Electricity Market Professional (EMP) Program - 2022
Module-I

CTBCM Alternative Choices – Local and International Analysis and Perspectives

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1. Introduction

Electricity supply chain consists of various distinct and interconnected segments such as primary fuel supply, generation, transmission, distribution and supply or retail services. All these segments have to work in an integrated manner to let the consumers enjoy all the benefits of having electricity. Across the globe, these sectors are organized in a diverse and unique manner according to the local market conditions and evolution of the electricity and other economic sectors.

In some countries, there are vertically integrated utilities that are responsible to manage all the segments of the electricity supply chain owing all generation, transmission, distribution and supply or retail activities. Another variant of this model is that the vertically integrated utility also procure power from independent power producers (IPPs) along its own generation to meet its demand. The electricity sector historically developed under this model. Normally, these utilities worked under a regulated model in which all of their activities were overseen by the state regulators.

With the restructuring of the electricity market, unbundled the different segments of the electricity supply chain and introduced the Single Buyer (SB) model in which a single entity (normally government owned) was responsible to procure all the power from the IPPs and others to meet the electricity demand of the consumers. The Single Buyer then resell this power to the distribution and retail companies. This model also has different variants such as procurement and resale, agent-based procurement and settlement etc.

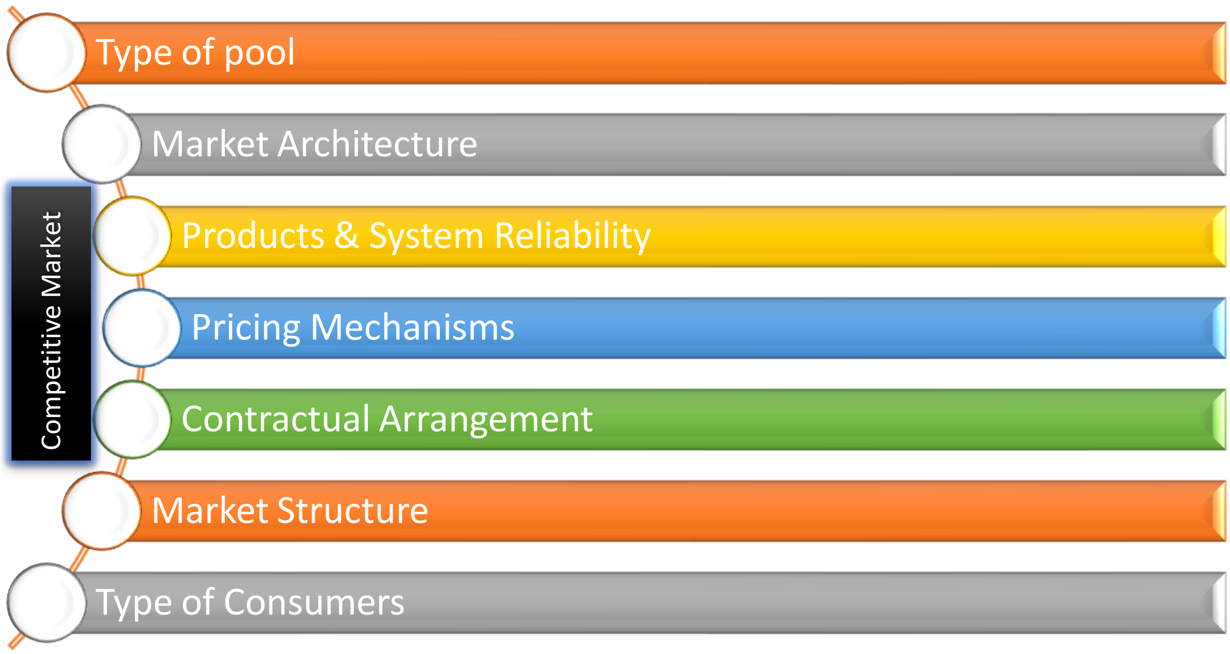
Under the Single Buyer Model, countries introduced competition in the generation sector by using auctions for long-term Power Purchase Agreements (PPAs) while the supply or retail sector was regulated. In several countries, the single buyer also owned the transmission and system operation. Some countries used the traditional regulated tariffs method for procurement of power by the Single Buyer from IPPs.

It is important to mention here that as generation is the most capital-intensive sector in terms of total electricity cost as it consists of around eighty percent of the total cost, making this segment subject to market and improving efficiency will give huge benefits. In this segment, there is great potential for improving efficiency and reducing costs.

Wholesale power markets entail a fully competitive generation sector with multiple sellers and buyers which interact in a marketplace to make the most efficient deals. Generation is normally deregulated and sells into a competitive wholesale market; while distribution utilities and large customers purchase competitively in the wholesale market. Wholesale power markets encompass various markets that operate at different time horizons (e.g. forward and spot), offer different products (energy, capacity, reserves and ancillary) and have adopted a variety of structures (e.g. power exchange and pool; cost and bid-based, single side bidding or double side bidding, simple bidding or complex bidding etc.).

Considering the design and various features of the wholesale markets, global experience shows that every Wholesale Electricity Market (WEM) in the world is unique. The particular structure of the market depends on the market dynamics, culture, historical events to choose from various options available and to address various issues in the local context. Market design in one country can't be replicated exactly in another country, but it has to be modified to cater for the needs of country where it is being implemented. Markets needs to be designed very carefully in order the reforms to be successful even under favorable conditions. The California electricity crisis demonstrates that designing and implementing successful electricity markets is a complex task even for developed countries with plenty of industry and institutional endowments.

Every market design is based on certain parameters which distinguish it from its other variants. There are several options against each parameter to choose for the market design. The selection of different options against each parameter make a market design unique and tailor made according to the local conditions. Broadly speaking, following is the list of parameters on which the market design is based:



Careful review of the global markets reveals that there is no single standard market model considering the differences in electricity market structures (see Figure 1 and Table 1) and regulatory policies around the world.

Figure 1: Diversity in market design across the globe

Table 1. Diversity in Market Design

Market	Type of Pool	Market Architecture	Products & System Reliability	Pricing Mechanisms	Contractual Arrangement	Market Structure	Stats
AESO	Price Based Gross Pool	• 7 Days Ahead Scheduling • Real Time Market	• Energy • Ancillary Services	Ex-post Real Time Hourly Marginal Price	• Financial Forward Contracts, • Derivative Markets	ISO Model	Energy: 84.9 TWh Peak Demand: 11.6 GW Gen Capacity: 16.5 GW
NYISO	Price Based Gross Pool	• Day Ahead and Real Time Markets	• Energy • Capacity • Ancillary Services • Demand Response • TCC • Virtual Market	Ex-ante Day Ahead and Ex-Post Real Time Hourly LBMP	• Physical and Financial Forward Contracts, Derivative Markets	ISO Model	Energy: 161 TWh Peak Demand: 33.9 GW Gen Capacity: 37.8 GW
Brazil	Cost Based Gross Pool	• Real Time Market to primarily Settle Imbalances	• Energy • Capacity	Ex-ante Weekly System Marginal Price for different Load Blocks and Zones	• Financial Forward Contracts	System Operator and Market Operator are separate entities	Energy: 593 TWh Peak Demand 89 GW Gen Capacity 170.15 GW

Market	Type of Pool	Market Architecture	Products & System Reliability	Pricing Mechanisms	Contractual Arrangement	Market Structure	Stats
Peru	Cost Based Gross Pool	• Real Time Market	• Energy • Capacity	Ex-post 15 mins LBMP	• Financial Forward Contracts	ISO	Energy: 49 TWh Peak Demand: 6.6 GW Gen Capacity: 12.5 GW
Peru	Cost Based Gross Pool	• Real Time Market	• Energy • Capacity	Ex-post 15 mins LBMP	• Financial Forward Contracts	ISO	Energy: 49 TWh Peak Demand: 6.6 GWGen Capacity: 12.5 GW
Argentina	Cost Based Gross Pool	• Hour- Ahead Cost Bids and Real Time Market primarily for Settlement of Imbalance	• Energy • Capacity • Ancillary Services	Ex-Post hourly LBMP	• Financial Forward Contracts	ISO	Energy: 137 TWh Peak Demand: 22 GW Gen Capacity: 38 GW
Philippines	Price Based Gross Pool	• Hour Ahead Market, and • Real Time Markets	• Energy, • Ancillary Services	Ex-ante Hour Ahead and Ex-post Real Time Prices (LBMP)	• Financial Forward Contracts	MO is Independent and SO is part of Transmission company	Energy: 94.8 TWh Peak Demand: 14 GW Gen Capacity: 20.5 GW
Turkey	Net Pool	• Day Ahead Market • Intraday Market • Real Time Market	• Energy • Ancillary service	Hourly Day Ahead Marginal Price and Ex-post Hourly Real Time Marginal Price	• Physical and Financial forward Contracts • Derivative Markets	IMO is independent Market Operator and SO is part of Transmission Company	Energy: 303 TWh Peak Demand: 47GW Gen Capacity: 89 GW
Denmark	Net Pool	• Day Ahead Market • Intraday Market • Real Time Market	• Energy • Ancillary service	Hourly Day Ahead Marginal price, Hourly SMP for Balancing Market	• Physical and Financial forward Contracts, • Derivative Market	Power Exchanges, SO is part of Transmission Company	Energy 33.5 TWh Peak Demand 6.5 GW Gen Capacity 14.3 GW
India	Hybrid	• Term Ahead Market • Intraday Market • Day Ahead Market • DSM	• Energy • Capacity • Ancillary Services	Deviation Settlement Price every 15 minutes	• Long Term PPAs, • Term Ahead Contracts	Regional, Sate and National SOs, + Exchanges	Energy 1,547 TWh Peak Demand 192 GW Gen Capacity 368.79 GW

However, from the several market models implemented in different parts of the world, it is possible to distinguish two main types of market organization which are the following:

(i) Goss Pools or centralized markets
(ii) Net-Pool (Exchange Model) or decentralized markets.

