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# Power flow tracing based transmission congestion pricing in deregulated power markets

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ABSTRACT

The objective of this paper is to propose a simple transmission congestion pricing scheme based on tracing principle by considering generator fixed cost, cost for incurring loss and transmission congestion cost. Restructuring has brought about considerable changes by the virtue of which electricity is now a commodity and has converted into deregulated type. Such a competitive market has paved way for innumerable participants. This concept of restructuring has led to overloading of transmission lines. In this paper, power flow tracing has been employed by using suitable optimization algorithm, where the real power generation has been maximized. Congestion in the transmission line has been produced in a new fashion by maximizing the real power demand. The power flow under normal operating condition and congestion is determined and hence the difference in power flow is estimated. Based on the estimated power flow difference, the transmission line congestion cost is computed. Pool model and bilateral model has been considered in simulation study to introduce the concept of deregulation. The proposed method is tested and validated on Modified IEEE 30 bus test system and Indian utility 69 bus test system.


## Introduction

The vertically integrated structure of power industry is being replaced by market structure in the world range. In such a structure, a transmission system is being used by multiple generation and load entities that do not own the transmission system. Formerly, when the electric network was operated by one vertically integrated utility, there was not much interest in this subject. However, with the unbundling of generation and transmission facilities, and with accompanying deregulation of the power, the topic has acquired new significance as the different parties acting in the power grid are interested in a fair operation and fair allocation of transmission costs. In view of market operation it becomes more important to know the contribution of individual generators and loads to transmission lines and power transfer between individual generators to loads.

Rosado et al. explain the tracing of power flow using commons method and node method. The results obtained from these methods are not perfect and time required is more [1]. Bialek proposes a topological approach for allocating the power flow from a particular generator or a load in every branch flow based on an electricity tracing method [2].

Bialek and Kattuman recommend a tracing methodology is based on the assumption that the incoming flows are proportionally distributed among the out coming flows at any network node [3]. Panto et al. introduce modified Topological Load Distribution Factor (TLDF) based method to trace the power flow in the transmission losses to enable the decoupling of the extended matrices [4]. Xie suggests a new method using direct path from buses to buses by multiplying with the incidence matrix and to find the power transfers from individual generators to loads and branches. [5].

Abhyankar et al. discusses optimization technique based tracing algorithms using the continuity equations for the lossy flow networks with modified bus incidence matrix to discriminate the power flow between the sending end and the receiving end. [6]. Mustafa and Shareef elaborates about graph method, node method and common method for the allocation of power flow in the power system network. [7].

Hamid et al. introduces a concept of load tracing and generator tracing using Evolutionary Programming (EP). The power flow from generator to all system loads is traced and losses are allocated in the transmission lines. These method have the advantage of no assumption to formulate the tracing of power flow [8,9].

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