Design of power markets: Different market structures and options for India

Payal Malik

> The "central institutional issue of public utility regulation" remains…finding the best possible mix of inevitably imperfect regulation and inevitably imperfect competition...even when highly imperfect it (competition) can often be a valuable supplement to regulation.
>
> *Alfred E. Kahn*
>
> *The Economics of Regulation: Principles and Institutions*

Introduction

The eclipse of the state-regulated, vertically integrated utility as the dominant institutional form in the electricity industry is now a worldwide phenomenon. This phenomenon is a component of a broader trend towards the privatisation of state enterprises and liberalisation of markets for the services of infrastructure industries. Though market design experiments are being conducted in countries across the world, the organisational form that will replace it from among many possible forms still remains very uncertain. As has been pointed out in the literature, these forms are not mutually exclusive, and therefore, perhaps, in the place of a single organisational form, a hybrid of certain basic forms may evolve. Irrespective of the final market design, the restructuring exercise is consistent with the analysis by Joskow and Schmalansee (1983). The reform model proposed by them predicated competitive markets for generation, the operation of transmission facilities on an open-access non-discriminatory common-carrier basis, and retail competition among power marketers that rely on regulated distribution companies for delivery. The regulation of the wholesale and retail energy markets will be reduced to the imposition of structural requirements and operational guidelines and monitoring, while retaining a substantial regulation of the "wires" market for transmission and distribution. These changes entail unbundling, thereby reversing the vertical integration of utilities.

1. Traditionally, the electricity industry was viewed as a natural monopoly, i.e. an industry in which technology does not permit multiple non-colluding competitive firms to co-exist profitably. Thus, the solution was tightly regulating the vertically integrated monopolist with direct public control as the limiting case. The shift from the traditional industry organisation to an industry requiring a regulation of functionally specialised firms and oversight of competitive markets was inspired by several reasons. First, technological innovations have significantly reduced the economically efficient plant size for electricity generation; while in the seventies the optimal scale for electricity production ranged between 600 and 800 MW, by the nineties the optimal scale had declined to about 100 MW. Second, unbundling was considered necessary to expose cross-subsidies and improve efficiency via better pricing and stronger incentives for product variety. Third, privatisation and liberalisation came to be viewed as necessary to overcome organisational inertia and to attract new investment.

In this paper, we critically analyse the different market structure options and the broad organisational forms of restructured wholesale markets for electricity that have emerged. While doing this, we use some illustrative examples of the experiences of a few countries, without providing the details of the entire restructuring exercise. This is covered comprehensively in Section 2 of the paper. Having analysed the various options, we go on to discuss the possible restructuring options in the Indian context in Section 3. In this section, we draw heavily from the design solutions recommended by various committees and reports over the past few years. Not so suprisingly, the cornerstone of most of the solutions lies in market structures that would allow consumers to benefit through efficiency gains from deregulation and competition in generation and supply. The most critical recommendation in almost all the reports has been the importance of providing non-discriminatory open access to the network for transmission and distribution along with the regulation of transmission and distribution tariffs. We recognise the constraints to competition that arise in the transition to competitive power markets in India. Institutionalising competition in power is not easy, and we briefly outline the institutional arrangements for the same in Section 3 of this paper. Unfortunately, the power sector reform process in India has been extremely conservative. It was partly due to the absence of a legislation that mandated open access and partly due to policies that have not yet created conditions for markets in power to develop. The result of the prevailing conservative attitude to change has been slow, inconsistent, piecemeal and often wayward reforms. We end with a few observations in Section 4.

2. Different organisational forms of electricity markets

Creating well-functioning wholesale and retail markets is a significant technical and institutional challenge. Unlike in other commodities, markets in electricity do not happen; they have to be created, more so in developing countries, where supply shortages and transmission capacity constraints make the design of power markets extremely difficult. Power markets deviate from standard economics in two ways: the demand side is largely disconnected from the market, and details of the supply costs violate a basic competitive assumption. Supply and demand characteristics comprise a market's core structure, but in a power market these are unusually complex. The supply side cannot store its output so that real-time production characteristics are important and demand-side flaws (like low elasticity of demand and huge fluctuations in demand) interact detrimentally with this characteristic. Consequently, the market cannot satisfactorily operate on its own, and is essentially incomplete. It requires regulatory supervision backed by a pricing policy in areas of real-time energy, operating reserves, and installed capacity.

It is also true in the context of developing countries the liberalisation of wholesale markets and creation of bid-based spot markets should be deferred until there is ample generation and transmission capacity. This, however, does not mean that competition of some form or a more liberal power sector cannot be conceived; it just means that the creation of wholesale markets in power may not be a short-term option for developing countries like India. Therefore, most developing countries should start with limited forms of competition to wholesale competition through spot markets once the sector can manage full competition without uncontrollable market power (Besant-Jones and Tenenbaum 2001).

In the long run, imperfect competition in power markets stems from the same factors as in other industries, such as economies of scale and other entry barriers, and oligopolistic ownership. Competition is imperfect in intermediate time frames because production is capital-intensive and construction delays are long compared to variations in supply and demand conditions. Competition is inherently imperfect on short time scales because of technical rigidities on the supply side and inelastic demand. So the best that can be done in these imperfect conditions is to create market designs that can simulate competitive conditions. Some market structures are amenable to such designs and some are not. In the next section, we examine some broad market structures, before going on to examine their feasibility in the Indian context.

2.1 Market structure

The notion of market structure developed as part of the "structure-conduct-performance" paradigm of industrial organisation in the early 1950s. It refers to the properties of the market closely tied to technology and ownership. The reform of the power sector critically depends upon the market structure conceived as poor market structure, and it poses the greatest threat to the health of power markets. Embedded in different market structures is the market microstructure that defines the general architecture and rules of the markets that evolve from a specific structure. These come under the purview of market-design problems presented by Chao and Wilson (1999) and Wilson (1999). Hogan (2002) has very succinctly ascribed the requirement of a market design: incentives, incentives and incentives.

The market design defines the trading arrangements that get the buyers and sellers of the markets together in a competitive market. These trading arrangements define the detailed rules of access to the transmission facility with the right of access to these facilities being enshrined the law governing the electricity sector of a country. Merely by declaring the industry deregulated and providing open access to the transmission system cannot produce competitive markets in electricity. Open access is only the starting point, where all the market participants, i.e. the producers of electricity can access the transmission and distribution wires without any discrimination. One essential ingredient of implementing open access requires the specification of trading arrangements, which can be centralised or decentralised. It can be based on bilateral contracting, a centralised exchange, or a tightly controlled pool. Trades can be physical or financial obligations, and they can be forward or spot contracts; the market can include or not include financial hedges; the “official” market can be mandatory or optional and encourage or discourage secondary markets.

These arrangements will be discussed in detail in the next sub-section. The stress would be on the incentives created in the operation of each of these designs. We shall now briefly discuss the broad market structures as identified in Hunt-Shuttleworth, 1996, that trace out the market structures from the vertical integration of the industry and monopoly franchises to a market structure permitting all customers to choose their suppliers.

Vertical integration with monopoly franchisees was the chosen form of market structure for 100 years after electricity was commercialised in 1878, where a single company in each area produced, transported and retailed the product and operated the system. This vertical integration of functions was the typical organisation that was accompanied by a legal monopoly within a service area. Besides the natural monopoly argument favouring this market structure, the technical challenges of coordinating generation with transmission demanded a complex integration of generation and transmission (via the system operator). Further, the managers of the generating plants had to obey the system operator and the best way to do that was to have them in the same company. Finally, the long-term planning of transmission and generation also benefited from the vertical integration of generation with transmission. In India too, the alleged “natural monopoly” and “limited contestability” characteristics of all three physical processes of the electricity sector, i.e. generation, transmission and distribution were used for a long time to justify the structuring of the Indian electricity industry as a collection of public sector monopolies.

However, the economies of scale in the generation of electricity have been extensively argued against in literature (Joskow and Rose, 1985), and hence the proponents of restructuring argued for the dismantling of these monolithic utilities in order to make them more amenable to competition. There was also dissatisfaction with limited incentives for efficient operations faced by government-owned electric utilities. It was observed that in spite of there being scale economies in the production of electricity, these failed to get realised due to lack of incentives for input choice provided by the regulatory process or state-ownership. In the case of a government-owned utility, the management chooses higher than cost-minimising levels of labour or capital to increase its political clout and long-term viability. Wolak (1999) argues that regulated utilities and state-owned enterprises have historically had difficulties making economically efficient new generation capacity investment decisions, both in terms of size and fuel to be used in generation. Therefore, deregulating generation is essential to introduce competition from the supply side. In most countries, radical approaches towards restructuring the electricity industry include the privatisation of the state-owned generating assets, prior to the introduction of wholesale markets in power.

