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**Use of Microgrids and DERs for Black Start and Islanding Operation**

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**Abstract;**

DER are fast emerging in either MV or LV networks, allowing that the concept of autonomous microgrids and multi-microgrids may turn into a reality. The new distributed generation units are also now required to present more flexibility of operation via local control loops and by allowing remote control [1]. Storage devices are able to operate as voltage source controllers with grid forming capabilities, which allow frequency control. Active response from loads are providing additional dynamic flexibility.

A microgrid can be considered as a set of LV feeders on which several microsources, storage devices and responsive and controllable loads are connected. A microgrid also includes a local communication system and a hierarchical control structure which is headed by a MicroGrid Central Controller. The enlargement of the control concept to a large number of microgrids leads to the multi-microgrid concept, a higher level structure formed at the MV level, consisting of several LV microgrids and DER units connected on adjacent MV feeders depending on HV/MV substation. The development of the multi-microgrid concept requires a communication infrastructure with a local control architecture headed by a local semi-autonomous control center, virtually housed at the HV/MV substation level [1].

The controllability / flexibility of the DER units, where storage with fast frequency control functionalities can be adopted, allows islanding operation of the microgrids and multi-microgrids for emergency conditions providing increased resilience to the grid. Black start can also be exploited with this local control architecture, by developing a bottom up approach where black start is initiated at the microgrid level and progresses upstream, via the synchronization of the different microgrids with the existing generating units connected directly to the MV grid. This requires the development of a sequence of actions, controlled via a decentralized approach, where the virtual local control center is issuing the required restoration commands.

Multi-hop wireless networks, replacing PLC solutions, for the last-mile segment, capable of supporting the communications QoS requirements targeted for these systems, namely those related with control and management solutions, can be adopted to deal with communication needs under these emergency conditions.

**References:**

[1] "Establishing a Network Code on Requirements for Grid Connection of Generators", Commission Regulations (EU) 2016/631 of 14 April 2016.

[2] Nuno José Gil, J. A. Peças Lopes, "Exploiting Automated Demand Response, Generation and Storage Capabilities for Hierarchical Frequency Control in Islanded Multi-Microgrids", PSCC'2008, Glasgow, June 2008.