Modeling of Price Elasticity in Optimal Bidding Strategies by using Artificial Bee Colony (ABC)

V. Madhu Sudana Reddy, B. Subramanyam, M. Surya Kalavathi

Abstract: ***The electrical power business has the difficulties to build benefits and minimize their related dangers in the business framework. In this paper proposed a versatile system of Artificial Bee Colony (ABC) for streamline the target capacity and to improve results, with variety of value flexibility (Price elasticity). The Demand expectation is resolved with utilization of Neural Network. The proposed calculation is taking into account conduct of honey bee province of honey bees. The outcomes will clarify about business sector conduct amid flexibility and in-versatility. The execution of the proposed strategy could be actualized in the MATLAB.***

Keywords: ***ABC, Price Elasticity, ANN, optimal bidding, electricity power market***

I. INTRODUCTION

Late changes in the power business in a few nations have prompted a not so much managed but rather more aggressive vitality market. In this condition, expense is supplanted by cost and each GENCO will attempt to augment its own particular benefit. For a GENCO, it is basic to devise a decent offering methodology as per its Rivals' offering conduct, the model of interest and force framework working conditions.

By and large there are diverse systems for creating offering techniques in power markets. A non agreeable inadequate amusement was utilized in [1] to pick a GENCO's ideal offering method in deregulated force pools. Every pool member knew its own particular operation costs, yet didn't know his or her rival's expenses. The amusement with deficient data was changed into a diversion with complete, however blemished data and was illuminated utilizing the Nash harmony thought. In [2], contenders' offers were known and the creators performed an advancement methodology to discover the Nash harmony in view of the offer affectability of these contenders. In [3], the hereditary calculation was utilized to build up an offering method for the generator and merchant amid the exchanging procedure. In [4], the offering issue was demonstrated as a bi-level issue by accepting complete data on GENCO's adversaries. The paper [5] has contemplated the balance creation of the era organizations from diverse viewpoints utilizing the amusement model, concentrated on the effect of value tops on the power market. A technique to anticipate the ideal vitality generation of a force maker in an oligopoly power business sector is displayed.

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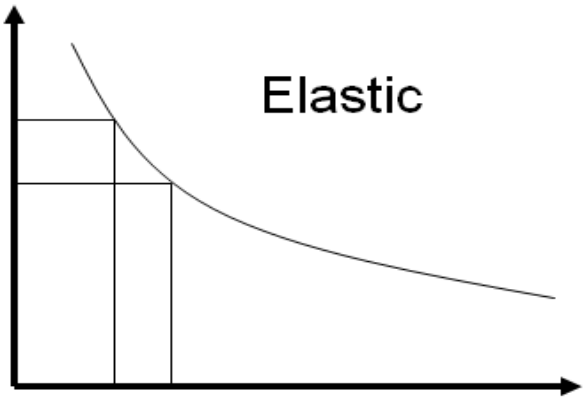
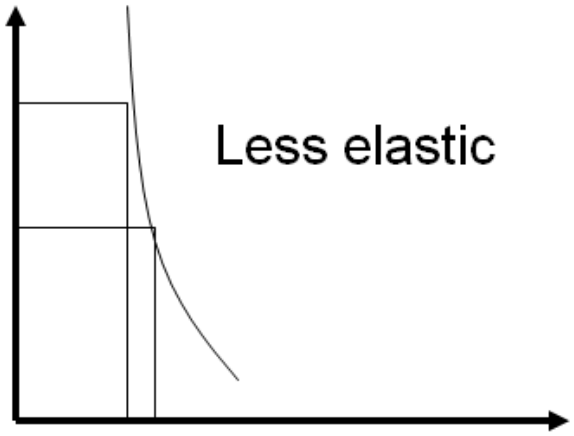
However this model doesn't consider the specialized requirements of the era organizations. In [6], A changed cournot, noncooperative diversion model is utilized to focus the normal harmony condition of the oligopoly power market. Every era organization knows the business sector opposite interest capacity and has a few evaluated expense capacities for every era unit of alternate organizations. Vitality request, and specifically power request in India has been developing at an exceptionally quick rate in the course of the most recent decade. Given, current patterns in populace development, industrialization, urbanization, modernization and salary development, power utilization is relied upon to increment generously in the coming decades too. This infers tremendous new money related speculations will be expected to take care of demand in this segment.

