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Emergency and postemergency control in the formation of microgrids

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At the present time, there is a worldwide tendency to clustering the electrical power systems at LV and MV levels – creating the microgrids. Russian power systems are not an exception. In this connection, numerous of technical issues appear in control approaches in general and in particular in emergency and postemergency control.

The hierarchical structure of ensuring the reliability of power supply is composed of 3 levels, where enclosing parts of distribution grids and object's inner power supply grids into microgrids is lined up with the third level, which, in its turn, gains absolutely new value here from consumer's point of view.

As microgrids are meant to operate both in interconnected and islanded modes, the ability to steadily island and backward synchronize with an upper grid provides reduction of the negative impact of failure rate of electrical power system's elements, as well as power quality parameters influence toward operation regime of the loads. At that point, goals of the 1st and 2nd hierarchical reliability levels (supply-demand balance reliability and bulk system reliability) are not leaved out, but implemented within a microgrid, becoming more comprehensive as emergency transients are tougher in LV/MV islanded systems due to lower power reserves, low mutual impedances between generating units, energy storage systems (ESS) and loads, decreased overall inertia constant of the interconnected grid.

The consequence of previously described features is particular requirements for the following emergency automatics: overload-preventing automatics for overhead lines, cables and transformers; out-of-step automatics and underfrequency load shedding.

Low inertia constants of some distributed generation units and low time constants of electromagnetic transients of generating units and ESS, interconnected with a grid by means of power-electronics, provide an ability to realize additional (fast) control signals in overload-preventing automatics, dispatching generating units and ESS with an aim to prevent considered elements tripping.

Tripping off generating units by signals from out-of-step automatics is justified exceptionally in cases of exceeding the maximum allowed asynchronous regime duration or considerable influence toward electrical rotating loads, where the latter has to be reasoned by calculations.

Controllable loads, appearing as one of the distributed energy resources, in common with centralized evaluation of latters bids (microgrid central controller or particular agent in multi-agent system) lead to higher accuracy of underfrequency load shedding, limiting volume of tripped-off loads.

Distinguished features of such a fully controlled low-scale electric power systems are preventive monitoring of meeting stable-islanding conditions in real time with control values dosage and centralized blackstart capability, which form emergency automatics types, thus are considered here.

In the end, as emergency automatics fit in all hierarchical levels of microgrid's automatic control system (ACS), it is explicit that availability of telemechanics has the crucial impact on service capability of the emergency automatics. The latter fact should be evaluated as restriction while conducting feasibility analysis of ACS types at design stage.