Most electricity markets can be classified as of being of type (i) or (ii) above having variations as per local conditions. The following sections describe in detail the choices available against each design parameter and reasons against selection or rejection of any specific option. The Design Parameters adopted in CTBCM are summarized in Table 2.

Table 2: Market Design parameters of CTBCM

Sr.#	Design Parameter	Adopted for CTBCM
1	Type of Pool	CTBCM is **Cost-based Pool** with Centralized Security Constrained Economic Dispatch (**SCED**) (US, Canada, South & Latin America, Philippines)
2	Market Architecture	**Real Time Market** with ex-post settlement (South & Latin America, US, Canada)
3.1	Products	Energy and Capacity (Brazil, Peru, US)
3.2	Resource Adequacy	Ensured through Capacity Obligations, & centralized Auctions (USA, Brazil)
4.1	Basis of Market Price	For Energy: Hourly - Marginal Generator dispatched based on Variable Cost clearing the total demand; For Capacity: Yearly - Capacity charge of Marginal Generator clearing the incremental demand during stressed hours (Latin American Countries)
4.2	Market Price Formation	Single Price (System Marginal Cost) (IESO, AESO, Turkey) OPTIONS: Zonal Price, Nodal Price
4.3	Market Clearing	MO Clears the imbalances only in Pool (NYIOS, PJM, Philippines)
#	Design Parameter	Adopted for CTBCM
5.1	Procurement for Base Supplier - Charging Consumers on Regulated Tariff	Centralized procurement for all DISCOs, Contracts signed individually proportional to their demand (Brazil)
5.2	Procurement by Other /Competitive Suppliers for BPCs	Mutually negotiated bilateral contracts. (All markets)
5.3	Contracts Types	Following Forward Supply Contracts with SCED: (Load following, Generation following, Fixed quantities, Energy with associated capacity, Capacity only) (Latin America, Canada, Philippines)

Sr.#	Design Parameter	Adopted for CTBCM
6	Market Structure / Institutional Arrangement	System Operator (embedded in Transmission Company), Independent Market Operator, IAA
7	Types of Consumers & Provision of Network Services	• Eligible Consumers (BPC ≥ 1MW) • Non-Eligible Consumers (< 1MW)
8	Types of Suppliers	Base Supplier (also performs function of Last Resort Supplier) Other than Base Suppliers / Competitive Suppliers

2. Type of Pools

Electricity systems are operated in an integrated manner where several generating stations are connected to the transmission network to supply electricity to the load which is also connected to the same transmission system. A place where electricity is traded in bulk quantities among several players i.e. generators, traders, suppliers, large consumers is called a Pool. Based on its organization, there are two types of pools i.e. Gross Pool and Net Pool.

2.1. Gross Pool

In a Gross pool, all generation companies must offer price-quantity pairs for the supply of electricity to the System Operator/Market Operator and make all generation available for security constrained economic dispatch. All these offers are stacked to form an aggregated supply curve. The offered prices can be based on predetermined variable costs (such pools are referred to as **Cost Based Pools**) or the generators can be free to offer any price they like (such pools are referred to as **Price Based Pools**) with certain limitations such as price caps and floors. The offers can be simple (i.e. a price and quantity pair for single hour) or complex. The problem with simple bidding is that it overlooks the complex constrains on how generation units operate. The complex bidding allows generators to submit offers that reflects the complex constraints on how generation units operate.

On the demand side, the System Operator may forecast demand and dispatch generating units against this. This is called a one-sided pool as shown in Figure 1, here demand curve is taken vertical and non-elastic, as per the demand forecast to find the clearing price. In more sophisticated pools, the System Operator may dispatch based on a demand curve created from price-quantity bids made by the buyers on the market, such as distribution companies and bulk consumers. This is called a two-sided pool which is depicted in **Figure-3**.

In a Gross pool, generators are not allowed to withhold their capacity or self-dispatch themselves. Such pools are implemented in Philippines, Australia and most of south and north American Markets where the System Operators are responsible for economic dispatch of the power plants.

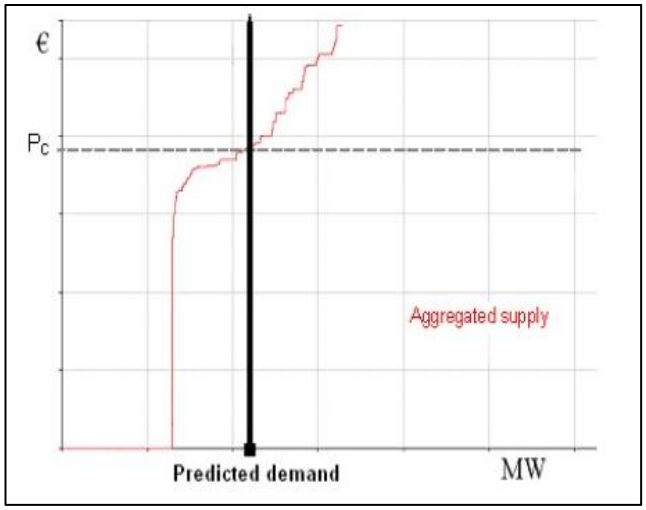


Figure 2. Price discovery – Intersection of supply stack and predicted demand, one-sided pool

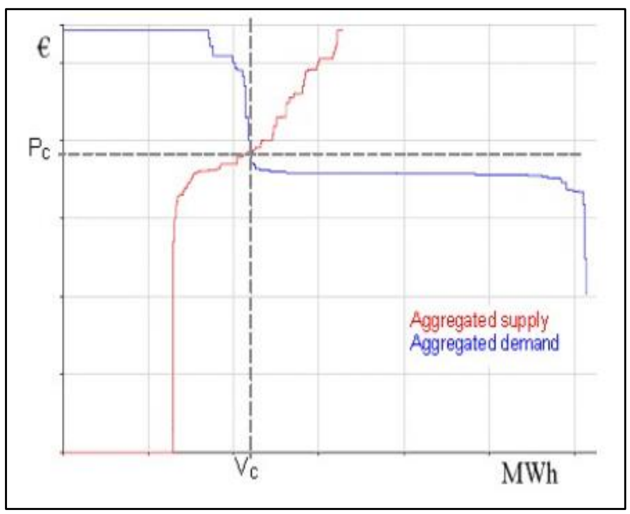


Figure 3. Price discovery - intersection of demand and supply, two-sided pool

Bids and offers are normally firm and they are matched in the market clearing process and result in an obligation to take and deliver the matched volumes. These volumes are financially settled.

A pool can operate a day-ahead market (e.g. the former England & Wales Pool) or a close to real time market (e.g. five minutes-ahead). There can also be a combination of several markets (day-ahead, intra-day and five minutes-ahead). Where a five-minutes-ahead market is operated, other sessions can still be run based on non-firm offers and bids.

Centralized markets such as Gross Pools can optimize more easily than bilateral markets, because in finalizing generation schedule, the centralized system can check that all transmission constraints are satisfied. In a decentralized system, the same issue can be resolved through an iterative process of redispatch, but such a process is less likely to arrive at the most optimal constrained dispatch solution. One of the other main advantages of a pool model is that it allows for Locational Marginal Pricing (LMP). LMP is based on the marginal cost of supplying the next increment of electric energy demand at a specific location in the electric power network accounting for both generation and network characteristics. The consequence is that instead of one uniform price, there is a price per location, which can be at each node or on a wider zonal approach. Congestion costs are no longer socialized, and each market player pays for congestion caused. However, it must be noted that all such advance features are activated as per maturity of the market which requires certain time to develop.

2.2. Net Pool (Exchange Model)

Net Pools or Bilateral Contracts Model is another alternative market mechanism to trade electricity which is based on physical bilateral contracts. This means that sellers and buyers freely enter into bilateral contracts which can be self-dispatched, for power supply. Sellers will normally be generators and buyers will be Load Serving Entities (i.e. suppliers) and large consumers. The contracts volumes and prices are negotiated bilaterally, and the System Operator is informed about the agreed volumes to check the feasibility for dispatch. prices normally remain confidential among the parties. During real time operations, there will always be differences between the contracted volumes and the actual metered volumes for generators as well as demand. There can be unforeseen outage at the generation end, or the demand can arise more or less than what has been communicated earlier. This means that the System Operator have to consider these uncertainties about the information being communicated by the parties and has to make necessary arrangements to be able to balance the generation and load during real time operations. There are several mechanisms to deal with this. In more advanced markets, the System Operator runs a balancing power market in order to establish a market-based price for the settlement of these imbalances.

For trading energy, in parallel to the bilateral contracts, a voluntary Power Exchange could also be set up or could develop on the initiative of the market participants. A Power Exchange is a platform that facilitates the trade among participants i.e. it is just a convenient location for potential buyers and potential sellers to meet. Exchanges comes in many forms. A power exchange could offer day-ahead and intra-day trade to enable the market participants to balance their position before real time.

The power exchange has no metered generation or consumption and therefore never has imbalances because electricity bought is always equal to electricity sold. The imbalances occur at real time which are settled by the Market Operator based on the principles of that market. The quantity contracted in a power exchange is payable by the buyer whether he consumes or resells it in another market. If the buyer uses more than contracted then it has to buy it in the balancing market or if he consumes less, he has to sell the excess amount in the balancing market.