A few papers have been distributed that gauge the US private power interest utilizing total information at the state level in the course of the most recent 30 years. The lion's share of these studies has utilized board information and a dynamic conformity approach (Halvorsen (1975), Houthakker (1980), Baltagi et. Al. (2002), Kamerschen and Porter (2004), Bernstein and Griffin (2006) and Paul et al. (2009)), and use comparative controls in the right-hand side of the model. They vary from each other in the particular of the value variable, in the time period secured, and in the estimation technique. Most of the studies utilization normal vitality costs. With respect to time period secured, quite a bit of this before work depends on information from the 1970s and 1980s, and just two late studies (Bernstein and Griffin, 2006, and Paul et al., 2009) spread the years until 2006. As far as detail of the model and estimation strategy, most of the studies utilized settled or irregular impacts models, consolidated with a basic instrumental variable methodology. As indicated by financial hypothesis, power interest will fall as the vitality cost builds, holding every other element consistent. The customer's affectability to value changes can be measured by the coefficient of value flexibility: the rate change popular isolated by the rate change in cost. Value flexibility is a standardized measure (at the relative cost change) of the force of how the use of a decent (for this situation power) changes when its value changes by one percent. It encourages a correlation of the force of burden changes among clients, since the value change has been considered out; the value versatility is a relative measure of reaction.

The Price Elasticity idea has been incorporated with power market operation (wholesale and retail), auxiliary administration, purchaser request and advantage capacity, interest profile impromptu creation, unwavering quality study and era planning. Dominant parts of the studies which have evaluated value flexibility of power utilization are from the field of financial matters, vitality and open approach.

Such estimations of interest flexibilities are taking into account cross sectional information, time arrangement information, board information and time divisional business sector information. But few like who created equation to get self and cross flexibility and who alluded yearly report of Power Smart Pricing (PSP) [7], the vast majority of the studies managing burden/interest profile alteration have either "set/expected" the value versatility or "adjusted" the alluded qualities. Dependability of such adjustments /presumptions is restricted to the recreations just as the verifiable estimation gets to be fundamental regarding the matter of the strategy ad lib e.g. to have remedy in the power utilization design by changing the current levy component. This is a result of the way that the heap profiles of different buyer classes in diverse demographic ranges vary because of the monetary development, levy structure and accessibility of substitutes.





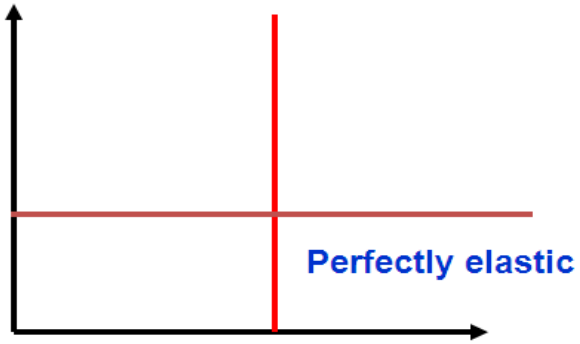


Fig 1: Properties of Price Elasticity (K)

II. ARTIFICIAL BEE COLONY (ABC)

Karaboga has spoken to Artificial Bee Colony (ABC) calculation, which is in view of the scrounging conduct of bumble bees [8]. ABC is a standout amongst the most as of late presented streamlining calculations. The past studies on ABC demonstrated that this calculation is productive and focused execution may be gotten by utilizing this calculation contrasted with alternate calculations in numerous designing fields.