Another market structure emerged in 1978 in the US, when the Public Utilities Regulatory Policies Act (PURPA) enabled the entry of independent power producers (IPPs) and encouraged the co-generation and development of renewable energy sources by imposing obligations on utilities to procure supplies from qualified facilities. However, this meant the continuation of the utilities' vertical integration, though with the introduction of this model there was some potential for competition in generation[1]. This model became the chosen model for many developing countries including India, which were restructuring their power sector. The IPPs could only sell to the existing utilities (the single buyer), which was generally perceived as good credit risk. Instead of forcing the generators to compete in the market for wholesale electricity, sinking or swimming on the basis of their competitiveness and efficiency, they were awarded sweetheart contracts with seemingly ironclad guarantees regarding sales, rates of return, prices of inputs and outputs, and market scope. Such contracts maintained the vertically integrated nature of the industry and failed to introduce competition in the market for bulk electricity. Clearly, such contracts rendered competition superfluous (see Box 1, The Single-Buyer Model).

The wholesale competition model as described in Sally Hunt (2002) has a fully competitive generating sector with large distribution companies (discos) and large customers as the buyers. This is the model recommended by her for the reforming of the market structure. In this model

- All generation is deregulated and sells into a competitive wholesale market.
- The technology of generation is thought to exhibit constant or decreasing returns to scale at current levels for production.

[1] The aim of PURPA in the United States was not to introduce competition, but to encourage environmentally benign generation sources.

BOX 1

The Single – Buyer Model

gerous Path toward Competitive Electricity Markets

Many Asian, African, and Eastern European countries freeing up their electricity markets are preserving an artificial monopoly over the wholesale trading of electricity even after the vertically integrated national power company is unbundled. Evidence so far suggests that this “single-buyer” model has major disadvantages in developing countries: it invites corruption, weakens payment discipline, and imposes large contingent liabilities on the government. These disadvantages in most cases overshadow the higher short-term costs of a “bilateral contracts model” where generators contract with customers.

o popular?

The popularity of the single-buyer model is due to a number of technical, economic, and institutional factors:

- The single-buyer model preserves a key role for the sector ministry in decisions on investments in generation capacity, and for the stateowned electricity company in the sector’s day-to-day financial affairs—and thus tends to be favored by these influential players.
- The single-buyer model makes it possible to shield financiers of generation projects from market risk and retail-level regulatory risk, reducing financing costs or making the investment commercially bankable.
- The single-buyer model appeals to the populist instincts of politicians reluctant to support the state’s complete withdrawal from wholesale electricity trading.

s the downside?

- decisions about adding generation capacity are made by government officials who do not have to bear the financial consequences of their actions.

- Distribution companies (Discos) and large consumers purchase competitively in the wholesale market.
- No default option for the large customers other than the spot market price[2].
- Discos provide for small consumers by making contracts with generators or marketers.

---

[2] This may not be an option in developing countries because there would be the need for a default supplier till the time the wholesale market develops

Under this new unbundled structure of generation and transmission with competitive trading between wholesale market participants, the traditional pool-operating functions have been more clearly defined and segregated into:

- Market operation functions related to energy trading, scheduling, and settlement of transactions in different time horizons (week, day or hour ahead before physical transactions occur) and

- System operation functions related to operation and control of the bulk power system to (i) meet load and security needs with real-time dispatch to balance supply and demand, (ii) to manage ancillary services to maintain system reliability, and (iii) to manage transmission congestion, etc.

Finally, the most developed form of market structure is the one that allows for customer choice and retail competition. A prerequisite for successful customer choice is a well-functioning wholesale market and associated institutions, which we discuss in Section 2.4. The agreement between a retail customer and a retail company is unregulated and can be structured in many ways. For instance, the price of service can vary by time and season, or other financial and quality of service obligations can apply. Retailers can contract with generators, or they can choose to buy energy directly from other supplier companies, such as aggregators. The retailer pays the wholesale market (or its own supplier company) for the energy consumed by its own retail consumers. In addition, the retailer can arrange for the provision of network services, or the customer can arrange for those services directly (see Annex 1 for the different types of market structures).

2.2 Pre-conditions for competitive market structure in power

The starting point of competition in power is the presence of many sellers and many buyers. Therefore, to create competition from the supply side, it is crucial that there is a minimal concentration of market power in generation utilities. Thus, in many cases of reform, the first-best solution to mitigate market power has been a full divestiture of the existing generation into smaller groups or plants to create enough competitors. Another essential element for a competitive market in electricity is allowing choice to the customer, which can be a distribution company, a large industrial user, co-operatives and other bulk consumer, or a retail consumer. The single-buyer model is an antithesis to customer choice and there is an absolute need for an arrangement that allows for distribution companies to procure bulk supply from other sources. Further, these buyers should be responsive to prices. For this to happen it is important for a substantial portion of the load to have usage tracked hourly and that buyers pay prices which vary hourly with system conditions. Therefore, the highest priority must be accorded to the establishing of the essential conditions of an ideally functioning power market, which do not exist as of now—namely, real-time metering and pricing at least on an hourly basis to a sufficient fraction of the market. Once this infrastructure is installed, demand side participation would operate to moderate price spikes. If at all such spikes exist, they would be economically beneficent, in consideration of their effects on both the supply and demand side and would induce efficient levels of capacity and conservation. Thus, demand shifts are necessary to capture as they play a key role in determining long-run characteristics of supply.

Ideally, there should be only minor transmission constraints. To have none would imply excess investment in transmission. However, if constraints exist, generation plants behind such constraints can in principle bid high prices and achieve them. Constraints can prevent other plants from bidding lower to prevent high-priced plants from operating. Large constraints, where the ability to transmit power is small compared to demand levels, will fragment a grid into different competitive zones (i.e. several markets). Trading arrangements that can overcome most of these constraints need to be clearly spelt out. Therefore, an efficient management of the existing network through short-term congestion management rules, congestion pricing rules, and financial transmission rights should be undertaken.

Applications, licences, and approvals must be simple and quickly addressed. Contracts with the transmission company must not present a barrier in terms of standards of connection, and requirements for back-up supplies to fulfil power purchase contract terms must not be onerous.

It also needs to be recognised that while reliance on market participants to make most or all investment decisions for generation and demand alternatives seems both natural and much like other normal markets, extending this to the realm of transmission investments is less obvious. Thus, for the most part, the transmission expansion would be a regulatory decision. Competition in electricity would only succeed with associated financial transmission rights, which provide a key ingredient for long-term contracting and property rights for expansion. The design of a mixed system of merchant and regulated transmission investment presents a challenge for regulators and market participants. An incentive regulation of transmission, distribution and system operations can yield significant benefits if carried out properly.

2.3 Market design: Various organisational forms

The success of the liberalised market structure model of wholesale competition is predicated on a proper organisation of the wholesale market that would most efficiently:

- allocate energy generation among suppliers and demanders
- allocate transmission capacity among suppliers and demanders
- provide reserve capacities for generation and transmission to meet contingencies and ensure the reliability and security of the

system. The provision of reserves is often called ancillary services.

Each of the components has an important time dimension that differentiates between forward planning and real time operations. Forward plans distinguish between long-term and short-term, with the short-term identified by “day-ahead” plans for the next day’s operating cycle and “hour-ahead” plans for the next few hours. Real-time operations are conducted on a time frame that ranges from 1 hour down to 5 minutes ahead of actual dispatch.

In this section, we discuss the organisational designs of such markets. The peculiar features of the electricity industry like the temporal and stochastic variability of demand and supply, non-storability of power, multiple technologies with varying sensitivities to capital and fuel costs, and dependence on a reliable and secure transmission system, are important considerations in designing these markets. In addition, economic problems associated with electricity like the immobility of generation and transmission facilities, scale economies of generation (though this problem has eased), non-linearity in transmission and externalities (mainly in transmission), further complicate the design of markets. However, the criteria for selecting market design are necessarily to induce short-term efficiencies that would also provide for efficiency over the long term including incentives for investment in generation and transmission facilities. The market design should be considered as a way of establishing a mode of competition that is most effective in realising the potential gains from trade.

The breakthrough that made real competition possible on an electricity grid was the concept of an independent system operator (ISO) that operates a centralised spot market, more or less integrated with real-time physical operations and open to competitive buyers, while managing all significant unpriced effects as a non-discriminating monopoly. An ISO is generally an independent, non-profit entity under the control of a board representing some combination of market participants and the general public overseen by the regulators. As the sector develops, profit-making companies will compete to provide ISO services for a fee, with incentives to operate the system efficiently. An ISO could even own the grid assets (the Transco model) as long as it remains unaffiliated with the market participants. An example is the National Grid Corporation (NGC) in the United Kingdom. This is also the model in Spain and Scandinavia. Another possible option is the separation of the system operator from the ownership of the transmission (Gridco model). This has been adopted in Argentina and most of Australia. In the United States, there are ISOs in California, New England, New York, and Pennsylvania-New Jersey-Maryland (PJM), to name a few. But the transmission ownership in each of these regions remains with the old utilities, and so transmission ownership is fragmented (see Annex 2 for an overview of the design of power markets in different countries).

According to Wilson (2001), every jurisdiction uses a different structure of governance, regulation, system management and markets and there is no standard organisation of liberalised wholesale power markets. In one extreme, broad authority is assigned to the ISO with the intention of recapturing the advantages of tight coordination obtained previously from vertical integration. Instances can be found in Britain during the period 1989–2001 and in the US, in the Northeast, including New England, New York, and PJM. During the 1990s, electricity markets based on an ISO and an open, centralised spot market have been established in countries and regions like Norway, Argentina, New Zealand, Colombia, Peru, Ukraine, Victoria (and subsequently all of eastern mainland Australia), Spain, Alberta, and California.

