Effects of FACTs Device in Transmission Cost Processing Model

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Abstract : In a competitive environment, transmission cost allocation is one of the major challenges due to increasing power transactions in transmission open access. The projected method is evaluated by considering the bilateral & multilateral transactions. The transmission cost allocation method is based on equivalent bilateral exchanges. According to this, each demand is supplied by a fraction of each generator uniformly divided among all generators. The impact of power flow due to a transaction on all the lines of a network is usually determined by power flow solution. This paper discusses congestion problem in the deregulated electricity market using an optimal power flow (OPF). In this paper, the transmission lines are decongested using re-dispatch method and then taxes are calculated. It also considers the installation of flexible A.C. transmission systems (FACTS) devices in the network to help reduce taxes. The optimal location of FACTS devices can be recognized by the bus on which highest tax is implemented. The IEEE 9-bus and IEEE 14-bus system is used to simulate the market and illustrate the proposed method. The results show that when SVC are included, the amount of re-dispatched power reduces significantly resulting in an optimal operating point closer to that dictated by the market settlement. It is also proved that SVC is a viable option for congestion management, both from the technical as well as cost-efficiency point of views..

IndexTerms **- Optimal Power Flow (OPF), Transmission pricing, Open Access ,MATPOWER,SVC**

I. INTRODUCTION

Today across the world, the power industry is moving towards a deregulated framework, in which consumers would be able to choose from a host of competing providers. In conventional methods, the line flow impacts are calculated by implementing repeated power flows using Newton Raphson (NR) method for varying magnitude of power transacted, which is a time consuming process. A common FACTS device shared by the various frameworks of deregulated electricity markets across the world is the designation of an independent system operator (ISO). It is responsible for real-time load balancing, congestion, management and provision of transmission pricing. This paper follows the trends of new power market and presents a methodology to determine the pricing based on probabilistic techniques.

Depending upon the type of the transmission transaction, one or all of these components are included in the pricing scheme. Transmission pricing is broadly classified as

a) Postage Stamp; b) MW-Mile (original); c) Unused absolute MW-Mile; d) Unused reverse MW-Mile; e) Unused zero counter-flow MW-Mile; f) Used absolute MW-Mile; g) Used reverse MW-Mile and h) Used zero counter-flow MW-Mile. The transmission pricing is nothing but the cost allocated to a new customer. In the proposed work, re-dispatch technique is used to reduce the congestion. Re-dispatch technique as a low cost method can be applied to transmission lines as good solution for optimization of optimal power flow problem by incorporating FACTS devices and reducing congestion and taxes. In this paper, a corrective solution for congestion management has been reviewed by using SVC. The FACTS devices support the system congestion relief even as taxes as well as transmission losses reduces gradually. Analysis of results with and without FACTS devices confirms that these devices are appropriate for both, long time congestion management and reduction of the taxes. One of the most common methods of transmission pricing is the postage stamp method which allocates the fixed cost for transferring energy regardless of the distance and power trace. This method recovers the transmission cost. Similarly, the MW-Mile method is a pricing approach that can consider the real state of power system. In this method, transmission cost is allocated based on the extent of use of the transmission network by user. So here we analyze two pricing methodologies with flow charts. Evaluation of all these methods have already been done [5] but, Transmission pricing using FACTS device is a new work. The projected work has been tested on IEEE 9 bus and IEEE 14 bus system using MATLAB simulation programs. The calculation was done in an optimal Power Flow solution. A Graphical illustration of the allocation figures is obtained which shows the transmission pricing with and without SVC.

II. ALGORITHMS OF CONGESTION MANAGEMENT

A generator is constraints to restrict power supply to consumers due to limited transmission line capacity, it is defined as congestion. And in this condition when a low cost generator is forced to supply power, it will probably have to deploy higher cot units to increase generation to meet the load demand. In this condition, total generation cost rises and automatically social welfare is affected. Recently, there has been keen interest in solving congestion using FACTS devices [8].