This model with bilateral contracts and a voluntary power exchange has been implemented in several European countries, with exchanges in the Netherlands (Amsterdam Power exchange), France (Power next), the Scandinavian countries (Wordpools), Germany (EEX), Poland (Plop) and Austria (EXAA), NordPool. One can even have several competing exchanges in one country, as was the case in Germany (EEX and LPX) and England (UKPX, APX, Powered and IPE).

Both market models, pools and bilateral contracts, though so much different, can coexist. A pool could have bilateral contracts alongside of it and in a bilateral contacts mechanism a voluntary power exchange could be considered. Therefore, to better illustrate the difference between both, one can draw a line between markets with central dispatch of generating units and with self-dispatch. As shown in Figure-3, central dispatch market can also have bilateral contracts, but they are subject to centralized dispatch by the System Operator and are more of financial nature. Generally speaking, central dispatch of all generating units is related to mandatory pools. Self-dispatch means that generators decide on the dispatch of their own generating units and this regime applies to bilateral contracts which are of physical nature.

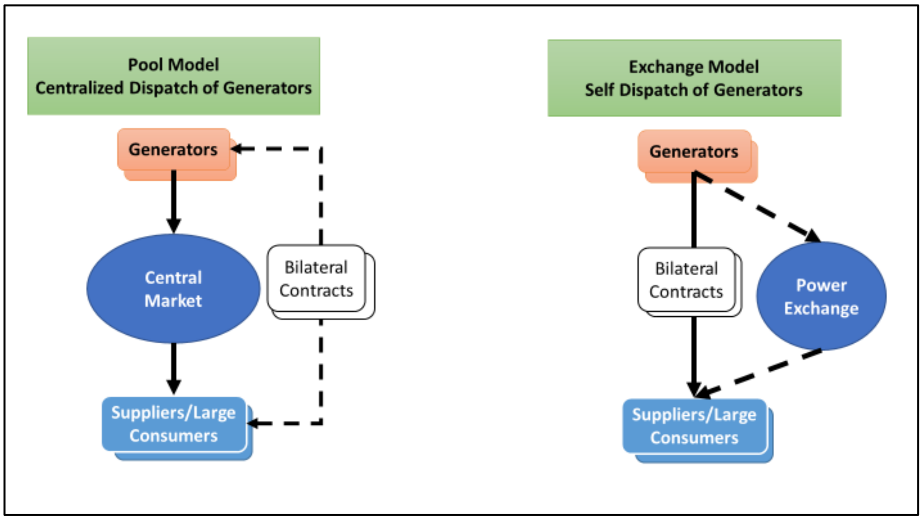


Figure-4: Difference between a Pool Model and an Exchange Model

2.3. Type of POOL chosen for CTBCM

While considering the existing circumstances, legal requirements, the nature of the legacy contracts, physical infrastructure of the transmission grid and the readiness of the institutions and market players, a cost-based Pool model has been considered as the most suitable option for Pakistan. All generation plants connected at the transmission voltage will be subject to SCED being run by the System Operators and participants will be allowed to have bilateral contracts to hedge prices. This approach was adopted based on careful analysis of the local conditions and the lessons learned from international experiences as discussed in the following paragraph.

Cost-based spot markets with capacity and ancillary services obligations (such as those developed in Latin America) offer a simpler and less risky alternative for introducing wholesale competition in developing countries that lack appropriate conditions for full bid-based competition (J. E. Besant- Jones, 2006, p. 78). After several years of operational experience, the cost-based spot market can evolve into a bid-based spot market (J. Besant-Jones & Tenenbaum, 2001, p. 7). Cost-based pools have worked relatively well in Latin America, despite being an inferior form of competition compared to bid-based pools. Moreover, cost-based pools ensure efficient dispatch if generators tell the truth about their production costs and make it difficult for generators to exercise market power.

2.4. Alternative Choices and its pre-conditions

An alternative option evaluated was to implement a net-pool i.e. a bilateral contract model based on self-dispatch. The first constraint in this regard was the provisions of the Act which mandated a centralized economic dispatch and prohibited any self-dispatch. The second hindrance was the historical operation and organization of the power system which was based on centralized economic dispatch. The third disadvantage of such model was the structure of the legacy PPAs which are more suited and economical to be operated under a centralized economic dispatch model. The self-dispatch model in such conditions would result in a sub-optimal dispatch. Also, Pakistan being a longitudinal country with significant transmission constraints where a self-dispatch markets require a strong interconnected transmission network, therefore, implementing this model would have created severe problems.

Another alternative evaluated was to consider the choice of using prices instead of variable costs in the economic dispatch. In this regard, the global experience showed that such bid-based approach requires sophisticated mechanisms to establish and to monitor. Market power can be a huge risk in such markets i.e. the California crisis. Also, such mechanisms required the maturity of the participants in order to take rational decisions instead of gambling which could severely impact the efficiency of the market. Another important consideration was regarding the nature of legacy PPAs for which the relevant cost for dispatch is the variable costs and there is no provision to bid prices to the System Operator in order to be dispatched.

While carefully evaluating all these alternatives as discussed above, it was concluded that the cost-based centralized dispatch model is the most suitable option for Pakistan to transition towards competition and to establish a competitive wholesale market.

3. Market Architecture

Market Architecture means at what intervals the trade in electricity is happening in the market and what type of trading platforms are available at various time intervals. Markets can be arranged to provide several trading platforms to market participants at various intervals for balancing their position and concluding trade. A Gross pool can operate a day-ahead market (e.g. North American ISOs, the former England & Wales Pool) or a close to real time market (e.g. five minutes-ahead). There can also be a combination of several markets (day-ahead, intra-day and five minutes-ahead). These can include:

- **Long- and Medium-term forward Contracts:** Forward contract or simply a forward is a non-standardized contract between two parties to buy or sell energy at a specified future time at a price agreed on at that time. Years in advance of when power is delivered, suppliers, consumers and System Operators needs to make sure that there is sufficient investment in capacity to supply the potential demand. To achieve this, the suppliers and consumers sign contracts in advance with generators to meet their requirements. In some markets, it is even mandatory to do so to ensure resource adequacy in the system.
- **Day Ahead Markets:** The Day-Ahead Energy Market (day-ahead market) is a market where market participants purchase and sell electric energy at day-ahead prices for the following day. This helps the participants to balance their positions. As the actual day approaches and a more reliable

forecast of demand is possible, LSEs or consumers will review their energy contracts to be sure they have the supplies they need. If they have contracted more than their needs, they will sell some of it. If they have contracted less, they will buy some in the day-ahead market.

- **Intraday Markets**: The intraday market supplements the day-ahead market and helps secure the necessary balance between supply and demand in the power market to clear any mismatch that is still left from the day-ahead market. Global experience shows that the intra-day markets are less active in the countries having day-ahead markets because participants normally balance their positions at day ahead and are less active in the intra-day.
- **Real Time Market**: In most of the market based on centralized economic dispatch, the System Operator runs a real time market based on the offers and bids of the market participants. All participants are required to submit bids and offers for the hour of operation. This information is used by the System Operator to finalize the generation schedule for that hour.
- **Balancing Market**. Balancing markets are generally used to balance as closely as possible production and consumption to energy delivery. Markets other than the balancing markets are cleared well in advance of energy delivery and thus the production and consumption levels scheduled in these markets can significantly differ from the actual production and consumption at balancing time. The System Operator procure all the necessary resources through this market in order to be able to balance the generation and load in real time.
- **Ancillary Services**: As the time of operation arrives, the short time horizon forces a change in the market structure. It is no longer possible to make fresh solicitation for resources. Instead, the system operator must already have direct control over resources. This control may have been arranged through a market organized earlier such as the balancing market or real time market. Instead of selling hourly energy, that market sells control over the generator or resources which is then used by the System Operator as needed.

Enabling these sophisticated features required times for the systems to adjust and to develop the maturity of the market participants to use these for their benefits. Most European markets have implemented the day-ahead, intra-day and balancing markets. South and North American markets have also gradually introduced these sophisticated features into their markets. If we take the example of Alberta and Ontario wholesale electricity markets, they are yet to introduce day ahead Market which are under development phase. Moreover, there are several other examples like Turkey, Latin American markets, which started as in its simplest form and then evolved into more sophisticated type of Market.

3.1. Market Architecture in CTBCM and Alternate options

Considering the historical boom and bust cycles in the power sector of Pakistan, CTBCM has introduced long-term bilateral contract market through Capacity Obligations to ensure resource adequacy in the system. The bilateral contracts shall be signed sufficient in advance to make sure that generation capacity is being built in advance of the load growth.

In order to compliment the bilateral contracts and to enable the centralized economic dispatch of power plants, a Balancing Mechanism for Energy (BME) has been introduced. This BME can be qualified under the real time market definition as discussed above. BME is a mechanism through which both parties to a bilateral contract sale or purchase the differences between contractual and actual energy quantities injected to or extracted from the grid/market. This mechanism allows flexibility for the participants and boost efficiency (consistent with economic dispatch). The MO will calculate the imbalance prices for each trading period (hourly at the start of Market) and will require credit cover for cases of nonpayment the amounts arising from this mechanism. Later on, this mechanism may evolve towards trading platform providing the spot price

In order to complement the Capacity Obligations, a Balancing Mechanism for Capacity (BMC) has been introduced. This mechanism will be employed to settle imbalances between contracted amounts and available amounts for Generators/Sellers and contracted amounts and actually demanded amounts for Buyers. This mechanism will be operated once in a year and is based on Demand Curve Formulation and Critical Hours approach.

