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Decentralised consensus-based hierarchical control of a hybrid AC–DC microgrid robust to communication delays

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Abstract-

The continuous growth of distributed renewable energy resources in medium and low-voltage networks supports the case for a distributed architecture for electricity supply relying on microgrids. Whereas decentralised architectures for the primary and secondary control layers of the hierarchical control of microgrids have already been proposed, the tertiary control (economic dispatch) has been mainly formulated as a centralised control or as a distributed control that relies on a central agent to coordinate the operation between distributed generators. This paper proposes a fully decentralised hierarchical microgrid control based on a consensus-based economic dispatch problem. Unlike the proposals found in the literature, the convergence of the proposed tertiary control layer is robust to communication delays and the secondary control layer applies an incremental formulation for a seamless integration with the tertiary layer. The robustness and performance of the proposed hierarchical control are compared with those of a conventional centralised approach and a previously published decentralised approach. The proposal is validated using detailed non-linear real-time simulations, and its stability is proved by modal analysis and using Lyapunov functions.

Index Terms- Consensus; Decentralised control; Economic dispatch; Hierarchical control; Microgrids

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