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Performance Evaluation of Microgrid Management Function in KERI pilot plant

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As usual, the microgrid operates in grid-connect mode, but, when a fault occurs in the upstream grid, it should disconnect and shift into islanded operation mode. In grid-connect mode, the frequency of the microgrid is maintained within a tight range by the main grid.

Therefore, the controlling power flow at PCC (Point of Common Coupling) is necessary management function rather than the frequency and voltage. In an islanded operation, however, which has relatively few microsources, the local frequency and voltage control of the microgrid is not straightforward. To achieve the management goals in two different operation modes, the cooperative control strategy of all components is needed.

The microgrid has a hierarchical control structure as shown in Fig. 1. It has two control layers: MMS (Microgrid Management System) and LC (Local Controller). The MMS is responsible for the supervisory control of micro sources and the energy storage system.

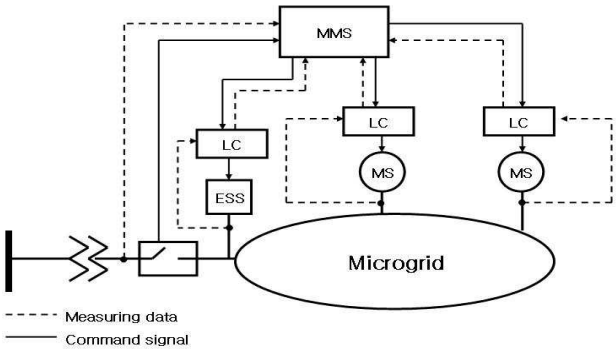

Fig. 1. The hierarchical control structure of microgrid.

In grid-connected mode, the MMS compares the measured power flow at PCC and the reference value to obtain the error. This error is regulated by regulator in MMS. The total required power command is applied to the dispatch function to generate a power output set-point for each individual available controllable microsource.

In islanded operation, the control scheme of the ESS has to be switched from fixed power control to frequency/voltage control during islanded operation.

Otherwise, other controllable micro sources are still fixed power control. By proper control action of the ESS, the frequency and voltage of the microgrid can be brought back to the normal values after a disturbance.

Though the frequency and the voltage of microgrid in islanded operation can be effectively controlled by applying an F/V control scheme in the ESS, the control capability of the ESS may be limited by its available energy storage capacity. Therefore, the power output of the ESS should be brought back to zero as soon as possible. The secondary regulation control is in charge of returning the current power output of the ESS to the pre-planned value, which is usually set at zero. This secondary regulation control is performed by using cooperative control scheme of micro sources and ESS in MMS. The performance evaluation test results show that the power flow at PCC in grid-connected mode is regulated at certain constant level by control algorithm of MMS. It means that microgrid can acts as aggregated constant load or generator. Therefore, the distribution operator can utilize the microgrid to achieve the effective system operation goals such as peak reduction, congestion avoidance, and voltage control. In islanded mode, the ESS, which has a relatively fast response time, plays a primary control role. The test results indicate that the ESS can handle the frequency and the voltage very well. The control capability of the ESS may be limited, however, by its available energy storage capacity. Therefore, power output of ESS should be brought back to zero as soon as possible. The secondary regulation control is in charge of bringing back the current power output of ESS to a pre-planned value, usually zero. The results show that the proposed cooperative control scheme can regulate the frequency and voltage and reduce the consumption of the stored energy of ESS in islanded mode.