

Optimal Bidding strategy in South Region Day-ahead Market Model using New Aggregated Demand Model and Hybrid Technique

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ABSTRACT

In this paper a half breed calculation (ABC_PSO) comprising of Artificial Bee Colony (ABC) and Particle Swarm Optimization (PSO) in light of demonstrating for the ideal offering systems in an aggressive power force business sector is proposed. We set forward a novel enhanced strategy which enhances the Profit of the suppliers. In the aforementioned technique ideal using so as to offer parameters are controlled the two periods of the Artificial Bee Colony (ABC). From the streamlined parameters the definite arrangement is anticipated by utilizing third phase of the ABC calculation i.e scout honey bee. Here, the honey bee's populace speed and the position vector are enhanced by utilizing the method of PSO rather than Scout honey bee, to locate the precise offering parameters. The Indian Energy Exchange (IEX) hourly based burden request dataset is utilized for using so as to foresee the heap Artificial Neural Network (ANN) system. At long last the proposed system is executed in the MATLAB/simulink stage and viability is investigated by utilizing the correlation of distinctive procedures like Artificial Bee Colony (ABC) calculation, Particle Swarm Optimization (PSO) calculation, ABC_PSO. The aftereffects of examination exhibited the prevalence of the proposed approach and affirm its capability to take care of the issue.

Keywords

ABC, PSO, ANN, optimal bidding, electricity power market

1. INTRODUCTION

IN MANY nations everywhere throughout the world, the force business is moving towards a focused system and a business sector environment is supplanting the customary brought together operation approach. The fundamental goal of a power business sector is to diminish the expense of power through rivalry. The business sector environment normally comprises of a pool and a story to complete reciprocal contracts. Satisfactory new programming apparatuses are expected to bolster new exercises in the pool, for example, advancement based era schedulers and value offering instruments. The pool, or power trade (PX), is an e-business commercial center where producing organizations (GENCOs) submit supplier offers and their comparing costs and purchaser organizations (CONCOs) do likewise with interest offers. The business sector administrator (MO) utilizes a business sector clearing device to clear the business sector at consistently and these outcomes in a business sector clearing value (MCP) and the arrangement of acknowledged generation and utilization offers. From a pool point of view, a suitable business sector clearing device is a twofold closeout system [1]–[3]. Hourly barbers are performed each one in turn

and repair heuristics are utilized to make comes about in fact possible. Hourly conformity markets are likewise used to consider deviations and to repair infeasibilities. In this paper we proposed two systems for estimating burden utilizes Artificial Neural Network (ANN) and to streamline target capacity by utilizing ABC, PSO and ABC_PSO

2. PROBLEM FORMULATION

The power market structure containing number of sellers and large consumers are applying bidding model to maximize their profits and to minimize the associated risks. Instead of this the demand of the system must be satisfied. Suppliers should apply bid slightly higher values at their optimum production cost, but it depends on the market behaviors, competitors and technical constraints. In this proposed system

consider P_i number of generators and q number of large consumers, ISO controls the demand side bidding of the participants in the network. The sellers require bidding of a linear non decreasing supply curve and the large consumers should have non increasing demand curve respectively to a power exchange (PX). The optimum linear sellers curve and the linear large consumers curve are described in the following equations (1) and (2) respectively.

The following is a sellers curve

$$G_i(P_i) = a_i + b_i P_i \quad (1)$$

For large consumers linear demand curve is

$$W_j(L_j) = c_j - d_j L_j \quad (2)$$

Where, $i = 1, 2, \dots, K$ and $j = 1, 2, \dots, q$,

P_i is the real power output of the i^{th} generation unit, a_i and b_i is the bidding coefficients of the i^{th} seller, c_j and d_j is the bidding coefficients of the j^{th} large consumer and L_j is an active power load of the j^{th} large consumer,

while a_i, b_i, c_j and d_j are positive values. The power exchange system mainly considers the generation, demand, dispatch and schedule that meet the constraints to maximize profits. In addition, when the power generation sellers and large consumers bid linear supply and demand functions of the network constraints are ignored, and maximizing payoff leads to a uniform market clearing price for all suppliers and

consumers. Thus when only the constraints like, generation output, load flow and customer demand are considered, PX determines the set of generation outputs $P = (P_1, P_2, K, \dots, P_p)^T$ and a set of large consumer's demands $L = (L_1, L_2, K, \dots, L_q)^T$ by solving equations (3) to (7).

