ISSN 2229-5518

Electricity Sector Restructuring Experience of Different Countries

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Abstract— Electricity Market from economic, regulatory and engineering perspective is a very demanding system to control .There is requirement of provision of cost efficiency, lower impact of environment alongwith maintenance of security of supply for use of competition and regulation in the electricity market. Many countries due to failure of its system for adequately management of electricity companies, followed restructuring for its electricity sector. In various countries, different restructuring models were experimented but in the initial phase restructuring was opposed by the parties favouring existing vertically integrated electricity sector. In the paper , restructuring experience of different countries are outlined .

Index Terms—Deregulation, Wholesale Electricity Market, Forward Markets, Independent system Operator, Power Exchange.

1 INTRODUCTION

Electric utilities have been vertically integrated monopolies that have combined generation, transmission and distribution facilities to serve the needs of the customer in their service territories. The price of electricity was traditionally set by a regulatory process, rather than using market forces, which were designed to recover the cost of producing and delivering electricity to customers as well as the capital cost. Due to this monopolistic service regime, customers had no choice of supplier; and suppliers were not free to pursue outside their designated service territories. The main reason for deregulation in developing countries has been to provide electricity to customers at lower prices, and to open the market for competition by allowing smaller players to have access to the electricity market by reducing the share of large state owned utilities. On the other hand ,high growth in demand and irrational tariff policies have been the driving forces for the deregulation in developing countries .Technical and managerial inefficiencies in these countries have made it difficult to sustain generation and transmission expansions and hence many utilities were forced by international funding agencies to restructure their power industries[1].

Eletricity markets are having a very important characteristic of its organizational structure which has been accommodated as the most significant change in the industry. Vertically integrated industry structure (a regulated monopoly) as the traditional industry structure was owned and operated as a single organization for distribution, transmission, and generation functions[2]. However, the vertically integrated structure, by virtue of the fact that it is a monopolistic structure, is not amendable to introduction of competition.

Current industry structure primarily requires separate functions of the generation and distribution (or consumption) from transmission as considering different functions associated with selling and buying electric energy. The reason behind separation of transmission which is the means of transporting the tradable commodity and ability to influence the transmission- use through, for example, line ratings, line maintenance schedules and network data would be to avoid very powerful competitive advantage to a participant. Beside this, another important function is system operation which is traditionally viewed as a generation/transmission function. This function has evolved to the Independent System Operator (ISO) in the most electricity markets presently which is responsible for coordinating maintenance schedules and performing security assessment.

The deregulation processes have been started with debate for defending the vertically integrated model from opposition by private and state monopolies [3]. The first was Chile to start effort in 1980s for restructuring its electricity sector. The most discussed deregulation was the British one, with more interest in Norway Model and much attention to actions in Unites States, especially California State. In South America a major transformation took place throughout the electric power industry from 1980 onwards (chronological progress-shown in fig.1).

2 RESTRUCTUING EXPERIENCE OF DIFFERENT COUNTRIES

The electricity sector reform in many developed countries have already undertaken since the 1980s. Initially it was not clear to how to increase efficiency by electricity sector reform. As a matter of fact over various countries, there exists diversity in the wholesale electricity market operation. A transparent, open marketplace would encourage competition among generators and reveal the inefficiencies of the current system to improve the efficiency of the

electricity sector.

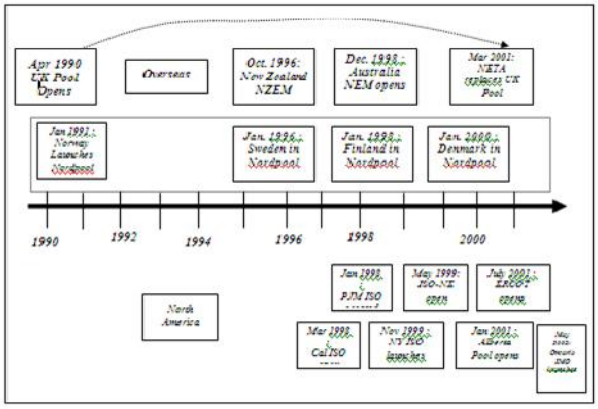

Fig.1. Chronological progression of developments of power markets across the world.

