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Finding a representative network losses model for large-scale transmission expansion planning with renewable energy sources

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Abstract— The global drive for integration of RESs (renewable energy sources) means that TEP (transmission expansion planning) has to be carried out over geographically wide and large-scale networks under high levels of uncertainty. This leads to complex combinatorial TEP optimization problems, requiring a huge amount of OPF (optimal power flow) computations. The algorithm employed to calculate the OPF must be reasonably accurate but computationally very efficient, because it has to be run for a lot of operational conditions. Overly simplified OPF formulations are not adequate, since they neglect aspects which play a relevant role in TEP. Specifically, network losses significantly influence TEP solutions, but they are often disregarded due to their computational burden. Given their potential impact on the optimal TEP solution, the main focus of this paper is to find an appropriate losses model in the context of medium to long-term TEP for large-scale power systems. Keeping the balance between accuracy and computation time is essential in such problems. The paper presents two alternative linear losses models, as well as two variants of existing ones. These models are compared and tested using case studies, including small, medium and large-scale networks. Practical conclusions and recommendations are drawn from numerical results.

Index Terms— Transmission losses; DC model; Linear approximation; Transmission expansion planning; Optimal power flow; SOS2

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