3.2. Evolution of CTBCM and other Markets

At the start of CTBCM, there will be small number of participants as most part of generation is already contracted in the form of long-term PPAs. However, with the passage of time, demand will grow and these PPAs will expire and there is more volume available for trade and also the market participants become mature, these sophisticated trading platforms can be introduced. CTBCM design fully allows the integration of all these sophisticated features in the future.

3.3. Alternative Choices and its pre-conditions

An alternative choice was to implement a Power Exchange. Although, a Power Exchange (PX) is a feature of self-dispatch markets as discussed above while our legal framework (i.e. NEPRA Act) requires a centralized economic dispatch. However, many players in the market propose this idea for Pakistan. The practicality of this idea and the reasons why it couldn't be implemented are discussed in detail in the following paragraphs.

Currently all the demand in Pakistan is already contracted through long term PPAs and during coming years (up to 2025) there will be more than adequate contracted capacity in the system. If a PX is introduced at this point of time, there will not be any liquidity in the system (as demand is already over contracted) during many years to come until the demand also grows and demand and supply gap comes close to zero.

Idea of a PX with existing Long Term PPA's

During development of the market design and its consultative sessions, several ideas regarding establishment of a Power Exchange in Pakistan instead of the design being proposed. One of the most interesting idea that came under discussion is depicted in Figure-5 below. The ideas in brief meant that the existing generators in the power exchange can participate in such a way that by just changing the existing financial flow (but of course without any additional financial impact on any of the entities), we can increase the liquidity in the market and hence power exchange can be established.

In-order to operationalize the idea, let's assume that it can be done, but how it can be done is discussed hereunder from our perspective. This analysis will help the reader to understand whether this preposition is possible in Pakistan from day one or not or whether this will bring any benefits in terms of reducing costs and optimizing dispatch or not.

What will be needed to have a PX from day one in Pakistan is as follows (we are ignoring the intraday market for ease of understanding and also ignoring the types of inflexible contracts that we have in Pakistan):

- Bilateralize the existing PPAs. If it does not happen, create an entity (SPS). SPS then can have agency agreements with 10 distribution companies (DISCOs).
- Generator will bid according to their production cost or variable cost in the Day-Ahead to MO / PX
- Demand participants (or SPS) will submit hourly Day-Ahead forecast to MO / PX
- Market Operator (MO) will Run the PX in the Day-Ahead
- At gate closure, MO runs the software and come up with a market clearing price (MCP) for each hour where supply and demand curves meet keeping in view the security constraints
- SO will dispatch the quantum that clears in PX according to the security constraint economic dispatch
- MO should have the IT capability where generator can submit their bids and demand can submit their hourly forecast
- Robust system and procedure are required to collect the collateral from Participants for the trading in PX before the hour of operation (real time dispatch).
- Financial flow and settlement will be as per the diagram given in Figure-5.

In this hypothetical example, if marginal clearing price (MCP) is 6000 PKR/MWh and as per the agreed PPA, energy price is 8000 PKR/MWh based on pass through variable cost.

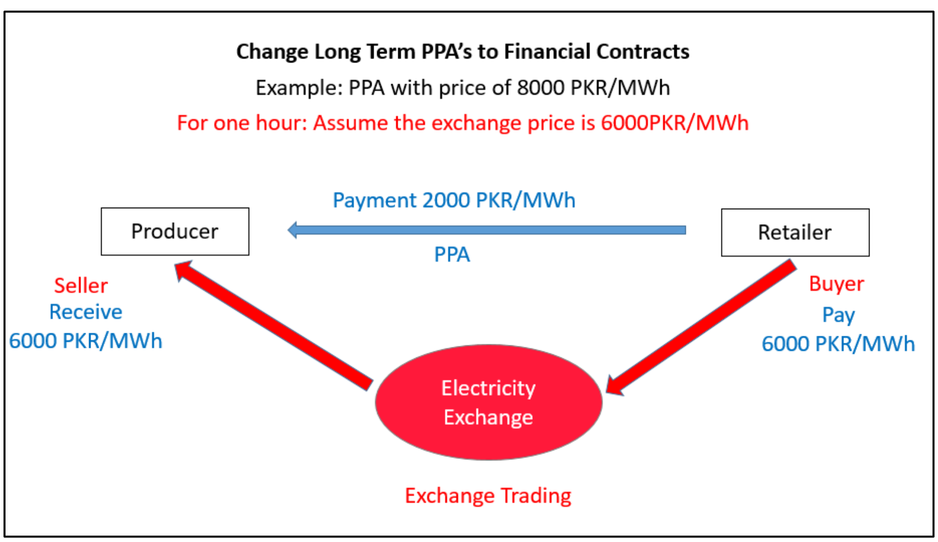


Figure-5: Establishment of a Power Exchange and Integration of Legacy PPAs

In the above diagram the retailer (SPS in this case) is participating in the PX and pays the MCP at PKR 6000/MWh to PX and also the delta of PKR 2000/MWh to the producer separately to balance the price as per PPA.

On the other hand, if the MCP is higher than the PPA price, Retailer (SPS) will pay the MCP in PX and generator will pay back the difference of MCP and PPA price to SPS separately.

Situation in Pakistan which is an Impediment for establishment of a PX (Power Exchange)

The concept of a power exchange is based on the fact that there are multiple buyers and sellers willing to sell or buy their products (Energy, Capacity) conveniently. Both the demand and supply sides analyze their day ahead requirement and try to balance out any deviations between contracted quantities and actual consumption / supply, by procuring / selling in the PX to minimize the impact of real time balancing costs. In Pakistan, we have Generation Following long term contracts with Take or Pay capacity and Pass Through energy. Whole demand seems to be adequately contracted which means that if there is any PX, demand side will not participate (as it has no deviations or imbalances to procure from the PX).

Similarly, generators are paid capacity charges (fixed charges) based upon their availability. Variable cost is a regulated pass through cost. If it participate in PX, it will always submit the same bid (for availability purpose it will try to be available for all the time to secure fixed capacity charges and due to regulated variable charge, it will submit same price all the time). Therefore, submitting the same bid at all times without any optimizing strategy makes no sense at all.

For deeper analysis, we can segregate the demand in two type of consumers: **Eligible and Non-Eligible**. In Pakistan any BPC having load above 1MW or above is eligible consumer and it can procure from the market. These eligible consumers can participate in the PX and there may be some liquidity. But as currently these eligible consumers are in the system and enough capacity has already been procured on their behalf. If such consumers are allowed to procure from the market, the this will create the issue of stranded costs and cross-subsidy which also needs to be addressed which also may limit the number of participants in the exchange and hence low liquidity.

The following Table shows various features of a Power Exchange and its comparison with situation in Pakistan.

Table 3: Various features of Exchange and the situation in Pakistan

Sr.No.	Features of Exchange	Pakistan's Situation	Remarks
1	Demand participants procure from the power exchange only those volumes that are not covered in Bilateral Contracts	All volume is already contracted (as explained above)	There will be no liquidity in the market as whole demand is already contracted
2	There are double side auctions in the PX i.e.	As demand is already contracted and no new	Eligible Consumer

Sr.No.	Features of Exchange	Pakistan's Situation	Remarks
	both demand side and generation side bid in the PX	procurement will be needed by DISCOs, they will not bid in the PX until demand and contracted quantities balanced in future otherwise there will be stranded costs	• BPCs can participate but will be paying additional charges (as explained above) which will result in less participation by BPC's Non-Eligible Consumer • DISCOs will not participate either, as demand is already over contracted.
3	Payment in the PX is Ex-ante means participants have to pay in advance	Pre-payment looks not possible by the demand participants For most of the PPA's, 45 days payment period is there after generation month.	Serious payment issues in Pakistan due to heavy losses and less recovery by DISCOs
4	Price determination by the willingness to pay by demand and willingness to sell by generators – true market price	As per the **Case** depicted above, demand side will not bid and price will not reflect true market price. At the same time, it can be easily worked out if one has the aggregated demand forecast of the system	Determination of True market price is only possible if both demand and supply bid in the PX
5	Generators cleared in exchange are considered committed and **self-dispatched**	As per NEPRA Act, SO is bound to dispatch the units **centrally** on Security Constraint economic principals	No self-dispatch Ref from NEPRA Act • **Section 14B Generation*: Sub-Section (4)*** *In the case of a generation facility connecting directly or indirectly to the transmission facilities of the national grid company, the licensee shall make the generation facility available to the national grid company for the safe, reliable, non-discriminatory, economic dispatch and operation of the national transmission grid and connected facilities; subject to the compensation fixed by the Authority for voltage support and uneconomic dispatch*

Sr.No.	Features of Exchange	Pakistan's Situation	Remarks
			directed by the national grid company. • **Section 14D Duties of Generating Companies*: Sub-Section (2)*** *In the case of a generation facility connecting directly or indirectly to the transmission facilities of the national grid company or a provincial grid company, the generation company shall make the generation facility available for the safe, reliable, non-discriminatory, economic dispatch and operation of the national transmission grid and connected facilities, subject to the compensation fixed by the Authority for voltage support and uneconomic dispatch directed by the system operator.*

In view of the arguments stated above, it can be easily concluded that it is not possible to implement a power exchange in Pakistan. Instead the recommended path is to initially start the market with bilateral contracts and centralized dispatch keeping in view transmission constraints, participants capacities etc. and with the passage of time when demand and supply are in balance, power trading platform can be established.