The other extreme form is more decentralised, with the ISO's responsibility, beyond managing transmission, limited to facilitating private markets for other ingredients. For instance, the ISO not only allocates transmission access, but also auctions tradable transmission rights and conducts auction markets for counterflows used to ease transmission congestion. Similarly, it ensures the joint feasibility of participants' operating schedules, with each allowed to retain the discretion to construct its own schedule to meet obligations contracted in various markets. And again, the operator conducts procurement auctions to obtain reserve capacity, but each participant retains the option to self-provide or contract elsewhere for resources to meet its reserve obligations. Separating the markets for energy, transmission rights and counterflows and reserves sacrifices tight coordination. However, it reflects the priority accorded to maximising the role of private markets and minimising decisions immune to market tests. Examples are in Australia, Scandinavia, California 1998-2000, and Texas, as well as Britain's new system that began operation in 2001.

More recently, during the restructuring debate in California, and previously in Norway and Spain, a more flexible wholesale model was proposed and implemented. Besides pool-based trading, *physical bilateral trades* scheduling generation and demand outside the pool was allowed. The separation of the market operation functions and the system operation functions into two independent entities—the MO and the SO—has been used in the hybrid pool plus physical bilateral trading model. For instance, in California, the power exchange (PX) matched bilateral physical trades between generation and demand, and submitted these schedules to the independent system operator, who was responsible for system reliability and transmission congestion management. (PX was dissolved during the California electricity crisis of 2000-2001.) This separation allows the possibility of several entities conducting trading even under competition. This seems to be the general trend in most new restructuring experiences, including the recent reform of the UK wholesale market. However, Hogan (2002) points out that the underlying premise in many market design proposals that the functions of the independent system operator can be largely separated from the operation of a wholesale spot market, is seriously flawed.

Sally Hunt (2002) identifies the wheeling model as another trading arrangement. Under this model an integrated utility with its own generation runs the transmission and system operations and provides access to transmission by scheduling contracts at the request of the traders after it has scheduled its own resources for its own load. The utility provides for imbalances and manages congestion and ancillary services using its own generation resources. These services are priced at regulated rates. Also, there is no formal spot market. However, according to the author, this model would stifle competition in generation, because the system operator is not independent of the utility. The trading arrangements required for competition are dependent upon a system operator who is fully independent of the generators, which is not true of the wheeling model. Moreover, the native load gets the first priority in scheduling, and this kind of scheduling priority is inconsistent with competition. The wheeling model at best allows for marginal competition and does not allow for many trades. If it did, it would converge to the wholesale competition model and that would then require a market-based framework to deal with scheduling, imbalances, congestion management, and ancillary services. However, Finon (2002), analysing this model in the context of the French electricity industry, argues that the model can be successful in introducing competition. France undertook a minimal reform of the organisation of its electricity industry, while retaining vertical and horizontal integration and the public ownership of the incumbent company. The reform was based on the introduction of a rule of third-party access (TPA) to the network, allowing bilateral direct sale arrangements on a limited number of eligible customers (30 per cent), without any notable changes in the market structure. The author contends that a combination of vertical integration and state ownership—the least attractive market structure to competition and entry at the wholesale level—can also allow for competitive entry.

However, the caveat to this possibility is the presence of the institutional capabilities of the reforming country in question, which would require the setting up of an independent regulatory authority with an effective control of network access. In France, the regulatory governance structure ensured the promotion of market rules and the creation of a power exchange for balancing the incumbent's dominant position. Secondly, in the case of France an external institutional environment, i.e. the European law of electricity market liberalisation neutralised the national institutional inertia to reform. The EU directive relating to the deregulation of electricity markets helped in the rule-making process and limited the capture of the regulator by the public incumbent or the government. The author also points out that this model in a closed and autarkic national context in the British public electricity industry of 1984 failed to produce favourable results. Thus, the success of this trading arrangement is subject to institutional arrangements, which may not be replicated by developing countries.

2.4.1: Integrated trading arrangements: The pool

The most common form of an integrated trading model is the pool. As mentioned, pools integrate system operations and market operations by integrating markets for energy, imbalances, congestion management and reserves. Typically, they inherit procedures from national monopolies or regional power pools that previously coordinated the schedules of utilities or distribution companies serving adjacent areas. The system operator is the manager of the pool who runs the spot market using a large computer optimisation programme to convert the information from traders about their willingness to buy and sell. The system operator running the pool minimises costs subject to the constraint of not overloading the transmission system. Thus, the pool is an integrated spot market and dispatch centre that internalises network interactions and real time events, with the software producing a list of generators who should operate (based on their supply price) and the level of their output. This helps in producing a spot price, which is obtained from the shadow price given the constraint that the supply matches demand for that hour. Since the software is completely neutral about which plant it chooses and the price it puts out, all generators who bid below the spot price will be generating and all customers who bid above the spot price will be consuming. Sally Hunt (2002), endorsing these trading arrangements, says, "… It is an incentive compatible system for dispatch, congestion relief and pricing all rolled into one."

Present in its purest form in Britain before 2001 (and PJM still), the pool market operates as a direct revelation game; participants reveal their supply costs and demand values, as well as various technical constraints that become inputs to an algorithm. The objective is usually stated as maximising the gains from trade as measured by these submitted costs and values.

However, these arrangements do not preclude forward contracts between buyers and sellers of electricity, in which most of the energy physically delivered is established in forward contracts, prior to the moment of real-time delivery. The residual trade is in real time. Another important advantage of these trading arrangements is that any imbalance in the forward contracts is settled from the spot market pool at the spot price. Thus, if the contracts fail to deliver, both the buyer and seller can take recourse to the wholesale spot market where electricity is being traded anyway, to meet their contractual obligations. However, once the spot market pool is there for all to use, most trading is done under financial contracts (which incorporate these forward contracts) that define monetary payments based on spot prices rather than under contracts that allocate physical delivery obligations. So, it is possible that Genco A, who has contracted a delivery of 50 MW to a buyer Z at a mutually agreed price of Rs X/ MWh, need not be the physical supplier of energy to the buyer. There is no one-to-one correspondence between the buyer and seller. The system operator would incorporate the contract in the bids he receives, but would dispatch the cost-minimising load of 50 MW from any Genco or a combination (not necessarily Genco A) at a particular point in time, if the contract were flexible. Only in the case of an inflexible (physical) contract would there be a matching of the buyer and seller as per the contract. However, in these kinds of inflexible physical contracting, the market participants cannot exploit the full benefits of gains from trade in a competitive market. Financial contracting as opposed to the physical contracting is much more flexible and efficient. The pre-negotiated contract would then be used as a benchmark to settle the difference between the contract price and the spot market price.

The original UK pool used a system known as gross settlement, under which contracts are settled between participants after the real time dispatch. This form of contract is known as a contract for differences (CfD) because it replaces a trade at the market price with a transaction at the contract price. Under net settlement, the system operator is made aware of the contract schedules between market participants which are then used for financial settlement and not for physical dispatch, as explained in the example above. Then in such a case, each bilateral trade is the contract quantity times the difference between the contract price and the spot price. Thus, a CfD acts as fixed price contract—either the seller pays the buyer (if the market price is above the contract price) or the buyer pays the seller (if the contract price is above the market price). Stoft (2002), illustrating the benefits of bilateral trades implemented through CfDs, argues that these CfDs completely insulate the traders from the spot price, provided that the traders produce and consume amounts contracted for. When CfDs are used, the only effect of the spot market is to provide a convenient remedy for deviations from contract position. Such deviations only affect the party who deviates. Even in the presence of these bilateral trades, both the customer and the supplier would behave as if they were operating in the spot market because their incentive to deviate from the contract quantity is determined by the spot price. Such deviations are desirable and can only make them better off while doing no harm to their trading partners. According to the advocates of these trading arrangements, CfDs give the best of both worlds. Traders are protected from the volatility of spot prices, and the real-time market is protected from the inefficiency of the forward bilateral contracting. Moreover, while insulating bilateral trade from the spot market, the CfD, together with the two-settlement system[3], also insulates traders' use of the spot market from the effects of the bilateral trade.

In some wholesale markets, physical bilateral trades are also allowed, in addition to voluntary pool trading with the help of financial bilateral contracts of the kind explained above. Buyers and sellers individually contract with each other for power quantities at negotiated prices, terms, and conditions. We discuss the trading arrangements required for the execution of such contracts in the next section.

2.4.2 Decentralised trading arrangements: physical bilateral trade

In these trading arrangements, there is no explicit coordination of the markets for energy, transmission, and reserves. Rather than invoking traders' obligations as in a pool, these systems operate on the principle that essentially every service provided to the ISO is priced explicitly in a market. There are no obligations beyond those contracted explicitly in a voluntary market transaction and paid for at the market prices. The bilateral view generally admits that a centralised Day Ahead market is needed but contends that it should not trade energy. Instead it should facilitate bilateral trades of energy by selling transmission rights to the traders. This is generally claimed to be a simplification, and for the auctioneer it is a great simplification relative to solving the constrained optimisation exercise of the integrated trading model.

