network and loads at different levels. The concept of Smart Grid recently evolved ensures the deployment of sensory devices such as Phasor Measurement Units (PMUs) at strategic location of entire network to get the system parameters such as voltage, current, angle, frequency, rate of change of frequency for effective monitoring of network in real time to understand the overall system functionality. Till date most of the utilities are using PMUs information for visualization and manual decision, however the system demands real time control generation utilizing the signals received through PMUs. The Smart Grid can only be conceptualized if an intelligent automation with integration of Information, communication and control (ICT) technologies is developed to monitor the Grid parameters and precise control injection in real time for ensuring power balance mechanism. The Smart Power Flow Control (SPFC) strategy driven with ICT using PMUs signals can be a new generation control strategies. The usage of SPFC is required at each level of distribution, transmission and generation systems in a clustered form. The forming of clustered control may be conceptualized by dividing the entire distribution network in groups, on the same line entire transmission network and the generators are also clustered. The hierarchy of control, using ICT which is linked with PMUs signalling at each level, is developed and suitably interfaced at distribution, transmission and generation level resulting in a fast-coordinated control with changing power injection statistics using FACTS controllers. This may be a natural option for self-healing feature and improved network performance. The Smart Grid basics are developed with Grid parameters regulation under changing system dynamics. The integration of Renewable Energy Resources (RES) is another big challenge in large power network due to variability of RES and intermittency, this poses serious concern to Grid operators while interfacing with existing Grid structure. The Grid interface technology along with control is another area of research and required a careful Grid Architecture design. The control and operation of RES in existing power system becomes a challenge as the power injection pattern of conventional sources changes due to operational reasons. The Smart Grid Architecture should be capable of addressing the issues of power injection pattern, control modulation with SPFC concept and integration of RES without affecting the operational conflict, if any. The concept of Smart Grid with Smart Power Flow Controller needs to be evolved for efficient system operation. The research will enable to understand the large power system operation complexities and applicability of SPFC in Smart Grid Framework resulting in Grid Security. The interface issues of RES with large Grid needs to be explored with new solutions for smooth power evacuation and overall system stability. In next decade, the power system is going to witness a major change of technology integration and adoption of new controllers in form of intelligent controller to drive the large power network to a relatively safe operational mode with PMUs.