2.1 Chile Market

Hydropower production in Chile varies from 60% to 95%.For supply, there are 4 Gencos with one owned by State Government. Gencos are dispatched depending on audited generation costs and reservoir levels.There are 3 Transcos and private 13 Discos. A poolco which is Economic load dispatch center (CDEC) forecasts global demand and updates values monthly.The system operator in charge of coordinating grid operation is run only by generators favoring the development of several private transmitters. In Chile, wholesale market includes a unified market place, a transport system that “carries” power and market prices defined a spot price for each node along grid. A poolco manages dispatch, reliability and pooling functions .The National Energy Commission (CNE) provides arbitration in the case of disputes [4]. Losses including energy theft were halved in Chile within just seven years and Number of customers per distribution worker has multifolded in ten years after restructuring.

2.2 Colombia Market

Wholesale Electricity Market came into operation in July 1995. Rules promoting free competition in the generation and commercialization business were implemented. Transmission and distribution business were treated as monopolies and competitions were implemented wherever possible. For the reservoirs of the national interconnected system (NIS) defining minimum operative levels a methodology was ruled. CREG (Energy Regulation Commission Group) defined limits for the horizontal and vertical integration business. An energy stock market (generator pool) and a central operator (National Dispatch Centre) of the NIS to support its operation. Transactions between transmission and commercialization bidders are made under two modalities which are through subscription of guaranteed bilateral contracts and through direct transcations in the energy stock market ,free offer and demand .Projects of expansion plan are assigned through a scheme of public bids.There is open access to the NTS(National Transmssion System)network [5].

Transmission charges are based on connection charges and use of network charges. Evolution of the electricity sector has multifolded by significant increase in private participation.Competition in commercialization to unregulated users has incremented.

2.3 Argentina Market

Power sector restructuring activities in Argentina started in 1990, resulting in the enactment of the Electric Power Regulatory Frame .It created the National Regulatory Agency (ENRE) and wholesale Power Market. Transco and Disco required license to operate. Generation developed as free activity in competition and having the transmission network as open access. Marginal declared costs was basis for dispatch on recognition of remuneration for capacity as a function of system failure risks. Transport is organized as a monopolistic activity with national network (Transener) and six concessionaires for regional network(Distros);it included concession contract , transport tariffs based on the economic cost of losses (node factors) and network unavailability (adaptation factors), plus network O &M costs; expansion at the expense of interested parties ;failure penalties as a function of transport charges. It was mandatory for Transport concessionaries to provide nondiscriminatory open access to their transmission system. All existing and future load must to be served by distribution concessionaries in their concession area[6]. Wholesale electricity market is undertaken by private company (Cammesa) whose share holders are the associations of generators, distributors, transporters, the national state with equal distribution of shares and the large users .

2.4 Australia Market

The process of restructuring of the electricity industry in Australia was initiated in 1991, and by 1998 a National Electricity Market was developed, where the National Electricity Management Company (NEMCO) acted as both the ISO and IMO. Generators could sell energy either by bidding in the spot market, or through formal (bilateral) contracts. The most extensive restructuring is occurring in the South Australia, Victoria, New South Wales and Queensland to form National Electricity Market (NEM).The key aspect of transition process were like elimination of barriers to entry and of barriers to trade between states, creation of pool style (bulk electricity

market) competitive entities in generation and in retail supply and development of regulatory arrangements appropriate to the new regime [7]. Table1 below summarizes the deregulated structure in Australia.

