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New multi-stage and stochastic mathematical model for maximizing RES hosting capacity - part II: numerical results

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Abstract— A new multistage and stochastic mathematical model of an integrated distribution system planning problem is described in Part I. The efficiency and validity of this model are tested by carrying out a case study on a standard IEEE 41-bus radial distribution system. The numerical results show that the simultaneous integration of energy storage systems (ESSs) and reactive power sources largely enables a substantially increased penetration of variable generation (wind and solar) in the system, and consequently, reduces overall system costs and network losses. For the system, a combined wind and solar PV power of up to nearly three times the base-case peak load is installed over a three-year planning horizon. In addition, the proposed planning approach also considerably defers network expansion and/or reinforcement needs. Generally, it is clearly demonstrated in an innovative way that the joint planning of distributed generation, reactive power sources, and ESSs, brings significant improvements to the system such as reduction of losses, electricity cost, and emissions as a result of increased renewable energy sources (RESs) penetration. Besides, the proposed modeling framework considerably improves the voltage profile in the system, which is crucial for a normal operation of the system as a whole. Finally, the novel planning model proposed can be considered as a major leap forward toward developing controllable grids, which support large-scale integration of RESs

Index Terms— Distributed generation, distribution network systems, energy storage systems, integrated planning, renewable energy sources, stochastic programming

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