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PXiSE solutions for Microgrid challenges

Microgrids are facing many challenges. Load disturbances on low inertia grids combined with renewable generation intermittency and random electric vehicle charging loads increase requirements on microgrid controllers. Current microgrid controllers follow the traditional Energy Management Systems approach that use network flow models for dispatching controllable generation. These are neither accurate enough nor fast enough to be used in control of systems with fast dynamics. As more renewables are added to the grid, spinning inertia becomes smaller making the system more difficult to control and in systems with 100 percent renewable generation there is essentially no inertia. Traditional control systems depend on inertia to stabilize the grid. Thus, the current measurement and control approaches are not fast enough nor accurate enough for microgrid control.

PXiSE introduced a new control system based on time synchronized high-speed measurements available from existing protective relays. The system uses closed-loop control technology and runs at 60 Hz rates compared to current rates of 0.25 Hz (four seconds). Closed-loop controls are not new in the power industry; they are used for synchronous generator control, but have not been used for control in other parts of the power grid. The basic idea of closed-loop control is to measure the variable to be controlled (for example frequency), compare that with the desired value (for example 60 Hz) and calculate the change required to cause the measured variable to equal the desired value. For example, for closed-loop control of frequency, if the measured value is below 60 Hz, the controller computes and applies the necessary power to bring the frequency back to its setpoint.

However, voltage and frequency are by both real and reactive power injected into the grid. Thus for precise control we need to control both voltage and frequency as a multi-variable system. We introduced a solution called â€œ2x2 decoupledâ€ control. This technology is used in other industries including airplane and ship autopilots, noise cancelling headsets, gun control systems and other process control systems in refining and paper-making. We demonstrated this type of controller using a low cost industrial hardened PC at a large wind farm with a battery. Originally, the battery was used to control the rate of change of power injected into the grid to match the speed of response of diesel generations. This allows diesel generators to control frequency using the traditional method called â€œdroopâ€ control. However, droop controls introduce frequency â€œchatterâ€ that can cause power quality problems when the chattering becomes too great. Chatter will become more pronounced as additional renewables are added to the grid.

The PXiSE controller solves three fundamental problems: control of demand at the point of interconnection, control of frequency, and control of voltage with no interaction between the variables. It does this by using fast closed-loop multi-variable decoupled controllers. We control both frequency and power flow from the wind farm at a specified â€œsetpointâ€ in compliance with the IEEE 2030.7 Standards for microgrid controllers. The control system provides the wind farm owner with the ability to respond to curtailment signals from the system operator while holding frequency and voltage at their desired setpoints.

The wind farm becomes a virtual island by simply setting the power flow setpoint to zero. In this mode, the system can physically separate from the grid and operate as an island microgrid. It reconnects at any time since it maintains its voltage angle equal to the system voltage angle.

Our control technology controls grids with essentially zero inertia (100 percent renewable distributed generation.) This is accomplished using fast closed-loop controllers with time-synchronized data from existing protective relay and low cost industrial hardened PCs.

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Additional submitted attachment is included below.

PXiSE for Microgrids

April 24, 2017

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