	NSW(New South Wales)	Victoria	South Australia	Queensland
Generation	NSW's three exECNSW(Electricity Commission)generating companies and SMHEA(Snowy mountain hydro electricity authority)	Five exSECV(State Electricty Commission) generating companies plus SMHEA	ETSA(Electricity Transmission System Authority) Generation corporation trading as optima energy.	Three generating companies.
Transmission wires	Transmission company:Transgrid	Transmission company:Power Net Victoria	Transmission company:ETSA Transmission corp.	Transmission company.
Bulk Market	NSW Region of NEM1	Victoria region of NEM1	Participating in the Victorian Region of NEM1.	State poll,separate market company
Distribution wires	6 distributors with ring-fenced retailers	5 distributors with ring-fenced retailers	ETSA power corporation	7 distribution wires business
Retail Supply	6 host retailers and unlimited independent supply licenses	5 host retailers and unlimited supply licenses	ETSA power corp.(host retailers);unlimited supply licenses	3 host retailers and unlimited supply licenses

Table1.Electricty Restructuring in Australia

2.5 Nordic Power Market

In Norway, the electricity reforms were initiated in 1991. In 1993, Nordic power exchange was established as an independent company. Swedish electricity market unbundled in 1996. Thereafter, a common electricity exchange for Norway and Sweden was established under the name of Nord Pool. In 1998, Finland effectively entered into Nordic Market[8]. Denmark joined Nord Pool subsequently. Nord Pool is owned by the Transmission System operators (TSO) of Norway and Sweden. Nord Pool provides freedom of choice to the large consumers. It organizes trade in standardized physical and financial power contracts. Close cooperation between the system operation and market operation is the key feature of Nord Pool. Major contractual relation among Nordic countries is given in figure 2.

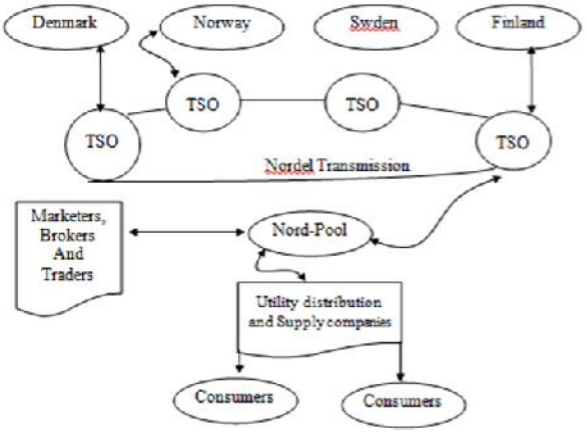

Fig2. Nordic Market – Major Contractual Relationship

2.5.1 Nord Power (Pool Group)

(i) Nord Pool Spot :

It consist of Nord Pool Spot AS and its wholly owned subsidiary Nord Pool Finland Oy, operates the physical day-ahead market Elspot in whole Nordic region and the physical intra-day market Elbas in Finland, Sweden and Zealand (Eastern Denmark). Elspot and Elbas are Nord Pool Spot auction based markets for trade in power contracts for physical delivery. On Elspot, hourly power contracts are traded daily for physical delivery in the next day's 24-hour period. On Elbas, continuous adjustment trading in hourly contracts can be performed until one hour before the delivery hour. Its function is to be the aftermarket to the Elspot market at the Nord Pool.

(ii) Nord Pool ASA - Financial Market :

Nord Pool Financial market is a regulated market place which trade in standardized derivative instruments like forward and future contracts going out several years, and has now started trade in options. Outside this market, there is quite a large and liquid market for over the counter forward and option contracts. The objective of

financial market is to provide an efficient market, with excellent liquidity and a high level of security to offer a number of financial power contracts that can be used profitably by a variety of customer groups. This market is wholly owned by Nord Pool Group.

(iii) Nord Pool Clearing ASA :

It is a licensed and regulated clearing-house. It is central counter party for all derivative contracts traded through exchange and OTC. It guarantees settlement for trade and anonymity for participants. It is wholly owned subsidiary of Nord Pool Group.

(iv) Nord Pool Consulting AS :

It is a consulting firm specializing in development of power market worldwide. It is also a wholly owned subsidiary of Nord Pool Group.