$$a_i + b_i P_i = R \quad (3)$$

$$c_j - d_j = R \quad (4)$$

$$\sum_{i=1}^p P_i = Q(R) + \sum_{j=1}^q L_j \quad (5)$$

Where, P_i is the active power output of the i^{th} generation unit, $Q(R)$ is the aggregate a pool load forecast, L_j is an active power load of the j^{th} large consumer. The consideration of the constraints is given below,

$$P_{\min,i} \leq P_i \leq P_{\max,i} \quad i = 1, 2, 3, \dots, p \quad (6)$$

$$L_{\min,j} \leq L_j \leq L_{\max,j} \quad j = 1, 2, 3, \dots, q \quad (7)$$

$P_{\min,i}$ & $P_{\max,i}$ are the generation output limits of the i^{th} seller, and $L_{\min,j}$ & $L_{\max,j}$ are the demand limits of the j^{th} large consumer. The value of $Q(R)$ is given by solving equations (3) to (5).

$$Q(R) = Q_o - KR \quad (8)$$

Where Q_o is constant number and K is a coefficient denoting price elasticity of the aggregate demand. If pool demand is largely inelastic, then $k=0$.

$$P_i = \frac{R - a_i}{b_i} \quad i = 1, 2, 3, \dots, p \quad (9)$$

$$L_j = \frac{c_j - R}{d_j} \quad i = 1, 2, 3, \dots, q \quad (10)$$

$$R = \frac{Q_o + \sum_{i=1}^p \frac{a_i}{b_i} + \sum_{j=1}^q \frac{c_j}{d_j}}{K + \sum_{i=1}^p \frac{1}{b_i} + \sum_{j=1}^q \frac{1}{d_j}} \quad (11)$$

Where, R is the market clearing price, the above equations (9), (10) and (11) violates the generation and consumer demand limits (6) and (7), it must be customized to accommodate these constraints. In a sealed bid auction based

power market, there is no need to solve the equations (6) and (7). The objective function 'F' is used for the Artificial Bee Colony Algorithm; here referred to as "ABC", depending on the objective function the best value can be calculated. The hybrid technique using Particle Swarm Optimization, here referred to as "PSO", at the third step of the ABC algorithm. The large consumer demand has been given by the Neural Network, here referred to as "NN". It is trained with the datasets of the generating units on the basis of the bus system. The detailed explanation of the proposed hybrid technique is given in the following section

The maximization of the objective function for building a bidding strategy can be described by the following equation.

$$\text{Max } F = F(a_i, b_i) = RP_i - C_i(P_i) \quad (12)$$

Where, $C_i(P_i) = e_i P_i + f_i P_i^2$ is the production cost function of the i^{th} supplier, e_i and f_i are the cost coefficients of the i^{th} supplier. The objective is to determine a_i and b_i so as to maximize $F(a_i, b_i)$, subject to the constraints (1) to (7). Similarly the consumers have the revenue function; the maximization of the objective for building a bidding strategy can be described by the following equation.

$$\text{Max } B = B(c_j, d_j) = B_j(L_j) - R_j L_j \quad (13)$$

Where, $B_j(L_j) = g_j L_j - h_j L_j^2$ is the demand function of the j^{th} large consumer, g_j and h_j are the demand coefficients of the j^{th} large consumer. The objective is to determine c_j and d_j so as to maximize $B(c_j, d_j)$ subject to the constraints (1) to (5).

The maximization of the Profit should provide the optimum bidding strategy of the power system.

3. FORMATION OF THE PROPOSED HYBRID METHOD

The proposed hybrid method is the combination of the ABC algorithm and the PSO method. This technique is used for the determination of the best values; it could be a optimal value. Here the ABC algorithm is used to determine the best values of the system; in this the third stage of the ABC is replaced by using the PSO method. The proposed method is implemented in two ways, i.e., demand prediction and the optimum bidding strategy determination. The first stage of the proposed method predict the demands of the system by using Neural Network (NN), thereby it aligns with the historical data i.e., the previous days demand. Then it produces the demand of the system. Later the next step is the determination of the best objective function of the system using the ABC and the PSO method. The proposed method demand prediction is given in the following section

