Price Discovery Algorithm on Peer-to-peer Trading Platform

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This algorithm facilitates a price discovery on Peer-to-peer Trading Platform so that Prosumer and Consumer can maximize the <u>Buyer and Seller surplus</u>.

					wh To 12AM-1PM	
Bidding Form for Energ	y Sale/	Ene	rgy Purchase			
 Bidding For			Energy Sale			
 Customer ID			C0005			
 Yesterday Market Clearing Price			6.2	Rs./Kwh		
Select Time Block	Fr	om	7AM-8AM	То	12AM-1PM	
Kwh Offered			100	Kwh		
Offered Price in Rs/Kwh			7.2	Rs./Kwh		
Market clearing agreement:						
I here by agreed to Sale my Supply-Kwh at Market Clearing Price, if my Offered-price is grater than the Market Clearing Price.			Agreed			
 ** All gray coloured cells are drop down selectable fields.						

Figure 1 Bidding Form for Energy Seller (i.e. Prosumer)

Bidding form for Energy Seller will content:

- Selectable dropdown field for bidding purpose (i.e. Sale or Purchase)
- Customer ID
- Market clearing price in yesterday
- Selection field (FROM, FOR) and corresponding time Block.
- Selection field (TO, FOR) and corresponding time Block.
- Kwh Offered
- Offered price in Rs./Kwh
- Consent to be given at the time of bidding whether to trade on Market clearing agreement term, which may be Agreed/Not agreed.

Bidding For		Energy Purchae		
Customer ID		C0005		
Yesterday Market Clearing Price		6.2	Rs./Kwh	
Select Time Block	From	7AM-8AM	То	12AM-1PM
Kwh Offered		100	Kwh	
Offered Price in Rs/Kwh		7.2	Rs./Kwh	
Market clearing agreement:				
I here by agreed to Purchase my Demand-Kwh at Market Clearing Price, if my Offered-price is Less than the Market Clearing Price.		Not-Agreed		

Figure 2: Purchase Bid Submission form for Consumer

After submission of bid following steps are to be repeated for each time block:

Step-1: Arrange Purchase Bid, order by higher to lower, as per offered price.

Step-1 : Arr	D-1 : Arrange Purchase Bid higher to lower as per offered price.Consumer Bid (Demand)NumersCurrent Electricity Grid PriceConsumer Offered PriceConsumer Requir KwhConsent to trade at Clearing priceCumulative Demand kwh Clearing price87.75100Yes10087.6580No18087.5550Yes23087.5550Yes23087.270Yes35087.190Yes44086.75120Yes56086.550Yes510				
		Consumer Bio	l (Demand)		·
Consumers	Current Electricity Grid Price	Consumer Offered Price	Consumer Requir Kwh	Consent to trade at Market Clearing price	Cumulative Demand kwh
C1	8	7.75	100	Yes	100
C2	8	7.65	80	No	180
C3	8	7.55	50	Yes	230
C4	8	7.5	50	Yes	280
C5	8	7.2	70	Yes	350
C6	8	7.1	90	Yes	440
C7	8	6.75	120	Yes	560
C8	8	6.5	50	Yes	610
C9	8	6.11	100	Yes	710
C10	8	6	100	Yes	810
C11	8	5.4	130	Yes	940
C13	8	5.25	120	No	1060
C12	8	5.2	100	Yes	1160
C14	8	5	150	Yes	1310
		SUM=	1310		

Figure 3: Construction of Demand curve for a Time Block

Step-2: Arrange Supplier Bid, order by lower to higher, as per offered price.

		Supplie	er Bid		
Prosumer	Gross Meter Price	Supplier Offered Price	Supplier Offered Kwh	Consent to trade at Market Clearing price	Cumulative Supply kwh
P1	3.4	6	150	Yes	150
P2	3.4	6.1	100	Yes	250
P3	3.4	6.2	30	No	280
P4	3.4	6.25	130	Yes	410
P13	3.4	6.6	90	Yes	500
P5	3.4	6.75	100	Yes	600
P6	3.4	6.8	100	Yes	700
P7	3.4	7	100	No	800
P12	3.4	7.1	180	Yes	980
P8	3.4	7.2	50	Yes	1030
P11	3.4	7.2	120	Yes	1150
P9	3.4	7.3	40	Yes	1190
P10	3.4	7.5	80	Yes	1270

