Price Discovery Mechanism at 'PRATYAY' platform

Price discovery mechanism applicable for Contracts transacted at PXIL

Regulation 31 (8) of CERC (Power Market) Regulations, 2021 prescribes Power exchange to maintain a document on its website providing information of Price discovery mechanism applicable for all types of Contracts.

> *"Regulations 31 (8)*
>
> *Power Exchange shall create and maintain a document on its website providing detailed description of the algorithm used for price discovery for all type of contracts. The description shall include bid types, details of how the algorithm results in maximisation of economic surplus taking into account various bid types and congestion in transmission corridor, which shall be updated with every new version of the price discovery algorithm"*

The Hon'ble Commission has approved three types of price discovery mechanism for Contracts available on PXIL platform i.e. Uniform Market Clearing Price, Discriminatory Pricing and Continuous matching mechanism.

The details of all the three types of Price discovery mechanism are as under:

I. Double Sided closed bid Auction with uniform Market Clearing Price

1. Types of Orders

1.1. Normal Order – A Normal order contains price-quantity pair(s), where a Buyer is willing to buy all quantity upto the value specified at or below the quoted price and Seller is willing to sell all quantity upto the value specified at or above the quoted price.

1.2. Block Order – Exchange may allow different types of Block Orders as felt necessary from time to time like:

1.2.1. "All Or None" type of Block Orders contains price-quantity pair(s) for a set of contiguous time slots and shall be considered indivisible whereby they shall either be included or excluded in totality based on the selection criteria of meeting the clearing prices on the average in their respective bid zone.

Example:

a. Case 1 – Adequate Quantity and Price in all Time Slots

	Type of Order	Time Slots	01	02	03	04	05	06	07	08
Sell	**Block Order**	**Price**	4							
		Qty	50 MW							
Buy	**Normal Orders**	**Price**	6	6	5	5	6	5	4	5
		Qty	50	50	70	50	60	50	50	60

(Note: Price is in Rs. / kWh and Quantity in MW)

In the above, since there are corresponding Buy Orders in all the time slots, at a better Average Price than the Sell Block Order, the Sale Block Order gets cleared fully.

b. Inadequate Quantity in some Time Slots

	Type of Order	Time Slots	01	02	03	04	05	06	07	08
Sell	**Block Order**	**Price**	4							
		Qty	50 MW							
Buy	**Normal Orders**	**Price**	6	5	4	5	5	5	4	5
		Qty	50	20	70	30	60	50	30	10

(Note: Price is in Rs. / kWh and Quantity in MW)

In the above case, due to inadequate corresponding buy quantities in Time Slots 02, 04, 07 and 08, the Sale Block Order does not get cleared for any hour.

c. Average Price Criteria

	Type of Order	Time Slots	01	02	03	04	05	06	07	08
Sell	**Block Order**	**Price**	4							
		Qty	50 MW							
Buy	**Normal Orders**	**Price**	5	2	4	3	4.5	4	2.25	2.5
		Qty	50	60	60	50	50	50	50	55

(Note: Price is in Rs. / kWh and Quantity in MW)

In the above case, due to inadequate corresponding buy prices in Time Slots 02, 04,

07 and 08, the Average Price criteria for the Block Order is not met and therefore the Sale Block Order does not get cleared for any hour.

1.2.2. Any other type of Block Orders

1.2.3. Buyer / Seller may place multiple block orders, each of which can be up to a maximum quantum of 25 MW. The Exchange may modify the quantity limit of each block order through further circular.

1.3. Any other Orders as may be notified from time to time

2. Order Matching Rules: Without prejudice to the generality of the above, the Order matching rules will have the following features

2.1. **All purchase Orders** can have only non-increasing quantity for every increase in the Order price, and every sale Order will have only non-decreasing quantity for every increase in the Order price.

2.2. The Purchase or Sale Quantity would be considered to remain constant between consecutive price points as may be specified by an entity. Thus, for any order, the quoted volume would be held constant between one price point to the next quoted price point.

To clarify further,

2.2.1. If a Buyer Orders as follows:

Price (Rs. / kWh)	Quantity (in MW)
1	100
3	40
5	20

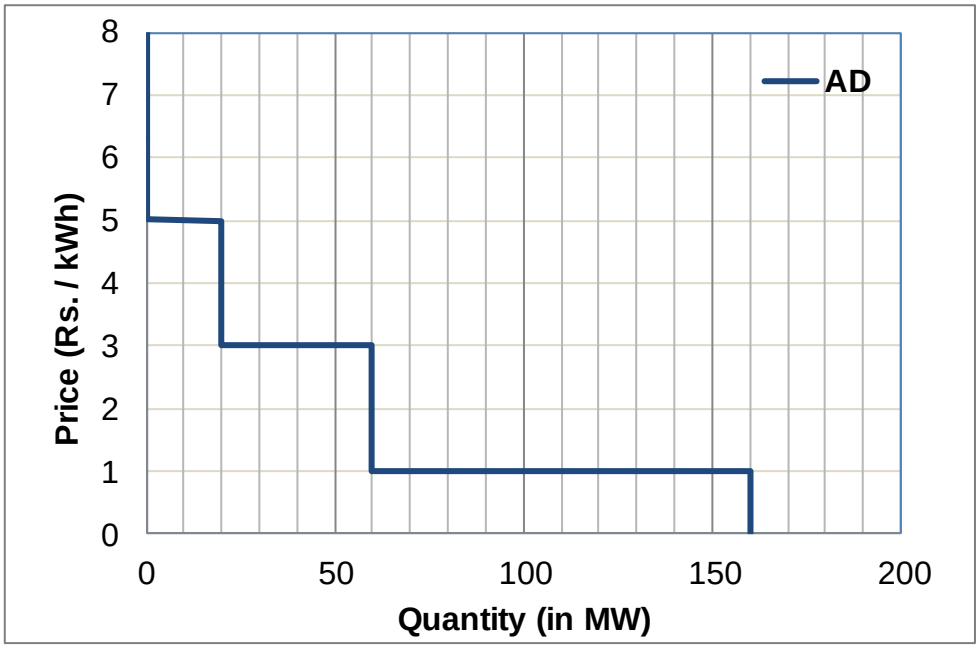
The above Order implies the following:

