Chapter 8

International Experience in Spot Market:Implications for India

The accumulated experience in the operation of power pool or power exchange has led to the understanding that designing an appropriate market for electricity much more challenging than it was envisaged before the implementation of the spot market. The agents of electricity market have numerous ways to bypass the regulatory mechanisms. Often, fixing one problem leads to another problem. Reliability of the power system after implementing market oriented trading regimes in western world is one of most the debated issue. The explosion of literature on the issue is telling example of its seriousness. In regulated and vertically integrated regime this was never an issue. Initially, reliability was automatically ensure under the vertically integrated integrated structure because of incentive for overinvestment in capacities under regulated regime. Actually, it was one of the factors that turned the tide towards market oriented reforms in developed countries. But as the time passed after the implementation of market based regime, reserve margins began to fall in various markets of Unites States, Europe and Australia. This was on account of two reason – i) capacities that were created during regulatory regime started to grow old which needed replacement and ii) growth in demand. New market oriented electricity trading arrangement did not provide enough investment to meet the increasing demand and replace the retired plants with new ones. As a result, experts started to question the ability of the market oriented reforms to bring in optimal investment in generation and transmission capacities.

Reliability under the old model is defined in terms of the probability that the lights will go out because of insufficient capacity to meet all load at times. Therefore, the system operator must force the curtailment of load (i.e., start rolling blackouts) so as to maintain the frequency (integrity) of the transmission system. System planners have historically aimed for a probability of outage in the order of one day in 5 or 10 years. To ensure these types of reliability levels, systems are planned with extra installed capacity. Installed reserve margins are determined based on the target reliability levels, and using stochastic analysis of demand forecast errors, generation and transmission outages and other factors.

In a well functioning markets for commodities including electricity, the concept of reliability is also entirely different. As a commodity becomes scarce, prices rise and "low-value" customers low on the demand curve choose not to consume. In properly functioning markets prices always settle at a level where supply equals demand. There is never a situation in which a price is posted at a level that a customer is prepared to pay, but the customer is told that it cannot buy because of lack of supply. Price always settles at the intersection of the supply and demand curves. Customers choose whether to consume or not at the market price. The choice is always theirs, not that of an independent system operator (ISO) or some other third party. Well-functioning markets are thus always "reliable" because the lights only go out if a customer wants them to, given the price Fraser (2001).

Of course, in the new market model there is still a role for operating reserve and other ancillary services because of the uncertainty involved in real-time electricity production and consumption – production and consumption must always be perfectly balanced.

Two most formidable challenges that spot market for electricity faces is efficient management of transmission network and adequate capacity additions in generation and transmission.

8.1 Generation Capacity Additions

Initially, spot market in western world had no capacity problem. In fact overcapacity of the erstwhile regulatory system was one the reason for introducing market oriented approach in electricity trading. But over the time there has been a realization that capacity additions are not enough. As the plants that were built during regulatory regime are about to reach limits of their operating life i.e., replacement of the old plants are warranted. Experts have initiated discussing about factors that would motivate investment in transmission and generation capacity.

Recent reviews of libralised electricity markets reveal that the reserve margins have been falling with time. Wen et al. (2004) claim reserve margins in various markets have been falling. This consequence of the liberalized market was not foreseen well in advance because most these liberalizing country had huge reserve capacity at the beginning of the libralisation process. Experts (Joskow 2007, Brunekreeft & McDaniel 2005) claim that this consequence is because, regulators or the system operators have not respected the integrity of the market and intervened when ever the prices reached high levels to reflect the true scarcity rent. As a result of such behaviours from the watchdogs of electricity sector regulatory risk for the investors has risen and the opportunity to recover capital costs through very high prices during very small periods of peak demand has reduced significantly. Walls et al. (2007) empirically test the impact of regulatory uncertainty on generation investment. Probably, this led to reduction in investment in reserve capacity affecting the reliability of the system. Second reason forwarded for lack of investment in new generation capacity might the risk aversion by the potential investors in generation capacity. Alternatively, even if the expected income of the potential investor in peaking capacity recovers the variable cost, capital costs and reasonable profit, the high volatility of prices renders the whole project risky for a risk avers investor (Finon 2006). Third reason that is forwarded is the oligopolistic behaviour of the incumbent utilities. In an oligopoly setting firm would underinvest to raise the market price provided that there are sufficient entry barriers (Bushnell & Ishii 2007).