In solving congestion problem using FACTS devices, both technical and cost-effective studies have to be conducted. These studies should be supported by adequate data i.e. locations of FACTS devices and generation cost. Against this backdrop, this paper proposes a method that is able to provide the most optimal solution for these data. The paper focuses on FACTS allocation for congestion management. Then, IEEE 30 bus is used to verify the proposed method. The first objective is to minimize generation cost as well as to keep the line flow within the transmission network capacity limit in order to avoid transmission congestion. The second objective is to minimize taxes by using FACTS devices, specially SVC, while the third objective is to calculate transmission pricing methodologies. The benefit gained is calculated as the difference between taxes with and without FACTS devices. The values are calculated for each line which is illustrated in fig

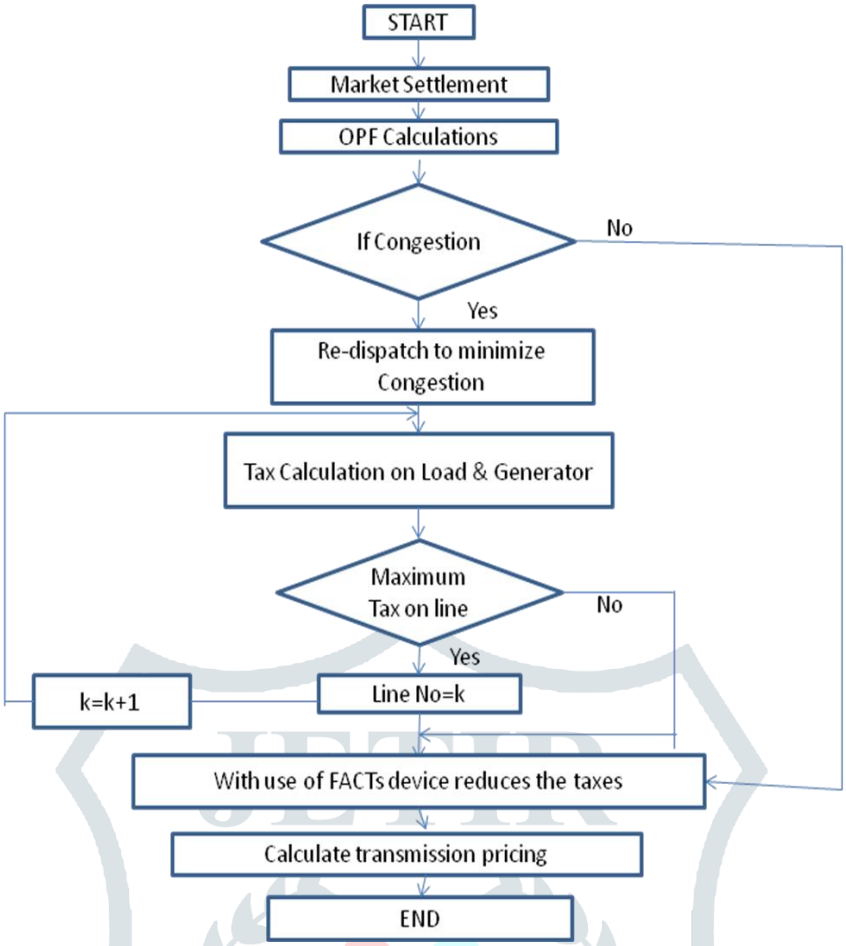

Figure.1: Algorithm for congestion management to reduce taxes and transmission pricing

Re-dispatch, proves as the most efficient remedy in managing congestion in a competitive market. The use of SVC in congestion management shows it can provide additional benefit to the system, in terms of both, removing the congestion and reducing the total congestion cost. The results were obtained for IEEE 9 and IEEE 14 bus systems. Simulation was done in MATLAB. The congestion problem in the deregulated electricity market was discussed in the light of optimal power flow. The congestion management method considered in this study was based on a constrained re-dispatch of generation schedule. From the re-dispatch, congestion management tax was evaluated. With the help of results it is indicated that SVC is applied to the bus where the tax is higher. Applying SVC reduce the taxes as well as losses. Simulation results on various systems show clear possibility of optimized location of SVC and removal of congestion. Congestion management, along with Re-dispatch strategy, proves to be technically as well as economically beneficial.

