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Methodology for integrating flexibility into realistic large-scale distribution network planning using Tabu search

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Abstract-

A successful energy transition will be firmly based on the effective integration of distributed energy resources and on the integration of new flexibility providers into the energy system. To make this possible, a deep transformation in the design, operation and planning of power distribution systems is required. Currently, a lack of comprehensive planning tools capable of supporting operators in their investment plan options exists. As a result, reinforcements of conventional grid assets are common solutions put in place. This paper proposes a methodology to obtain cost-optimal distribution network expansion plans, by modelling a single-stage distribution network planning tool, using conventional assets as well as flexibility contracting from demand response. A Tabu Search metaheuristic has been implemented in order to solve the optimization problem. A case study based on a realistic large-scale city network model is presented, for a planning horizon of ten years with significant load growth due to electromobility penetration. Results show that, in the case study analysed, the use of load flexibility in combination with conventional reinforcements can reduce the total expansion network cost by about 7.5 %. Furthermore, a sensitivity analysis on the cost of flexibility contracting is undertaken. Remarkably, the methodology presented generalises to further alternative solutions by providing a straightforward financial benchmark between the latter and conventional grid expansion.

Index Terms- Active distribution network; Distribution network planning; Tabu search algorithm; Demand response; Realistic model

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