[3] A settlement procedure when the system operator runs a Day Ahead (forward) and a Real-Time (spot market) market. The generators should be paid for power sold in DA market at the DA price regardless of whether they produce power or not. In addition any real time deviation from the quantity sold a day ahead should be paid for at the spot price.

So, rather than the ISO operating a spot market that prices energy (at least) each hour at more or less what it really costs or is worth in each hour and location on the grid, commercial trading and pricing are left to private competing market makers and traders, not be usurped by the monopoly ISO. NETA (in England) is an example of such a system. Larry E Ruff (1999), however, points out that preventing the ISO from pricing real-time events like congestion and reserve requirements does not eliminate these interactions and events, or allow them to go unmanaged, but merely forces the ISO to manage these interactions and events by less efficient and more intrusive non-market means.

Wilson (2001) is of the view that unbundled systems are more explicit with each price, i.e. the energy price, transportation price, price of the ancillary services are contested by competing offers. California priced energy and transmission separately, and its revised design in 2000 specified explicitly the local constraints on generation and transmission enforced by the operating engineers, thus enabling accounts to be settled at the clearing prices for suppliers' adjustment bids accepted to satisfy those constraints. The difference between the two designs lies in an integrated system's prerogative to fix prices only at points on the boundary where it interacts with suppliers, internalising all else. An unbundled system's multiple markets for each of the various resources require explicit specifications and market-clearing prices—in the case of California cited above, these are the clearing prices for adjustments, sufficient to stay within the specified constraints. The scarcity values of transmission capacities in market designs like PJM are inaccessible to participants, whereas designs that include separate markets for adjustments to satisfy explicit transmission constraints make these prices transparent and thereby reveal the scarcity values of transmission capacities.

Advocates of this type of physical contracting assert that the ISO should not be allowed to operate a real-time spot market integrated with dispatch, because this will crowd out very-short-term trading by competitive market-makers and middlemen and allow the ISO to become an unresponsive, unimaginative monopoly. The best way to prevent this is to assure that the ISO's real-time coordination process is not an open, efficient market, so that market participants will be forced into active short-term trading in non-ISO markets. In this view, any short-term inefficiency this created will be more than offset by the long-term benefits of competition in the market for market making. In this option, market participants trade contracts in diverse markets separate from the ISO, and then some time prior to operations submit to the ISO their contract-defined physical plans. The ISO uses some non-market coordination process to modify physical operations to deal with transmission constraints and with events that occur after the external markets close. Thus, the system operator is not intended to facilitate a spot market—it simply schedules trades that have been arranged elsewhere. The aim of the decentralised model is to leave as much of the trading as possible to the traders. The role of the contracts in this model is more explicit that in the integrated trading model. Unlike the pure financial nature of these contracts in the integrated trading model where only the demand and supply bids are used to make a trade happen and simultaneously minimising the overall system costs, in this model the contracts are physical in nature, i.e. the system operator must take the origin and destination of contracts specifically into account in the scheduling and dispatch process.

The ISO imposes high penalties on deviations between contract and actual quantities (except when the deviations are requested by the ISO as part of its non-market coordination process) in order to encourage market participants to minimize such deviations through active short-term contract trading.

2.4 The ideal arrangement: debate

The experts in the field seem divided on what constitutes an ideal trading arrangement. Chao and Wilson, while discussing the possibilities of manipulations in the integrated trading arrangement, comment that an optimisation programme is no better than its inputs. In fact, suppliers can and do treat the programme as a device whose outputs can be manipulated by the inputs they provide in the form of purported cost functions, availabilities, etc. Thus, the mode of competition consists of contending efforts to influence the "bottom line" results from the programme such as dispatched quantities and prices for energy, transmission, and ancillary services. In terms of economic theory, reliance on an optimisation programme affects the form and strength of traders' incentives at various points in the process but it does not obviate the role of incentives.

However, in a pure bilateral model based on physical bilateral trades, neither the homogeneity of transactions nor a single-market clearing price is ensured. Price discovery is not as automatic as in an integrated trading model and the buyers and sellers have to shop around to discover prices. The implementation issues in favour of physical contracts are:

- Centralised market designs like the pool arrangement create general management costs that should be shared by all market participants (trading outside the pool avoids these costs)

- Proponents of bilateral contracts do not trust the market clearing process to function adequately and they want to ensure their generation through physical contracts.

On the other hand, the proponents of the integrated model are great votaries of the pool arrangement and are strongly in favour of the ISO to conduct pool operations. Criticising the decentralists, they argue that in an attempt to have a small presence for the ISO, the decentralised trading arrangements restrict the ISO functions to reliability and separate from the operations of the spot market. In practice, the lack of an efficient spot market and efficient pricing drives the ISO to intervene ever more, but without the tools of the market. The ISO ends up large and intrusive, and the market works badly or not at all. Therefore, they assert that it is better to recognise the minimum requirements of an ISO; there are certain functions that only the ISO can perform, and if carried out efficiently, the result is healthy bilateral trading with liquid markets allowing easy entry.

On the other hand, some experts warn that on most dimensions, the alleged advantage of one extreme or the other is illusory. The market can be centralised or decentralised; it can be based on bilateral contracting, a centralised exchange, or a tightly controlled pool; trades can be physical or financial obligations, and there can be forward or spot contracts; the market may or may not include financial hedges; the "official" market can be mandatory or optional and may encourage or discourage secondary markets. Therefore, they favour designs that mix the two extremes to capture some of the advantages of each from parallel operations. For instance, for the three time frames of long-term, day-ahead and real-time, there are corresponding advantages from bilateral contracting, a central exchange and tightly controlled dispatch.

However, one may reiterate that irrespective of the arrangement, most of the energy would be traded with the help of prior contractual arrangements. Thus, the settlement dispatch and balancing systems, where in one case it is done after a constrained optimisation process, and in the other case, without such an arrangement, makes all the difference in the design of these alternate arrangements. What is crucial is that imbalances on account of contracted amount being different from the final demand should be priced appropriately. Arbitrary imbalance pricing in case of the decentralised trading arrangements can be a source of manipulation and speculation, and may result in increased cost to the industry. Thus, the latest trend in the wholesale market design is a simultaneous functioning of the pool along with the physical bilateral trades. In this hybrid design, the pool settles the energy imbalances, i.e. the mismatches between the contracted or scheduled quantities and the actual demand read from the meter. The source of power for settling energy imbalances can be a spot market for imbalances, managed by the SO and created by pooling all the non-contracted energy. Therefore, if the decentralised system has a market-based imbalance pricing mechanism, much of the inefficiencies of the physical bilateral trades are removed and it comes closer to an integrated trading model.

Market structure options for India

The Indian power market has traditionally been dominated by publicly-owned vertically integrated utilities. Central government generators own one-fifth of the generation facilities, which supply power on long-term arrangements to the state electricity boards (SEBs) other than in a few reforming states. In addition, nearly 15 per cent of the installed generation capacity is owned by the industry for the purpose of self-generation. One central government-owned utility owns and operates high-voltage transmission lines principally to transfer power across state boundaries. Post-1992, a few independent power producers (IPPs) have begun operations that supply power on long-term contracts to SEBs. The diversified ownership of assets and the presence of multiple players facilitate the introduction of competition (Ahluwalia 2000). In addition to this, the captive-generation capacity in India offers interesting possibilities for the creation of power markets. While the data is not conclusive, the estimated installed capacity in captive generation is roughly one-fourth of the total capacity. According to one estimate, 14,000 MW out of the 20,000 MW captive power is grid-connected, which would allow for surplus power exchanges by these captive producers of power and for many trading possibilities. Moreover, with some diplomatic moves, India can benefit from cross-border trading opportunities, with Bhutan and Nepal having large hydro potential and Bangladesh with large natural gas resources.

Table 1: Classification of power entities by ownership and functional area

	Generation	*Transmission*	*Distribution*
Central PSU	5	1	0
Central Boards	2	2	1
State Electricity Boards	15	16	16
State PSU	13	2	2
State JV	1	1	4
Private	8	0	5
Total	44	22	28

Source: Ahluwalia (2000)

The obvious shortcomings of the Indian power sector are on account of two broad reasons: (a) its being almost entirely in the public sector, with all the well-documented maladies this entails, and (b) the extreme degree of vertical and horizontal integration, implemented administrative controls on investment, production, pricing, sales, etc., which have turned the sector into a single entity under state control. The institutional structure that characterises this sector has led to high losses, low efficiency, irrational tariffs, low investment, obsolete technology, increasing shortages, and low growth prospects. The scale of losses and non-collection is of the order of 50 per cent in parts of India. This is inconsistent with good management and protection of the general body of customers, and would not be tolerated under a competitive market with a mix of private and public sector entities. Therefore, a revamp of the market

structure is mandatory for securing private investment, introducing competition, adding capacity, improving efficiency and reducing costs in the power sector.
The following table on the financial performance of the state electricity boards is a testimony to the fact that the market structure in its current form is unsustainable.