Buyer will buy quantity upto 20 MW if MCP is Rs. 5 per kWh or below

Buyer will buy quantity upto 60 MW (i.e. 40+20 = 60 MW and not 40 MW) if MCP is Rs. 3 per kWh or below

Buyer will buy quantity upto 160 MW (i.e. 20+40+100 = 160 MW and not 100 MW) if MCP is Rs. 1 per kWh or below

The Buyer's order curve would be as below:



2.2.2. If a Seller orders as follows:

Price (Rs. / kWh)	Quantity (in MW)
5	100
3	40
2	20

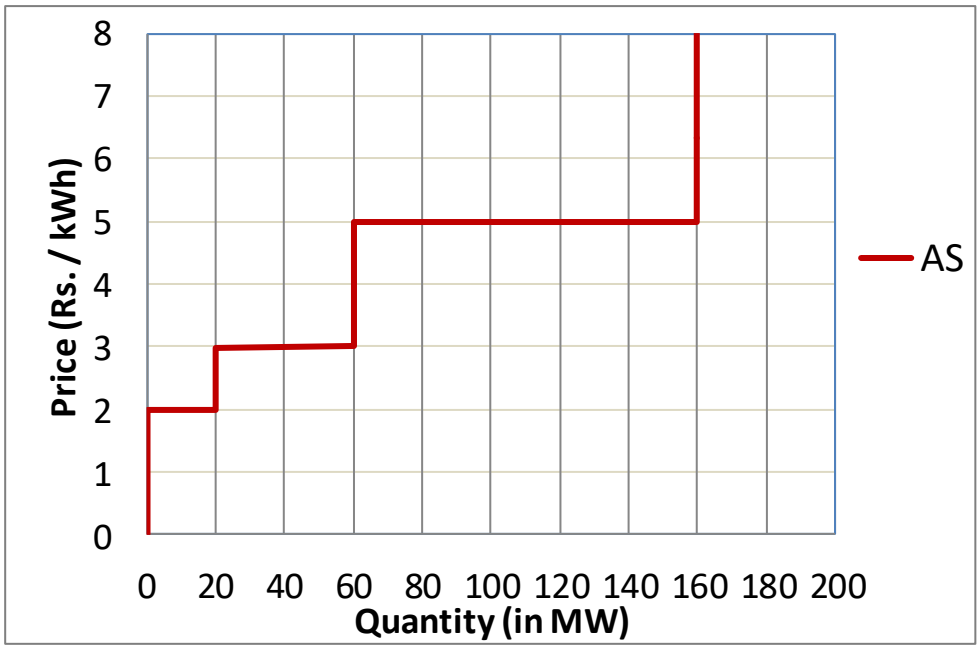
The above Order implies the following:

Seller will sell quantity upto 20 MW if MCP is Rs. 2 per KWh or above but less than Rs. 3 per kWh

Seller will sell quantity upto 60 MW (i.e. 20 + 40 = 60 MW and not 40 MW) if MCP is Rs. 3 per kWh or above but less than Rs. 5 per kWh

Seller will sell quantity upto 160 MW (i.e. 20+40+100 = 160 MW and not 100 MW) if MCP is Rs. 5 per kWh or above

The Seller's order curve would be as below:



3. Matching Process

3.1. In the initial instance, all the buy and sell orders are aggregated at each price tick to arrive at the Aggregate Demand (AD) and Aggregate Supply (AS) curves respectively for each time slot.

3.2. The intersection of AD and AS curves is determined to arrive at the Market Clearing Price and Market Clearing Volume for each time slot.