3.1 Demand Prediction using Nn

Using Artificial Neural network has predicted the demand in the first stage of the proposed method. The NN consists of three layers like, input layer, hidden layer and output layer, which is aligned with the previous historical datasets. Here, we are training the ANN using the target power demand with the corresponding input time intervals of a day, i.e., IEX (Indian Energy Exchange) daily demand dataset is given in Appendix. The back propagation algorithm is utilized for the training process. Once the neural network training process is completed, the network is trained well for identifying power demand according to the input time interval. Based on the output of the network, the ABC_PSO algorithm optimizes the bidding strategy. The optimization of bidding strategy using the ABC_PSO algorithm is explained in the following section

3.2 Optimum Bidding Strategy Determination Using Hybrid Technique

Hybrid technique is the combination of the ABC algorithm and the PSO technique. The ABC algorithm is used in the best objective function solutions; the final stage of the ABC algorithm uses the PSO technique. Artificial Bee Colony (ABC) is one of the most recently defined algorithms by Dervish Karaboga in 2005, motivated by the intelligent behavior of honey bees. It is as simple as Particle Swarm Optimization (PSO) and Differential Evolution (DE) algorithms, and uses only common control parameters such as colony size and maximum cycle number. The ABC algorithm mainly considers the three processes of bees, like employee bee, onlooker bee and scout bee. The employee bee is searching best values of the given process, onlooker bee checks the conditions that produce the solutions for the process and finally if the results do not satisfy the constraints, it could be given to the scout bee. It is an optional process, if the second process doesn't satisfy the limits that are used to produce random solutions of the given process.

The proposed hybrid technique PSO is used as the random solution generation. The particle swarm optimization (PSO) algorithm was first presented by Dr. Kennedy and Dr. Eberhart, and is a random evolution method based on intelligent search of the group birds. It has quick convergence speed and optimal searching ability for solving large-scale optimization problems. Here it is used for the scout bee stage of the ABC algorithm and it is used to find the random generation of optimum objective function values. This value is used for the onlooker bee iterations. The procedure for the ABC algorithm and the PSO is given in the following section.

3.2 Procedure

Step 1: Initialize the population of the generating unit's solutions $M_{i,j}$.

Step 2: Evaluate the populations using the employee bee; it could select the best value for the next iteration. It is the best value, that satisfies the maximized objective function value, which is given by,

$$Max F = F(a_i, b_i) = RP_i - C_i(P_i)$$

Step 3: The best objective function values are denoted by $E_{i,j}$.

Step 4: Set the iteration count is one, i.e., cycle=1.

Step 5: Produce the new solutions for the problem (food positions) in the onlooker bee.

$$V_{i,j} = m_{i,j} + \Phi_{i,j}(m_{i,j} - m_{k,j})$$

Where, k is the solution the neighborhood of i and Φ is a random number in the range [-1,1], $V_{i,j}$ is the neighborhood solution of $M_{i,j}$.

Step 6: Apply the objective function for the new food positions or the new solutions, the selected best value depends on the following conditions.

If the neighborhood solution $E_{i,j}$ is greater or most fit value compare to the initial $M_{i,j}$ value means, it has replaced the best objective function value.

If the neighborhood solution $E_{i,j}$ is not a fit value compared to the $M_{i,j}$ value means, it is to be replaced with the best objective value.

The best objective function values are not satisfied for the constraints means go to the next step.

Step 7: The scout bee has used the PSO technique, which generates the random solutions and it fixed the initial velocity is zero.

Step 8: Initialize the populations of the modified solutions $E_{i,j}$.

Step 9: Generate the random solutions, i.e., update the particle positions using the following equation.

$$V_{id}^{k+1} = wV_{id}^k + C_1 rand * (Pbest_{id} - S_{id}^k) + C_2 rand * (Gbest_{id} - S_{id}^k) \quad (14)$$

Current position can be modified by

$$S_{id}^k = S_{id}^k + V_{id}^{k+1}, i = 1, 2, \dots, n \text{ and } d = 1, 2, \dots, m. \quad (15)$$

Where, S^k is the current searching point, S^{k+1} is modified searching point, V^k is the current velocity, V^{k+1} is modified velocity, n is the number of particles in a group, m is the number of members in a group, w_i is the weight function for the velocity of the agent i . The weight function is given in the equation.

$$w_i = w_{\max} - \frac{w_{\max} - w_{\min}}{F_{\max}} * F \quad (16)$$

Step 10: Then the value is given to the step 2, the process continues until the maximized value obtained.

