International Journal of Engineering, Management, Humanities and Social Sciences Paradigms (IJEMHS)
(Volume 17, Issue 01)
Publishing Month: October 2015
An Indexed and Referred Journal
ISSN: 2347-601X
www.ijemhs.com

A Review on Cross Border Power Trading Model for Deregulated Electricity Markets

Surender Redhu[1] and Dharam Niwas[2]

[1]M. Tech. Scholar, Indus Institute of Engineering and Technology, Kinana, Jind, Haryana (India)
redhusurender@yahoo.com
[2]Asst. Prof., Indus Institute of Engineering and Technology, Kinana, Jind, Haryana (India)

Publishing Date: October 26, 2015

Abstract

This paper presents the overview of the concept of Cross border Power Trading Model for Deregulated Electricity Market. In India Power development has been carried out predominantly by the State controlled electricity boards. Almost all the countries are adopting deregulated industry structure for better utilization of the resources and for providing choice & quality service to the consumers at economical prices resulting in transparent price discovery. In this paper the design concept of cross border power trading model in competitive power market has been introduced by taking consideration of major issues faced by present power traders in Indian electricity market. This work focuses on trading arrangements, operation of power exchange and effectiveness of proposed pricing mechanism which is tested on linear demand and supply side bidding scenarios of market model. Suitable mathematical models are developed for calculations of market clearing price (MCP) and matrix laboratory version 7.5 software is used for the MCP simulations. This paper could be guide line for the policy makers, power systems designers and market operators to promote the cross border power trade in South Asian countries with system reliability and security.

Keywords: *Gencos, Transcos, Market Clearing Price, Discos, Cross Border Power Trade, Power Pool.*

I. Introduction

During the nineties decade, many electric utilities power network companies world-wide have been forced to change their ways of doing business, from vertically integrated mechanism to open market systems. The reasons have been many and have different over reasons and countries [1].

Among the developing countries, the main issue has been a high demand growth coupled with inefficient system management and irrational tariff policies, among others. This has affected the availability of financial resources to support investments in augmenting generation and transmission capacities. In such circumstances, many utility were forced to restructure their power sector under pressure from international funding agencies. In developed countries [2], on the other hand, the driving force has been to provide consumers with electricity at lower prices and to offer them a greater choice in purchasing economic energy.

Reforms have been undertaken by introducing commercial incentives in generation, transmission, distribution and retailing of electricity, with, in many cases, large resultant efficiency gains. The electricity bills now reflect at least two components: one from the distribution and transmission network operator responsible for the network and services, and the other from the company that generates the electrical energy.

Nepal, Pakistan, India and Bhutan have a potential of hydro energy resource of approximately 83000 MW, 21000 MW, 84000 MW and 21000 MW respectively [3]. Besides this Myanmar and Bangladesh have significant unexploited gas reserves. India currently trades power from Bhutan through bilateral contracts. The power generating capacity of Bhutan is relatively small and most of the generation is exported to India. There are quite revealing variations in the installed capacities of power utilities in South Asia. These variations also reflect the potentialities as based on their natural endowments. Hydro power has been the most vital source of total installed capacity in Bhutan (100 %), Nepal (90 %) and Sri Lanka (65 %) whereas the thermal power dominates in Bangladesh (95 % gas based), India (72 % mainly steam based) and Pakistan (71 %). In the composition of end use sectors, the share of industry has been over 37 percent in South Asia except Pakistan & Myanmar [4,5].

II. Literature Survey

This section presents the past literature corresponding to electricity markets associated with power trading models and present & future scenario for cross border power trading.

S.N. Singh et.al [1] discussed about Power industry restructuring, around the world, has a strong impact on Asian power industry as well. Indian power industry restructuring with a limited level of competition, since 1991, has already been introduced at generation level by allowing participation of Independent Power Producers (IPPs)..

Chai Chompoo-inwai et.al [2] gives the information about the model of deregulated electricity market in Thiland. Transmission congestion management (TCM) plays a significant role in power-system operation under today's deregulated environment. Its two major functions are to maintain power system within security limits and to collect money from market participants paying back to transmission-grid investors. The TCM issue has been widely debated during the past decade. Although the PJM model is adopted in some developing countries where the processes of restructuring of Electricity Supply Industry is still under the beginning phase, many concerns, such as advances in an information technology, energy security, social equity, price volatility, and the need to subsidize poor consumers, are necessitate factors to be considered before the establishment of TCM and settlement processes. Taking into account the above concerns, this paper proposes a TCM model for the electrical utility industry in Thailand during the transition period to the deregulated environment.