4. Products Traded & System Reliability

Any market is characterized by the types of the products traded in the market i.e. commodity markets, financial markets etc.There can be several products that can be traded in a competitive wholesale electricity market, these can include:

- **Energy**: Energy is the actual electricity produced to perform the actual useful work and is measured in kWh. This is a standard product traded in the market and is measured through commercial metering systems installed by the metering service providers. Different markets and regions define different trading periods and pricing mechanisms for trading energy. The settlement interval ranges from minutes to one hour such as Ontarian Market (IESO) have 5 minutes of settlement interval and US markets (NYISO, PJM, etc.) has hourly settlement process. Similarly, the pricing interval also varies from minutes to hour and even to one week such as Brazil observes weekly prices in the system due it its particular features of the market.
- **Capacity**: Capacity is the ability of the generation assets to produce electricity whenever needed. The concept of Capacity is related to the security and reliability of the electric power system and is used in various markets to remunerate capacity of the power plants. Capacity is a long-term

product and this mechanism is normally operated once in a year. There can be centralized mechanisms such as NYISO capacity market or alternatively, the LSEs and participating consumers can be obligated to procure capacity on their own.

- **Ancillary Services**: Besides energy generation, the security and reliability of the power system required variety of other services called Ancillary Services. Different countries and regions define different categories of ancillary services and use different labels. Some of the generic categories of ancillary services are frequency control including regulation and operating reserves, voltage support and black start or system restart capability. Ancillary Service markets can be operated separately, or it can be integrated into the energy market such as NYISO day ahead market that also procure ancillary services.
- **Demand Response**: Demand response is a relatively new mechanism of load management and is traded as a product in Capacity Markets. Under this mechanism, efforts are being done to influence retail demand so that it is more economical hour-by-hour, by increasing the portion of retail demand receiving a direct pass-through of hourly wholesale prices. Another alternative is the provision of interruptible service in which a consumer receives a compensation for agreeing that its load can be interrupted if the system is at stress. NYISO, PJM and many other market allows to offer this product.
- **Transmission Congestion Contracts**: In several markets, when transmission constraints become binding, market splitting occurs which create price differences in different zones of the market which creates a risk for market participants. Several markets introduce mechanisms and products to hedge this risk which are called transmission congestion contracts. As the Brazilian market has four zonal prices, therefore, the participants use the transmission congestion contracts to hedge against the congestion risk.
- **Virtual Markets**: In order to increase liquidity in the market and allow speculations and introduce products which are of financial nature. These products are designed to hedge prices and allow virtual trading. For example, NYISO operates a day ahead and real time market where virtual trading is allowed by the participants.
- **Carbon Credits**: With increase in the global efforts to curb carbon emissions to combat climate change, several trading platforms are introduced to trade these emissions. Several electricity markets such as NYISO are in the process of integrating carbon trading into their wholesale market

4.1. Products in CTBCM and Alternative choices

Considering the local condition, availability of infrastructure and mechanisms and the readiness of the market, two main products, Energy and Capacity, are introduced in CTBCM. The energy product will be traded to supply electricity consumption and “firm capacity” will be traded to provide enough and adequate capacity for medium and long-term security of supply.

- Energy and capacity will be traded mainly through contracts, complemented by trading through balancing mechanisms (BME and BMC) being administered by the Market Operator.

- Participants representing demand (e.g. DISCOs, KE, Competitive Suppliers, other Base Suppliers), or consuming electricity (Participant Consumers) must procure or own sufficient firm capacity to supply their own requirement and system reserves. Generators will own capacity certificates which will be tradable in the market. The general design of the Capacity Obligations and the Balancing Mechanism for Capacity are described at *Section* ***Error! Reference source not found.*** of the Detailed Design report.

4.2. Alternative Choices and its pre-conditions

Instead of implementing the market with two products i.e. energy and capacity, an alternative choice was to introduce energy only market where generators are only paid the marginal prices and there is no remuneration for capacity. The first hindrance to implement such design was the structure of the legacy PPAs which couldn't be integrated into such market. Secondly, it is very difficult to design and implement an energy only market with such a pricing mechanism (scarcity pricing) which ensures that there is enough revenue available in the market to stimulate enough investments in the system. Also, with the integration of renewables and the collapse of marginal prices, several markets have introduced capacity markets along with energy market to remunerate the dispatchability of generation assets. The examples include Alberta and Ontario wholesale electricity markets. So instead of creating and energy only market and then later on introducing capacity market later, it was concluded that it is more economical to introduce the capacity product at the start to ensure resource adequacy in the system. Several other international examples include several south and north American markets such as NYISO, CAISO, PJM, Brazil etc. Several European Markets have also introduced capacity Reliability mechanisms such as UK, France, Poland, Ireland, Italy, Spain etc.

Regarding ancillary service, it was observed that majority of the volume traded in the market will be by those generation companies already locked up in the long term PPAs which already have provisions for providing these services. So in order to minimize the disturbances, it was decided that at the start of the market, these services will be provided in similar manner as of today, however, the cost of such services will be accounted for separately and will be charges to all demand participants on pro-rata basis. The development of an ancillary service market will depend on the need and evolution of the market. Brazilian power market also has no ancillary service market but provide payments to hydro units for providing these services. Other advanced markets such as US and Europe have introduced market mechanisms to procure ancillary services.

Other sophisticated products such as demand response, transmission congestion contracts, virtual market and carbon credits are not needed at this time and will be introduced as per need and evolution of the market.

4.3. Evolution of CTBCM and other Markets

As discussed above, other sophisticated features such as market for ancillary services, transmission congestion contracts, demand response, virtual markets and carbon credits will be intruded as the market evolves and IT infrastructure is capable enough to allows such type of markets. IT infrastructure, SCADA and online metering are the prerequisites to introduce such sophisticated products in the market. These products will be gradually introduced when the need arise, and the pre-requisites are met.

5. 4-Pricing Mechanism

5.1. Basis of Market Price

Markets in different regions and countries have employed different mechanisms to determine the market price. Some markets use bidding from market participants (such as PJM and NYISO) to determine the price and clear the market while some other markets use a combination of forecasts and generation costs (such as Brazil, , Peru etc.) to determine the market price. Some markets allow participants to bid prices while other restrict the bidding to only variable costs. No matter what the underlying principles are, the competition forces all generators (except in some special circumstances i.e. scarcity or generators having market power) to bid their marginal cost into the market which is used as basis for determining the market price.

In centralized gross pools price, can be formed by the intersection of demand and supply curve, demand usually is non elastic and can have a vertical demand curve, on the other side generators supply curve can be based on prices bid by each generator or the variable cost of generation of each power plant. Normally, the supply offers are stacked as shown in Figures-6 below. This is called a merit order stack or simple supply stack. The x-axis of this graph shows the quantity while the y-axis shows the price at which this amount of generation capacity is available. The demand is represented by a vertical line. In the absence of any constraints and in the simplest way, the intersection of the demand and supply curves determine the market price. The market price is sometimes also called the system marginal price which is the cost of supplying an additional unit of electricity at that time.

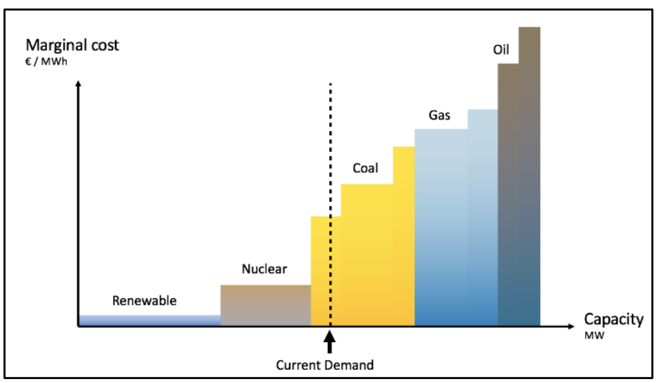


Figure 6: Marginal Price discovery

The Power Exchange also operate on similar principles; however, the only difference is that in a power exchange, both supply and demand side submits offers and bids and the exchange algorithm matches those offers and bids and determine a market clearing price. In an exchange, the demand is not a vertical line, but a curve with downward slope as shown in Figure-2 above.

5.2. Market Price formation

The price formation process is particularly important for providing signals to market participants regarding efficient system use and investment in new capacity. As discussed above, market price can be determined by employing different mechanisms in a centralized gross pool or a power exchange. These centralized markets can have:

- **Single Price**: In this mechanism, the market has single clearing price for all market participants irrespective of their location in the network. Impact of losses, transmission constraints and other uplifts are not part of the market price but are charged separately. Canadian markets (IESO, AESO), Denmark, Turkey employs this mechanism
- **Zonal Price:** As discussed above, transmission network put important limitations on the operation of power plants. As a result of these constraints, the cost of supplying power at one location is different than the cost of supplying at other location. While a single market price deals with such issues outside the market, another alternative approach is to introduce zonal prices that duly consider the impact of transmission congestions and losses. This pricing mechanism reflects the cost of supplying at that location on an average basis because several nodes are combined to define a zone. Energy market in Brazil and Capacity Market in NYISO has zonal prices.
- **Locational based Marginal Price (LBMP) or Nodal Price.** Nodal pricing refers to prices paid for electricity consumed or generated at a given transmission node. Nodal pricing better depicts the technical and economic effects of the network on the price of electricity as it implicitly includes the impact of grid losses and transmission congestion. LBMP has the following formula:

  LBMP= Energy + Congestion + Losses

  The energy price is same for all participants while the cost of congestion and losses differentiate the market price at each node. As an illustrative example, Figure-7 shows two nodes for NYISO system, where LBMP is implemented. In this example, the energy price is same in both zones that is $30.00 but due to congestion in East zone, the congestion charge of $5 is applied in East zone due to which MP is this zone is $35. Similarly, the impact of losses can also be worked out for each node, however, the losses calculation is a complex task.