In order to ensure reliable supply of electricity we need sufficient reserve margins. Initially reliability was thought to be a public good. This conceptualization lead to justification of regulatory intervention in the capacity market because public good is underprovided if it is left to the market. Oren (2003) clarified, it is only security of the system which is public good and capacity adequacy is a private good. Reliability is basically a combining of system security and capacity adequacy. Therefore, adequacy in capacity can very well be achieved through the market mechanism. But for ensuring security of the system we must depend on regulatory mechanism. If energy only market operates without a cap it might give sufficient incentive for capacity additions. But it is impossible to know whether high prices realised during peak periods are legitimate scarcity rent or are result of abuse of market power. Therefore, high prices become politically unacceptable and thus the price caps are introduced. Thus, assurance of reliability is common challenge that is faced by the deregulating or deregulated electricity markets.

Capacity charges have emerged as solution to ensure that investors are able to recover their sunk investment. This was done to arrest the fall in the reserve margins that are being experienced but some how it could not be as successful as expected. The idea of capacity charges is rooted in the concept of peak load pricing. The concept of peak load pricing evolved during the era of regulated monopoly Boiteux (1960). Therefore capacity charges in the liberalized market might have to be significantly changed to fit the new setting of electricity markets. There is no homogeneity on how a country implements these capacity charges. Wen et al. (2004) and Botterud & Korpas (2007) give a good introduction to various kind various kinds of capacity charges that are in use. We describe them more elaborately by synthesizing the two studies for more clarity.

Prices for capacity as result of auction reveals the value of available capacity in the generation market and on the other hand if customers are bidding for capacity the price also reveals their willingness to pay for the reliability. Hence, the value of reliability can be obtained through this process. There are different forms of capacity payments that exist in practice to ensure sufficient supply in the short and in the long run.

8.1.1 Capacity Obligation Model

In this model each consuming entities are forced to buy a particular amount of firm capacity in proportion (more than 100 percent) of their maximum capacity. In the same fashion a generators are also forced to sell less than their maximum available capacity. Therefore, a reserve is created. In order to meet the capacity obligation consuming entities can either write long term contract with generators or procure the capacity in the spot market for capacity operated by the ISO. This model is employed in Northeast of the USA including PJM (Pennsylvania-New Jersy-Maryland), NYPP (New York Power Pool) and NEPOOL (New England Pool). In PJM and NEPOOL, capacity obligations are defined for 'load serving entities Papalexopoulos (2004). Normally, ISO operates two kinds of capacity market. One is installed capacity market (long run) and second is operable capacity market. Installed capacity market relates to the actual installed capacity in the market, and addresses the system adequacy in a long term. On the other hand, the operable capacity market relates to the portion of installed capacity which is operating or available within 'an appropriate period' as specified by the market rules, or in other word, it ensures the availability of sufficient dispatchable capacity on hour-to-hour basis. Under this scheme reliable power supply can almost be ensured but this might lead to over investment, one of the problems, why power industry was deregulated. The problem of over investment in traditional power industry was prevalent because of the guaranteed return on the investment.

8.1.2 Administrative Capacity payment model

In this model explicit payment is made to the each unit of installed capacity in the system. This payment to generators is in addition to income from the energy market. Generators are paid on the basis of making their capacity available to be dispatched. It does not matter whether they are actually dispatched or not. Objective of this capacity payment is to encourage investments by increasing and stabilizing the volatile income of generators. The capacity payments are collected from customers as a prorated uplift similar to other uplift charges such as the transmission charge. Spain, Argentina, Colombia and Chile have included a fixed capacity payment in their market designs. Problem with such a system is that capacity fixed by the regulator is highly likely to deviate from the actual valuation of the capacity that can be achieved through market. Therefore, depending upon the direction of deviation, overinvestment or underinvestment in capacity will take place. Secondly, market will value capacity differently at different hours of the day but these capacity charges remain fixed for every hour.

Another variant of administrative capacity payment existed in the old electricity pool of England and Wales. Under this mechanism, capacity payment was added as an uplift to the half-hourly spot prices through the so called"reliability adder" system. The dynamic capacity payment was based on the loss of load probability (LOLP) and the value of lost load (VOLL). Capacity payment = VOLL * LOLP on half-hourly basis and paid to all available capacity. This was also implemented in Australia. This produces optimal result if we assume zero risk, no market power and no lack of demand response. It induces exactly right level of Installed capacity which minimizes the sum of the cost of the capacity and cost of lost load. But all this is based on how correctly the VOLL is set. On the other hand, there is no way to arrive at the value of VOLL which reflects market value of VOLL.