Table 2: Financial performance of SEBs

					RE	AP
S. No.		**1997-98**	**1998-99**	**1999-00**	**2000-01**	**2001-02**
1.	Cost of Supply (Paise/Kwh)	239.73	263.05	305.12	327.16	349.85
2.	Average Tariff (Paise/Kwh)	180.3	186.77	206.98	226.26	239.92
3.	% of Recovery	75.21	71.00	67.84	69.16	68.58
4.	Average Agriculture Tariff (Paise/Kwh)	20.22	21.01	22.61	35.38	41.54
5.	Commercial Losses (with subsidy (Rs. Cr.)	-7597.95	-10508.75	-15088.14	-17793.72	-24837.72
6.	Commercial Losses (without subsidy (Rs. Cr.)	-13963.00	-20860.00	-26353.00	-25259.00	-33177.00
7.	Net Internal Resources (Rs. Crore)	-6209.0	-8954.4	-13316.3	-15620.6	-19103.9
8.	Subsidy for Domestic Consumers (Rs. Crore)	5258.43	6332.48	8121.11	10036.07	12238.51
9.	Subsidy for Agricultural	19021.36	22473.1	24650.0	26950.0	30462.0

	Consumers (Rs. Crore)		3	2	0	0
10	Gross Subsidy (Rs. Crore) *	24749.78	29261.49	33144.68	37331.05	43060.10
11.	Subvention Received (Rs. Crore)	6364.8	10351.55	11264.53	7465.33	8339.62
12.	Shortfall in 3% statutory ROR (Rs. Crore)	9374.16	10599.95	16616.37	24118.45	28976.92
13.	Gross Subsidy Per Unit of Sales (Paise/Kwh)	87.25	98.81	110.98	118.57	126.62

Source: Planning Commission

*Gross subsidy includes subsidy for domestic consumers, agricultural consumers and on inter-state sales.
F. S. – Free Supply

The reform of the Indian power sector is most likely to be successful when the restructuring process integrates well-designed initiatives with regard to market structure or competition, pricing, quality standards, subsidies and universal service obligations. It is therefore important to conceptualise a market structure for the sector that strikes an optimal relationship between the liberalisation of the industry and regulatory systems. In the next section, we critically examine the various options for the design of market structures for the Indian power sector. Having discussed the possibilities, we outline the transitional concerns and arrangements for the introduction of competition.

3.1 Market structure design: options for India

The first comprehensive discussion on the design of the wheeling model appeared in the Report of the Expert Group on Restructuring of SEBs. It was proposed that in the first stage in the introduction of competition in the electricity industry, bulk consumers should be allowed to purchase electricity from competing producers. In order to allow for this, bulk consumers as well as the generating company from which the purchase is being made should have free and non-discriminatory access to the wires that will wheel this electricity, i.e. open access is crucial for this bulk transaction. This is perhaps one way to remove the artificial barriers in this sector that do not allow buyers and sellers to directly negotiate a power purchase. Perhaps, it is the absence of this provision that stalls the introduction of competition and its introduction will promote efficiency in the sector and allow pricing and investment to respond to market signals rather than remain distorted. This report recognises that transformation in a competitive market across the board is not possible merely through fiat, without the associated regulatory arrangements. In the context of the present supply shortages across the board, competition can lead to speculative pricing. Therefore, the report proposes that all the extant agreements for the generation and supply of electricity should remain in force so that the present arrangements of the supply of power to existing consumers are not disrupted. However, competition and open access should be introduced in respect of new or additional capacities, which may be allowed to access bulk consumers directly. Thus, in order to avoid any social or political upheaval, competition should be introduced gradually and at the margin. It has been suggested that this type of market would be easier to implement in developing countries because it would be voluntary and would not require the complicated protocols or software of a mandatory spot market.

Besant-Jones and Tenenbaum (2001) question whether this type of market design is feasible in a market structure other than the traditional vertically integrated utility. The scaling up of this model cannot ignore the additional requirements and specifications of the settlement and dispatch procedures of the kind outlined in Section 2 above. These types of voluntary markets involving one-on-one bilateral transactions have existed where the buyers and sellers are usually vertically integrated utilities, with sufficient generating capacity to meet their energy needs. Hence, participation in these markets was to “fine-tune” their supply needs (i.e. to lower their supply costs in certain hours rather than meet their basic supply needs).

Specifically, is it a viable option in an unbundled power sector (separate enterprises for generation, transmission, system operation, distribution and retail supply) in which buyers would have little or no supply of their own and therefore would have to rely on the market for most or all of their supply needs? Moreover, would it work in a developing country where there is simply not enough generating capacity to meet the demands of all connected customers?

Developing countries lack experience with this type of market and hence there are no clear-cut solutions. One issue that may prove to be of some concern is “balancing”. The need for a balancing mechanism arises because a distribution company’s moment-to-moment demand will rarely match the amount for which it has contracted, even if it is able to contract for all of its expected needs. This problem does not arise when trading is among vertically integrated enterprises because buyers will have their own generation supplies as well as the technical capacity to self-balance. If the balancing mechanism is an organised market with more than a few generators and distributors, the cost and complexity of setting up this residual balancing market may be the same as for a full, mandatory spot market.

A less costly alternative would be for distributors to acquire most of their needs from generators, through one or more supply contracts, and meet moment-to-moment fluctuations in its demand through the system operator or a hired generation company. Under this approach, balancing would be performed by the hired agent rather than by a balancing market.

Regardless of whether the underlying market structure is bundled or unbundled, it appears that voluntary bilateral markets of the kind discussed are feasible only if there is little congestion on the grid (i.e. ample transmission capacity):

- a small number of buyers and sellers;
- an independent operator who has a complete knowledge and effective operating control of the entire interconnected grid.

This type of market may not be workable once the number of buyers and sellers rises above a threshold, because it becomes increasingly difficult to match a group of bilaterally negotiated power-sales agreements of varying duration. This has been pointed out in Section 2, where we discussed the wheeling model. These agreements produce hard-to-predict physical demands on the grid, requiring a grid operator to balance the overall supply and demand of electricity on a moment-to-moment basis.

Moreover, allowing industrial customers to participate in such markets raises other concerns. If industrial customers have been subsidising residential and other customers (which is the case in many countries), industrial customers will no longer be a source of cross-subsidies if they can buy from other suppliers. This, in turn, may lead to the need for a big immediate increase in retail tariffs for non-industrial customers, rather than a series of phased-in increases over a longer period of time that could be managed by phasing the exodus of non-industrial customers from the market.

The Expert Group on the restructuring of the power sector in Punjab has suggested a few solutions to overcome these problems. In order to provide the security of supplies to bulk consumers buying from alternative sources, the SEB and its successor entities would need to function as default suppliers until the creation of a credible bulk electricity market. In the event of interruption or reduction in supply, bulk consumers should be free to draw power from the grid. In lieu of this service, the SEB may levy a minimum charge as recommended subsequently. The Group notes that as and when a bulk electricity market and power exchange become functional, the role of a default supplier as suggested above would need to be phased out by regulatory commissions. At that stage, the minimum charge would also need to be phased out correspondingly.

Further, the Group recognises that as the scope of open access expands with the growth in competitive supplies, it would be necessary to establish a well-functioning bulk electricity market that would optimise the benefits of a restructured power sector. The Group further recommends that expert help may be deployed for devising the market structure and its rules.

Lastly, the Group recognises that direct sales of power by generating companies to bulk consumers would deprive SEBs of cross-subsidies for financing below-cost tariffs of agricultural and household segments. However, this concern has been effectively met by identifying the allowable cross-subsidy element and recovering it as a wheeling surcharge from the bulk consumer using open access to the network for buying from alternative sources. The Group believes that as long as this surcharge is paid, the cross subsidy concern will be fully met and bulk consumers should be free to buy from competing suppliers.

An alternative to the single-buyer model of the kind in place in some of the reforming states has been suggested by the Report of the Energy Review Committee of the government of Mahrashtra and also by the Expert Committee on State-Specific Reforms, Government of India. The committees recommend a system of vesting contracts, which involve short-term (less than 5 years) PPAs between the existing plants and distribution zones. These contracts fulfil the following objectives:

- They impart an element of certainty with respect to power purchase costs for the distribution company and hence also at the retail level in the initial phase of transition.

- They provide security to the generation company regarding the buyer.

- They permit the allocation of existing capacity among the distribution companies so as to allow any combination of bulk price considered appropriate, including the replication of the existing pool price, if so desired.

- They lay down clear commercial principles wherein the producer and the user of energy engage in contracts, rather than indirectly, through the single buyer.

Initially, provisions of partial capacity allocations from a given plant to a distributor may need to be incorporated in the contract, in the same manner that capacity from NTPC is allocated to different states. Further, requirements of additional power of the distribution companies would be met directly by IPPs. This would ensure that new IPPs would be able to effect sales to any distribution company of their choice and would not be restricted to a single buyer. Vesting contracts may facilitate lower prices due to the increased creditworthiness of better-run distribution companies, which is merely an instance of market-driven incentives for better performance. As the higher-cost new power blends with the existing vesting contracts, the rise in the cost of power purchase per unit would be gradual. Lastly, these contracts would be tradable, in that all distribution companies would be able to buy and sell power from each other.