P. Bajpai et.al [3] Discuss about electric industry restructuring process in India, the main issue is to run the system in free and fair manner ensuring the desired quality of power to the consumers at most economical price through safe, secure and reliable operation of the power system. Although a number of market models are prevalent in the International arena, the same could not be directly adopted for Indian markets. With the enactment of Electricity Act 2003, along with other recent initiatives, Government of India has outlined the counters of a suitable enabling framework for the overall development of wholesale electricity market by introducing competition at various sectors.

H. Glavitsch et.al [4] discussed about the development of the European internal electricity market, several methods for the tarification of cross-border flows have been proposed. This paper presents a flow-based method for the calculation of TSO to TSO compensations for cross-border flows. The basic principle of this approach is the allocation of the costs of cross-border flows to the TSOs who are responsible for these flows. This method is cost reflective, non-transaction based and compatible with domestic tariffs. It can be applied when limited data are available. Each internal transmission network is then modelled as an aggregated node, called 'supernode', and the European network is synthesized by a graph of supernodes and arcs, each arc representing all cross-border lines between two adjacent countries

Milan Vukasovic et.al [5] discuss the South-East Europe (SEE) market in which the system operators (SO) started with the gradual implementation of market based methods for the transmission capacity allocation. In this paper, the special web-based simulating software, developed for the daily explicit auction and allocation of tie-lines transmission rights on the borders of TSO-EPCG (Transmission System Operator of Montenegro), is presented aswell as the monthly results achieved with its implementation. Details on the aforementioned simulator are given. After that, a small, coordinated flow-based internet simulator is created for the testing purposes, using PHP/MySQL and MATLAB as the development tools. The main advantages of the coordinated flow-based auction over the explicit NTC-based method are clearly underlined. Therefore, the proposed method can be a successful substitution for the currently applied market-based methods, and a step towards the open electricity market in SEE.

Jinsu Lee et.al [6] discussed about the West African Power Pool is currently developing the regional electricity market for its member states. As the basic design for the cross-border power trading system for the West African Power Pool, the step-by-step evolution, the Baseline System and the Full scale System, is estimated. Along with the interconnection project between member countries, the various functions from the data acquisition and processing by the Baseline System to the interchange trading by the Full scale System will be implemented gradually.

Walter Reinisch et.al [7] discuss about the auction-based electricity markets from the viewpoint of a power company in order to evaluate the market design. Optimal trading strategies under uncertainty are developed by abolishing the widespread assumption that a single company has no influence on the market price. The resulting trading strategies explain the high prices and the high volatility observed in real electricity auction markets and show to what extent power companies can manipulate the market price.

Hugh Outhred et.al [8] discuss about Comparison of market design, implementation and market power mitigation is made difficult because the practical outcomes depend on the fine detail of market design, the governance and regulatory framework, the resource portfolio available to the industry, the nature and pace of demand growth, and the morality and robustness of the society. It defines market power in a broad manner and then assesses the robustness of the Australian competitive electricity industry design to the exercise of market power.

Keinosuke Matsumoto et.al [9] discuss about Many business models of power trading systems have been proposed to aim at load reduction by COI"HIWX cooperating with electric power Suppliers in an electric power market. On the other hand, Web services are regarded as a new application paradigm in the world of the Internet. Then, we propose a network model of power trading systems using Web services in this paper. The adaptability of Web services to power trading systems was checked in the prototype of our network model and we got good results in our simulations. Each server provides functions as a SOAP (Simple Object Access Protocol) server, and it is coupled loosely with each other through SOAP. Storing SOAP message in HTTP packet can establish a flexibly correspond to each communication environment penetration communication way that is not conscious of a firewall. Switching of dynamic servers is possible by means of rewriting the server point information.

Nisheeth K. Singh et.al [10] discusses the changed scenario due to liberalization and opening of market on dynamic behavior of power system. Following a brief description of the large interconnected power system, forming the backbone of Internal European Market, significant changes in the pre and post liberalization in system operation are highlighted.

S. Völler et.al [11] discuss Germany renewable energy is paid by law with a high and constant amount wherefore there is no real competition between renewable and conventional power plants. This work analyses the possibilities of wind farm operators to take part in an open energy market and increase their income with new payment alternatives (e.g. energy exchange, control power).