Once the process has completed, the network is ready to produce the optimum bidding strategy of the system. The

performance of the all the three methods, the ABC technique and PSO are analyzed using the MATLAB platform. The corresponding results are tabulated and the graphical representation of the proposed system is given below.

4. EXPERIMENTAL RESULTS AND DISCUSSIONS

Table.1: Implementation parameters

Generators	Generation limits		Cost coefficients		
	Minimum	Maximum	a_i	b_i	c_i
G1	50	200	0	2.00	0.003
G2	20	80	0	1.75	0.017
G3	15	50	0	1.00	0.062
G4	10	35	0	3.25	0.008
G5	10	30	0	3.00	0.025
G6	12	40	0	3.00	0.025

The proposed hybrid method was implemented in MATLAB platform, mainly to increase the profit of the sellers, while satisfying the demands and also to minimize the associated risks of the system; this can be done by optimal bidding strategy. The demand prediction of the proposed method is done by the NN technique; this could produce the demand of the system using the historical data analysis. The proposed technique is the combination of the ABC and the PSO technique. The third stage of the ABC technique uses the PSO method; it is used for the random numbers of solution generation. The optimum bidding for every demand is calculated and the performance of each method is analyzed in this section. The standard IEEE 30 bus system optimum bidding strategy was determined by the various techniques like ABC technique, PSO method and the proposed methods are given in the following tables. The standard IEEE 30 bus system is given in the Appendix-1.

The figure in the Appendix illustrates tested IEEE 30 bus system structure, this system consists of six generators. The Forecasted Load evaluations for ABC technique, PSO method and Hybrid method is given in the following tables 2, 3, 4, 5, 6 and 7.

Table.2: Optimum bidding parameters with Profit using ABC

Time in hours	Generators values in MW						Load demand in MW	Profit	MCP
	G1	G2	G3	G4	G5	G6			
0.3	104	47	41	33	22	22	295.34	539.608	7.628
5.3	101	76	30	18	6	26	278.95	599.55	7.1

								9	6
									2
									8
10.3	96	66	43	22	19	38	241.04	593.287	7.449
15.3	56	80	45	32	28	38	235.08	426.673	7.699
20.3	109	52	41	32	30	19	318.42	668.888	7.449
24	109	68	50	32	14	27	285.82	707.414	7.449

Table.3: Optimum bidding parameters with Profit using PSO

Time in hours	Generators values in MW						Load demand in MW	Profit	MCP
	G1	G2	G3	G4	G5	G6			
0.3	102	65.5	35	33	25.75	28	295.34	568.11	7.838
5.3	50	30	27	13	26	12	278.95	155.50	7.978
10.3	54	42	32	20	14	13	241.047	220.06	7.978
15.3	87	79	38	21	23	39	235.08	558.26	7.628

20.3	97	78	34	25	23	25	318.42	58.561	7.628
24	130	74	50	17	17	28	285.82	85.628	7.628

Table.4: Optimum bidding parameters with Profit using ABC_PSO

Time in hours	Generators values in MW						Load demand in MW	Profit	MCP
	G1	G2	G3	G4	G5	G6			
0.3	96	49	40	30	13	39	295.34	487.996	7.69
5.3	111	61	50	23	22	25	278.95	594.855	7.69
10.3	119	64	30	14	16	39	241.047	709.719	7.69
15.3	135	45	27	19	22	33	235.08	917.291	7.44
20.3	115	80	48	20	16	35	318.42	740.553	7.69
24	134	60	48	27	28	13	285.82	849.528	7.69

Table.5: Optimum bidding parameters with Fuel cost using ABC

Time in hours	Generators values in MW						Load demand in MW	Fuel cost \$/hr	MCP
	G1	G2	G3	G4	G5	G6			
0.3	104	47	41	33	22	22	295.34	45.79	7.628
5.3	101	76	30	18	26	26	278.95	37.17	7.628

10.3	96	66	43	22	19	38	241.04	41.56	7.449
15.3	56	80	45	32	28	38	235.08	97.5	7.699
20.3	109	52	41	32	30	19	318.42	66.02	7.449
24	109	68	50	32	14	27	285.82	46.9	7.449

