Multistage distribution expansion planning leveraging load flexibility

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Abstract-

This paper presents the distribution network planning problem, utilizing conventional and non-conventional expansion measures. Here, conventional network expansions, i.e. transformers and lines installations, compete with non-conventional load flexibility contracting. The proposed multistage planning methodology aims at minimizing the net present value of all investment and operational costs, while annuity calculations are used to make technologies with different characteristics comparable. A novel combination of the pseudo-dynamic multistage planning approach called forward fill-in with a single-stage planning approach that utilizes load flexibility is developed. The single-stage distribution network planning model is based on the Tabu Search metaheuristic, which has proven to be scalable for realistic large-scale networks. In a case study, the multistage model is applied to a two-stage planning problem. In contrast to single-stage methodologies, the multistage methodology demonstrates the value of load flexibility, accounting for the time value of money when analysing savings due to network investment deferrals. In the case study, flexibility contracting at a cost of 10 €/kW per year results in total cost savings of 15.68 %.

Index Terms- Multistage; Distribution system; Expansion planning; Flexibility; Realistic network