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Impacts of optimal energy storage deployment and network reconfiguration on renewable integration level in distribution systems

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Abstract— Nowadays, there is a wide consensus about integrating more renewable energy sources-RESs to solve a multitude of global concerns such as meeting an increasing demand for electricity, reducing energy security and heavy dependence on fossil fuels for energy production, and reducing the overall carbon footprint of power production. Framed in this context, the coordination of RES integration with energy storage systems (ESSs), along with the network's switching capability and/or reinforcement, is expected to significantly improve system flexibility, thereby increasing the capability of the system in accommodating large-scale RES power. Hence, this paper presents a novel mechanism to quantify the impacts of network switching and/or reinforcement as well as deployment of ESSs on the level of renewable power integrated in the system. To carry out this analysis, a dynamic and multi-objective stochastic mixed integer linear programming (S-MILP) model is developed, which jointly takes the optimal deployment of RES-based DGs and ESSs into account in coordination with distribution network reinforcement and/or reconfiguration. The IEEE 119-bus test system is used as a case study. Numerical results clearly show the capability of ESS deployment in dramatically increasing the level of renewable DGs integrated in the system. Although case-dependent, the impact of network reconfiguration on RES power integration is not significant.

Index Terms— Energy storage; Distributed generation; Network reinforcement; Network switching; Renewable energy sources; Stochastic mixed integer linear programming

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