Table.6: Optimum bidding parameters with Fuel cost using PSO

Time in hours	Generators values in MW						Load demand in MW	Fuel cost \$/hr	MCP
	G1	G2	G3	G4	G5	G6			
0.3	102	65	33	33	25	28	295.34	53.95	7.838
5.3	50	30	27	13	26	12	278.95	23.52	7.978
10.3	54	42	32	20	14	13	241.047	23.56	7.978
15.3	87	79	38	21	23	39	235.08	71.91	7.628
20.3	97	78	34	25	23	25	318.42	82.22	7.628
24	130	74	50	17	17	28	285.82	58.22	7.628

Table.7: Optimum bidding parameters with Fuel cost using ABC_PSO

Time in hours	Generators values in MW						Load demand in MW	Fuel cost \$/hr	MCP
	G1	G2	G3	G4	G5	G6			
0.3	96	49	40	30	13	39	295.34	26.62	7.699
5.3	111	61	50	23	22	25	278.95	46.97	7.699
10.3	119	64	30	14	16	39	241.047	26.25	7.699
15.3	135	45	27	19	23	38	235.08	64.74	7.449
20.3	115	80	48	20	16	35	318.42	54.4	7.699
24	134	60	48	27	28	32	285.82	43.22	7.699

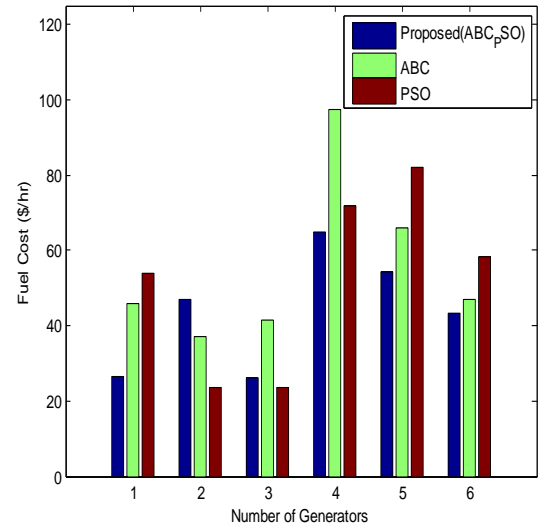


Fig 1: Fuel cost comparison using different approaches

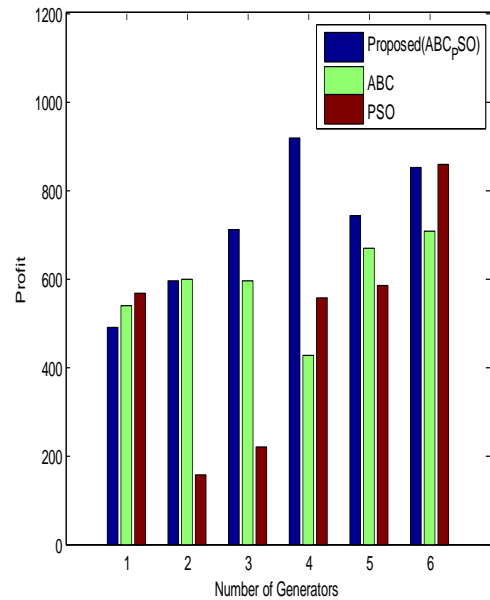


Fig 2: Profit comparison using different approaches

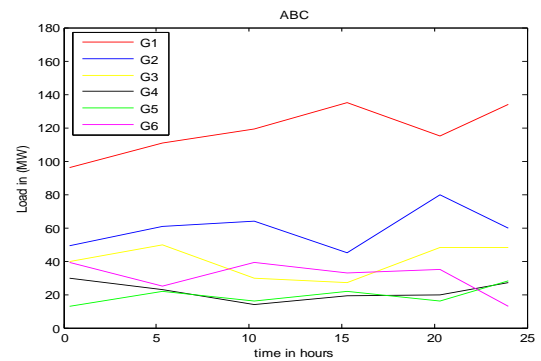


Fig 3: Load combination in ABC

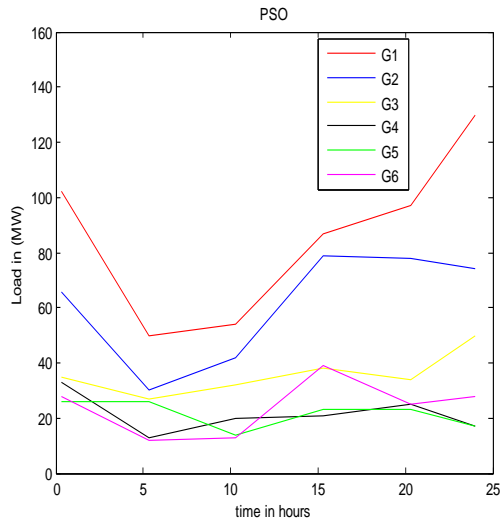


Fig 4: Load combination in PSO

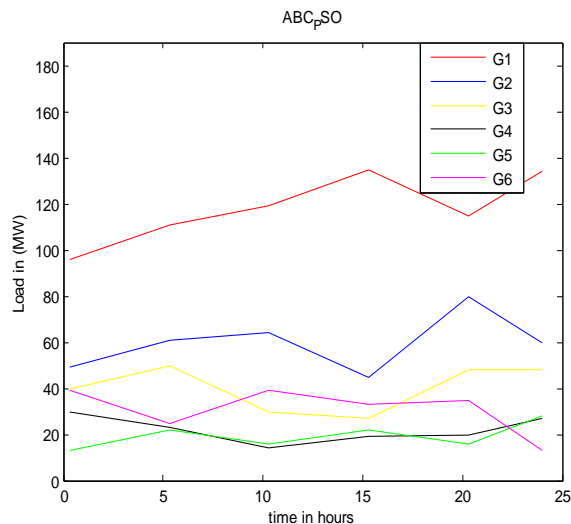


Fig 5: Load combination in Proposed (ABC_PSO) method

5. CONCLUSION