Vesting contracts provide “insurance” in case the market design is flawed, and they provide revenue and cost certainty to generators and distributors in the early years of reform. In most countries that have created short-term markets, vesting and other hedging instruments may cover as much as 80–90 per cent of the total power trade.

However, vesting contracts are not risk-free for distribution companies. If the contract prices are high due to corruption, or a non-competitive or a poorly negotiated procurement process, future distribution companies and their customers may not be able to pay the high prices. In such cases, a vesting contract will simply perpetuate a bad outcome and lead to “stranded costs”, when and if competition is introduced. Thus, these contracts should be used very cautiously as a purely transition mechanism.

3.2 New legislation and the market structure

The Electricity Act, 2003, dispenses with all entry barriers in the form of regulatory approvals and licences that were earlier required for undertaking thermal generation. The new regime requires little more than compliance with technical grid codes and is thus expected to reduce the lead times associated with large investments. Also, by allowing open access, it ensures that generators can bypass the metering and collection functions of inefficient distributors (SEBs) and sell to consumers directly. However, fears that direct access may rob the government of its cross-subsidy collections have resulted in the laying of provisions that allow the state governments a cross-subsidy surcharge on non-captive generation to be phased out in a time-bound manner by SERCs.

Further, the stringent regulations pertaining to captive generation have been relaxed. The Act liberally defines captive power generation and allows shared captive generation with no licensing or permission requirement. It permits large power consumers or an association of users to set up aggregated capacities and enjoy benefits arising from scale economies, free from grid uncertainties. Units are also allowed to sell surplus power to any licensee or end use consumer subject to the payment of transmission charges and cross-subsidy surcharges. Lastly, a physical separation of the captive generation plant from the premises of the customer by allowing open access to transmission and distribution wires on payments of wheeling charges has been allowed.

The Act also deems mandatory the split of the transmission business into wheeling and trading, since the bundling of the two functions creates a conflict of interest in the context of developing a competitive market and providing access to multiple suppliers. In the light of this, the Electricity Act takes a progressive step by prohibiting a transmission licensee from undertaking trading, and the latter is now required to segregate its wires business from its supply business. Under this Act, the bulk suppliers would receive a transmission charge to be decided by the SERCs, and a cross-subsidy surcharge, over and above the wheeling charge, in cases where the transmission business carries power for non-captive generators that have transacted directly with consumers.

The Act also envisages setting up a robust trading market and emphasises the need for establishing load dispatch centres (LDCs) at the national, regional and state levels, to coordinate the actions of the numerous traders. Unfortunately, it remains silent on the design of the power market, the settlement mechanisms, and the treatment of long-term contracts that have been entered into.

The Act also directs the distribution companies to provide open access to their distribution wires in a phased manner to be decided by the SERCs and this likely to provide a fillip to investment in metering, information and collection systems etc. This would also introduce an element of competition into the sector and would compel the distribution companies to refurbish their customer retention strategies. The distribution companies are to be recompensed for providing open access via the imposition of a cross-subsidy surcharge payable by alternative suppliers. Multiple distribution licencees are expected to result in competition and efficiency gains. In a developing country laying out its systems for the first time in many areas multiple distribution licences might well be a reasonable option. It is known that, while an increase in load density reduces distribution costs per kWh consumed, adding new customers does not reduce such costs beyond a low threshold of about 10,000 customers per distribution company. Thus, as long as load density is sufficiently high, one can conceive of a distribution company serving as few as 10,000 customers. Thus, this provision in the new legislation is quite welcome as it allows for the introduction of competition from the supply side.

Further, 100 per cent metering within two years from a date appointed by the Centre has been made mandatory for all utilities. The benefits of this move are likely to be manifest in the form of better information, transparent tariffs for all consumer categories, and a reduction in disparities in the quantum of subsidy that needs to be provided out of state budgets. Also, in an attempt to curtail distribution losses, the Act provides for stringent disconnection norms. Further, the tariff-setting procedure based on the sixth schedule of the Electricity (Supply) Act, 1948, has been abolished and in its place a new framework has been established. The latter aiming at eliminating cross-subsidies requires retail tariffs to be set up in accordance with Multi-Year Tariff principles. Lastly, under the Act, distributors do not require licences for rural areas. However, at present agricultural consumers enjoy enormous subsidies and it remains to be seen whether the removal of bureaucratic encumbrances would stimulate investments in the rural sector.

3.2 Transitional arrangements[4]

It is very clear that the implementation of trading and settlement systems of the kind discussed in Section 2 above would demand significant investments in technology-related processes, in institutional development, and also in human resources. In

[4] See Annex 3 for a list of the major issues that require to be addressed at the time of transition to competitive markets in electricity.

the Indian context, it is very important that in order to support a new market design, the provisions of the existing legal framework and contracting based on the integrated model of trading arrangements, be reviewed. PowerGrid Corporation[5] has pointed out the following transmission-related aspects of open access that could be of concern for the third party:

- **Wheeling power through its system (that is the third party distribution company) may cause overloading of one or more elements of its system**
- **Wheeling may cause voltage profile problems, and may require reactive support**
- **Relative priorities of different power flows that take the same transition path would require that the first priority be given to the "native" load, particularly when the SEBs with allocated shares in the generating station have been sharing the total transmission charges of the associated transmission system. As a consequence, open access on this transmission system would have to be restricted to the surplus transmission capacity available after the evacuation of the native load.**

Capacity can be a major constraint for transmission facilities to be operated on an open-access non-discriminatory common-carrier basis, and in the Indian context this gets further accentuated by chronic underinvestment in this capacity in the past. This is acceptable. However, this argument should not be made for the non-implementation or postponement of open access. Investment in transmission capacity would surely respond to demand signals, which in turn require the emergence of competitive markets. Though these signals would trickle down slowly in the initial phases of transition, they would provide accurate guidance to transmission expansion plans, i.e. where is it more appropriate to reinforce or build a new transmission line? If the buyers do not have any choice in the absence of competition (or open access), how can there be investment signals for efficient investment in transmission? So, rather than delaying competition till investment in transmission is sufficient, one should introduce competition to get the desired investment.

It should be recognised that open access is only a facilitator for trading in power; it would be imprudent to believe that it can be implemented without a major revamping of the scheduling and dispatch arrangements. Other requirements include balancing and settlement mechanisms in the open access scenario. A wholesale bulk market for trading (the kind of arrangement spelt out in the integrated trading arrangements in Section 2.4.1 above), where the state load dispatch centre (SLDC) or regional load dispatch centre (RLDC) acts as a surrogate for the pool, can be complex and difficult to implement right away. The institutional capabilities of the licensees and the SLDC would be a key consideration in the phasing of Open

[5] "Open Access in the Indian Context", Power Grid Corporation (2003), mimeo

Access. The SLDC/RLDC would need to draw up overall schedules and dispatches of generators, as per the contracts held by various parties. This would require considerations of technical constraints of generators and transmission system availability. Adequate settlement systems will also need to be in place that would include treatments and pricings of imbalances. This would definitely increase the complexity as the number of parties allowed open access increases. Therefore, experts[6] have argued in favour of the extension of the availability-based tariff mechanism (ABT) to state generators and major users. However, it can be only an interim measure since the ABT mechanism has been designed for imbalance trading between states and the appropriateness of this mechanism involving a large number of market participants within a region is questionable. In the absence of structured trading arrangements, reliance on ABT for the purpose of meeting imbalances would defeat the purpose of competition, as this would make engaging in contractual engagements very expensive.

These arrangements and their institutional requirements have been discussed in detail in Section 2 of the paper. The new legislation has therefore asked the regulators to come up with a plan that would outline these arrangements at the time when open access becomes mandatory. The period of transition should be used up for a consultative process by the regulators to draft the details of these arrangements. The phased introduction of open access and the concomitant enhancement of the institutional capabilities of the kind discussed earlier have to be carefully planned by the regulator within a year of the notification of the Electricity Act, 2003, on June 10, 2003.

The long-term adequacy of generation and transmission would require the power system to meet demand, taking into account scheduled and reasonably foreseen unscheduled outages of generators and transmission installations. The deregulation of prices must create sufficient incentives to stimulate generation expansion in the long run. However, an oversight of the market to ensure effective competition among generators would be the primary task of the regulators. In the Indian context, it is clear that like in any other restructuring exercise, concentration in generation capacities is an important concern, with almost 39 per cent of the gross thermal generation in the hands of a single company. Also, private sector participation is very marginal. Insufficient or ineffective competition among generators will yield profits and prices that are higher than under effective competition, which would undo the benefits of restructuring. Many countries in the transition to competitive markets in electricity required the largest utilities to sell some of their generating plants to ensure that the emerging power market was competitive. Perhaps, this could be also required of the single largest generation utility in India. In addition to this, an oversight of the market by regulators and adequate antitrust enforcement are necessary to counteract market power problems.

---

[6] Issues in Open Access Implementation, UPERC Discussion Paper, presented in the workshop on open access on September 1 , 2003, NOIDA, Uttar Pradesh.