The location of FACTS devices is proved to be an economic function. Thus, it can be concluded that congestion taxes and transmission costs gets reduced. The formulation of Pricing Methodology can ensure fairness of the method, cover the usage tax and provide correct economical incentive for efficient use, maintenance and future development of the transmission network. **2.**

III. RESULTS OF TRANSMISSION PRICING PARAMETERS FOR IEEE 14 BUS CASE STUDY

The Single line diagram of an IEEE-14 Bus system is as shown in Fig.10. The data regarding the initial dispatch is provided by market operator. The initial generation dispatch, Re-dispatch and their difference is obtained in Fig 3. Optimal Power Flow with line limits and congested lines are found and presented in Table 1. After solving congestion state, Re-dispatch is obtained which is given in Table 2. Once solving congestion, our simulator allocates taxes to the agents (load and generator).We analyze the fixed tax on load and on generator [8]. Approximately 80% and 50% taxes on load and generator respectively, are presumed while computing fixe tax. So, the total tax on load without SVC is computed. The tax is higher on those buses that have been applied to SVC. So in the given case, SVC is applied to bus No.3 and compute the taxes on load with SVC. The details are presented in Table 3 while Fig 4 gives its graphical representation. Similarly, the results for fixed tax on generator are verified and is given in Fig.5. The details are precise in Table 4 Table 5 gives an idea regarding losses incurred With and Without SVC for IEEE 14 bus system. Hence, it is proved that appropriate placement of FACTS devices using re-dispatch reduces losses. Transmission Pricing using Postage Stamp pricing method and MW-Mile method at generator buses were tested. The characteristics of the pricing schemes for each transmission pricing method are presented in Table 5 and Fig. 6, which provide inputs of all generators to the line flows under two methods.

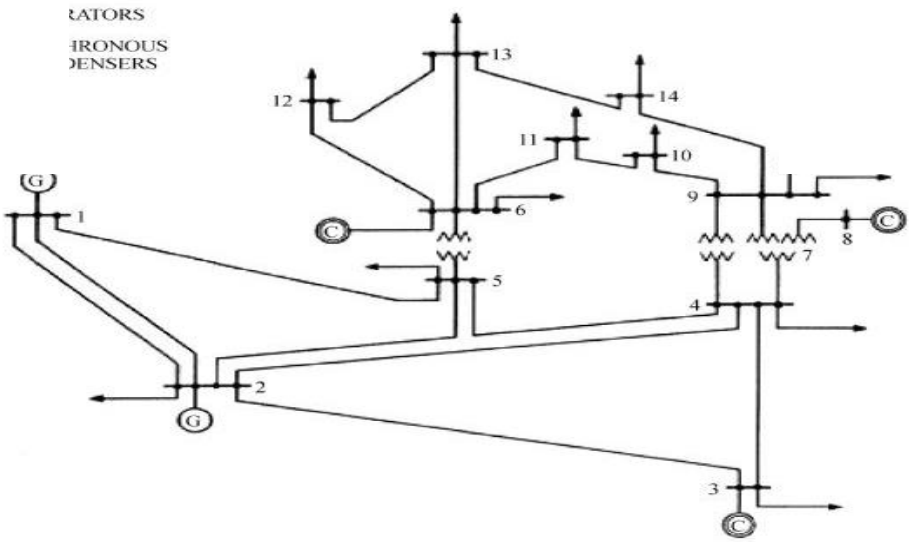

Figure 2. Single Line Diagram of IEEE 14 bus test system

Table 1 : Congested lines for initial dispatch

Line	Maximum capacity	Expected line flow capacity	Actual line flow
1	90	81	84.1196
2	50	45	45.0642

Table 2 : Re-Dispatch (MW)