In ABC, bumble bees are ordered into three gatherings to be specific utilized honey bees, spectator honey bees and scout honey bees. The quantities of utilized honey bees are equivalent to the spectator honey bees. The utilized honey bees are the honey bee which seeks the nourishment source and assemble the data about the nature of the sustenance source. Passerby honey bees stay in the hive and pursuit the nourishment sources on the premise of the data accumulated by the utilized honey bees. The scout honey bee, seeks new sustenance sources haphazardly in spots of the deserted nourishments sources. Like the other populace based calculations, ABC arrangement pursuit procedure is an iterative procedure. After, introduction of the ABC parameters and swarm, it requires the monotonous emphases of the three stages to be specific utilized honey bee stage, passerby honey bee stage and scout honey bee stage.

In ABC calculation, the position of a sustenance source speaks to a conceivable answer for the enhancement issue and the nectar measure of a nourishment source relates to the quality (wellness) of the related arrangement. The quantity of the utilized honey bees or the passerby honey bees is equivalent to the quantity of arrangements in the populace. At the first step, the ABC creates an arbitrarily appropriated introductory populace P(C=0) of SN arrangements (sustenance source positions), where SN signifies the measure of utilized honey bees or passerby honey bees. Every arrangement x_i (i=1, 2, . . . SN) is a D-dimensional vector. Here, D is the quantity of advancement parameters. After instatement, the number of inhabitants in the positions (arrangements) is liable to rehashed cycles, C = 1, 2,…, MCN, of the pursuit procedures of the utilized honey bees, the passerby honey bees and the scout honey bees.

An utilized honey bee creates an alteration on the position (arrangement) in her memory relying upon the neighborhood data (visual data) and tests the nectar sum (wellness quality) of the new source (new arrangement). In the event that the nectar measure of the new one is higher than that of the past one, the honey bee remembers the new position and overlooks the old one. Else she keeps the position of the past one in her memory. After every utilized honey bee finish the pursuit process; they share the nectar data of the nourishment sources and their position data with the passerby honey bees. A spectator honey bee assesses the nectar data taken from every utilized honey bee and picks a sustenance source with a likelihood identified with its nectar sum. As on account of the utilized honey bee, she creates an alteration on the position in her, memory and checks the nectar measure of the applicant source. In the event that the nectar is higher than that of the past one, the honey bee remembers the new position and overlooks the old on

The primary strides of the calculation are as underneath:

1. Initialize Population
2. rehash
3. Place the utilized honey bees on their nourishment sources
4. Place the passerby honey bees on the nourishment sources relying upon their nectar sums
5. Send the scouts to the quest zone for finding new nourishment sources
6. Memorize the best sustenance source discovered so far
7. until prerequisites are met

III. PROBLEM FORMULATION

The force framework creating organizations and huge customers require a suitable offering model to amplify their benefits yet in the meantime to minimize the related dangers. Rather than this the framework's interest must be fulfilled. Suppliers ought to offer somewhat higher at their minimal creation cost, it relies on upon the business sector practices, contenders and specialized requirements. In this proposed framework consider number of generators and number of substantial purchasers, who take an interest in the interest side offering and the system, is controlled by ISO. The supplier and the buyers ought to require to offer a straight non diminishing supply and non expanding interest bend individually to a force trade. The ideal direct supply bend and the straight request bend are depicted in the accompanying mathematical statements (1) and (2) separately. The accompanying is a supply bend

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

For large consumers linear demand curve is

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

Where, $i = 1,2 \ldots p$ and $j = 1,2 \ldots q$, P_i is the dynamic force yield of the i[th] generation unit, a_i and b_i is the bidding coefficients of the i^{th} supplier, 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 force trade framework predominantly considers the era, request, dispatch and timetable that meet the requirements to augment benefits. Furthermore, when the force era suppliers and extensive buyers offer straight supply and interest capacities the system requirements are overlooked and augmenting result prompts a uniform business sector clearing cost for all suppliers and shoppers. In this manner when just the limitations like, era yield, burden stream and client interest are considered. Power exchange finds the set of generation outputs $P = (P_1, P_2 \ldots P_p)^T$ and large consumer demand $L = (L_1, L_2 \ldots L_q)^T$. In this manner when just the limitations like, era yield, burden stream and client interest are considered.