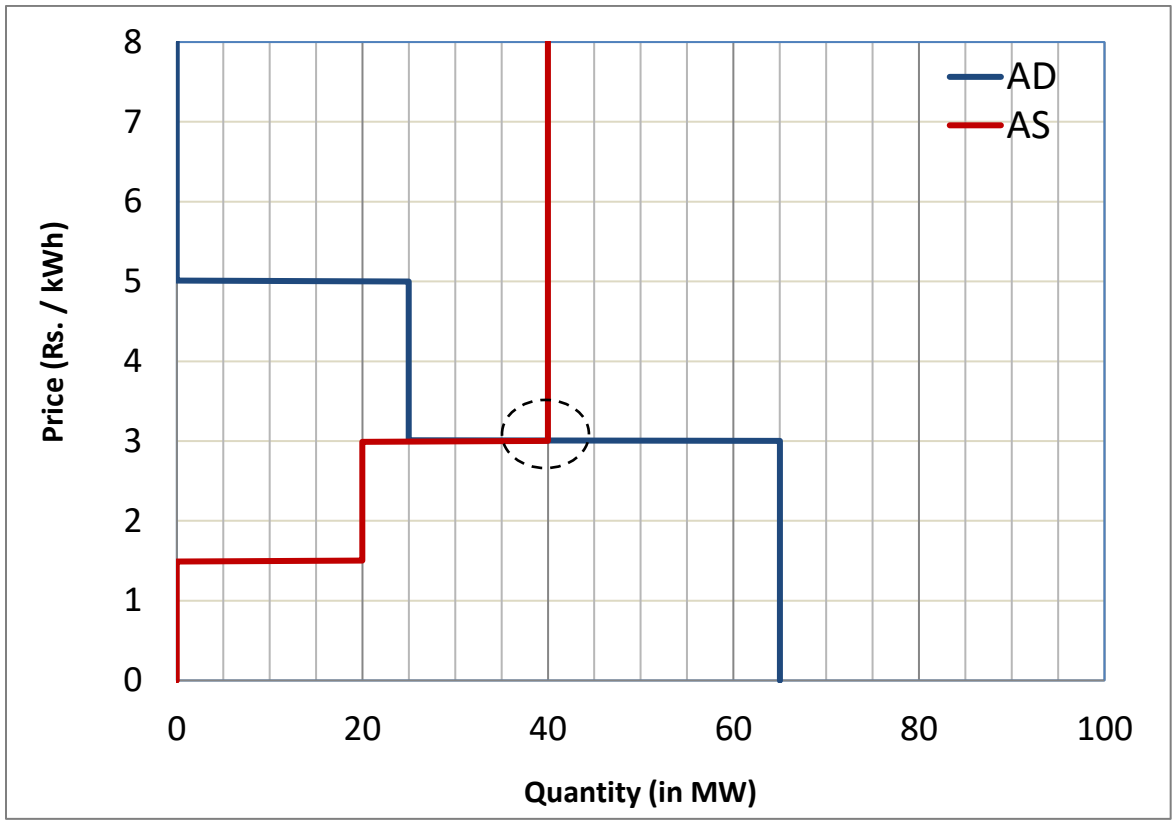
3.3. In case of overlapping Supply and Demand Curves, the following would apply:

3.3.1. In case of overlapping Supply and Demand curves for multiple executable volume points, the highest volume point will be Market Clearing Volume. This follows the principle of Maximum Executable Volume.

E.g.: Orders

Participant	Price (Rs. / kWh)	Qty (MW)	Time
Buyer 1	5	25	11:00
Buyer 2	3	40	11:10
Seller 1	3	20	11:20
Seller 2	1.5	20	11:30

The AD-AS curve for the above is as under



MCP = Rs. 3 per kWh and MCV = 40 MW

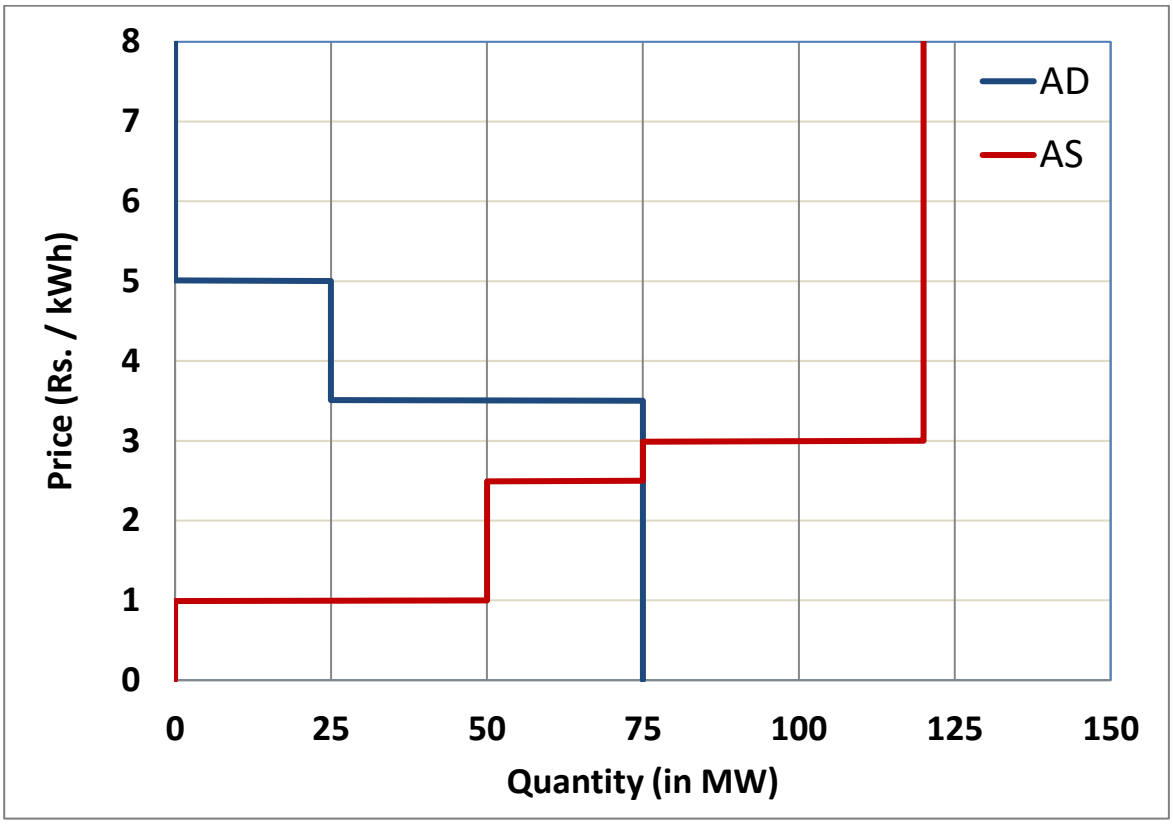
3.3.2. In case of overlapping Supply and Demand curves for multiple price ticks for the same executable volume, the clearing price would be determined based on social welfare maximisation, where in one of the feasible solutions shall be the Average of the lowest price tick and the highest price tick within which such overlap was applicable, as the Market Clearing Price.