The development of optimal bidding strategies using the new aggregated demand model and the hybrid technique was discussed in this paper. Here the proposed method is used to maximize the profit of the suppliers, while satisfying the demand and to minimize the associated risks of the system. The hybrid model of the proposed system is the combination of the ABC algorithm and the PSO technique. It consists of employee bee, onlooker bee and scout bee. The final stage of the ABC algorithm i.e., scout bee, uses the PSO technique, which produces the random number of solutions of the problem. The output of the proposed system is the maximized Profit values. In this paper we have also analyzed the optimal bidding strategy output of the other techniques like ABC technique and PSO method separately. These three techniques for Profit results were tabulated as shown in Table.2, 3 and 4 and compared with the help of Graphs shown in Fig.2, and also Fuel cost comparison shown in Fig.1. The comparative results proved that the proposed technique contains the maximized Profit and minimum Fuel cost values which are competent over the other techniques.

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8. APPENDIX

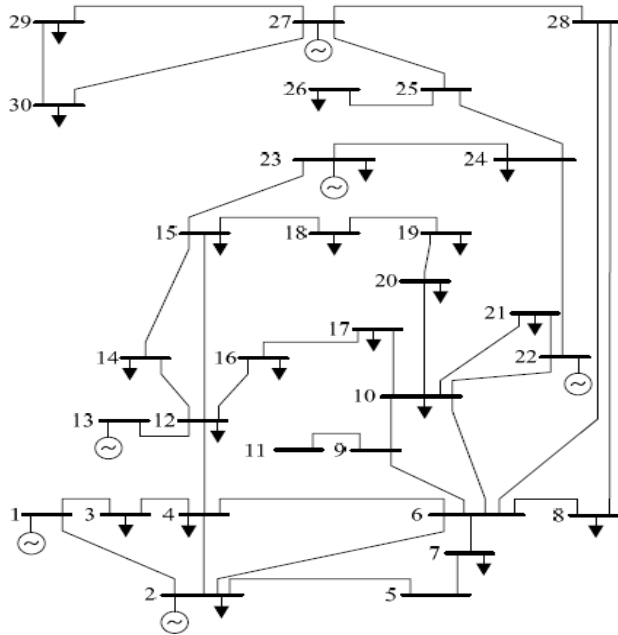


Fig: Structure of the IEEE 30 bus system

Table: IEX data

Date Hour Time Block	S1		
06-03-2014		Buy	Sell
1	00:00 - 00:15	295.37	145.40
	00:15 - 00:30	295.37	145.40
	00:30 - 00:45	295.37	145.40
	00:45 - 01:00	295.37	145.40
2	01:00 - 01:15	295.37	145.40
	01:15 - 01:30	295.37	145.40