Table II: Generation Market in India: Installed Capacity and Gross Generation

	INSTALLED CAPACITY			GROSS GENERATION		
	Hydel	Thermal	Total	Hydel	Thermal	Total
SEBs	22520.6 (85.77)	39319.49 (50.9)	61840.09 (59.82)	52121.00 (70.44)	222086.00 (52.62)	274207.00 (55.28)
EDs	110.17 (0.4)	183.08 (2.3)	293.25 (2.83)	117.00 (0.15)	476.00 (0.11)	593.00 (0.11)
Central Sector	3049.00 (11.61)	28556.51 (37.01)	31605.51 (30.57)	10075.00 (13.61)	162373.00 (38.47)	172448 (34.76)
NTPC	-	19934.00 (25.83)	19934.00 (19.28)			
DVC	144.00 (0.5)	2737.51 (3.5)	2881.51 (2.78)			
Private	576.20 (2.1)	9045.72 (11.7)	9621.92 (9.30)	1757.00 (2.37)	37066.00 (8.7)	38823.00 (7.82)
Others	-	-		9922 (13.4)	-	9922 (2.00)
Grand Total	26255.97	77104.8	103359.85	73992	422001.00	495993

Source: Annual Report on the Performance of SEBs, 2002

Also, the expansion of the transmission system to provide long-run economically efficient and reliable services in the presence

of competitive generators must be ensured by adequate transmission regulation. The regulation of transmission companies must allow for adequate revenues to compensate them for operation, maintenance, and investment costs. The transmission companies (TRANSCOs) must plan, budget, finance and construct transmission networks to accommodate new generators, provide for robust long-term competition, and maintain reliability. Thus, the regulatory commissions must draft regulations to ensure that the CTU/STU, as the case may be, has adequate planning processes that prevent transmission bottlenecks. As mentioned above, the commissions should also endeavour to build adequate price signals for the network operators to identify the transmission bottlenecks and remove them. This may imply non-uniform transmission pricing[7] and there may be a need to factor in aspects like line congestion and peak load pricing. The pricing structures may also not be simply on an energy-only basis, but may include commitment charges and usage-related charges separately. Thus, the transmission business model that can emerge in India is the SLDC or the RLDC, as the case may be, taking the responsibility of the independent system operator and a separate independent transmission entity, Gridco, in the form of the CTU or the STU. Gridco in this set-up is regulated and profit-making; it expands and maintains the transmission network and earns a return on assets through charges levied on the consumer. The ISO advises in transmission expansion and maintenance, but does not have responsibility to carry out these functions. The present arrangement, where the owners of the transmission network control the RLDC and the SLDC, would, therefore, need to be substituted by an independent set-up.

Lastly, the success of open access hinges on the availability of consumption data and hence the associated measurement infrastructure has to be put in place at the earliest. The energy flows between all generators and users have to be measured accurately and thus a robust infrastructure with good metering and communication equipment and billing systems needs to be in place. All this will require considerable investment, but with the liberalisation of power markets, there would be enough incentives to make these investments as the benefits would exceed the costs of such investments, especially when the costs are spread over a large number of customers. These infrastructure investments have significant implications for the structure and organisation of the distribution sector; for instance, TOD meters allow demand to be managed as cheaply (by aggregating end-user meter signals) at low voltage sub-stations as at the high-voltage sub-station level. This means that some parts of system control can move down to lower voltage sub-stations.

Given the complexity of the introduction of open access, the CII report (2002) recommends that customer eligibility to open access be

[7] There are three approaches to transmission prices: uniform pricing, nodal pricing and zonal pricing. The price signals given are different under different scenarios. We do not discuss this in detail. The interested reader may see Stoft (2002, Part 5).

introduced in a phased manner. Large industrial customers and electricity distributors should be made eligible first, followed by mid-sized commercial customers, and finally domestic customers. Large consumers like heavy industries and privatised distribution companies should be made eligible to strike bilateral contracts at the cheapest available prices from independent generators. Based on the consumption levels and the operating voltage levels, subsequent levels of customers should be made eligible with the eligibility determined by the regulator in consultation with customer representatives.

Finally, options for regional power markets should be looked into. In order to have operative bulk supply markets, there is a need to have a critical mass of market players. Thus, if not at the state level, this critical mass can be created at the regional level and the Indian electricity sector offers quite a few possibilities for regional trade. For successful regional exchanges of power to take place, there is a need for adequate inter-regional interconnections for power transfer. This is quite important, as currently there is a low capacity utilisation factor of HVDC inter-regional connections, due to weaknesses in the downstream transmission system.

4. Conclusions

For virtually all dimensions of the market, everywhere in the world, the pre-existing conditions are not amenable to the introduction of competitive markets in power. Thus, every aspect of the market requires some sort of institutional, structural or regulatory change. Wherever restructuring of the market for power has taken place, the limiting conditions of competition between and among generators and customers do not hold in practice. The gap between theory and practice is large, on account of many factors like imperfect economic dispatch, soft system constraints, possibilities of the emergence of dominant suppliers in energy and ancilliary services, seeking price advantages by market participants and the emergence of pockets of high concentration due to transmission constraints.

The complexities of the electric power system require nothing less than a paradigm shift in the institutions. Therefore, if the policymaker is convinced that the market needs to be restructured on competitive lines, it would have to, sooner than later, face the significant technical and institutional challenges for doing the same. The implementation of trading and settlement systems will call for significant investments in technology-related processes, and in institutional and human resources development. In our view, all efforts should be to get the pre conditions right, rather than equivocating issues that require immediate attention in order to usher in competition. In the Indian context these challenges get further accentuated as generation supplies and network capabilities are inadequate. Thus, while the procedural rules of the market would have to be spelt out after the market structure shifts from an integrated monopoly to competition, further measures are required to diminish the market power of dominant incumbents and to promote the entry of newcomers. A market dominated by large public sector players cannot be conducive to competition and efficiency. Thus, without underestimating the procedural and political economy problems that need to be overcome, it is indeed essential to move towards the privatisation of the public sector power utilities.

Selected References

Ahluwalia (2000);

Besant-Jones, J E, and B W Tenenbaum (2001): The California Power Crisis: Lessons for Developing Countries, Energy and Mining sector Board, World Bank.

Brennan, T J, Karen Palmer, and Salvador Martinez (2001): Implementing Electricity Restructuring: Policies, Potholes, and Prospects, Discussion Paper 01–62, Resources for the Future, Washington D.C.

Chao, H, and R Wilson (1999): Design of wholesale electricity markets**, Book Manuscript. Available at http://faculty-gsb.stanford.edu/wilson/E542/classmaterial.htm.**

CII Report (2002): Initiatives to develop Electricity Affordability and Supply, Empowering the Nation**, Tata McGraw Hill Publishing Company Limited.**

Finon (2002): Introducing Competition in the French Electricity Supply Industry: the destabilisation of a public hierarchy in an open institutional environment**, presented at the Annual Conference of the International Society for New Institutional Economics (ISNIE), Cambridge.**

Hogan (2002a): Electricity Restructuring: Reforms of Reforms**, Journal of Regulatory Economics, Vol. 21, Issue 1, pp. 103-132.**

— (2002b): Market power and Electricity competition**, presented at the 50th Annual Antitrust Law Spring meeting, American Bar association, Washington DC.**

Hunt, S (2002): Making competition work in Electricity**, John Wiley and Sons, Inc.**

Hunt, S, and G Shuttleworth (1996): Competition and Choice in Electricity, **John Wiley and Sons, Inc.**

Joskow, P, and R Schmalansee (1983): Markets for Power: An Analysis of electric utility deregulation**, MIT Press.**

Kahn, A (1988): The Economics of Regulation: Principles and Institutions**, MIT Press.**

Report of the Energy Review Committee **(2001), Government of Mahrashtra.**

Report of the Expert Committee on State-Specific Reforms: Structuring of APDRP, Reform Framework and Principles of Financial Restructuring of SEBs**, Ministry of Power, Government of India.**

Report of the Expert Group on Restructuring of SEBs **(2001), Ministry of Power, Government of India.**

Report of the Expert Group on Power Sector Reforms in Punjab **(2003). Available at www.pidb.com**

Report of the World Energy Council: Electricity Market Design and Creation in Asia Pacific **(2001).**

Ruff, L E (1999): Competitive Electricity Markets: Why they are working and how to improve them**, Working Paper, National Economic Research Associates, Cambridge, MA.**

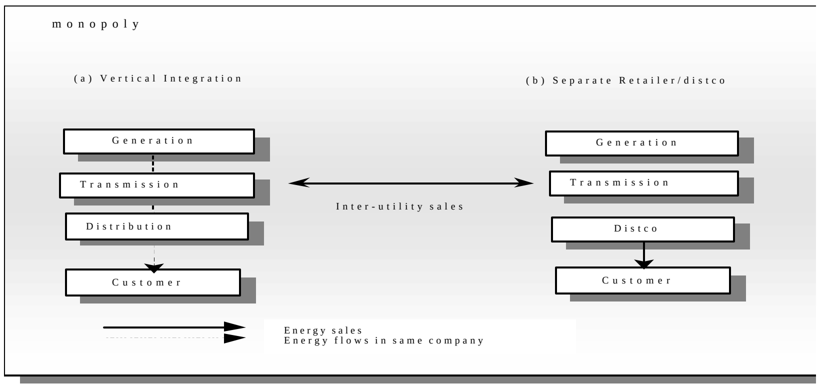
Stoft, S (2002): Power System Economics, Designing Markets for Electricity**, IEEE Press.**

Wilson, R (1999): Efficiency Considerations in Designing Electricity Markets, Report to the Competition Bureau of Industry Canada.