E.g.: Exact Overlapping at multiple price points for Demand and Supply Curves

Participant	Price (Rs. / kWh)	Qty (MW)	Time
Buyer 1	3.5	10	10:10
Buyer 2	5	25	10:50
Buyer 3	3.5	15	10:55
Buyer 4	3.5	25	10:59
Seller 1	2.5	25	11:10
Seller 2	1.0	50	11:50

Participant	Price (Rs. / kWh)	Qty (MW)	Time
Seller 3	3.0	45	11.55

The AS – AD curve is as under:



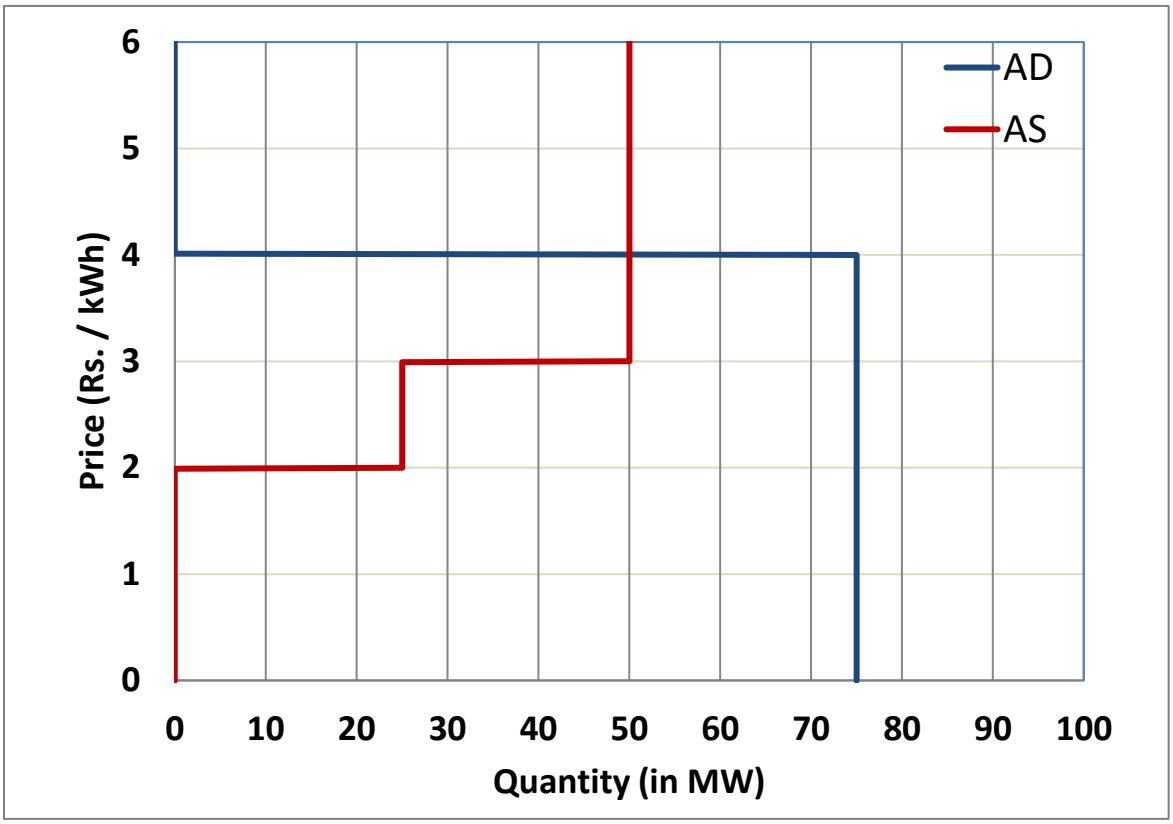
MCP = Rs. 3 per kWh (mid-point of 3.5 & 2.5) and MCV = 75 MW