	01:30 - 01:45	295.37	145.40
	01:45 - 02:00	295.37	145.40
3	02:00 - 02:15	295.37	145.40
	02:15 - 02:30	295.37	145.40
	02:30 - 02:45	295.37	145.40
	02:45 - 03:00	295.37	145.40
4	03:00 - 03:15	295.37	145.40
	03:15 - 03:30	295.37	145.40
	03:30 - 03:45	295.37	145.40
	03:45 - 04:00	295.37	145.40
5	04:00 - 04:15	295.37	145.40
	04:15 - 04:30	295.37	145.40
	04:30 - 04:45	295.37	145.40
	04:45 - 05:00	295.37	145.40
6	05:00 - 05:15	273.92	129.00
	05:15 - 05:30	273.92	129.00
	05:30 - 05:45	273.92	129.00
	05:45 - 06:00	273.88	129.00
7	06:00 - 06:15	232.57	132.90
	06:15 - 06:30	232.51	132.90
	06:30 - 06:45	232.53	132.90
	06:45 - 07:00	232.53	132.90
8	07:00 - 07:15	237.69	132.90
	07:15 -	237.69	132.90

	07:30		
	07:30 - 07:45	237.69	132.90
	07:45 - 08:00	237.69	132.90
9	08:00 - 08:15	237.60	132.90
	08:15 - 08:30	237.60	132.90
	08:30 - 08:45	237.60	132.90
	08:45 - 09:00	237.60	132.90
10	09:00 - 09:15	237.43	132.90
	09:15 - 09:30	237.42	132.90
	09:30 - 09:45	237.42	132.90
	09:45 - 10:00	237.43	132.90
11	10:00 - 10:15	241.97	137.00
	10:15 - 10:30	241.97	137.00
	10:30 - 10:45	241.97	137.00
	10:45 - 11:00	241.97	137.00
12	11:00 - 11:15	241.97	137.00
	11:15 - 11:30	241.97	137.00
	11:30 - 11:45	241.97	137.00
	11:45 - 12:00	241.97	137.00
13	12:00 - 12:15	240.97	136.00
	12:15 - 12:30	240.97	136.00
	12:30 - 12:45	240.97	136.00
	12:45 - 13:00	240.97	136.00
14	13:00 - 13:15	240.97	136.00

	13:15 - 13:30	240.97	136.00
	13:30 - 13:45	240.97	136.00
	13:45 - 14:00	240.97	136.00
15	14:00 - 14:15	240.97	136.00
	14:15 - 14:30	240.97	136.00
	14:30 - 14:45	240.97	136.00
	14:45 - 15:00	240.97	136.00
	15:00 - 15:15	240.97	136.00
16	15:15 - 15:30	240.97	136.00
	15:30 - 15:45	240.97	136.00
	15:45 - 16:00	240.97	136.00
	16:00 - 16:15	298.17	193.20
17	16:15 - 16:30	298.17	193.20
	16:30 - 16:45	298.17	193.20
	16:45 - 17:00	298.17	193.20
	17:00 - 17:15	298.17	193.20
18	17:15 - 17:30	298.17	193.20
	17:30 - 17:45	298.17	193.20
	17:45 - 18:00	298.17	193.20
	18:00 - 18:15	303.27	198.30
19	18:15 - 18:30	303.27	198.30
	18:30 - 18:45	303.27	198.30
	18:45 - 19:00	303.27	198.30
	19:00 -	263.22	192.90
20			

	19:15		
	19:15 - 19:30	266.00	192.90
	19:30 - 19:45	266.00	192.90
	19:45 - 20:00	270.20	192.90
21	20:00 - 20:15	319.40	189.40
	20:15 - 20:30	319.40	189.40
	20:30 - 20:45	336.45	189.40
	20:45 - 21:00	336.45	189.40
22	21:00 - 21:15	335.19	189.40
	21:15 - 21:30	335.19	189.40
	21:30 - 21:45	335.14	189.40
	2321:45 - 22:00	335.14	189.40
23	22:00 - 22:15	304.57	154.60
	22:15 - 22:30	304.57	154.60
	22:30 - 22:45	304.57	154.60
	22:45 - 23:00	304.57	154.60
24	23:00 - 23:15	304.57	154.60
	23:15 - 23:30	304.57	154.60
	23:30 - 23:45	304.57	154.60
	23:45 - 24:00	304.57	154.60