(v) Nordel:

Nordel is an association for electricity cooperation between forum for market participants, nordic system operators and TSOs of nordic countries. The primary objectives of organization are to create and maintain the necessary conditions for an effective nordic electricity market.

2.5.2 Nord pool Features

Nord pool is first multinational commodity exchange for Electric sector in the world .It provide open market to all Nordic Countries with common framework.-Nordic and Europian markets are example of decentralized day ahead spot market.There are no general cross border tariff among Nordic Countries.Trading of electricity generated by hydropower dominates the cross-border exchanges between the Nordic countries. The balance of electricity trade between the four countries depends on rainfall conditions because of great variation in fuel type capacity of Nordic countries. If hydropower potential is good, Sweden and Norway record trade surpluses, if hydro resource is poor Denmark and Finland will benefit from the electricity trading.-There are only one Market Operator (MO)-Nord Pool and five System Operator (SO) which are Svenska Kraftnät in Sweden, Fingrid in Finland, Statnett in Norway, Eltra in western Denmark, and Elkraft System in eastern Denmark[9].There are separate regulatory agencies in the four countries. The MO is in principle only responsible for facilitating the trade of electricity as the commodity, but within the physical constraints set by the SO. The operation of the physical system is the sole responsibility of the SO. Further, the market participants are given the freedom and responsibility of controlling (scheduling) their resources, and have to optimize the utilization of their physical and contractual assets.Transmission system operations are organized on a national basis for Nordic countries.The Five TSOs in the Nordic area are owner of respective main national grid The National Transmission System Operators (TSOs) are responsible for reliability and balance settlements.
The Elspot market is formed as a day-ahead physical-delivery power market and the deadline for submitting bids for the following day's delivery hours is fixed as 12 am (noon). There are three types of bids available in Elspot; the hourly bid or single bid, block bid and flexible hourly bid.Participants can submit bids to Nord Pool Spot electronically either through EDIEL communication or through the internet application ElwWeb.Nord Pool offers futures contracts for one to nine days ahead and for one to six weeks ahead in time. These futures contracts are settled daily. All these futures and forward contracts use the daily average system price as reference. There are also contracts to hedge zonal price differences, either one quarter or one year ahead.Prices for real-time are determined by the marginal bid like in the day-ahead spot market.Real time market is also known as Regulated Power Market in Norway.Nord Pool PX has a market share of 43% of the physical Nordic demand; the remaining 57% is traded bi-laterally.Nord Pool also operates a trading platform for financial derivatives as well as clearing house for bi-lateral contracts.

Congestion Management is done by market splitting i.e. resolving congestion in day ahead market and counter trade i.e. resolving congestion in real time.Point of Connection tariff structure is followed to promote space.UI pricing mechanism is followed for deviation from schedule.Dr. Per Christer,Senior Vice President ,Nord Pool Consultancy has given the Nord Pool Market Model (shown in fig3.).