8.1.3 Other Market Based Instruments

Doorman (2000) proposes capacity subscriptions, where consumers buy the right to a use a maximum amount of capacity. At the same time, they allow their demand to be physically limited to this maximum amount during periods of scarcity in the power system. The main advantage here is that consumers can determine themselves their level of reliability through the amount of maximum capacity that they subscribe to. However, the problem is that the mechanism requires the installation of physical equipment to allow the system operator to limit the demand for all customers which is exorbitantly costly.

Stoft (2002) proposes operating reserve pricing as a means for securing adequate capacity. In this scheme, the system operator purchases operating reserve capacity and determines at which price these reserves can be used in the spot market. The duration of using these reserves and the corresponding price level can be determined by the system operator. These parameters directly influence the generatorsŠ income from the spot market, and thereby also the profitability of new investments. An analogous alternative is that the system operator owns a strategic reserve itself that it dispatches in a similar manner.

Wang et al. (2007) develops a novel reserve trade mechanism between electricity users and the retailer of the market. First, the differences between the procurement of operating reserve in decentralized and centralized ways are analyzed. The comparison of the equilibrium solutions reveals that the centralized procurement that results in a systemic optimal solution is better than the decentralized procurement that results in a Nash equilibrium solution. Furthermore, an incentive contract based on a Principal-agent model, that is able to induce a systemic optimality as well as a Pareto equilibrium and manage risks at the same time is designed. The proposed model is equitable and beneficial to all participants.

Oren (2003) suggests to look at capacity charges as a premium that is paid to ensure price stability i.e., having a price cap along capacity charges is just another way of organising the market where price cap for energy units will serve as strike price of the call option. The short term inelasticity of demand and steep supply curve, a case that we encountered in chapter 5, may necessitate the setting of a price cap at an administratively chosen VOLL. In more generalised framework, Individual distribution companies can buy options for different strike prices which he will call when spot prices reach the strike price for which he had contracted for. The price of option is basically the capacity payment. In practice, regulator or ISO does it on behalf of all distribution companies for a strike price which is supposed to represent VOLL. Thought in this manner, capacity payments would yield optimal capacity of generation, provided capacity payments are introduced in transparent and predictable manner with appropriate estimates of VOLL.

Argentina among the developing countries has shown that a successful liberalised bulk market can work effectively in developing countries. Before, macroeconomic crisis hit Argentinean economy in 2002, liberalised electricity market, initiated in 1992, was generally successful in adding sufficient capacity, achieving efficiency gains reflected by falling prices and ensuring reasonable rate of profits during the period of 1992 to 2002 (Pollitt 2008). Regulation of bulk market ensured competitive behaviour by the generators who bid in spot market. This was done by the cost based bidding by the generators. To operate a cost-based market, all suppliers are required to submit, to the market operator and regulator, the characteristics of their generation units – heat rates (for fossil fuel units), variable operating and maintenance costs, and other demonstrable variable costs such as emissions costs. Fossil fuel suppliers are also required to submit information on their input fuel costs – typically the fuel supply contract associated with the generation unit. This information is used by the system operator to compute a variable cost for the generation unit. A simplified version of this exercise was done chapter 5. This exercise can significantly limit the possibility market power exercise by the generators compared to a regime where generators simply bid on the basis of price. In the case of price bidding, system operator has to just accept the price without bothering about actual marginal cost of the plant that generator is bidding. Therefore, the price bid in such a manner may have an element of market power exercises. But the generation units under the cost based bidding scheme will have to stick to the marginal cost that was approved by the regulator. System operator takes approved marginal cost as willingness to supply bid of the supplier in the pricing and dispatch process. Cost based dispatching is commonly used in Latin American countries. Since the macroeconomics crisis of 2002 Argentina's electricity sector could not perform well. Pollitt (2008) attributes it the poor polices for energy sector that were followed after the crisis.

Argentina's and probably many other Latin American countries' experience would be quite helpful in making prudent policies regarding electricity sector. Given the experiences of western countries, some scholars suggest single buyer model to be good compromise for developing countries (Finon 2006). But our survey of Indian experience in single buyer model or independent power producers programme (IPP) shows that it has failed to deliver result in terms cost and quantum both –neither sufficient quantity was added by private sector nor it was cost efficient. Therefore, middle path demonstrated by Latin American countries –the cost based budding – seems to ensure efficient dispatching and can potentially control for market power exercise by the generators. On the other hand generators would now incentive to invest as they have access to the fast growing market instead of single consumer as was the case under single buyer model.