$$\sum_{i=1}^{p} P_i = Q(R) + \sum_{j=1}^{q} L_j \quad (3)$$

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,

$$P_{\min,i} \le P_i \le P_{\max,i} \qquad i = 1,2,3 \ldots p \quad (4)$$

$$L_{\min,j} \le L_j \le L_{\max,j} \qquad j = 1,2,3 \ldots q \quad (5)$$

$P_{\min,i}$ & $P_{\max,i}$ are the generator output limits of the i^{th} supplier, $L_{\min,j}$ & $L_{\max,j}$ are the demand limits of the j^{th} large consumer.

$$Q(R) = Q_o - KR \quad (6)$$

Where, Q_o is the constant number, K is a coefficient denoting the price elasticity of the aggregate demand.

3.1 Demand Prediction Using NN

The primary phase of the proposed system is interest expectation; this should be possible by the NN procedure. The NN comprises of three layers like, info layer, concealed layer and yield layer, which is prepared with the authentic datasets, i.e., the earlier year request dataset. The dataset comprises of the interest variety for each period, which is utilized for the preparation of the NN. The interest of every period is fluctuating as per the heap, so it produces the exponential yield of the interest. The preparation procedure of the NN is finished by the back proliferation calculation; it is given by the accompanying.

3.2 Training Process

Step 1: Instate every one of the qualities like info, yield and weight of the neuron.

Step 2: Determine the BP error of the input dataset T .

$$E_{BP} = D_{\exp}{}^{NN}{}_{T} - D_{\exp}{}^{NN}{}_{out} \quad (7)$$

Where, $D_{\exp}{}^{NN}{}_{T}$ is the target demand of the system, $D_{\exp}{}^{NN}{}_{out}$ is the actual output demand.

Step 3: Evaluate the output demand of the system using the following relation.

$$D_{\exp}{}^{NN}{}_{out} = \sum_{n=1}^{N} w_{2n1} D_{\exp}{}^{NN}(n) \quad (8)$$

Where, $D_{\exp}{}^{NN}(n) = \frac{1}{[1+e^{(-w_{1n}e(n)-w_{2n}\Delta e)}]}$

The above comparisons are spoken to the yield layer and concealed layer initiation works individually.

Step 4: To focus the new weight of the considerable number of neurons utilizing the accompanying connection.

$$w_{new} = w_{old} + \Delta w \quad (9)$$

Where, Δw is the change in weight, The change in weight can be controlled by the accompanying connection, $\Delta w = \xi D_{\exp}{}^{NN} E_{BP}$, ξ is the taking in rate which is extending from 1/5 to 1/2.

Step 5: To focus the minimized E_{BP} quality. This procedure will be rehashed from step 2, until gets the minimum mistake esteem. $10E_{BP}<1$

When the procedure is finished, the system is all around prepared and gives the framework's interest. The anticipated interest is utilized for the assessment of the ideal offering technique. The second phase of the proposed ABC procedure is to focus the Price elasticity.

IV. EXPERIMENTAL RESULTS AND DISCUSSIONS

The proposed Artificial Bee Colony (ABC) strategy was actualized in MATLAB stage. In this method essentially to break down the suppliers' benefit, the requests' Benefit and M.C.P. with variation of Price Elasticity and additionally minimize the related dangers of the framework; this should be possible by the ideal offering system. The interest expectation of the proposed strategy is finished by the NN procedure; this could be delivering the framework's interest utilizing the authentic information examination. The third phase of the ABC procedure, it is utilized for the arbitrary quantities of arrangement era.

The ideal offering for each interest is figured in this area. The standard IEEE 30 bus framework ideal offering system was dictated by the ABC strategy.

The standard IEEE 30 bus framework is given in the accompanying figure.