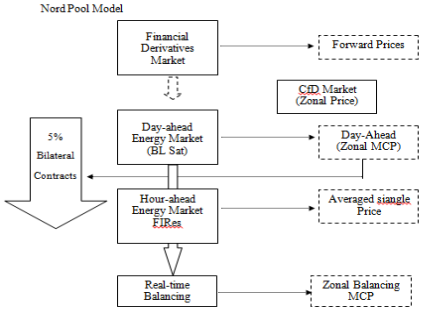

Figure 3.Nord Pool Model as given by Dr. Per Christer

2.6 Pennsylvania – New Jersey – Maryland (PJM) Market

The Pennsylvania – New Jersey – Maryland in-

terconnection (PJM) has been a pool between the three founding utilities that enables co-ordination of trade since 1927. PJM is responsible for the management of a competitive wholesale electricity market across the control areas of its members and for safe and reliable operation of the unified transmission system. All generators defined as a capacity resource in PJM system are obliged to submit an offer into the day-ahead PJM market. Market participants are allowed to self schedule. Transmission system security and reliability considerations are taken into account for the total market clearing operation. A marginal pricing principle is used for market clearing. Each generator at its specific node is paid market clearing price . All loads at their specific nodes are charged as per the market-clearing price . PJM Interconnection is a non-profit company ,a limited liability, governed by a board of managers. There is a specific unit 'Market Monitoring Unit (MMU)' within PJM to oversee the functioning of the market. States have public utility commissions (PUCs) and the Federal Energy Regulatory Commission (FERC)(shown in fig4). PUCs regulate generation and distribution's intra-state utility business. The FERC regulates interstate energy transactions including wholesale power transactions on transmission lines[10].

2.7 California State

Public, Political pressure and higher electricity cost have resulted in ending the regulated monopolies of vertically integrated utilities. Deregulation in US proceeded with the Public Utility Regulating Policies Act approval in 1978 and the Energy Policy Act (EPAct) in 1992.Federal Energy Regulatory Commission(FERC) approved non-discriminatory open access to transmission services in 1995.Utilities and Regulators, including American Electric Power (AEP) , the California Public Utilities Commission (CPUC),the New England Electric System (NEES) and the Pennsylvania / New Jersey / Maryland(PJM) pool have formulated several proposal for change[11].

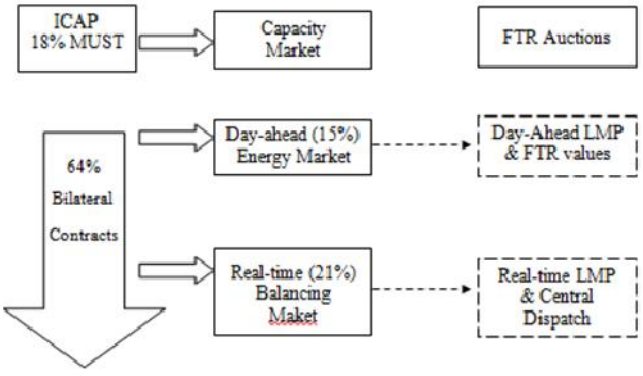

Figure 4. PJM Model

The Comprehensive National Energy Strategy announced on April 1998 and stressed that it relies as much as possible on free markets and competition. An Independent System Operator (ISO) and Power Exchange (PX) have been established in 1998 based on market structure after the CPUC's decision in 1995 which became watershed for the road towards competitive market. The outlining of the proposed California Model filed with FERC on April 29, 1996 withthree investor owned utilities (IOUs) in California which were Pacific Gas & Electric or PG&E, Southern California Edison and San Diego Gas Electric. There are three significant characteristic in California Model-

a) To simplify the transmission pricing scheme including nodal and congestion charge assessing, Zonal Approach is applied.

b) A Scheduling coordinator (SC) or PX have been introduced to manage multiple separate energy forward markets (each with a supply and demand portfolio). An adjustment approach is adopted to perform inter-zonal congestion management.

c) An adjustment bid approach is adopted to perform inter-zonal congestion management.

An Independent System Operator (ISO) and a Power Exchange (PX) have been established in 1998 based on market structure and rules governed by FERC.Multiple separate energy forward markets, each with a supply and demand portfolio managed by a Scheduling Coordinator (SC) or PX have been introduced .The total separation of the wholesale power exchange and the market participant was done from ISO.

Power Exchange will be independent entitiy for managing bid of energy for each half-hour on a day ahead basis for ISO dispatch decision. The ISO will control the power dispatch and the transmission system [12]. It will have no financial interest in the Power Exchange or in any generation, load, and transmission or in distribution facilities. The ISO will coordinate the information exchange in an open market and willwork as per North American Reliability Council (NERC) and Western System Coordinating Council (WSSC) reliability standards. The ISO will coordinate day-ahead scheduling and balancing for all users of the transmission grid and also will procure ancillary services.