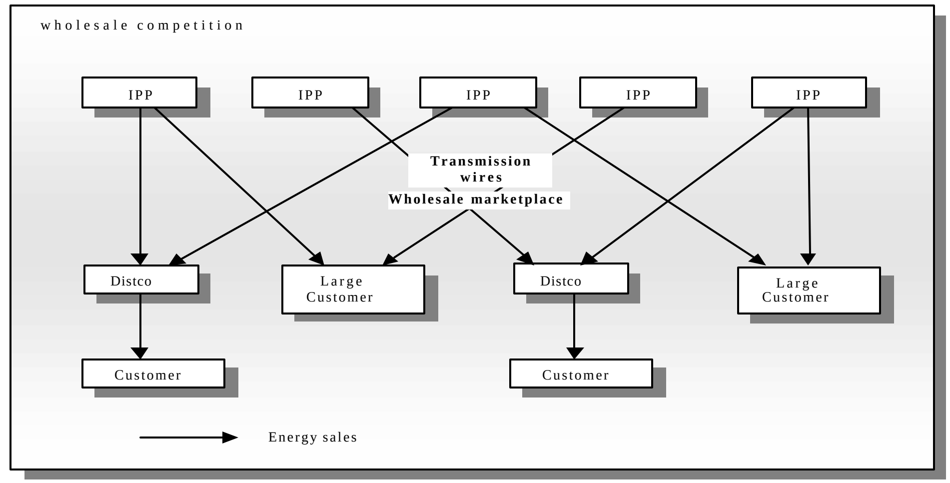
Wilson, R (2001): Architecture of Power Markets, Econometrica, 2002, vol. 70, issue 4, pages 1299-1340.

Wolak, F (1999): Market Design and Price Behaviour in Restructured Electricity Markets: An International Comparison, Energy Institute, University of California, Berkeley CA.

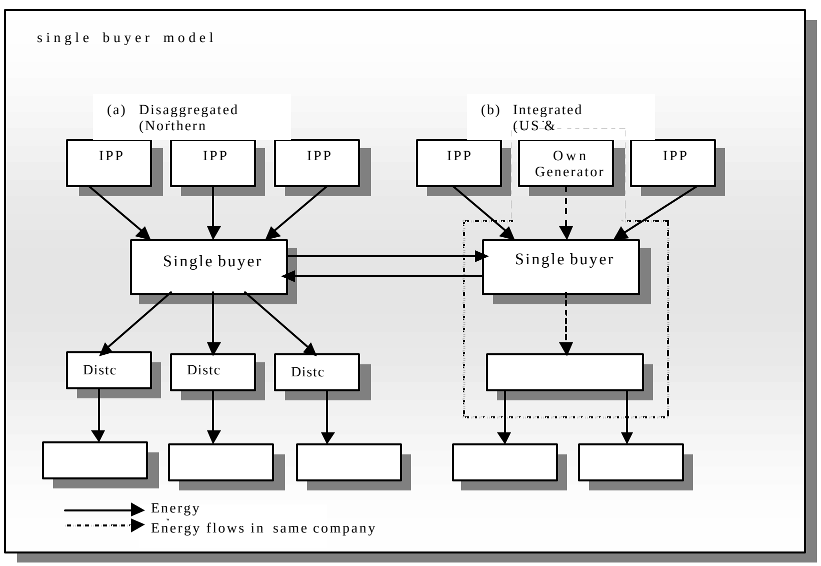
ANNEX



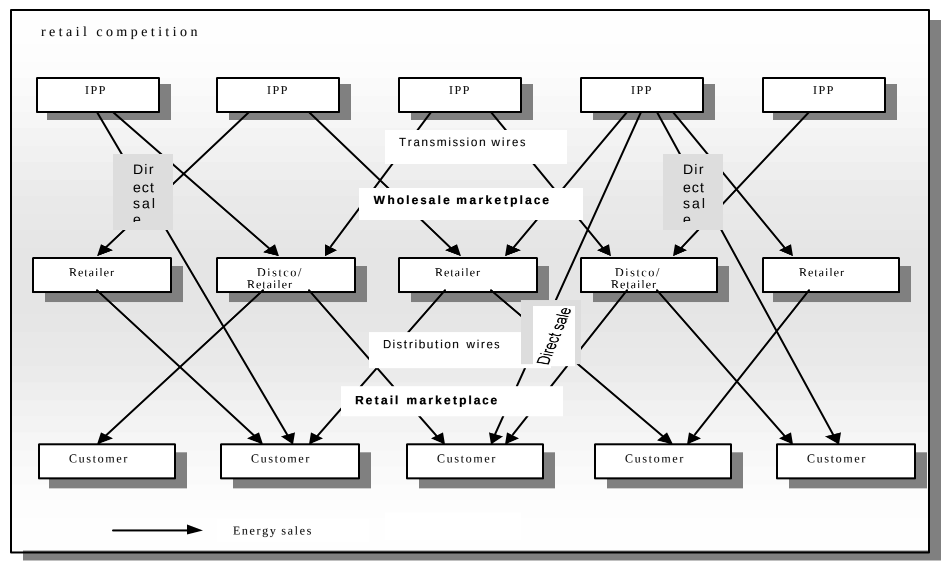
monopoly
(a) Vertical Integration
(b) Separate Retailer/distco
Generation
Transmission
Distribution
Customer
Generation
Transmission
Distco
Customer
Inter-utility sales
Energy sales
Energy flows in same company



wholesale competition
IPP
IPP
IPP
IPP
IPP
Transmission wires
Wholesale marketplace
Distco
Large Customer
Distco
Large Customer
Customer
Customer
Energy sales



single buyer model
(a) Disaggregated (Northern
(b) Integrated (US &
IPP
IPP
IPP
IPP
Own Generator
IPP
Single buyer
Single buyer
Distc
Distc
Distc
Energy
Energy flows in same company



retail competition
IPP
IPP
IPP
IPP
IPP
Transmission wires
Wholesale marketplace
Direct sale
Direct sale
Retailer
Distco/ Retailer
Retailer
Distco/ Retailer
Retailer
Distribution wires
Direct sale
Retail marketplace
Customer
Customer
Customer
Customer
Customer
Energy sales

Annex 2

Design of Power Markets: An Overview

Market	**Generation**	**Owner**	**Grid well connected?**	**Market Model**	**Market price**	**Market timing**
Alberta	Thermal	Mixed	Yes	Mandatory pool + merit order dispatch	Marginal	
Argentina	45% hydro	Mixed	No	Optional pool + merit order dispatch	Marginal capped	1 hour
Australia	Thermal	Mixed	No	Mandatory pool + merit order dispatch	Marginal	½hour
Victoria	Thermal	Private	Yes	Mandatory pool + merit order dispatch	Marginal	½hour
California	Thermal	Private	Yes	Contract dispatch + optional balancing pool	Marginal	1 hour
Chile	60% hydro	Private	No	Cost tariffs + mandatory contracts + optional pool	Marginal	
Colombia	70% hydro	Mixed	No	Mandatory pool + merit order dispatch	Marginal	1 hour
England & Wales	Thermal	Private	Yes	Contracts dispatch + optional balancing pool	Marginal	½hour
New York	Thermal	Private	Yes	Contracts dispatch + optional balancing pool	Marginal	1 hour
New Zealand	Thermal	2/3 govt	No	Contracts dispatch + optional pool	Marginal	½hour
Norway	98% hydro	Mixed	Yes	Contracts dispatch + optional balancing pool	Marginal	1 hour
PJM	Thermal	Private	Yes	Contracts dispatch + optional balancing pool	Marginal	1 hour
Spain	Thermal	Private	Yes	Contracts dispatch + optional balancing pool	Marginal	1 hour
Sweden	50% hydro 50% nuclear	Mixed	Yes	Contracts dispatch + optional balancing pool	Marginal	1 hour

Source: Electricity Market Design and Creation in Asia Pacific, World Energy Council, 2001

Annex 3
Transition Issues

1. How—and why—do we draw a line between regulated and competitive sectors of the electricity industry?

2. Should the same companies own and control both regulated "wires" and competitive generation?

3. Since we have to regulate prices for the "wires," how do we set their rates?

4. How do we keep electricity markets competitive?

5. Who should be responsible for keeping loads balanced and dispatching power?

6. As utilities compete, how can we ensure reliability?

7. Should the states or the federal government set the course of retail electricity competition?

8. What should be the role of public power after restructuring?

9. Will it cost utilities to adapt to competition, and if so, who should pay?

10. What are the implications of restructuring for environmental protection?

11. What happens to utility-funded "public benefit" programs in a competitive electricity market?

Source: Implementing Electricity Restructuring: Policies, Potholes, and Prospects; Timothy J. Brennan, Karen Palmer, and Salvador Martinez; 2001