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Superordinated Control for Increasing Feed-in Capacity and Improving Power Quality in Low Voltage Distribution Grids

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Abstract : The ever increasing amount of distributed generation in low voltage distribution grids (mainly PV and micro-CHP) can lead to reverse load flows from low to medium/high voltage levels at times of high feed-in. Reverse load flow leads to rising voltages that may even exceed the limits specified in the grid codes. Furthermore, the share of electrical loads connected to low voltage distribution grids via switched power supplies continuously increases. In combination with inverter-based feed-in, this results in high harmonic levels reducing overall power quality. Especially high levels of third-order harmonic currents can lead to neutral conductor overload, which is even more critical if lines with reduced neutral conductor section areas are used. This paper illustrates a possible concept for smart grids in order to increase the feed-in capacity, improve power quality and to ensure safe operation of low voltage distribution grids at all times. The key feature of the concept is a hierarchically structured control strategy that is run on a superordinated controller, which is connected to several distributed grid analyzers and inverters via broad band powerline (BPL). The strategy is devised to ensure both quick response time as well as the technically and economically reasonable use of the available inverters in the grid (PV-inverters, batteries, stepless line voltage regulators). These inverters are provided with standard features for voltage control, e.g. voltage dependent reactive power control. In addition they can receive reactive power set points transmitted by the superordinated controller. To further improve power quality, the inverters are capable of active harmonic filtering, as well as voltage balancing, whereas the latter is primarily done by the stepless line voltage regulators. By additionally connecting the superordinated controller to the control center of the grid operator, supervisory control and data acquisition capabilities for the low voltage distribution grid are enabled, which allows easy monitoring and manual input. Such a low voltage distribution grid can also be used as a virtual power plant.

Keywords : distributed generation, distribution grid, power quality, smart grid, virtual power plant, voltage control
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