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Representation of storage operations in network-constrained optimization models for medium- and long-term operation

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Abstract— This paper proposes a model to carry out analysis of storage facilities operation including a transmission network. The model represents short-term storage operation in an approxi-mated way that reduces computational requirements, which makes it suitable for medium and long-term operational planning in power systems with a high level of renewable energy penetra-tion. In the proposed model, we cluster hourly data using the so-called system-states framework developed in previous work. Within this framework, non-consecutive similar time periods are grouped, while chronological information is represented by a tran-sition matrix among states. We extend the system-state framework from a single-bus system to a transmission network. We define and analyze two alternative sets of representative variables for clustering hours to obtain system states when the transmission network is considered. This extension of the system states framework allows us to evaluate the impact of transmission congestions in medium- and long-term planning models in a rea-sonable computation time. A case study shows that the proposed model is 235 times faster than an hourly approach, used as benchmark, whereas the overall system cost is approximated with less than 2% error. The overall charging/discharging trends are similar enough to those of the hourly model, being hydro storage better approximated than fast-ramping batteries. Besides, for the analyzed case study, it is shown how congestion in the transmission network in fact improves the accuracy of the proposed approach.

Index Terms— power system models, energy storage, optimal power flow, system states, optimization

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