8.2 Transmission

The transmission service is a natural monopoly segment of the ESI. As we discussed in chapter 4, non-discriminatory access to the grid/network is the key for effective functioning of the competitive generation sector. Therefore, sufficient capacity in transmission would be necessary for ensuring competitive generation. Transmission company has little incentive to ensure sufficient transmission capacity on its own. Therefore, the regulatory mechanism has to ensure that 1) the sufficient capacity is made available as and when required and 2) there exists non-discriminatory access to grid.

Complementarity of of investment in transmission and generation is well understood but at times, in liberalised regimes, they can be substitutes as well (Leautier 2001). For example, increase in demand in a particular region can be satisfied either by investing in a power plant with in the region or by strengthening the transmission network so that larger quantity of power can be transmitted from other regions to meet the increased demand. According to Stoft (2006) this situation leads whole range od strategic behaviour in investment activity that may lead to delayed and suboptimal investment.

Therefore, future expectations about the transmission policy will have significant impact investment in generation capacities. Uncertainties about transmission policy may lead to postponement of generation investment for prolonged periods. This is because, in an unbundled power system, an optimal investment in generation would require information about the future plan of investment in transmission and vice versa. Therefore, one way to solve this problem is to let one of the segment (either generators or transmission owners) reveal their investment plan first so that the other segment can optimally react to the first movers actions. However, there is a possibility that first mover may become victim of opportunistic behaviour of the second mover – suppose transmitter commits to invest in transmission network in a particular region *ex ante* and on the basis this commitment, generator invests in a new plant but transmitter does not actually invest *ex-post.* Therefore, each party knowing that it may be a victim of opportunistic behaviour *ex-post,* reduces investment *ex-ante.*

In addition to this, physical properties of the transmission is such that power flow from one point to another on a power system causes some power to flow on most transmission lines in the grid, although the amount that flows on remote lines is too small to matter [see (Kattuman et al. 2003) for technical details]. Alternating Current power lines are in some ways like a set of connected water pipes without valves between them. Pushing water from one point to another affects the flow in almost every pipe. Therefore, in an interconnected network any injection of power in one line owner's net work will have repercussions for other transmission line owners. Such externalities necessitate some sort of regulatory interventions. The owners can not be given physical control or the right to charge anyone who uses the line because access provided by network owner of a particular region will have implications on other transmission network owners as well. Usually, transmission network owners are only given financial or revenue rights while physical control of the whole network is given to a system operator i.e., independent system operator (ISO) so that such externality could be internalised. This leads the problem of incentive for ISO to perform efficiently and independently.

Broadly there are three models for system operation

1. *Transco Model:* In addition this Transco model may lead to inefficiencies in decisions involving a trade-off between transmission and generation . For example, expansion of transmission capacity to a load pocket is a substitute for new generating plants in an area. As recognized by the Federal Trade Commission (1999), the Transco may have incentives to favor its own transmission assets relative to any generation source, thereby discouraging new generation sources in the load pocketQ in order to ensure more intensive use of its transmission capacity. Thus, even if the transmission assets are entirely separate from generation companies, the Transco model creates significant problems.

2. *ISO Model:*under the ISO model, transmission assets are managed (but not owned) by a non-profit supervisory body. The ISO framework has two principal advantages over the Transco model – it extends the level playing field, since the ISO will not discriminate between generators or between transmission and

generation; and it creates the possibility of competitive supply in some parts of the transmission business. However, ISOs have been widely criticized for being vulnerable to lobbying [see (Boyce & Hollis 2005) for their own work and a review]. This most common model adopted for system operation.

3. *For-profit ISO Model:*Another model proposed by Boyce & Hollis (2005) is for-profit ISO. They claim that it solves the typical problems faced under Transco and ISO models.

Abdala (2008) argues that in a weak institutional system there is an increased likelihood of regulatory capture giving way to distributive politics and opportunistic behaviour by organised interest groups in the economy. In such a situation for-profit ISO model as proposed by Boyce & Hollis (2005) might be more appropriate way to organise transmission system operation.

In an interconnected network management of congestion is one of the key functions of the system operator. The solution suggested in the CERC staff paper (CERC 2006, p. 55) favours nodal pricing [locational Marginal pricing (LMP)]. This concept of the LMP was developed seminal work of Hogan (1992). Idea behind LMP is splitting of the market under the condition of transmission capacity constraint. For having good review of the LMP see (CERC 2006, p. 55) and Stoft (2006). Simulation results of Perez-Arriaga et al. (1995) show that LMP do not cover all costs. Transmission pricing, with experiences in operation of liberalised electricity market, is being recognised as far more crucial in efficient signaling for investment in generation in terms quantum, technology and location of plants and location of the load centers than it was initially imagined. In Indian context, not much discussion has taken place in this regard. Liberalised market show falling transmission capacity across the countries should be major concern that needs to be addressed. Europe in its quest for internal electricity market is struggling with these issues. Ehrenmann & Smeers (2005) brigs out the inefficient in cogestion management that is based on the methodology of market splitting or LMP[1].

