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A new approach of clustering operational states for power network expansion planning problems dealing with RES generation operational variability and uncertainty

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Abstract— The global drive for integration of renewable energy sources (RESs) means they will have an increasing role in power systems. It is inevitable that such resources introduce more operational variability and uncertainty to system functioning because of their intermittent nature. As a result, uncertainty management becomes a critical issue in long-term Transmission Expansion Planning (TEP) in power systems which feature a significant share of renewable power generation, especially in terms of computational requirements. A significant part of this uncertainty is often handled by a set of operational states, here referred to as «snapshots». Snapshots are generation-demand patterns that lead to optimal power flow (OPF) patterns in the network. A set of snapshots, each one with an estimated probability, is then used in network expansion optimization. In long-term TEP of large networks, the amount of operational states must be reduced to make the problem computationally tractable. This paper shows how representative snapshots can be selected by means of clustering, without relevant loss of accuracy in a TEP context, when appropriate classification variables are used for the clustering process. The approach relies on two ideas. First, snapshots are characterized by their OPF patterns instead of generation-

demand patterns. This is simply because network expansion is the target problem, and losses and congestions are the drivers of network investments. Second, OPF patterns are classified using a «moments» technique, a well-known approach to address Optical Pattern Recognition problems. Numerical examples are presented to illustrate the benefits of the proposed clustering methodology. The method seems to be very promising in terms of clustering efficiency and accuracy of the TEP solutions.

Index Terms— Clustering; dimension reduction; method of moments; transmission expansion planning; uncertainty

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