Scheduling Coordinators (SCs) aggregate participants in the energy trade and are free to use protocols that may differ from pool rules. SCs run a forward market in which parties can bid to buy and sell energy and submit the preferred schedule to the ISO and work with the latter to adjust schedules when necessary(figure 5).

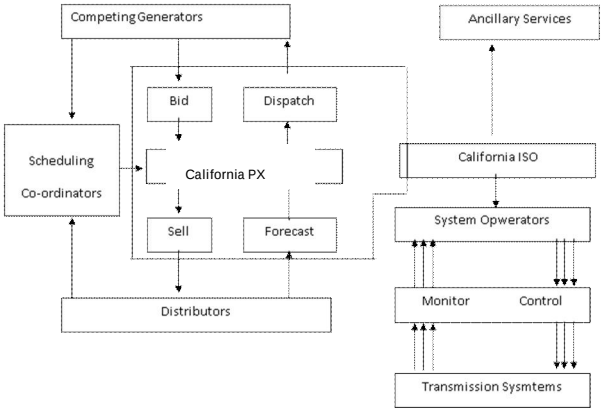

Figure 5.California structure with inclusion of Scheduling Coordinators.

2.8 New Zealand Electricity market

The New Zealand electricity system consists of Nort and South Island as two alternative current (AC system connected by 1200 MW underwater HVDC cable.All capacity on South Island is hydroelectric and it exported power to North Island.Approximately 75% of the North Island demand is met from hydroelectric source with the remaining 25% split between geothermal sources and fossil fuel (coal, gas and oil) sources. Prior to February 1,1996 ,the generating industry was dominated by state-owned Electricity corporation of New Zealand(ECNZ) which owned and operated 95% of total capacity.A wholesale market as Contact Energy ltd. for electricity was formed as seperate state owned enterprise from ECNZ On February 1,1996. There are currently 38 electricity distribution companies,providing equal access distribution services and electricity supply to customers and one electricity retailer providing electricity supply only[13].The wholesale electricity market in New Zealand commenced operation under the name Electricity Market Company(EMCO) on October 1,1996.

The New Zealand Electricity Market(NZEM) introduces competition within the wholesale electricity sector through creation of a national electricity pool and a spot market for electricity.The EMCO operates the market througha bidding system and is the clearing –house for market transactions.TransPower , the operator and developer of the national grid ,performs the various services like provision of reliable national grid ,efficient scheduling and dispatch generation to satisfy market demand,purchasing of ancillary services and providing information to the grid users in an open ,non-discriminatory manner in the wholesale electricity market.

2.9 Canada market

The restructuring in the Alberta's electric industry was started to retain benefits of the existing low cost generators for customers in 1996.In the new structure ,power pool was defined for all energy- trade in the province.Generation sector made fully competitive with competitive bidding except the case of old retired power plants.IPP was brought to meet load growth. Grid Company of Alberta,(GridCo) administered a province –wide transmission grid.The transmission grid was owned by the four utilities that own transmission facilities in the province and contract all individual owners to supply transmission services.The Electric Transmission Council as advisory group formed to represent the interests of consumers and transmission users[14].

3.0 England & Wales market

UK government took a historic step by privatizing the publicly owned electric power industry in England and Wales (E&W) in 1988.Generation, Transmission and Distribution of electricity were divided into three large companies. All existing fossil fuel plants were taken over by National Power and powerGen .

The National Grid Company (NGC) provides transmission services from generators to the Regional Electricity Supply Companies (RECs) and coordinates transmission and dispatch of electricity generators [15].NGC runs both the physical and financial side of the E& W electricity market. It serves as both the Independent system operator (ISO) and the Power Exchange and determine both half-hourly market clearing prices and runs the physical national grid, making generator dispatch decisions in real time to manage congestion on the grid and provide ancillary services for reliable supply to all the consumers [16]. NGC uses GOAL (generation ordering and loading)

program to determine the merit order of dispatching generation alongwith reserve capacity[17].