3.4. In case of Over-Supply or Over-Demand, the AD and AS curves would be drawn as follows:

3.4.1. Over-Demand Orders

Participant	Price (Rs. / kWh)	Qty (MW)	Time
Buyer 1	4	25	10:10
Buyer 2	4	50	10:50
Seller 1	2	25	11:00
Seller 2	3	25	11:10

The AS – AD curve is as under:

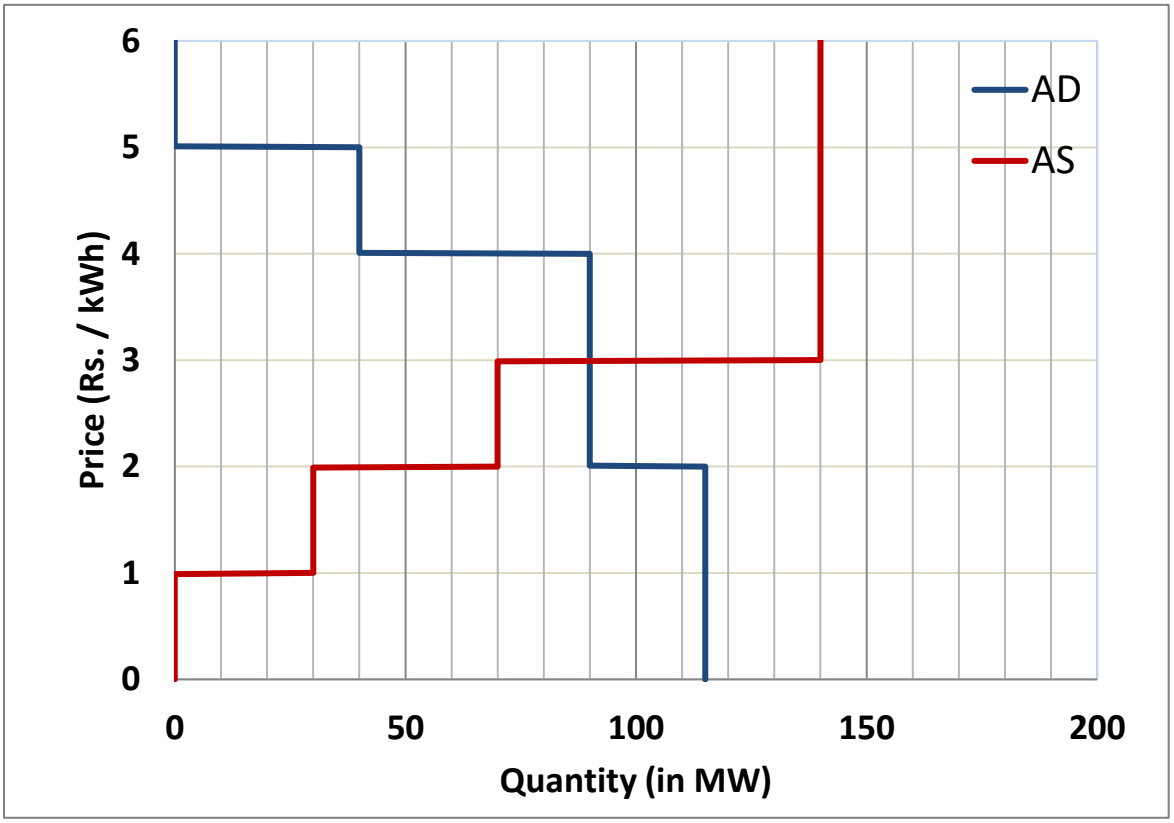


MCP = Rs. 4 per kWh and MCV = 50 MW

3.4.2. Over-Supply Orders

Participant	Price (Rs. / kWh)	Qty (MW)	Time
Buyer 1	2	25	10:10
Buyer 2	4	50	10:30
Buyer 3	5	40	10:50
Seller 1	1	30	10:20
Seller 2	2	40	10:40
Seller 3	3	70	11:10

The AS – AD curve is as under:



MCP = Rs. 3 per kWh and MCV = 90 MW

3.5. All the Sell Orders which have Price less than or equal to Market Clearing Price and all the Buy Orders which have Price more than or equal to Market Clearing Price qualify for matching.

3.6. All the Block orders would then be checked to see if the same can be included in all the hours in case the Average of MCP across the hours for which block order exist, fulfills the price of the block order.

3.7. Across all the time slots, the Block orders that are included as per step 4.6 above are traded first along with Normal orders which qualify both the price and volume criteria

3.8. In case of several equally placed orders, selection would be based on time precedence of the submitted orders. Order preference based on time precedence, in case of equally placed orders, shall be undertaken only for Block Orders. The order of priority is as below:

3.8.1. Price – Best quoted price shall be given highest preference

3.8.2. Quantity – Among equally priced orders, that block order which

maximizes the executable volume is given higher preference

3.8.3. Time – Among equally priced orders with equal volume, the order submitted earlier would be given higher preference

3.9. Price Rounding off would be to the nearest defined price tick (as given in the Contract Specifications)

3.10. In some cases, an order may be rejected despite appearing to be a valid order on the basis of price. This happens in a situation where inclusion of such an order might result in change in MCP in an adverse direction or block orders getting unduly rejected. The reason for rejection is that in case if such order is accepted, the average price of market changes in such a way that the order is no longer justified to be in. This may be both due to price as well as volume harmonizing. Such orders are termed as paradoxically rejected orders.