M.S. Elsobki et.al [12] The Egyptian Electricity Market and this market is currently arranged in the form of three separate subsectors; generation, transmission, and distribution. Both, the transmission subsector, one company, and the distribution subsector, nine companies, are fully owned by the government. The generation sector is mainly composed of four government owned thermal generation companies, a hydro generation company, and three privately owned pay-or-take BOOT projects.

Sangamesh G.Sakri et.al [13] discussed about power trading in Karnataka and discuss that In India the power sector reforms were initiated in 1991. It began with the participation of the private investors' in generation, and then focused on the unbundling of vertically integrated utilities. The Regulatory Commissions were formed in 1998 and the Electricity Act 2003 was enacted to accelerate the reforms. In states, the reforms were initiated in November 2003. The Karnataka state started reforming its power sector in 1999, with passing of the Karnataka Electricity Reforms Act. After the unbundling of the State Electricity Board (SEB) and formation of the Karnataka Electricity Regulatory Commission (KERC), the state is pursuing Accelerated Power Development and Reform Programme (APDRP). In this paper various activities of the power sector reforms in Karnataka are discussed.

S. N. Singh et.al [14] discuss about the wind competitive electricity market the Electricity market presents challenges to power system planners and operators. It is not possible for wind generators to bid into the competitive electricity market due to high cost and intermittent nature of available power. This paper analyses and proposes the pricing mechanism for wind power in the competitive electricity market. The both demand and supply side bidding scenarios with case studies are presented in the paper. The impact of wind power in market mechanism such as market collusion, ancillary series and market power are also discussed. This paper could be guide line for the policy makers and market operators to promote the wind power with system reliability and security.

A.K.Basu et.al [15] discuss about micro grid scenario. Micro grid is an epitome of a macro grid but works in low voltage comprising of various small-distributed energy resources (DERs), energy storage devices, and controllable loads being interfaced through fast acting power electronic devices. Combined heat and power (CHP) produced by DERs are utilized in the local market where Micro Grid operates either in island mode or in grid-connected mode.

Nils Flatabø et. al [16] discuss the design concept of Nord Pool. The electricity industry of the Nordic countries went through a major restructuring during the 1990s. A wholesale market with significant competition has been established. Nord Pool was established in 1993 as a Norwegian electricity exchange, and extended its trade to Norway and Sweden in 1996. It thus became the world's first multinational exchange for trade in electric power contracts, and presently it is the only truly international electricity market. There is one market operator, and there are five system operators. Each country has its own regulatory agency. There are no general cross border tariffs. In 2001, power contracts worth nearly NOK 412 billion, about 55 billion Euro, were cleared by Nord Pool, and the combined volume of contracts traded was 2769 TWh, that is more than seven times the physical consumption.

Androcec et.al [17] discusses the Impact of Cross-Border Electricity Trading on Market Participants. In the paper, it is shown how electricity trading, congestion and transit is influncing on market participants in each area. Market participants are generators, suppliers (consumers), traders and TSOs. It is shown an example with four connected areas, where this benefits and losses for the involved parties are presented. Although there are still imperfect markets in Europe, we assume some prerequisites: the electricity market is fully opened, there is one power exchange in the region, a TSO model is implemented and there may be different price areas.

Lucia Parisio et.al [18] discussed the electricity prices and cross-border trade. In this paper drive the equilibrium bid function in isolated domestic electricity market and then analyse their modifications when cross border trade among them is managed using the implicit auction method. We show that cross border trade can induce price convergence across countries and thereby reallocate gains losses as a result of two concomitant effects. A volume effect due to mere increase/decrease of demand and supply in each market and a bid effect due to the modifications of bid functions brought about by interconnection. The latter effect can either contrast or reinforce the former also drive the conditions affecting the net results.

Ashwani Kumar et.al [19] discuss the congestion management in competitive power market Congestion management is one of the major tasks performed by system operators (SOs) to ensure the operation of transmission system within operating limits. In the emerging electric power market, the congestion management becomes extremely important and it can impose a barrier to the electricity trading. This paper presents papers/literature on congestion management issues in the deregulated electricity markets. There are 211 citations referenced in this bibliography. The general electronic web sites and the web sites dealing with the issue of congestion management are also listed.

Hiroshi Asano et.al [20] discuss the Restructuring the Electricity Industry and Emerging Issues in Japan. This paper describes the evolution of the electricity industry regulatory reform in Japan including scope of retail competition, power market development and maintenance of stable, secure supply. The paper also address and discuss new issues related to the further regulatory reform and reliable operations of power markets and systems including demand participation in the competitive market.

