Transmission Service Cost Calculation with Power Loss and Congestion Considerations

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ABSTRACT

One of the most challenging issues of transmission grids in restructured power networks is determining the real transmission service cost. In this paper, a method for calculating the transmission service in different grids is presented. In the proposed method, the cost of power loss and congestion of transmission services are considered. Using this integrated model, the strengths and weaknesses of a power grid can be straightforwardly analyzed. All simulations have been done on IEEE nine-bus test system. Computing the transmission service cost, the next step is to optimize power loss and congestion using NSGA-II which is a two objective genetic algorithm method in which optimal power flow is implemented and power loss and congestion are considered as objective functions. Numerical results prove the effectiveness of the proposed optimizing method in which decreasing the cost of power loss and congestion have a direct effect on improving the quality of transmission services.

Keywords: Cost of Congestion, Cost of Power Loss, IEEE Nine-Bus Test System, NSGA-II Optimizing Algorithm, Transmission Service

INTRODUCTION

The power network has been deregulated over the past years. In this regards, pricing of transmission services was always considered as one of the most complex issues and drew most of researchers’ interests. The significant impact of this subject in the transmission network pricing is the increase of free capacity of transmission lines. So, Economic efficiency is the greatest attribute which can be obtained only through deregulated power market.

Many studies have been done in transmission service costs. General concepts of transmission service cost and a comprehensive framework of the transmission grids in restructuring systems were examined (Perez, 1995; Yu & David, 1997; Araneda, 2002; Ahiakwor, Chukwu, & Dike, 2008; Seshadri, 2008; Zima, Matevosyan, Zima, & Soder, 2009; Luis & Perez, 2009; Pablo, Ramirez, Carlos, & Coello, 2009). Wakefield (1997) introduces a
general framework that deals with transmission service costs.

This framework is defined in three stages:

1. Defining transmission services
2. Determining the costs of transmission services
3. Calculating the transmission costs.

Adverse impacts of poor transmission pricing methods on transmission grids has been studied by Analysis Group (2001), which gives a through information related to the impact of traditional pricing methods in the new electricity market structure. Methods of transmission network pricing based on the trades have been mentioned in recent years. The real power flow in a transmission network in order to calculate the transmission service costs is presented by Pantos, Grgic, and Gubina (2003). Assessing the pricing methods and doing relative comparison among different methods of transmission services was studied. Some studies have been investigated the optimization of transmission service costs. For instance, an optimal pricing method is proposed by Farmer, Perera, and Cory (1995) in which the optimal pricing is determined by overall profit optimization algorithm. Total benefit is the operation cost of network capacity. In this study, the mathematical programming method is used to program the proposed method. Besides, a new method to evaluate the set of optimal prices that must be paid by transmission services was suggested by Perera, Farmer, and Cory (1996).

Research which is done by Ahiakwor, Chukwu, and Dike (2008) introduces an optimal method of pricing of the transmission services. However, the proposed method does consider the regulations of deregulated power market. In this article, the cost function considers neither the cost of congestions nor power loss. While the power which flows through a line becomes higher than the maximum limit, the congestion will occurs. The important factor which leads to congestion of power lines in transmission network is the insufficient investment in transmission network. The loss in the transmission grids not only depends on the location of network equipment but also depends on the flowing capacity of each line. Since the voltage of the network is almost constant, the increase in the power flowing capacity of each line leads to increase in the current as well as the resistance losses of related power line. Power loss always occupies some percent of the transmission grid capacity and Reduction in power loss requires increasing in the investment of transmission network. Evaluating the actual amount of congestion and loss costs in each network has a substantial contribution to knowledge the weaknesses of the networks and will release network capacity.

One of the most challenging issues regarding transmission lines is to allocate the real cost of transmission services. Many fixed and variable parameters affect the cost of transmission services. In a restructured power system, providing a signal as a tool to assist investors to choose among different pricing strategies to cover the capital and operating cost is critical (Reilly, 2010). It should be noted that the main important parameter in determining the price of transmission services is returning equipment’s investment and operating cost. Although, several studies have been done to find the best pricing plan, each of them has its limitations and there is no absolute solution (Krause, 2003). Besides, allocating an appropriate value of transmission services has an important effect on congestion of transmission and future planning of power system. In a restructured power system, where both suppliers and customers are involved in transmission service cost, determining proper cost of transmission services has a direct effect of decreasing congestion of transmission lines.

Increasing tariff rates for consumers will prevent over load in a zone and will motivate producers to generate more power that consequently, lead to decrease congestion in the associated zone.

In this paper, the calculation of cost of power loss and congestion is introduced and is applied to an IEEE nine-bus test system.
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