Line	1	2
OPF	112.5	62.5

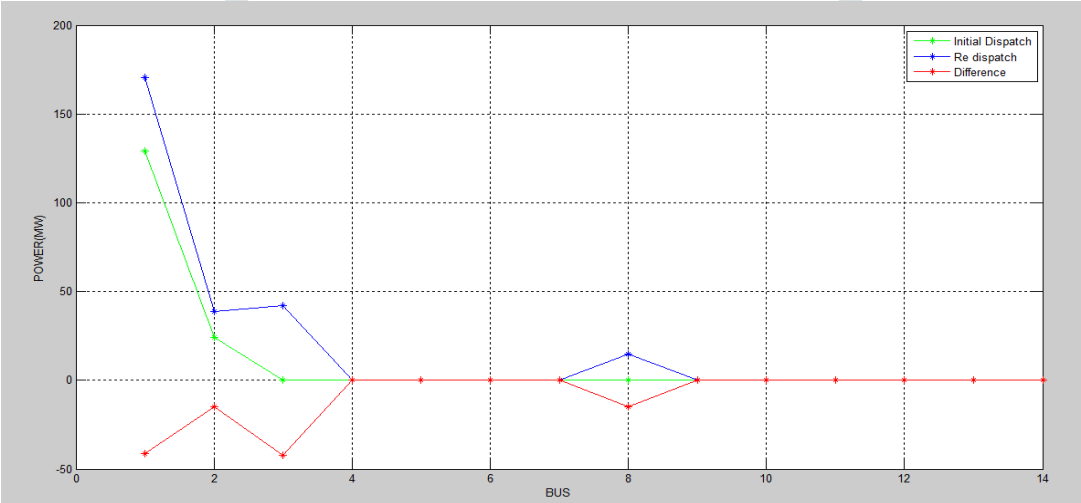

Figure 3. Difference in initial power flow and Re-dispatched power at all buses in power system.

Table 3: Results of total tax on load without and with SVC for IEEE 9-bus system for bus No. 3

Bus	Without SVC	With SVC	Difference	Change in percentage
2	35.5880	26.0350	9.553	73.15
3	154.4880	88.9500	65.538	57.57
4	78.3920	7.9950	70.397	10.19
5	12.4640	3.2800	9.184	26.31
6	18.3680	15.3750	2.993	83.70
9	48.3800	34.0300	14.35	70.33
10	14.7600	11.8900	2.87	80.55
11	5.7400	3.6900	2.05	64.28
12	10.0040	3.2800	6.724	32.78
13	22.1400	11.8900	10.25	53.70
14	24.4360	10.2500	14.186	41.94

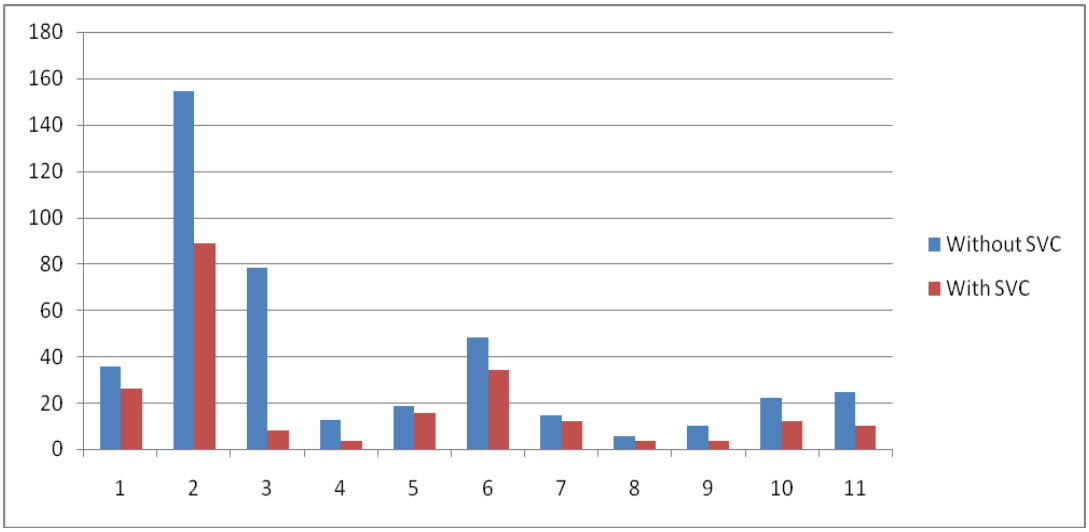

Figure 4. Total Tax due to load at different buses Without and With SVC

Table 4 : Results of total tax on generator without and with SVC for IEEE 9-bus system

Bus	Without SVC	With SVC	Difference Value	Chang in Percentage
1	93.8897	83.8897	10.00	89.34
2	21.2648	18.2600	3.0048	85.86
3	23.1880	19.1880	4.00	82.74
6	7.2351	5.2351	2.00	72.35
8	8.1571	6.1571	2.00	75.48