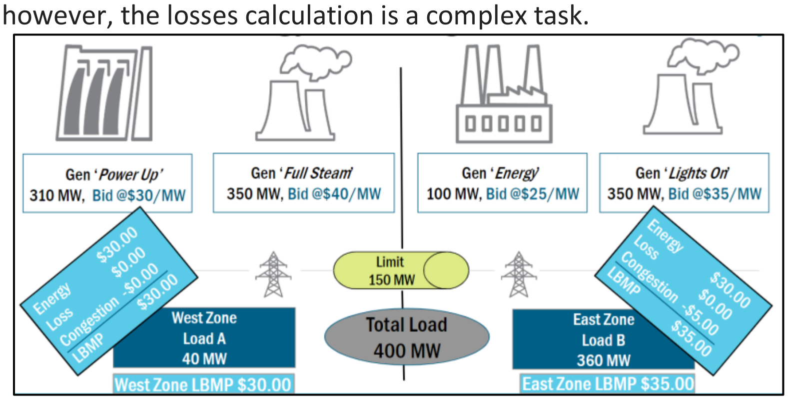


Figure 7: LBMP in NYISO

5.3. Market Clearing

Market clearing and settlement refers to the clearing mechanism performed by the Market operator to clear the volume traded in the organized market. Regarding Market Clearing, there are two options, either Market Operator settles the whole quantity (gross volume) i.e. all generators are paid at the market price by the MO and all demand pays the market price to MO, or alternatively, the market participants settles the contract quantiles bilaterally and MO only settles the imbalances. Figure 8 below shows a gross settlement mechanism and Figure-9 shows a net settlement mechanism

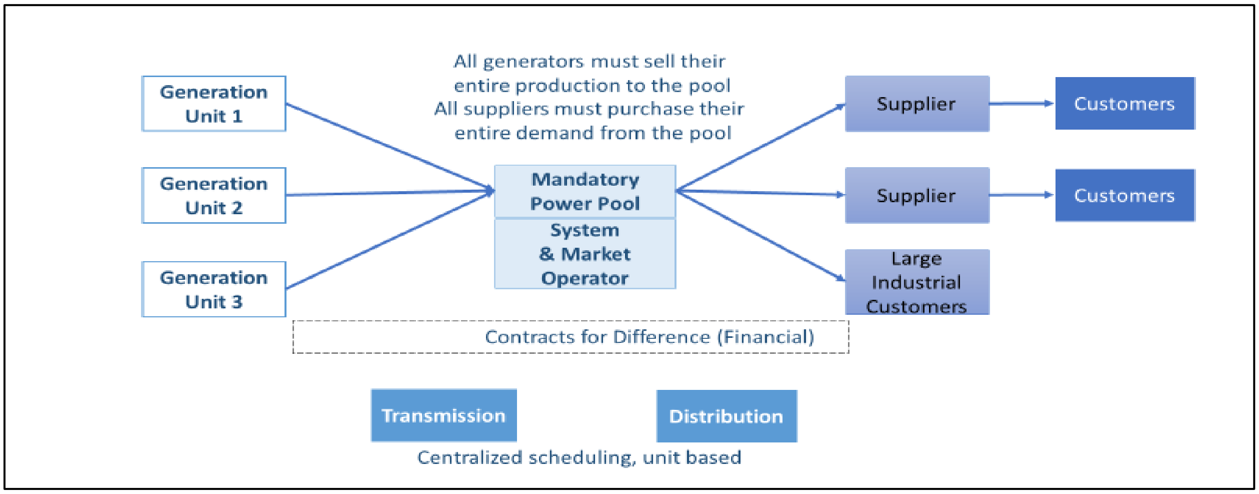


Figure 8: Mandatory pools market clearing

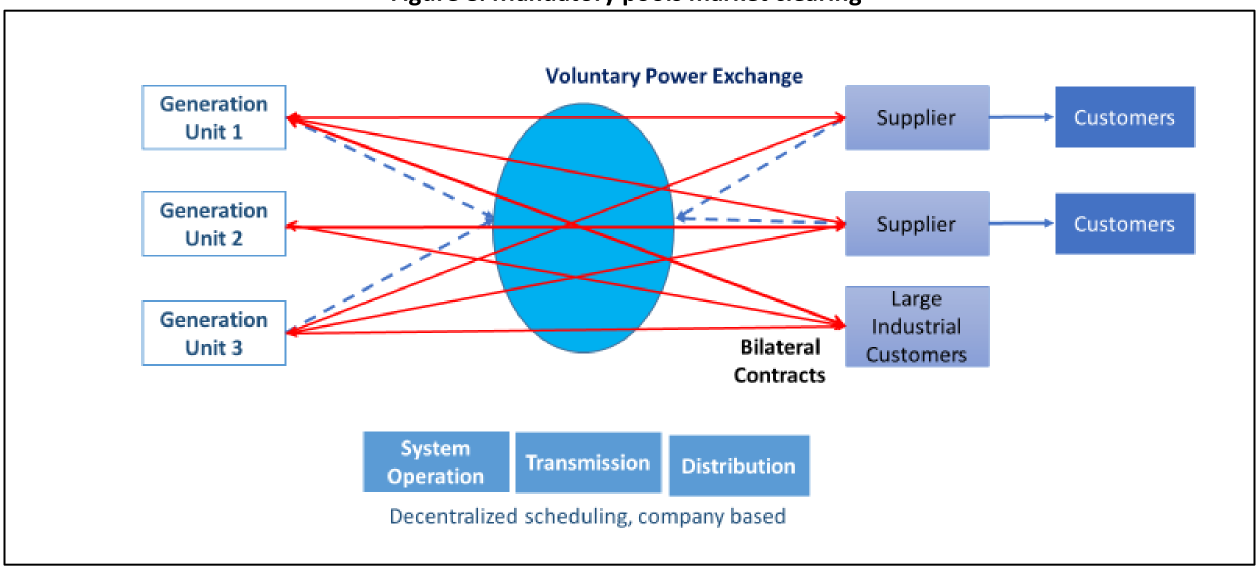


Figure 9: Voluntary Power Exchange

5.4. Pricing Mechanism in CTBCM:

During the market design, several options were carefully evaluated to form the basis of market price in CTBCM and it was concluded that a cost-based pool model with single market price is the most suitable option to be implemented in Pakistan. Other alternatives like price-based pool and LBMP required more sophisticated mechanisms, IT infrastructure and the maturity of the market players to understand and there are certain pre-conditions which are not yet existing in Pakistan.

Regarding market clearing, both gross clearing and net clearing methods were evaluated in detail. Considering the existing payment culture, it was concluded that the gross payment mechanism is not a suitable option as there will also be cash shortage with MO due to non-payment form the DISCOs. Therefore, it was decided that MO will only settles the imbalances arising from contractual amount and actual operation. As this amount will be usually small, therefore, for this purpose, MO will require credit covers from the participants to cover the non-payment risk to the extent of BME and BMC. The contractual amounts will be paid directly among the contracting parties and MO will have no role regarding that.

Other choices such as Zonal Prices and Locational Based Marginal Prices may be introduced gradually, depending upon the needs and maturity of the market players and systems. Several markets in developed countries are started with single market pricing and then evolve to zonal and nodal pricing. For example, Canadian markets AESO and IESO still using single marginal price and now after 20+ years are in transition to these sophisticated mechanisms.

5.5. Alternative Choices and its pre-conditions

Regarding basis of the market price, an alternative choice evaluated was to implement a price-based pool with double sided auctions. It was observed that most of the power traded in the market will be through legacy contracts which don't allow generators to bid prices. Their energy generation costs are determined by NEPRA which are used for dispatch purposes by the System Operator. Also, on the demand side, considering the existing institutional capacity of the DISCOs, there was no basis for them to bid price-quantity pairs into the market as all of their demand is already contracted under the legacy contracts. Furthermore, implementing a price-based pool requires strong monitoring mechanism to detect and control market power. These mechanisms can be implemented at later stages when there is enough uncontracted generation and demand available to optimize their portfolios, but this requires a transition time to implement.

Also, global experience regarding implementation of the wholesale markets in developing countries supported the idea of a variable cost-based market. Following is an excerpt from world bank paper "**Taking stock of Wholesale Power Markets in developing Countries** "regarding choice of cost-based pool vs price-based pool for developing countries:

"*Cost-based spot markets with capacity and ancillary services obligations (such as those developed in Latin America) offer a simpler and less risky alternative for introducing wholesale competition in developing countries that lack appropriate conditions for full bid-based competition (J. E. Besant-Jones, 2006, p. 78).30 After several years of operational experience the cost-based spot market can evolve into a bid-based spot market (J. Besant-Jones & Tenenbaum, 2001, p. 7). It is argued that cost-based markets would provide the time necessary for the market to evolve until wholesale competition is viable. Cost-based pools have worked relatively well in Latin America, despite being an inferior form of competition compared to bid-based pools. Moreover, cost-based pools ensure efficient dispatch as long as generators tell the truth about their production costs and make it difficult for generators to exercise market power31 (J. Besant-Jones & Tenenbaum, 2001, p. 7)."*

The Single Price or SMP (system marginal price) is selected over zonal prices or LBMP because it is the most simplest approach and could be implemented within existing circumstances while the other two alternative require strong and sophisticated IT Systems, installation of SCADA systems and other complex mechanisms to develop. In the absence of these preconditions, it is not practicable to go for these alternatives. As discussed above, several markets in developed countries are started with single market pricing and then evolve to zonal and nodal pricing. For example, Canadian markets AESO and IESO still using single marginal price and now after 20+ years are in transition to these sophisticated mechanisms.