3.11. In case of identification of a congested zone, the Market is split into multiple regions as per the congested corridor

3.12. For each Region the MCP and MCV is generated as per the above steps

3.13. The electricity flow from the Surplus Region is flown through the Congested corridor (subject to the available transmission capacity on the congested corridor) to the Deficit Region and helps in balancing the surplus / deficit mismatch to the extent of the flow in accordance with the principles detailed in Section 6 - "Congestion Management – Market Splitting"

4. Congestion Management – Market Splitting

Congestion management on PXIL's system is handled through market splitting where the energy transaction and the associated transmission capacity between the bidding zones are handled concurrently.

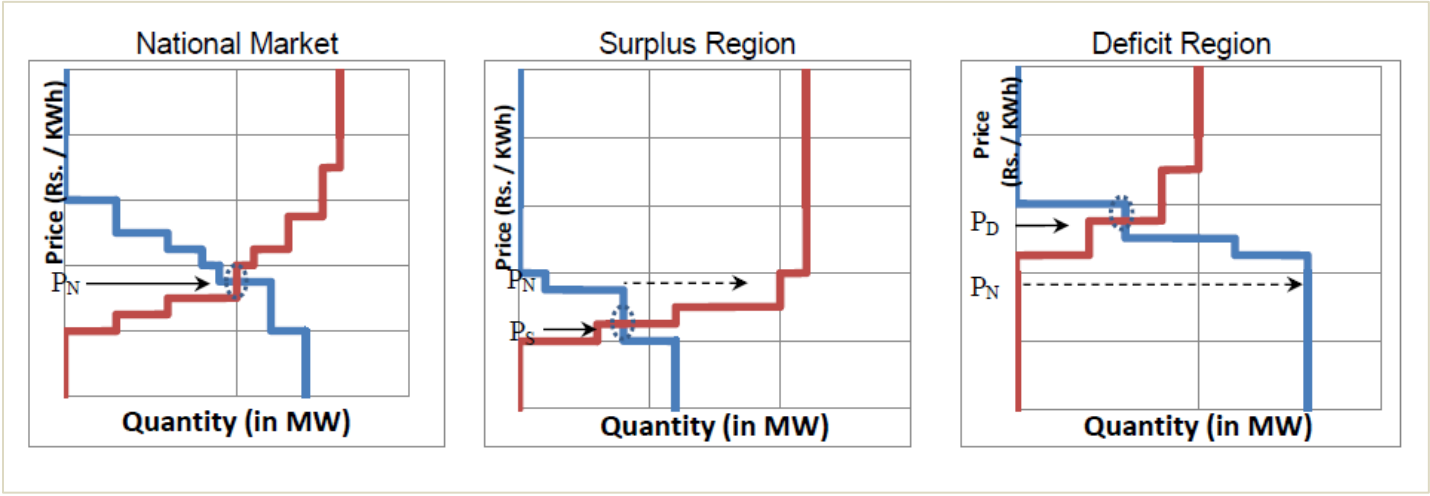
Once a congested zone is identified, based on unavailability of adequate transmission capacity to cater to the zone's demand, the congested zone is separated from the rest of the market.

In the first instance, both the markets are cleared as standalone markets and then the deficit area which has the higher price is flown as much electricity as the capacity of the congested line will allow from the surplus area with the lower price.

A generic situation is described below:

In the first step, the unconstrained situation is run where all buy and sell orders are aggregated to form the aggregate demand (AD) and aggregate supply (AS) curves. The market clearing price of this unconstrained market is the Unconstrained Market Clearing Price (denoted by P_N herein below)

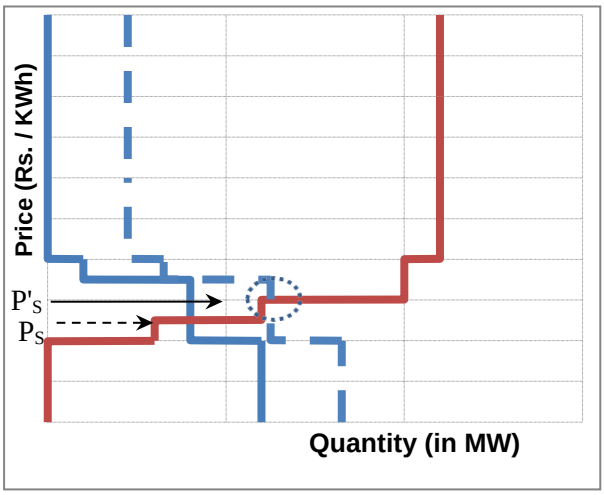
Once the congested zone is identified, the orders in the zones are taken separately and the price calculation done for each separately. The price curves for the two markets are as below:



