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A multi-year transmission planning under a deregulated market

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ABSTRACT

Due to the deregulation of power industry, the transmission expansion plan is different from the process done by the integrated monopolies. In a monopoly electric market, the transmission expansion plan is carried out by the vertically integrated utility. The power company integrates its generations' exploiting plans and its transmission expansion plans to maintain the system reliability. While in a deregulated power industry, generation, transmission, and distribution companies belong to different owners. The problem becomes more difficult. Generators experiencing transmission constraints can be expected to lobby for new transmission facilities that might relieve their constraints, while generators closer the load centers will likely toward not to build any new transmission facilities that would increase their competition. In order to provide a fair environment for all market participants, this paper proposed a reasonable expansion plan taking the operation cost, load curtailment cost, and investment cost into account. Due to the complexity of this model, the algorithm that combines the genetic algorithm with the linear programming method (GA–LP) is used to solve this problem. The 6-bus system and 24-bus IEEE reliability test system are used to verify the proposed model, and comparisons of test results between the proposed model and the traditional model are also demonstrated in this paper.

1. Introduction

Transmission planning addresses the problem of enhancing an existing transmission network to serve the growing electricity market in an optimal way, subject to some economic and technical constraints. Transmission planning problems can be classified as static or dynamic. The static expansion is given the network configuration for a given year and the peak generation/demand for the next year to determine the expansion with the minimum cost. By dynamic expansion planning, it is usually referred to a year-by-year expansion plan that goes from the initial year through the horizon year. Investments for a particular year can also have some impacts on the years afterward.

In a monopoly electric market, the transmission function is carried out by the vertically integrated utility. As an integral part of such a utility, the transmission function is to physically integrate the utility's generation plants and its captive customers. Many techniques such as branch-and-bound algorithm [1], Bender decomposition [2–4], genetic algorithms [5], and simulated annealing [6,7] are presented to solve the transmission expansion in a monopoly electric market. In [8], the authors propose the reinforcement and expansion of the transmission network as a way of mitigating the impact of increasingly plausible deliberate outages. The proposed model selects the new lines to be built according not only for economic issues but also for the vulnerability of the transmission network against a set of credible intentional outages.

Along with the development of the deregulation of power industry, many studies about transmission network expansions, either static or dynamic, considering the competitive environment have been presented. In [9], the authors classify the publications of transmission expansion based on the solution methods, the treatment of the planning horizon, and the consideration of the new competitive schemes in the power sector. In [10], transmission planning approaches are categorized and summarized. Transmission planning issue in deregulated power systems is discussed, and the abstract of the most interesting publications on the subject of transmission planning under deregulation are presented.

In [11], a market-based approach for transmission expansion planning is proposed. This paper uses an improved differential evolution method to solve this problem. In [12], Probabilistic locational marginal prices and new market-based criteria are presented. This paper considers random and nonrandom power system uncertainties and selects the final plan after risk assessment of all solutions.

In [13], a new strategy for transmission expansion under a competitive market environment is presented in this paper. This model considers a variety of market-driven power-flow patterns while a decision analysis scheme is incorporated to minimize the risk of the selected plan. In [14], the authors propose a method for choosing the best transmission system expansion plan considering a probabilistic reliability criterion. The method minimizes the

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