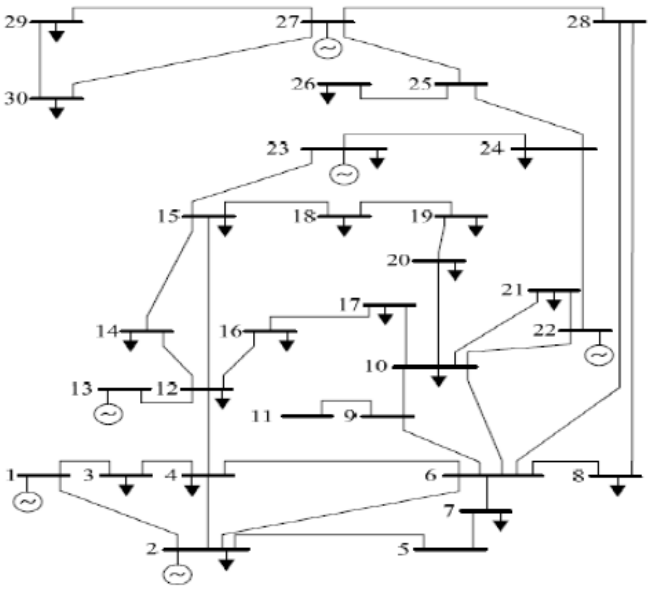


Figure 2: Structure of the IEEE 30 bus system

The figure.2 outlines attempted IEEE 30 bus system structure, this system involves six generators. The expected M.C.P, Profit and Benefit of preference qualities using ABC strategy with variation of Price Elasticity, is given in the going with Table 1-7 and Figures 3, 4 and 5.

Table 1: M.C.P, Profit and Benefit values for Price Elasticity (K) = 0

Generator Number	Profit	Benefit	MCP
G1	283.5005	677.637	8.0446
G2	193.5413	571.29	8.0446
G3	228.3641	1712.277	8.0446
G4	39.7146	2699.975	8.0446
G5	151.3508	3534.384	8.0446
G6	207.086	4215.503	8.0446

Table 2: M.C.P, Profit and Benefit values for Price Elasticity (K) = -2

Generator Number	Profit	Benefit	MCP
G1	117.501	673.9128	8.148
G2	14.7605	568.1672	8.148
G3	44.111	1702.307	8.148
G4	134.2506	2683.158	8.148
G5	42.5089	3510.719	8.148
G6	82.6607	4184.992	8.148

Table 3: M.C.P, Profit and Benefit values for Price Elasticity (K) = -5

Generator Number	Profit	Benefit	MCP
G1	159.1754	662.7059	8.4594
G2	54.1564	558.7699	8.4594
G3	68.357	1672.306	8.4594
G4	23.202	2632.552	8.4594
G5	5.6079	3439.51	8.4594
G6	6.2283	4093.178	8.4594

Table 4: M.C.P, Profit and Benefit values for Price Elasticity (K) = -10

Generator Number	Profit	Benefit	MCP
G1	11.2608	652.5281	8.7421
G2	108.2954	550.2354	8.7421
G3	12.2249	1645.059	8.7421
G4	44.8173	2586.593	8.7421
G5	22.8092	3374.838	8.7421
G6	72.3408	4009.794	8.7421

Table 5: M.C.P, Profit and Benefit values for Price Elasticity (K) = 2

Generator Number	Profit	Benefit	MCP
G1	271.2291	683.2653	7.8882
G2	117.123	576.0095	7.8882
G3	217.3067	1727.344	7.8882
G4	143.8749	2725.39	7.8882
G5	64.3495	3570.147	7.8882
G6	177.6924	4261.614	7.8882

Table 6: M.C.P, Profit and Benefit values for Price Elasticity (K) = 5

Generator Number	Profit	Benefit	MCP
G1	173.141	686.5728	7.7963
G2	213.3211	578.783	7.7963
G3	228.528	1736.199	7.7963
G4	170.2634	2740.325	7.7963
G5	77.1256	3591.163	7.7963
G6	143.7013	4288.711	7.7963

Table 7: M.C.P, Profit and Benefit values for Price Elasticity (K) = 10

Generator Number	Profit	Benefit	MCP
G1	146.7362	696.5262	7.5198
G2	304.8234	587.1293	7.5198
G3	344.7042	1762.845	7.5198
G4	147.4873	2785.271	7.5198
G5	227.3921	3654.408	7.5198
G6	205.4862	4370.256	7.5198

