SHORT ABSTRACT

A new type of microgrid called multifrequency microgrid (MFMG) is investigated in this thesis. It is formed based on the superposition theorem, orthogonal power flow theory, and frequency selectivity criteria. It is a unique system where different frequency voltages and currents are present on the multifrequency (MF) bus and different frequency powers maintain orthogonality and transmit simultaneously through the MF bus without mixing. Frequency selectivity criteria states that the consumers can choose any available frequency power from the MF bus based on their requirements. This research work focuses on the basic architecture, converters, and control strategies of MFMG.

In this thesis, the basic architecture of MFMG is defined where a voltage source converter named DC/MF converter acts as the building block. The DC/MF converter is used as grid side, grid feeding, grid forming, load side, and battery side converter, and all control strategies are explained. The presence of different frequency powers on the MF bus and frequency selective power transmission create different new active and reactive power imbalance situations which are not present in traditional microgrids. No power balancing strategy is discussed in the literature for MFMG. In this thesis, all new active and reactive power imbalance cases are discussed and the conditions are identified to balance different frequency active and reactive powers in MFMG for grid connected and islanded modes. New power balancing strategies are proposed here to solve all power imbalance cases based on the power balancing conditions. An energy storage system (ESS) needs to be integrated with MFMG due to the uncertainty and intermittency of renewable sources. In this thesis, an algorithm is proposed to coordinate the ESS and different renewable sources to balance different frequency load power demands of MFMG for optimum power generation through communication under a cooperative framework. The framework is constructed based on the assumption that any load prefers to absorb power from the closest source for minimum power loss and cost.