III. Concept of Power Trading

The objective of this section is to introduce the overview of basics of power trading (Restructuring). Trading electricity using a common power system is the only way for a large group of consumers to buy electricity from a large group of producers. The objective of the electricity trading system is that all the consumers pay for the amount of electricity they have consumed and at the same time all the producers get paid for their generation. In a nutshell, in a typical cost plus reasonable profit regulation regime, the incentives to cut cost are non-existent. Under competition, most of the risks are borne at least initially by owners – they would be responsible for bad decisions as also for profits from sound decision and managements practices. Rules, regulations and procedures have been developed over the years for facilitating short term trading in electricity, with the clear objective of:

- Utilizing the surplus generation capacity.
- Utilizing the surplus transmission capacity.
- Benefiting the consumers, by giving them the right to choose the supplier of power.

As the market develops and new business opportunities arise, trading across borders is becoming a key interest to more and more companies. Trading across different borders still implies trading with different rules and regulations. Cross border trade and investment are both the end and the means by which South Asia can achieve energy security. Through investment and cooperation, South Asia will be able to both close its burgeoning supply/demand gap and stimulate further reform, which will in turn open markets for further investment. It will now be possible for Indian companies to import power from across the border and sell it in the domestic market. The Central Electricity Regulatory Commission (CERC) announced significant changes in the power trading policy, including a regulatory framework for cross-border trading of power. The regulator has made a change in the definition of 'inter-country trading" that will enable trade of power between India and its neighboring countries like Nepal, Bhutan, Bangladesh, Myanmar, Sri Lanka, Pakistan. Cross-border trading forms a part of inter-country trading. There have been very few instances of power import from across the border in the recent past. One of them is the Tala transmission project, which brings power from Bhutan to Delhi. This is being developed by Tata Power for Power Grid Corporation of India Ltd (PGCIL), the country's largest power transmission company. Tata Power has also recently signed a Power Purchase Agreement (PPA) for trading of power through the Dagachu power project in Bhutan. This had to be accommodated through policy changes.

Modern power industry operation is particularly difficult to understand because of the dichotomy between electricity's business and physical manifestations. From the business perspective, electric power is an exchangeable commodity that can be traded much like any other commodity like oil, wheat, etc and for which futures markets and hedging systems do exist. But, in its physical manifestation, electricity is quite unlike all other traded commodities. The fundamental difference is that it cannot be stored to any significant degree. This greatly affects how it must be managed as a business asset, and greatly constrains its present and future market prices do or don't interact, as compared to other commodities. In large part due to its 'storage-less' nature, electricity can be transported only on a real-time basis, and in a manner heavily constrained by myriad physical laws that are complicated in their interactions but nearly instantaneous in their impact.

The net effect of all of these differences is that modern electricity trading and wholesale transportation systems are quite different from the practices existed previously. Restructuring has been accompanied by a variety of new problems, which have given rise to controversy between many governmental organizations and private companies. The changing nature of electricity utility industry has brought many new practices to power system operation. The philosophy and techniques of planning and operation well established over past decades have begun to change and it is needed to recognize and meet these challenges. To create the competition in power market there may be different ways of restructuring the power industry. But considering the organizational set-up, financial condition, control structure and their coordination, different reform models are categorized.

Various markets all around the world can be classified on different basis. The classification can be done in the following manner:

- Classification based on energy trading
- Classification based on contractual models
- Classification based on operational mechanisms of different ISOs
- Classification based on ownership of transmission network.

International Journal of Engineering, Management, Humanities and Social Sciences Paradigms (IJEMHS)
(Volume 17, Issue 01)
Publishing Month: October 2015
An Indexed and Referred Journal
ISSN: 2347-601X
www.ijemhs.com

IV. Problem Statement & Purposed Scheme

• To make Cross Border Power trading model for deregulated electricity market. The cross border competitive electricity market presents challenges to power system planners, power system designers and operators. It is not easy to introduce competitive electricity market in cross border international model scenario.

• This analyses and proposes the pricing mechanism for Cross Border Power Trading in the deregulated electricity market. Demand and supply side bidding scenarios with case studies are presented for further work. The impact of Indian power market price is also discussed. This work could be guide line for the policy makers, power systems designers, and market operators to promote the cross border countries power market with system reliability and security.

The reason for deregulation is different for different countries. Many countries made the changes as a result of failure of the state to adequately manage electricity companies. In other countries, the force behind this has been the lack of public resources to finance the required investment for the development.

Figure 1.1 Shows the typically structure of a vertically integrated utility where links of information flow existed only between the generators and the transmission system. Similarly, money (cash) flow was unidirectional, from the consumer to the electric utility.