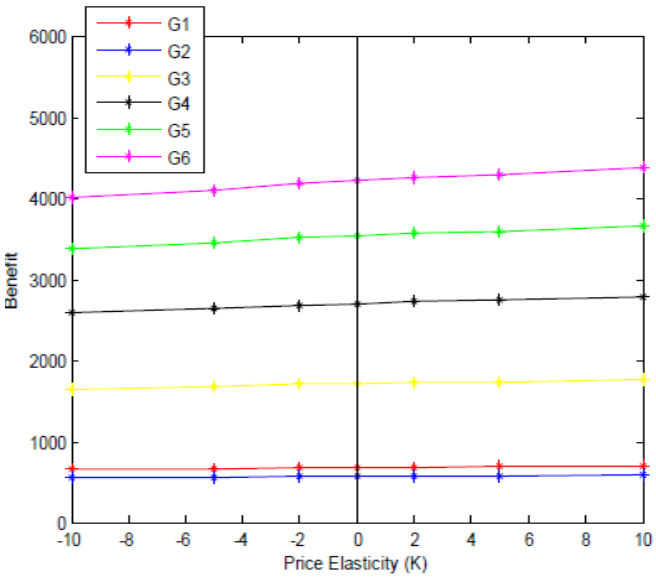


Fig 3: Benefit for different Price Elasticity (K)

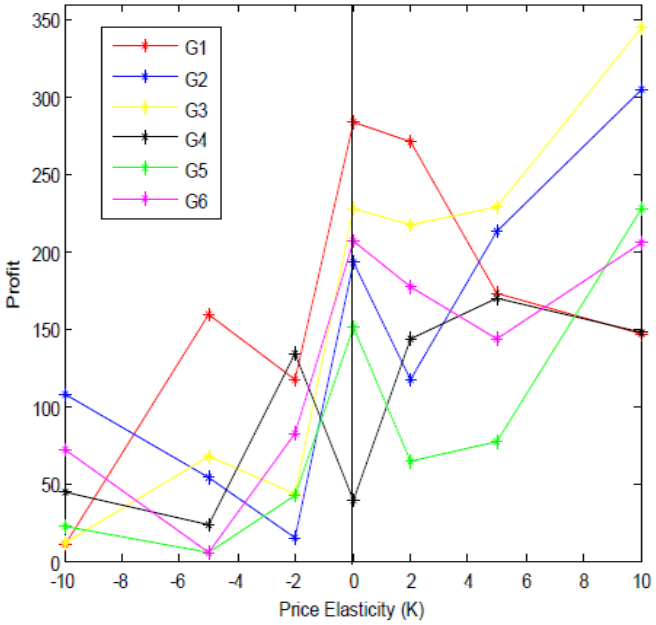


Fig 4: Profit for different Price Elasticity (K)

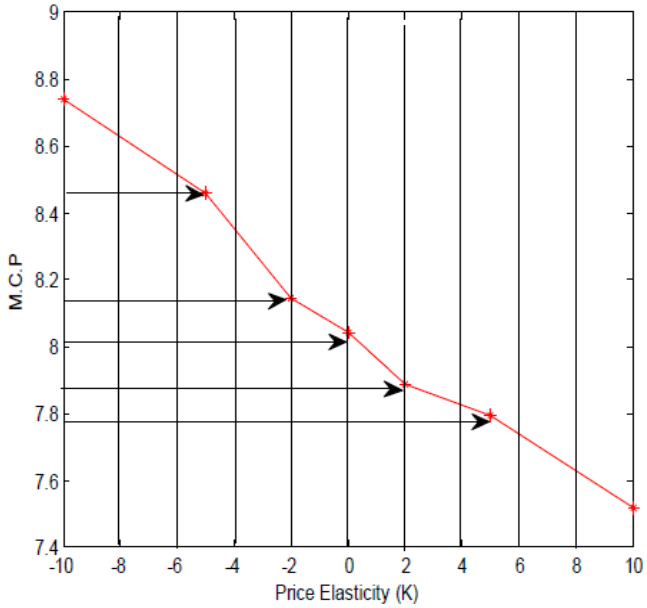


Fig 5: M.C.P for different Price Elasticity values

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