Figure 4 : Construction of Supply Curve for a Time Block

Step-3: Find Demand and Supply Curve and intersection of the two curves

Dema	and Curve	Supply (Curve
Consumer	Cumulative	Supplier Offered	Cumulative
Offered Price	Demand kwh	Price	Supply kwh
7.75	100	6	150
7.65	180	6.1	250
7.55	230	6.2	280
7.5	280	6.25	410
7.2	350	6.6	500
7.1	440	6.75	600
6.75	560	6.8	700
6.5	610	7	800
6.11	710	7.1	980
6	810	7.2	1030
5.4	940	7.2	1150
5.25	1060	7.3	1190
5.2	1160	7.5	1270
5	1310		

Figure 5: Demand & Supply Curve for a Time-Block



Intersection between Demand & Supply curve (assume curves are linear)

Figure 6: Market clearing price discovery for a Time Block

Here, Market clearing price discovered Rs. 6.6/Kwh

Step-4: Find Demand KWH, at market clearing price and arrange them in FIFO

- Excluding those who are not willing to purchase on market clearing price and market clearing price > Offered price
- Arrange Purchase Bid in FIFO

		Consumer Bid	l (Demand)			Consumer Bid (Demand) in FIFO					
Consumers	Current Electricity Grid Price	Consumer Offered Price	Consumer Requir Kwh	Consent to trade at Market Clearing price	Cumulative Demand kwh	Consumers	Current Electricity Grid Price	Consumer Offered Price	Consumer Requir Kwh	Consent to trade at Market Clearing price	Cumulative Demand kwh
1	8	7.75	100	Yes	100	C1	8	7.75	100	Yes	100
C2	8	7.65	80	No	180	C2	8	7.65	80	No	180
3	8	7.55	50	Yes	230	C3	8	7.55	50	Yes	230
04	8	7.5	50	Yes	280	C4	8	7.5	50	Yes	280
C5	8	7.2	70	Yes	350	C5	8	7.2	70	Yes	350
C6	8	7.1	90	Yes	440	C6	8	7.1	90	Yes	440
C7	8	6.75	120	Yes	560	C7	8	6.75	120	Yes	560
C8	8	6.5	50	Yes	610	C8	8	6.5	50	Yes	610
09	8	6.11	100	Yes	710	C9	8	6.11	100	Yes	710
C10	8	6	100	Yes	810	C10	8	6	100	Yes	810
.11	8	5.4	130	Yes	940	C11	8	5.4	130	Yes	940
C13	8	5.25	120	No	1060	C12	8	5.2	100	Yes	1040
12	8	5.2	100	Yes	1160	C14	8	5	150	Yes	1190
214	8	5	150	Yes	1310		TOTAL DE	MAND KWH =	1190		
		SUM=	1310								

Figure 7: Demand at Market Clearing Price for a Time Block

Step-5: Find Supply KWH, at market clearing price and arrange them in FIFO

• Excluding those who are not willing to sale on market clearing price and market clearing price < Offered price

		Supplie	er Bid					Supplier I	Bid in FIFO		
Prosumer	Gross Meter Price	Supplier Offered Price	Supplier Offered Kwh	Consent to trade at Market Clearing price	Cumulative Supply kwh	Prosumer	Gross Meter Price	Supplier Offered Price	Supplier Offered Kwh	Consent to trade at Market Clearing price	Cumulative Supply kwh
P1	3.4	6	150	Yes	150	P1	3.4	6	150	Yes	150
P2	3.4	6.1	100	Yes	250	P2	3.4	6.1	100	Yes	250
P3	3.4	6.2	30	No	280	P3	3.4	6.2	30	No	280
P4	3.4	6.25	130	Yes	410	P4	3.4	6.25	130	Yes	410
P13	3.4	6.6	90	Yes	500	P5	3.4	6.75	100	Yes	510
P5	3.4	6.75	100	Yes	600	P6	3.4	6.8	100	Yes	610
P6	3.4	6.8	100	Yes	700	P8	3.4	7.2	50	Yes	660
P7	3.4	7	100	No	800	P9	3.4	7.3	40	Yes	700
P12	3.4	7.1	180	Yes	980	P10	3.4	7.5	80	Yes	780
P8	3.4	7.2	50	Yes	1030	P11	3.4	7.2	120	Yes	900
P11	3.4	7.2	120	Yes	1150	P12	3.4	7.1	180	Yes	1080
P9	3.4	7.3	40	Yes	1190	P13	3.4	6.6	90	Yes	1170
P10	3.4	7.5	80	Yes	1270		TOTAL SU	JPPLY KWH =	1170		
		SUM=	1270								