Regarding market clearing, the alternative choice was to implement a mandatory pool model where all payments are cleared by the market operator. As discussed above, considering the current payment culture which warrants sovereign guarantees form the government, it was not possible to implement this option. The major disadvantage would have been that the MO will have no cash to pay to the generators due to non-payment from the DISCOs and will always be in debt. Nobody would trust such a market operator who is always unable to pay and has huge debts. Therefore, this option was not practicable in Pakistan as opposed to developed countries where there are no payment issues and the markets are cleared on time.

6. Power Procurement and Contractual Arrangements

Electricity can be traded via bilateral contracts negotiated between the two parties such as the buyer and the seller. These parties could be a generator and a trader or the generator and a utility, a supplier and large customer etc. Bilateral trade of these types can coexist with a wide range of industry structures. These include, of course, profit-making corporations operating in a competitive energy market, but bilateral trade also arises in many other contexts. For example, a state corporation or a regulated public utility that owns most of its own generation may choose to negotiate a deal in order to cover a specific need that it has not been able to fill. Or a state corporation or a regulated public utility may find that they have a surplus of generation' capacity and that they can provide better value to their own customers by marketing some of the excess capacity to nearby regions. A municipal utility may save money by outsourcing the supply of its power. Neighboring countries may have very different market structures, and nevertheless allow trade in power across the border.

Standardized contracts may be for immediate delivery, or they may be for delivery at any one of several future dates. A contract for immediate delivery is called a spot contract, the market for these contracts is called the spot market, and the going price in this market is the spot price. A contract for future delivery is a forward contract, a market for these is a forward market, and the going price in this market is a forward price. Although we often speak and write about the forward market in the singular, in fact, forward contracts are distinguished by the date of future delivery, so that there are really multiple forward markets and prices. For example, there may be a l-month forward market, a 6-month forward market, and a I-year forward market, each with its own forward price.

6.1. Forward Contracts

A forward contract is a private agreement between two parties giving the buyer an obligation to purchase a product (and the seller an obligation to sell a product) at a set price at a future point in time.

Unlike standard futures contracts, a forward contract can be customized to a commodity, amount and delivery date. Commodities traded can be grains, precious metals, natural gas, oil, or even poultry. A forward contract settlement can occur on a cash or delivery basis.

Forward contracts do not trade on a centralized exchange and are therefore regarded as over the counter (OTC) instruments. While their OTC nature makes it easier to customize terms, the lack of a centralized clearinghouse also gives rise to a higher degree of default risk. As a result, forward contracts are not as easily available to the retail investor as futures contracts.

6.2. Future Contracts

Both forward and futures contracts involve the agreement to buy or sell a commodity at a set price in the future. But there are slight differences between the two. While a forward contract does not trade on an exchange, a futures contract does. Settlement for the forward contract takes place at the end of the contract, while the futures contract Profit and Loss settles on a daily basis. Most importantly, futures contracts exist as standardized contracts that are not customized between counterparties.

6.3. Derivatives

A derivative is a financial security with a value that is reliant upon or derived from, an underlying asset or group of assets—a benchmark. The derivative itself is a contract between two or more parties, and the derivative derives its price from fluctuations in the price of the underlying asset.

The most common underlying assets for derivatives are stocks, bonds, commodities, currencies, interest rates, and market indexes. These assets are commonly purchased through brokerages.

Derivatives can trade over the counter (OTC) or on an exchange. OTC derivatives constitute a greater proportion of the derivatives market. OTC-traded derivatives, generally have a greater possibility of counterparty risk. Counterparty risk is the danger that one of the parties involved in the transaction might default.

6.4. Contractual Arrangement in CTBCM and evolution

In CTBCM several types **of Forward Supply Contracts** are allowed for participants to choose from in order to fulfill their needs. The broad categories of these contracts are:

- Generation Following supply contract
- Load Following supply contract
- Fixed quantities supply contract
- Capacity only supply contract
- Capacity and associated energy supply contract

These contracts are discussed with adequate details in the main report. All of these contracts will be of financial nature to hedge prices among the parties and the dispatch of power plants will be based on SCED run by the System Operator. The terms and conditions of the bilateral contracts will not impact the dispatch of the generators. The system variable costs will be optimized through SCED and the imbalances arising due to this centralized operation will be settled by MO on marginal price. In this manner the utilization of the generation resources will be optimized and will result in the lowest cost generation benefitting all market participants.

Other sophisticated features such as Futures and Derivatives may be developed at later stages by private parties depending upon the needs of the market players because it requires transition time, maturity of the market and market liquidity where multiple number of participants are trading.

6.5. Integration of legacy contracts into CTBCM

The legacy contracts have been integrated into CTBCM via generation following design. Through careful evaluation of the terms and conditions of the legacy contracts, this the generation following design was chosen to be the most suitable option for this purpose.

6.6. Procurement by DISCOs (as Base Suppliers)

Considering the existing institutional capacities of the DISCOs and knowing that there are certain low performing DISCOs, a centralized procurement mechanism, subject to Indicative Generation Capacity Expansion Plan (IGCEP) prepared by NTDC and approved by NEPRA and competitive auctions organized by Independent Auction Administrator (IAA), is proposed. All future needs of the DISCOs (i.e. the capacity obligations) will be fulfilled by incremental auctions conducted by IAA based on DISCO forecast and IGCEP output. After successful completion of the competitive auctions and fulfillment of other necessary requirement, each DISCO will sign a bilateral contract with all of the generators awarded in the auction proportional to its requirement. A similar mechanism has been implemented in Brazil. The detailed mechanism is explained in the main report.

6.7. Procurement by BPC or Competitive Suppliers

BPCs can contract directly by choosing any of the above stated contract types and become a Market Participant, or they can be a customer of a competitive supplier, which shall represent all its consumers aggregated demand at the wholesale market. Competitive suppliers will also be required to sign bilateral contracts on privately negotiated terms and condition in order to fulfill their capacity obligations.

Moreover, an OTC bilateral contracts trading platform may also be introduced at later stages in the market as the market volume and participants number increases. Also, private exchanges may be established by private investors to provide a trading platform of financial contracts such a derivatives CFDs, as ICE operates in several north American markets.

6.8. Alternative Options and its pre-conditions

Regarding obligations to sign bilateral contract to fulfill the capacity obligations, an alternative option was to implement a merchant market where all generation is selling to the central pool and all demand is buying from the central pool. In order to implement this option, all the legacy contracts need to be cancelled which is not legally possible and economically justifiable considering that it will destroy investors’ confidence in the market. So, this option was discarded as it was not practicable.

Regarding integration of the legacy contracts, the following options were evaluated:

1. **Forced Market Integration:** Integration of all legacy contracts into the market through legislation without any regard to contractual terms
2. **Forced Contract Negotiation:** Contracts renegotiated to ensure consistency with the Market Rules
3. **Voluntary Renegotiation:** Contracts renegotiated to ensure maximum integration with some adaptation in Market Rules
4. **Adaptation of Market Rules:** IPPs allowed to complete their contractual terms with modification of the Market Rules
5. **Virtual Generation/Managed Contracts:** All contracts managed by one entity and that entity trade in the Market
6. **Contractual Buy-Outs:** All contracts are bought and full compensation is paid to the IPPs

By carefully evaluating the pros and cons of each option and the risks associated with each one, it was decided that the option 4 i.e. the adaptation of the market rules is the most suitable option for Pakistan.

Another alternative option regarding future procurement is to trust on the actions of the market players and hope that generation will develop on merchant basis. However, this requires major pre-conditions to be met before such market could develop. Some of these pre-conditions are:

- 100% payments in the market
- Transparency in Operations
- Efficient Operation of the System through SCADA
- Tools based Dispatch Decisions
- Accurate short- and medium-term forecasting
- Enabled ICT to avoid gaming
- Proactive and competent Regulatory Body
- Strengthened Institutions
- Maturity of Processes
- Alignment of legal, policy and regulatory framework
- Several years of demonstrated performance

Until and unless these pre-conditions are fulfilled to a satisfactory level, a merchant market can’t be developed.

Regarding centralized auction, an alternative option is to allow DISCOs to individually conduct competitive auctions and procure capacity to meet their obligations. In such scenario, considering the current situation of power sector, the low-performing DISCOs will be unable to find any sellers or may be charged very higher price because of high nonpayment risk. In order to cover this risk until the performance of these DISCOs is improved, a centralized procurement mechanism for all DISCOs has been proposed to neutralize the individual counter party risk for the low performing DISCOs.

As global experience shows that a major trustworthy auctioneer can obtain better price by auctioning large quantiles and attracting large players. Therefore, a decentralized procurement process by individual DISCOs for regulated consumers can result in higher cost compared to centralized single auction.

7. Market Structure /Institutional Arrangement

Market Structure means that how institutions are arranged differently to perform various functions of the electricity supply chain. For example, a transmission company can also perform the function of the System Operator function, a power exchange can work separately in some European markets whereas in USA and other north American markets, these three functions can be performed by a single independent company.

7.1. TSO Model

Transmission System Operator (TSO) model is mostly implemented in self-dispatch markets such as Europe, in which a TSO, independent of transmission companies is responsible for secure and reliable operation of the system. It also runs the balancing market to procure the necessary resources to manage load and generation in real time. The Market Operator is a separate entity responsible to settle imbalances and a power exchange is also operated separately.

7.2. ISO Model:

The Independent System Operator (ISO) model is mostly implemented in North American markets. In this model an independent entity called the ISO is responsible for transmission planning, system operations as well as market options.