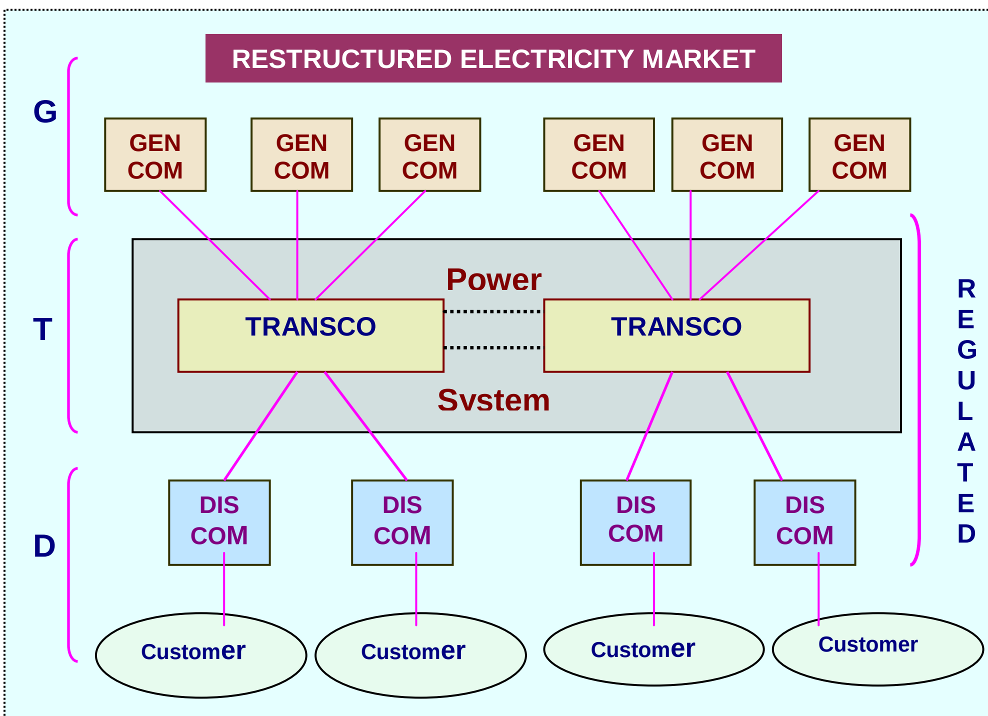

Figure 1.1 Restructured Electricity Market

Generating Companies (Gencos): The generators produce and sell electricity. This may refer either to individual generating units or more often to a group of generating units within a single company ownership structure with the sole objective of producing power, and commonly referred to as Independent Power Producers (IPP). Different markets may classify generators based on their rated capacity or in the way the generators have been contracted to operate in the market [21].

Transmission Companies (Transcos): The transmission companies are those entities, which own and operate the transmission wires their prime responsibility is to transport the electricity from the generators to consumers, and making available the transmission wires to all entities into the system. For their services, they levy the transmission tariff. In some systems [22], these Transcos are classified according to the operating voltage levels, such as national Transcos (at 400KV and 220 KV), regional Transcos (at 132 KV).

V. Conclusion and Future Scope

The growth of power demand in India is very high. So the proposed model will try to meet the Indian power demand by promoting competition into the Indian cross border region and result in better demand side management in the region. Besides this it will help the poor developing countries in its neighborhood to better utilize its resources and earn foreign exchange.

Power Exchange as a market operator will operate the proposed Day Ahead auction market with uniform price clearing in a price area. PX will provide equal and same-time information to all the market participants through on-line bulletin board. Power exchange, as institution, is able to pool risks and can create liquidity (through physical and financial products), thereby limiting the adverse exposure to traders within reasonable limits. In addition, such institution facilitates efficient clearing and settlement in cooperation with the system operator.

This paper focuses on trading arrangements, operation of power exchange and effectiveness of proposed pricing mechanism which is tested on linear demand and supply side bidding scenarios of market model. Suitable mathematical models are developed for calculations of market clearing price (MCP) and market clearing volume (MCP) simulations. This work could be guide line for the policy makers, power systems designers and market operators to promote the cross border power trade in South Asian countries with system reliability and security. Such type of model can be applied to the South Asia by promoting competition. Each country in south Asia has different peak load .timings. So such type of model can also be used in importing and exporting the electricity in South Asia.