• Arrang Selling Bid in FIFO

Figure 8: Supply at Market Clearing Price for a Time Block

Step-6: Allocate Purchase/Demand Bids

- If [Demand Kwh (i.e. 1190) > Supply Kwh (i.e.1170)] at market clearing price (i.e. Rs 6.6/Kwh), Release all Demand kwh as per Supplied kwh (i.e. 1170 kwh) in FIFO at market clearing price.
- If [Demand Kwh < Supply Kwh] at market clearing price, Release all Demand kwh at market clearing price.

	Step-6 : Sin	nce (Demand Kw	/h > Supply K	wh), Release a	all Demand k	wh as per Su	upplied	kwh (i.e. 1	170 kwh	ı) in FIFO	at market	clearing p	r
			Consumer B	id in FIFO				Bid Re	eased				
	Consumers	Current Electricity Grid Price	Consumer Offered Price	Consumer Requir Kwh	Consent to trade at Market Clearing price	Cumulative Demand kwh		Released Kwh	Price				
	C1	8	7.75	100	Yes	100		100	6.6				
	C2	8	7.65	80	No	180		80	6.6				
	C3	8	7.55	50	Yes	230		50	6.6				
	C4	8	7.5	50	Yes	280		50	6.6				
	C5	8	7.2	70	Yes	350		70	6.6				
ß	C6	8	7.1	90	Yes	440		90	6.6				
e E	C7	8	6.75	120	Yes	560		120	6.6				
ñ	C8	8	6.5	50	Yes	610		50	6.6				
	C9	8	6.11	100	Yes	710		100	6.6				
	C10	8	6	100	Yes	810		100	6.6				
	C11	8	5.4	130	Yes	940		130	6.6				
	C12	8	5.2	100	Yes	1040		100	6.6				
	C14	8	5	150	Yes	1190		130	6.6				
		TOTAL D	EMAND KWH =	1190				1170					

Figure 9: Allocation of Demand

Allocation could not be done to the purchaser, since:

-KWH is not available to sale.

-Allotment done as per FIFO.

Step-6: Allocate Supplier Bids

- If [Supply Kwh (i.e.1170) < Demand Kwh (i.e. 1190)] at market clearing price (i.e. Rs 6.6/Kwh), Release all supplier kwh at market clearing price.
- If [Supply Kwh > Demand Kwh] at market clearing price, Release Supplier kwh as per Demanded kwh in FIFO at market clearing price.

		Supplier Bi	id in FIFO			Bid Re	eased	
Prosumer	Gross Meter Price	Supplier Offered Price	Supplier Offered Kwh	Consent to trade at Market Clearing price	Cumulative Supply kwh	Released Kwh	Price	
P1	3.4	6	150	Yes	150	150	6.6	
P2	3.4	6.1	100	Yes	250	100	6.6	
P3	3.4	6.2	30	No	280	30	6.6	
P4	3.4	6.25	130	Yes	410	130	6.6	
P5	3.4	6.75	100	Yes	510	100	6.6	
P6	3.4	6.8	100	Yes	610	100	6.6	
P8	3.4	7.2	50	Yes	660	50	6.6	
P9	3.4	7.3	40	Yes	700	40	6.6	
P10	3.4	7.5	80	Yes	780	80	6.6	
P11	3.4	7.2	120	Yes	900	120	6.6	
P12	3.4	7.1	180	Yes	1080	180	6.6	
P13	3.4	6.6	90	Yes	1170	90	6.6	
	TOTAL	SUPPLY KWH =	1170			1170		

Figure 10: allocation of Supply

The above 6 price discovery processes will be run for each time block, i.e. for 24 Time blocks. Allocation will be done to Consumer and Prosumers, and a contract will be made for each allocation which may be kept for billing.