7.3. Market Structure in CTBCM

By carefully evaluating the current institutional structure, it was concluded that the CTBCM could be properly implemented with the existing institutional structure. The NPCC of NTDC will perform the function of the System Operator and will obtain a license for this purpose. The Planning function will also be performed by SO as per provisions of the Act. The Market Operator will be a separate independent entity.

7.4. Alternative Options and its pre-conditions

An alternative option is to establish and ISO model at the start of CTBCM in a manner similar to those of North American Markets where the ISO model has been successfully implemented as these markets are based on centralized economic dispatch.

In case of Pakistan, as the sector is already de-bundled, and these different functions are performed by different entities. For the start of the market, it will be a distraction to change the institutional structure first and then implement the market. The goal for Pakistan could be the establishment of an ISO model where different inter-related functions are housed under one company to enhance coordinated planning and execution, that suits how the market is organized in Pakistan. However, this shall not be made a precondition to start CTBCM, and the market shall start with the current institutional structure in which different functions are performed by different entities

8. Types of Consumers

Electricity sector consists of various players such as generation, transmission and distribution companies, traders, suppliers and consumers. Consumers are players that purchase electricity for self-consumption and not for resale. Consumers are of various categories such as domestic, commercial, agriculture or industrial units. From consumption point of view, the consumers can be small consuming minor quantities (few kWhrs) such as household consumers or large consuming bulk quantities (several MWhrs) such as an industrial unit of car manufacturing etc. The large consumers are also called bulk power consumers (BPCs). From the power procurement and markets point of view, the consumers can be categorized as eligible and non-eligible consumers as defined below.

8.1. Eligible and Non-Eligible Consumers

Eligible consumer is defined as a consumer that has the choice to change their supplier of electric power. In Pakistan, this choice is only given to Bulk Power Consumers (BPCs) as per provision of NEPRA Act. So currently in Pakistan, only BPCs are Eligible Consumers.

Non eligible consumer is defined as a person/entity purchase electricity for his own use and such person or entity have no option to purchase electricity from any supplier on his negotiated prices or to change the supplier. The price/rate of electricity they are consuming is fully regulated and approved by the regulator. Such consumers are also called as captive consumers. In Pakistan thought there is provision for BPCs but operationally no BPC is availing this. And the main reason for this is the existing single buyer model. So currently all the consumers are actually non-eligible consumers.

8.2. Eligible Consumers threshold

In global electricity market, a threshold is being set (related to peak demand or energy consumption) for consumers in order to grant them the choice to participate in the wholesale market and have a choice buy electricity from any other supplier than the incumbent DISCO. This threshold plays very important role in order to control the pace of market development so that the incumbent DISCOs are able to recover any of their stranded costs during a transition period. Normally, it is set very high at start of the market to limit the number of market participants and gradually reduced as the infrastructure is being developed.

8.3. Eligible Consumer Threshold in CTBCM

Consistent with the provisions of NEPRA Act, the eligibility threshold in CTBCM is set at the level of Bulk Power Consumers (BPCs) as defined in the Act. As per the standard practice in many wholesale Markets the threshold is selected, as soon as the market competitiveness increases, and multiple suppliers come into market, this threshold will gradually be decreased by NEPRA, and retail competition will be introduced.

Bulk Power Consumers (eligible consumers) can freely negotiate contract conditions and prices with generators or Competitive Suppliers. Alternatively, a BPC can agree a retail supply contract with a Competitive Supplier, where the contract commits the supplier to buying at best possible prices, through competition. In Pakistan, a supplier regime will be introduced granting supplier licenses to qualified companies which should supply only to BPCs. Once the wholesale market is matured, this choice of suppliers will be gradually extended to all other consumers as well, and hence full retail competition will be introduced

This approach as adopted in many developing countries while establishing wholesale electricity markets will ensure gradual transitions towards retail competition without any abrupt changes which could endanger the development of the market.

8.4. Alternative choices and its pre-condition

Instead of planning the gradual transition towards a retail market, an alternative option was to implement the retail market at once by making all consumers eligible from day one of implementation of CTBCM. However, this transition needs to be planned carefully as global experience shows that the major benefits of introducing competition in electricity can be obtained at the wholesale level. Once the wholesale market is established and system are ready and tested, a retail competition can be gradually introduced. This approach is adopted in many developing countries wholesale markets like, Philippines, turkey, India, Brazil etc.

In Pakistan, considering the inflexible long-term contracts, the immediate implementation of the retail market and letting the consumers to leave the incumbent DISCOs will create a death spiral for the DISCOs increasing the costs for remaining consumers which will force them to leave as well. Therefore, it needs to be planned carefully and proper mechanisms shall be devised to provide the right signals for competition.

9. Types of Suppliers

Suppliers are participants that buy in the market to resell electricity to consumers. They take the capacity obligations of their consumers and cover them with firm capacity contracts. In the United States, the expression used for a supplier that sells to consumers or to electricity utilities that supply consumers is Load Serving Entity (LSE).

Suppliers will be licensed entities in CTBCM as per provisions of the NEPRA Act. These suppliers can be broadly categorized as following:

9.1. Base Supplier

Base Suppliers are the regulated rate providers. They are allowed to sale electricity at regulated rates to end consumers in their respective service territory. These suppliers will also perform the function of Last Resort Supplier. They cannot negotiate tariff with consumers and must have to offer the approved regulated rates of electricity.

9.2. Competitive Supplier

Competitive Supplier are private Suppliers and they can freely negotiate Prices with consumers. Such suppliers are allowed to sale electricity only to eligible consumers. They can't sell electricity to any non-eligible consumer located in the service territory of a Base Supplier.

9.3. Suppliers in CTBCM

In CTBCM, there will be Competitive as well as Base Suppliers performing their respective functions as described below:

- **Role of Competitive Suppliers:** These are suppliers involved in supplying energy to those consumers which are given the possibility to choose their own suppliers. Such consumers are also called eligible consumers. In the context of NEPRA Act. currently the BPCs are the eligible consumers. The international experience shows that, at the initial stages of the market, a relatively strict criterion is established to qualify as eligible consumers, limiting the number of consumers that may exercise this possibility. However, as the market matures, appropriate metering systems are implemented and adequate processes are established, gradually more consumers are given the possibility to choose their supplier and, hence, larger retail competition is introduced.

  In the case of Pakistan, a supplier regime will be introduced granting supplier licenses to qualified companies which should supply only to BPCs. Once the wholesale market is matured, this choice of suppliers will be gradually extended to all other consumers as well, and hence full retail competition will be introduced. These suppliers will negotiate the price and conditions of the supply with their customers and such conditions and prices will not be determined by NEPRA. These suppliers can request a specific territory or can be granted a license to sell to eligible consumers across the country.

- **Role of Base Suppliers:** These will be licensed entities with specific territory specified in their respective licenses, which will be responsible to provide supply to all consumers located in such territory which require it (including those BPCs who are not getting supply from a Competitive Supplier). These suppliers will sell electricity at the regulated rates and can't bilaterally negotiate with any of their consumers or any other party that they are selling to. These suppliers will also be responsible to supply to those customers whose Competitive Supplier has defaulted, until they find a new supplier. In CTBCM, the suppliers of the incumbent DISCOs and KE will be assigned the functions of the last resort suppliers. An important requirement for the Base Supplier is to have a distribution license as well along with a Base Supplier license.

9.4. Alternative choices and its pre-conditions

Regarding the role of the Base Suppliers, an alternative option could be that these suppliers are also allowed to offer competitive rates to compete with other suppliers. Although some regulations permit that a single company can offer competitive rates and at the same time regulated ones, there are multiple reasons why a last resort supplier should not be allowed to offer both types of tariffs. Among them:

- Competitive supply is an activity at risk. That is, the supplier must sign contracts with generators and obtain customers to sell such energy. If the prices obtained for the generation are not attractive for the BPCs, the supplier may suffer the consequences. The last resort supplier, however, has a client base which pays the tariffs determined by NEPRA. Therefore, in principle, it may offer more competitive prices since a significant part of its revenues come from regulated customers. The risk profile is totally different that the profile that a competitive supplier should afford.
- The LRS will offer two different tariffs for the same product. Obviously, the BPC will select the most convenient. So, the tariff determination made by NEPRA is jeopardized for such customers.
- The end-user tariffs, determined by NEPRA, considers all the costs supported by the DISCOs (including the procurement of power) and divide them by the forecasted demand. The LRS may offer a very low rate to a BPC being sure that, later on, the differences in the revenues obtained would be compensated by the regulator in the next tariff review. [This problem arises because the regulator determines the tariffs using the actual costs of the DISCO, and in particular the cost of power procurement. In the jurisdictions in which it is allowed that the same supplier offer regulated and competitive rates (i.e. Turkey), the regulated end-user tariffs (LR tariffs) are determined without taking into consideration the actual costs associated with power procurement. In Turkey, for example, the reference for these tariffs are the prices offered by EÜAS and the results on the day ahead market.
- Even more. As in Pakistan the end-user tariffs are the same for all DISCOs, if one of them is very active (and sells a lot of energy to BPCs at competitive rates) it will transfer the problem to the other DISCOs. This is totally unfair.
- Finally, for a regulator, it is much more complicated to evaluate the LRS costs if they conduct both quite different activities (one regulated and the other not)

One may argue that all of these problems are not unsolvable ones. But they make the regulatory tasks much more complex and with multiple possibilities of arbitrage. Therefore, most countries has "solved" the problem not permitting the LRS (Base Suppliers in our case) to offer competitive prices. If a company wants to offer both products, simply creates a holding which will control two separate companies.