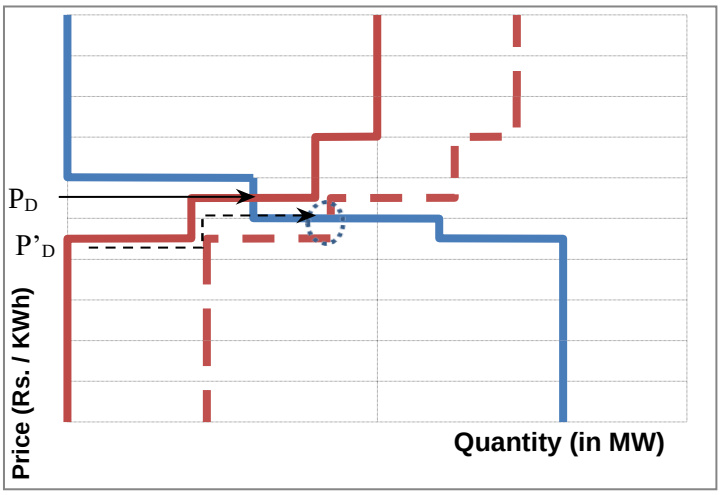
The MCP in the surplus region (denoted by PS hereinabove) being lower than PN indicates that extra sale capacity is available at PN and therefore it is a surplus market. Conversely the MCP in the deficit region (denoted by PD hereinabove) being higher than the PN indicates that extra demand is available at PN and therefore it is deficit market.

The available transmission capacity between the two markets is used such that electricity flow takes place from the surplus market to the deficit market. The available capacity is added as a demand in the surplus market and as supply in the deficit market. This results in the displacement of the price curves, as shown below.

Surplus Market



Deficit Market



The isolated market prices will now be at the intersection of the sale curve and displaced purchase curve in surplus market viz. P'_S and at the intersection of the displaced sale curve and the purchase curve in the deficit market viz. P'_D. As a result of the above action, the market prices in both the deficit as well as the surplus markets are evened out as much as possible and the transmission capacity is utilized so that the power flow exactly equals the available capacity.

The difference between the P'_D and P'_S, multiplied by the total electricity transfer carried out over the congested corridor, is the total congestion revenue.

II. Discriminatory Price –Double sided Auction

A. Without prejudice to the generality, the Order matching rules will have the following features

- Details relating to bid session for placement and modification of bids shall be specified by PXIL to its Members through Circular, which will be uploaded on PXIL website from time to time.
- Orders of any Buyer/Seller cannot be more than the NoC quantum specified by SLDC for Bilateral transaction
- Lowest priced Offer from Sell shall be matched with highest price bid from Buy
- In case of same Price, the participant offering highest quantum will be given preference
- In case of same Price and same quantity offered by more than one Seller or Buyer the Orders will be matched on time priority for Weekly Contracts

B. Sellers and Buyers are allowed to quote the "Minimum Acceptable Quantity" for Weekly Contracts

- Exchange would define Minimum Acceptable Quantity (MAQ) from time to time. The MAQ would either be specific values in MW, e.g., 1 MW, 5 MW etc. or would be a percentage of the Bid or any other methodology as would be prescribed by Exchange from time to time. The values would be determined on the basis of economic despatch even if only the MAQ is despatched for a Seller or Buyer. Members would be allowed to put a MAQ with every bid. The MAQ will define what quantity should be matched as the lowest denomination.
- A bid of 50 MW with 5 MW as MAQ will mean that the Member intends to buy/sell minimum 5 MW and any trade less than 5 MW will not be accepted. All bilateral trades (between any one buyer and any one seller) would be matched based on the MAQ. In case trades get matched between a buyer and seller whose MAQ has already been matched then Seller or Buyer can be matched for any quantity above that in volume steps of 0.01 MW.
- Therefore, if Buyer A (who has 50 MW Bid with 5 MW MAQ) is matched with Seller B (who also has 50 MW Bid with 5 MW MAQ) for 10 MW and if there is additional matching possible for 2 MW then PXIL system would allow to match and the final Trade would be for 12 MW.

- However if Buyer A and Seller B are matched for 42 MW after consideration of the MAQs, and there is one more Seller C (that has 100 MW Bid with 10 MW MAQ) then, as the trade available is less than Seller C's MAQ the trade will not get executed because this will be a new bilateral trade

III. Continuous Trade Matching:

In trading session of products with Continuous Matching methodology, the participants shall submit Orders on a continuous basis during the trading period. The buyers and sellers Order will be matched on continuous basis with price-time priority.

Without prejudice to the generality of the above, in the Continuous Trading sessions, Buyers and Sellers will enter their Orders and the Orders will be matched as per the order type, price and time of Order.

1. Rules for Continuous Matching: Price Time priority

1.1. In the contracts with Continuous matching, if two Orders entered in the terminals are eligible for a match as per the matching rules, then matching will take place instantly

1.1.1. For order matching, the best buy order is the one with the highest price and the best sell order is the one with the lowest price.

1.1.2. The best buy order is matched with the best sell order for the same contract.

1.1.3. The Orders are matched based on price and time priority. In case of more than one Order having the same price, the Order submitted at the earliest will get the priority in matching.

1.1.4. An order may match partially with another order resulting in multiple trades.

1.1.5. Members can proactively enter orders in the system, which will be displayed in the system till the full quantity is matched by one or more of counter-orders and result into trade(s) or is cancelled by the member.