3.1 Indian Market

Indian Power sector is in a transition phase from a regulated sector to a competitive market (taken as author is from India). A competitive market provides the participants with benefits of psrice determination by market forces ,easy access to market, transparent working however it also brings with it many changes that need to be taken care of by the market participants at various stages of development.

The power sector in India has seen significant developments post the enactment of the Electricity Act 2003[18]. The policy and regulatory efforts have also been synchronized to ensure rapid development of the power markets in the country.

In this direction, Electricity Act 2003 has come into force from June 2003 in India. It introduces the concept of trading bulk electricity. The Act has enabled consumers and the distribution companies to have choice in the selection of electricity supplies . Similarly, the generator also has choice to select among the distribution companies (shown in figure 6.). The Act specifies the provisions for non-discriminatory use of transmission lines or distribution system or associated facilities with such lines or system by any licensee or consumer or a person engaged in generation.

At regional level, there are five regional load dispatch centers(NR,WR,ER,SR,NER) which are operated by Power Grid..At state level, there are 28 states which are responsible for their generation, transmission and distribution. States purchase power from Independent State Generation Supply (ISGS).Trade between states is facilitated by trading firms like PTC,NVVL and others[19].Distribution licenses and Government do not need trading license and transmission licenses and load dispatch centers can not trade power.About 2.5 % of total power generated in country is being traded presently.There are 17 licensed electricity traders for inter state trading till now.Most generation capacity (56% State,36%CGS,11%Private) tied up with long term contracts. Only surplus can be traded.The present inter-regional capacity is 11500MW which is planned to go upto 37000 MW upto 2012.India have Pool type centralized mechanism for dispatching central generating plants. On day ahead basis to meet forecast demand of SEB through respective RLDCs at regional level. But it is mandatory cost based (non bid) Power Pool.ABT mechanism facilitates Balancing market in an inherent way but it has got some limitations also.Current trading occur between ISGS and states STU / SEBS,

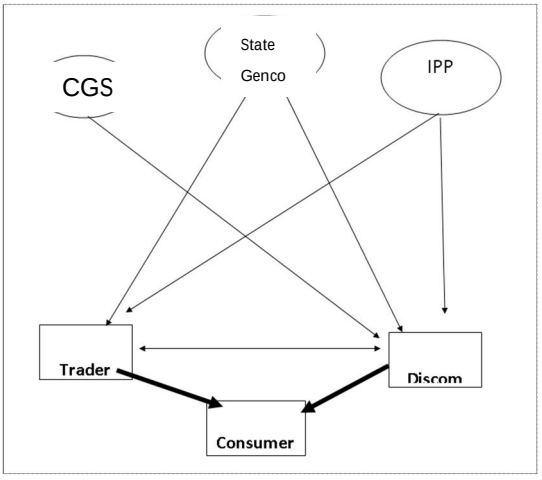

Figure 6.Indian Market Structure after Act-2003

between states, through international import /export (Bhutan, Nepal) and also by state embedded generators / IPPs / Loads and others.The RLDCS organize the day ahead scheduling of the ISGS[20] .Short term bilateral contracts are taking place through traders but they are lacking formal market and real time information. Often Sellers call for separate tenders for surplus available with them and traders compete with each others on prices to get the supply. This situation has resulted in prices of traded power moving only in one direction (higher). The root cause is one-sided competition. On the other hand, buyers are not getting adequate response against tenders called by them. A platform for wide sellers and buyers is not available.

4 CONCLUSION

In the various countries, most of the electric power industry has been going through a process of transition and restructuring by moving away from vertically integrated monopolies and towards more competitive market models since nineties. This has been achieved through as creating competition at each level in the power industry and having a clear separation between its generation, transmission and distribution activities as well. Different countries are im-

plementing industry restructuring in a variety of ways, depending on the characteristics of each market area which include: diversity of generation by fuel types, demand/supply balances, the extent of transmission capacity to facilitate energy imports to meet market demand and etc.. In designing and planning the market structure and rules for competition in their jurisdiction, governments, regulators and other industry participants are influenced by local market characteristics and the practices.

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