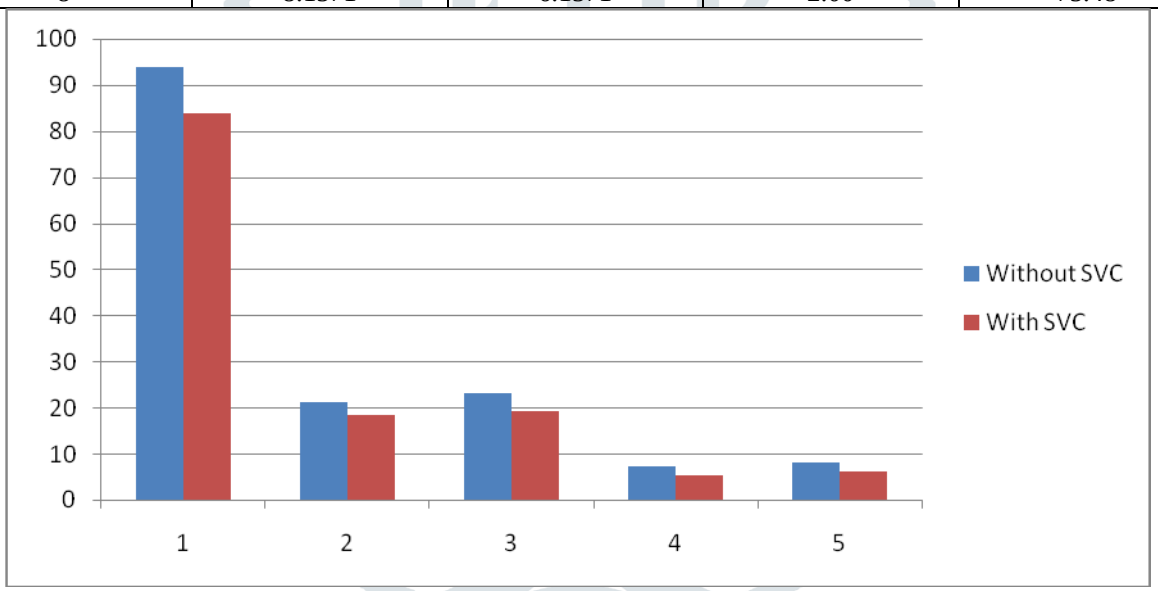

Figure 5. Total tax due to generator at different buses without and with SVC

Table 5 : Tabulated transmission pricing based on methods Without and with SVC

	G1	G2	G3	G5
Postage stamp Method without SVC	40970	9279	11118	10000
Postage Stamp Method With SVC	20997	5604	10734	8994
Mw-Mile (original)Method Without SVC	33202	29859	27508	24887
Mw-Mile (original) Method with SVC	24561	27202	26419	24085

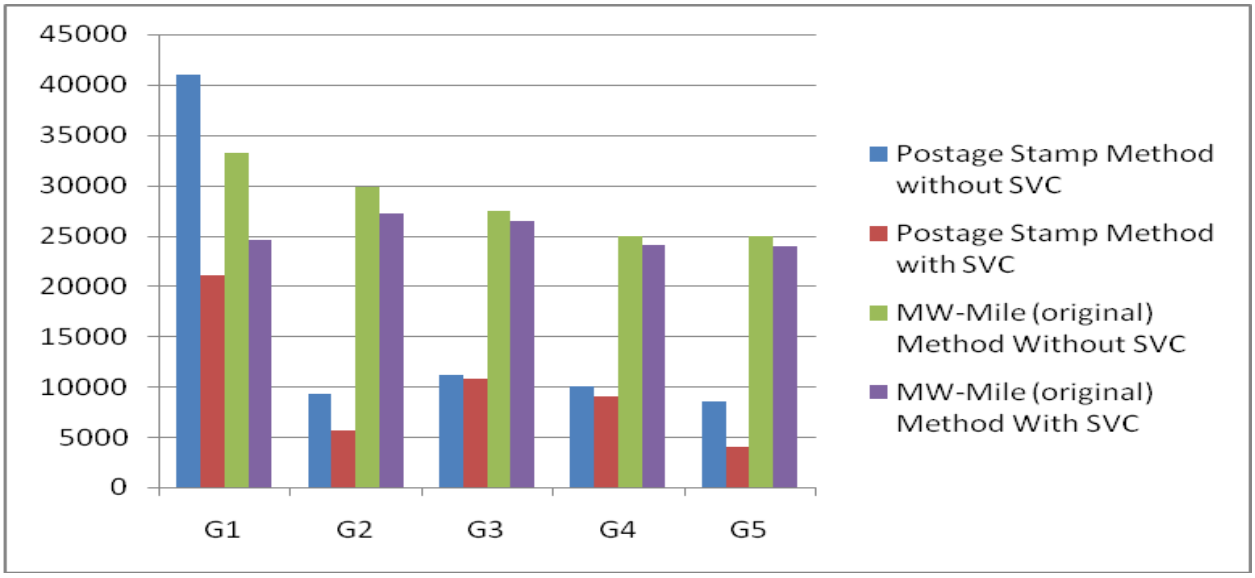

Figure 6. Transmission pricing based on pricing methods Without and With SVC at generator buses