1.1.6. Alternatively, members may react to an order available in market watch and place orders. In a matched pair, the order lying

unmatched is considered 'passive' (the one which was entered earlier) and the order that came later is considered ‘active’.

2. Price matching (Traded Price):

2.1. Orders will always be matched at the passive order price.

2.1.1. This ensures that the orders with an earlier time stamping with same price get priority over the orders that come in later. The price of the first Order entered in the system will be considered as the traded price for the contract.

Illustration

Buy Order Qty (MW)	Buyer Order Price (Rs. / MWh)	Sell Order Qty (MW)	Sell Order Price (Rs. / MWh)
100	3,400	150	3,600
50	3,300	100	3,700
100	3,000	100	4,000
100	2,500	60	5,500
50	2,000	100	6,000

In the above, the 5 best buy and Sell Orders are given. However, none of the Orders can match as the best buy Order price is lower than the best Sell Order price. These Orders will remain open and passive.

When a new participant enters a Buy Order for quantity 100 MW at price Rs. 3,650 per MWh, this buy Order (active) shall match with the best passive Order i.e. at rate Rs. 3,600 per MWh and the matched quantity will be 100 MW. The Traded price shall be Rs. 3,600 per MWh.

3. Types of Orders

The Order types that will be available for the contracts shall be notified through circulars from time to time. Some of the Order Types that may be made available are as under:

3.1. **Normal Order:** A Normal order contains price-quantity pair(s) for a

contract, where a Buyer is willing to buy all quantity up to the value specified at or below the quoted price and Seller is willing to sell all quantity up to the value specified at or above the quoted price.

Example:

Contracts	Buy Order Qty (MW)	Buyer Order Price (Rs. / MWh)	Sell Order Qty (MW)	Sell Order Price (Rs. / MWh)
Contract 1	100	3,400	150	3,200

MCV:

The entire 100 MW would get cleared against the resting sell bid and hence MCV = 100 MW

MCP:

The clearing price would come out to be the resting order quoted price and hence

MCP = Rs. 3,200 per MWh

3.2. Fill and Kill (FAK) Order

FAK means that the quantity which can be matched against resting order according to the matching rules of the selected product shall be matched and balance shall be immediately cancelled. FAK type orders would never rest in the order book.

Example:

3.2.1. Entered FAK Sell quantity is more than Standing Buy order

Standing Limit order resting in system:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
Limit Order	Buy	100	2,000

FAK order is placed with below parameters:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
FAK	Sell	120	1,500

MCV is 100 MW, cancelled quantity is 20 MW and MCP is Rs. 2,000 per MWh

3.2.2. Entered FAK Sell quantity is equal to Standing Buy order

Standing Limit order resting in system:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
Limit Order	Buy	100	2,000

FAK order is placed with below parameters:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
FAK	Sell	90	1,500

MCV is 90 MW, cancelled quantity is 0 MW and MCP is Rs. 2,000 per MWh

3.2.3. Entered FAK Sell Order and no standing Buy order

FAK Order is placed with below parameters:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
FAK	Sell	120	2,000

MCV is 0 MW and cancelled quantity is 120 MW

3.2.4. Entered FAK Sell price is greater than standing Buyer Order

Standing limit Order resting in the system:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
Limit Order	Buy	100	2,000

FAK Order is placed with below parameters:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
FAK	Sell	120	2,500

MCV is 0 MW and cancelled quantity is 120 MW

3.3. **Fill Or Kill (FOK) Order**

FOK means that either the entire Order quantity shall be matched against resting Order according to the matching rules of the selected product or the Order shall be cancelled i.e., either the Order shall be matched fully or cancelled. FOK type

orders would also never rest in the Order book.

Illustrations:

3.3.1. Entered FOK Sell quantity is more than Standing Buy order

Standing Limit order resting in system:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
Limit Order	Buy	100	2,000

FOK order is placed with below parameters:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
FOK	Sell	120	1,500

MCV is 0 MW and cancelled quantity is 120 MW

3.3.2. Entered FOK Sell quantity is equal to standing Buy quantity

Standing Limit order resting in system:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
Limit Order	Buy	100	2,000

FOK order is placed with below parameters:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
FOK	Sell	100	1,500

MCV is 100 MW, cancelled quantity is 0 MW and MCP is Rs. 2,000 per MWh

3.3.3. FOK Sell quantity is less than standing Buy quantity

Standing Limit order resting in system:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
Limit Order	Buy	100	2,000

FOK order is placed with below parameters:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
FOK	Sell	90	1,500

MCV is 90 MW, cancelled quantity is 0 MW and MCP is Rs. 2,000 per MWh

3.3.4. FOK Sell quantity is less than standing Buy quantity

Standing Limit order resting in system:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
Limit Order	Buy	100	2,000

FOK order is placed with below parameters:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
FOK	Sell	90	1,500

MCV is 0 MW and cancelled quantity is 90 MW

3.3.5. FOK Sell price is greater than standing Buy quantity

Standing Limit order resting in system:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
Limit Order	Buy	100	2,000

FOK order is placed with below parameters:

Order type	Side	Quantity (MW)	Price (Rs. / MWh)
FOK	Sell	120	2,500

MCV is 0 MW and cancelled quantity is 120 MW.