The Electricity Act 2003 ensures that Power Grid Corporation of India Ltd. (PGCIL) remains in control of the transmission system for the purpose capacity expansion planning and maintainance. Private entry of capital is allowed for capacity addition only after PGCIL's approval. In this regard private entry for capital through competitive bidding as was experienced in Argentina (Pollitt 2008, Abdala 2008) would be quite useful. PGCIL's has already initiated programme of private entry through joint venture and Independent Private Transmission Company (IPTC) route. But delays in approval by the appropriate authority have been reported. Currently system operation is also managed by PGCIL sponsored 5 load dispatch centres for different regions but Electricity Act 2003 has mandated for separation system operation from the PGCIL in phased manner. Thus the idea is to move from a transco model to ISO model.

8.3 Retail Competition

Another important aspect of power sector reforms is introduction of retail competition i.e., consumers should have option to choose among different suppliers. India's Electricity Act 2003 allows for multiple distribution licensee in single distribution zone. This implies that every licensee in a particular distribution zone has to be provide with access to grid in non-discriminatory manner. Justification behind retail market liberalisation is that final consumers of electricity should be exposed to price that emerge in the whole sale electricity market. This would motivate the retail consumers to react to the real time prices of electricity which may lead to reduction (increase) in consumption during peak (off-peak) hours when prices in spot market is high (low). It may lead to flattening of daily load curve implying significant reduction in requirement of generation capacity. Many countries have introduce retail

[1]a special issue on congestion management came in *Utilities Policy* Volume 13, Issue 2

competition in electricity.

Defeuilley (2009) reviews that performance of retail competition in many of the developed countries where retail market is open to competition. Natural measure of competition in retail market would the percentage of consumers who are active i.e., who exercise their freedom. But this is difficult to measure because information about those consumers who renegotiated their contract with their incumbent utility and those took effort to enquire what is best deal for them after introduction of competition but remaind with incumbent utility are not available. Only observable variable is those consumers who switched their suppliers. Switching of retail consumers from the incumbent utility has been quite limited till now (Defeuilley 2009).

Joskow & Tirole (2006) argues that consumers may not to react to real time prices because of following reasons

- Retail consumers do have incentive to properly adjust their consumption to real time prices if only their total consumption over a given period is recorded i.e., they are on traditional meter.

- Even if the consumption of retail consumers are recorded on real time basis, transaction cost associated with monitoring the evolution of hourly prices and constantly optimising the use of equipment may be larger for small consumers, although they may be reduced by internet based information system.

- Consumers, even if they want to, may not be able to adjust their consumption freely. They may be constrained by physical attributes of distribution network as they are currently configured; in particular rationing occurs at the level of zones instead of individual consumers. Joskow & Tirole (2006) refer to this problem as problem of joint interruptibility problem.

Even though the objective of the retail competition was to expose final consumers of electricity to price that emerge in the whole sale market, none of the markets have introduced real time pricing. This is because of the costs of the real time metering is high and may not be politically feasible idea. We have suggested somewhere else Siddiqui (2007) mechanism for India, where retail consumers with different valuation of reliability could be priced differently when there exists joint interruptibility problem. This may reduce requirement of peaking capacity to some extent. Putting infrastructure to ensure successful operation of the retail competition is going to be challenging for India. As there are many states where even traditional meters are not working properly while large amount rural areas are yet to get electricity.

8.4 Conclusion

Experiences show that spot market mechanism has lead to significant decline in generation and transmission capacities. The encouraging example of Argentina (cost based bidding) in such a situation offers a methodology of how to control the market power exercise by generators without hurting the competitive mechanism. Even in case transmission Argentina's system did quite well before the crisis (Abdala 2008). This sounds encouraging when Independent power producers programme has miserable failed to add capacity in India and many other developing countries. India's existing institutional capabilities are well developed for cost based bidding mechanism. Information developed by Central Electricity Authority while giving techno-economic clearance to plants can used for cost based bidding.

Regarding governance of transmission, rules are yet to evolve. CERC's proposal has to be concretised by further research and review of past experiences of other countries. This is an area where research is lacking even for developed countries (Joskow & Tirole 2005). Competition in retail segment of the industry seems infeasible in the current context of available infrastructure, political and economic environment.