IV.CONCLUSION

Re-dispatch, proves as the most efficient remedy in managing congestion in a competitive market. The use of SVC in congestion management shows it can provide additional benefit to the system, in terms of both, removing the congestion and reducing the total congestion cost. The results were obtained for IEEE 9 and IEEE 14 bus systems. Simulation was done in MATLAB. The congestion problem in the deregulated electricity market was discussed in the light of optimal power flow. The congestion management method considered in this study was based on a constrained re-dispatch of generation schedule. From the re-dispatch, congestion management tax was evaluated. With the help of results it is indicated that SVC is applied to the bus where the tax is higher. Applying SVC reduce the taxes as well as losses. Simulation results on various systems show clear possibility of optimized location of SVC and removal of congestion. Congestion management, along with Re-dispatch strategy, proves to be technically as well as economically beneficial.
The location of FACTS devices is proved to be an economic function. Thus, it can be concluded that congestion taxes and transmission costs gets reduced. The formulation of Pricing Methodology can ensure fairness of the method, cover the usage tax and provide correct economical incentive for efficient use, maintenance and future development of the transmission network.

REFERENCES

[1] [1] A.M. Leite da Silva and G.P. Alvarez, "Operating reserve capacity requirements and pricing derugalated markets using probabilistic technique", IET Gener.Transm.Distrib.,2007,1,(3),pp.439-446.
[2] S.Jeyasankari,J.Jeslin Drusila Nesamalar, " Transaction Cost Allocation in Deregulated Power System Using An Analytical Method", IEEE Trans Power System, pp. 1090 - 1096 , November 2013.
[3] Amirsaman Arabali, Seyed Hamid Hosseini, Moein Moeini-Aghtaie, " Pricing of Transmission Services: An Efficient Analysis Based on Fixed and Variable Imposed Costs", IEEE Trans Power System, November 2012.
[4] R. Reta and A. Vargas, " New Price System to Mitigate Marginal Price Volatility In Electricity Markets", IEEE Latin America Trans Power System vol. 9, no. 5 , pp. 793-799 , September 2011.
[5] G. A. Orfanos , G. T. Tziasiou , " Evaluation of Transmission Pricing Methodologies for Pool Based Electricity Markets " , IEEE Trans Power System vol. 15 , no. 4 , pp. 1218 - 1224 , November 2011.
[6] Sandip Chanda,Abhinandan De, " Application of Particle Swarm Optimization for relieving Congestion in Deregulated Power System", IEEE Transaction on Power Systems, pp.837-840,November 2011.
[7] Rony Seto Wibowo, Naoto Yorino, Mehdi Eghbal, " FACTS Devices Allocation for Congestion Management Considering Voltage Stability by Means of MOPSO", IEEE T & D 2009.
[8] M. Judite Ferreira, Zita A. Vale, " A Congestion Management and Transmission Price Simulator for competitive Electricity markets", IEEE Transaction on Power Systems, pp.1-8, 2007.
[9] Diego mejia-Giraldo,James McCalley, " Adjustable Decision for reducing the Price Robustness of Capacity Expansion Planning", IEEE Transaction on Power Systems, Vol. 29, no. 4, pp.1573-1582,July 2014.
[10] Teo Guler, George Gross and Ron Coutu, " On the Economics of Power System Security in Multi-Settlement Electricity Markets", IEEE Transaction on Power Systems, vol.25, No. 1, pp.284-295,February 2010.
[11] Robert Baker, P. Eng., Dr. Xiaomiao Wu, P.Eng, Dr. Ashikur Bhuiya,P.Eng., " Transmission Loss Cost Reconciliation In Alberta's Deregulated Electric Market", pp.1277-1280, 2007.
[12] V. Sarkar and S. A. Khaparde, " Introduction to Multidimensional financial Transmission Rights", IEEE Transaction on Power Systems, Vol.23,No.1, pp.837-840, February 2008.
[13] V. Sarkar nad S.A. Khaparde, " A Comprehensive Assessment of the Evolution of Financial Transmission Rights", IEEE Transaction on Power Systems, Vol.23, No.4, pp.837-840,November 2008.