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Improvements of a multi-agent secondary controller for reconnecting a microgrid to the main grid

A. Tomás Martín; J. Roldán Pérez; N. Jankovic; S.J. Yagüe Yagüe; L. Sigrist; A. García Cerrada

Abstract-

Microgrids (MGs) can work either connected to or disconnected from the main grid, and seamless transition between modes is essential for reliable operation. Even though centralised secondary controllers are the obvious choice to resynchronise MGs with the main grid, and to control their power exchange, decentralised multi-agent secondary controllers have been proposed recently because they simplify the communication system required. However, aspects such as communication delays and implementation details have not received enough attention. This paper describes an improved decentralised multi-agent secondary controller based on consensus to resynchronise a MG with the main grid and control the power exchange afterwards. The effects of communication delays between agents and the potentially dangerous active power transients required to synchronise the MG were studied by small signal stability analysis and numerical simulations. The paper shows that both problems can be addressed with a systematic design of the decentralised secondary controller combined with derivative droop primary controllers. Results were validated in a real MG consisting of four 15 kVA power converters, electrical lines and loads, a 75 kVA grid emulator, and an industrial communication infrastructure. The proposed algorithm has been validated in a large system consisting of 69 buses, which includes seven grid-forming converters and primarily resistive lines. Additionally, the algorithm has been tested in scenarios with limited available energy from the converters and taking into account the control of the voltage amplitude difference between the microgrid and the main grid.

Index Terms- Microgrid; Synchronisation; Decentralised control; Multi-agent systems; Small-signal stability

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