References

[1] S.N. Singh and S.C. Srivastava, “Electric Power Industry Restructuring in India:Present Scenario and Future Prospect” IEEE Intemational Conference on Electric Utility Deregulation, Restructuring and Power Technologies (DRPT2004) Hong Kong April 2004.

[2] Chai Chompoo-inwai, Chitra Yingvivatanapong and Pradit Fuangfoo, “Transmission congestion Management During Transition Period of Electricity Deregulation in Thiland” IEEE Transactions on Industry Applications, Vol. 43, No.6, pp. 1483-1490, November/December 2007.

[3] P. Bajpai and S. N. Singh, “An Electric Power Trading Model for Indian Electricity Market” Power Engineering Society General Meeting, IEEE 2006.

[4] H. Glavitsch, G. Anderson, Th. Lekane, A. Marien and U. Naef, “A flow-based methodology for the calculation of TSO to TSO compensations for cross-border flows” Energy IJEPES 26, pp. 49-56, 2004.

[5] Milan Vukasovic, “Web-based simulation tools for the allocation of cross border transmission rights and implementation aspects in South-East Europe” Energy EPSR 78, pp. 1640-1647, 2008.

[6] Jinsu Lee, Hyosang Lee, and Sunghak Kim, “Designing the Cross-border Power Trading System for West African Power Pool” Transmission & Distribution conference and Exposition IEEE T&D Asia, 2009.

[7] Walter Reinisch and Tetsuo Tezuka, “Market Power and Trading Strategies on the Electricity Market: A Market Design View” IEEE Transactions on Power Systems, Vol. 21, NO. 3, AUGUST 2006.

[8] Hugh Outhred, “Comments on the International Comparison of Electricity Markets and Market Power Mitigation” IEEE 2007.

[9] Keinosuke Matsumoto,Tomoaki Maruo, Naoki Mori, Masashi Kitayamaand Yoshio Izui, “A Communication Network Model of Electric Power Trading Systems Using Web Services” IEEE June 2003.

[10] Nisheeth K. Singh, “Impact of Industry Restructuring on System Dynamic Performance” IEEE 2006.

[11] S. Völler, A.-R. Al-Awaad, J.F. Verstege, "Benefits of Energy Storages for Wind Power Trading" ICSET 2008.

[12] M.S. Elsobki, M.A. Abdel-Rahman, "Market Restructure Impact Assesment" CIRED2005.

[13] Sangamesh G.Sakri, Nagabhushan and S.A. Khaparde, "Power Sector Reforms in Karnataka" IEEE 2006.

[14] S. N. Singh and I. Erlich, "Strategies for Wind Power Trading in Competitive Electricity Markets" IEEE Transactions on Energy Conversion, Vol. 23, No. 1, pp. 249-256, March 2008.

[15] A.K.Basu, T.K.Panigrahi , S.Chowdhury, S.P.Chowdhury , N.Chakraborty, A.Sinha and Y.H.Song, Key Energy Management Issues of Setting Market Clearing Price (MCP) in MICRO-GRID Scenario, IEEE 2008.

[16] Nils Flatabø, Gerard Doorman, Ove S. Grande, Hans Randen, and Ivar Wangensteen, "Experience With the Nord Pool Design and Implementation" IEEE Transaction on Power Systems, Vol. 18, No. 2,pages 541-547, MAY 2003**.**

[17] I. Androcec, I. Wangensteen, S. Krajcar, "Impact of Cross-Border Electricity Trading on Market Participants" Power Engineering conference Lisbon, Portugal, March 18-20,IEEE 2009.

[18] Lucia Parisio and Bruno Bosco, Electricity prices and cross-border trade: Volume and strategy effects, Energy Economics Journal, vol. 30, issue 4, pp. 1760-1775, 2008.

[19] Ashwani Kumar, S.C. Srivastva and S.N. Singh, "Congestion management in competitive power market: A bibliography Survey", Energy EPSR 76, pages153-164, 2005.

[20] Hiroshi Asano "Restructuring the Electricity Industry and Emerging Issues in Japan" IEEE pp. 162-66, DRPT2008 6-9 April 2008.

[21] Subrata Mukhopadhyay, and Sudhindra K Dube, "Status of Power Exchange in India: Trading, Scheduling, and Real Time Operation of Regional Grids" Power Engineering Society General Meeting, IEEE 2005.

[22] Ashwani Kumar, S. C. Srivastava and S. N. Singh, "A Zonal Congestion Management Approach Using Real and Reactive Power Rescheduling" IEEE Transactions on Power Systems, vol. 19, no. 1, pp. 554-62, February 2004.