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Risk Assessment of Demand Side Bidding Strategy for Retailer in Day-Ahead Market

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Abstract: Competition of electrical industry has lead to appearance of participant such as retailers in demand side. Retailers as one of the demand side participants look for maximizing profit resulted form energy sale to their customers. There are uncertainties and risks in demand side, which influence on the retailers behavior. In this paper, different types of uncertainties and risks that retailers faced with and the risk types in day-ahead and regulated market were studied , proper mathematical model for these risks was suggested and the effect of retailer volume and price risks in bidding strategy of demand side has been studied and optimal bidding curve has been calculated in presence and absence of volume risk factor.

Key word: Bidding · Demand side · Retailer · Price risk · Volume risk

INTRODUCTION

In competitive generation markets, production planning has changed a great deal and companies must factor in their bidding strategies and historic market prices to calculate their production. Forced outages, however, are still a factor that can bring reduced income or even large losses and should be factored into production cost calculations. Unfortunately, there is no algorithm such as the convolution of load demand and generator probability density to see the effect of outages on production cost, it must be approached differently. Today, modern companies use techniques of risk management to be sure of not incurring large losses. Risk management consists of identifying risk, measuring risk (risk assessment) and minimizing risk. This work measures the risk due to forced outages that a generator company faces when bidding in an open market [1,2].

Retailers are the ones who buy electricity in large volume of wholesale market and sell it in retail. Retailers are located near to types of market for buying power. The first types are day-ahead market. In these markets, producers and retailers submit price quantity biddings for buying and selling electricity every day before noon. The biddings are determined for each of them next 12-36 hours.

Second type is regulation market in which retailers must supply or provide their surplus or shortfall at the regulating price only. Retailers that are able to cut some of their customers on 15-min notice may also participate in the regulating markets; or producer with an ability to ramp up or down significantly on 15-min notice are authorized to participate in the regulating market [3,4]. Therefore, in this market generators submit offers to increase or decrease the production level compared with their day-ahead market dispatch.

If the market demand at the time of physical dispatch turns out to be higher than the quantity purchased in day-ahead market, then the market is told to be up regulated. In the circumstance each purchaser who is short of power must buy their shortfall at the regulating price.This price is determined from where the total market demand meets the aggregate regulating market bidding curve. In this type of market, the regulating price is greater than the price in day-ahead market.

If the market demand at the time of physical dispatch turns out to be lower than the quantity purchased in the day-ahead market, then the market is told to be down regulated. In this case, each purchaser who has bought too much power must sell his or her excess at the regulating price. Therefore, the regulating price is less than the price in day-ahead market [5].

Therefore in the first viewpoint the retailer looks for submitting a bidding of less demand volume in day-ahead market in order to decrease MCP (Market Clearing Price)

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and with the hope that the market is down regulated he earns more profit buy purchasing shortage of volume energy regulated market.

There for optimal strategy in this Type lead the retailer toward a way to submit a bid of lower power volume than his required one. At the other side of hand, the retailer can be lead to profit in exact opposite way [6-12].

Therefore, it is tempting for the retailer to submit a less bid in day-ahead market systematically. However, this is not the balanced and optimal bidding strategy. If all market retailers submit an underbidding to the market it will be up regulated in the time of real distribution and this state the advantages of power shortage purchase in lower price will not be fulfilled. This is exactly right for the opposite situation.

Therefore, for energy purchase it is necessary for the retailers recognize all uncertainties and consider them in all models of energy purchase.

In this paper, different types of uncertainties and risks that retailers faced with and the risk types in day-ahead and regulated market were studied and proper mathematical model for these risks was suggested.

In next section, we offer a proper model for retailer in presence of volume risk factor and find the expected load volume offered in day-ahead market. In addition, the model is restudied in presence of price risk factor and gets the results. Finally, the model is simulated near both volume and price risks and the result are studied. It is necessary to mention that every section is simulated once for the state in which the day-ahead price is fixed and once more for the state in which day-ahead price is functional purchase load.

In next section, the previous section model for purchasers was extended. In this to model the result, that underbidding in day-ahead market is an optimal strategy.

In finally section we apply a more realistic probabilistic model and in this state we result the optimal bidding curve with and with out volume risk. It is necessary to mention that the objective function is a cost function, supposing that revenue is fixed.

Retailer Risk: In economics, risk means the probability of loss tolerance that means to be located at the threshold of uncertainty. The retailer plays the role of a dealer. Therefore, he is communicating with both customers and generators. He should know the different risk he face with and recognize their effects on his profit and loss.

The most significant risks that the retailer face with and effect on his behavior in market are as follows [3]:

- Price risk
- Volume risk

Price Risk: The first risk is related to profit. That means he is exposed to a risk of earning less money in the market than the one he expected. If both his demand volume in regulating market is higher than day-ahead market and higher than up regulated market, in a way that price in regulating market is higher than down regulated market, he losses because the retailer is forced to fulfill the rest of his need in higher price than day-ahead market that leads to his lost. Vice versa if his demand volume is in a way that he was forced to sell a volume of purchase power of day-ahead market in regulating market and the regulating market is down regulating. It means that its price is lower than the price of day-ahead market so the market retailer faces loss.

The price risk is a result of carelessness forecasting the created price. Simply it can be said that regarding instability in electricity price this risks leads to loss. The main reasons for this instability can be resulted from instability in uncertainty of fuel price load, generation uncertainty, transition congestion, customer behavior market and other covert factors such as market power [13-16].

However, the retailer should follow a proper strategy to avoid this risk. One of these proper strategies is to contact with the third company by the retailer and make a contract with each other on an agreed price for the future (e.g. tomorrow).

If the market price (day-ahead price) is more than disagreed price tomorrow, retailer will receive an amount from the third company and if the day-ahead market price is less than the agreed price the retailer must pay the adopted strategy in a proper one. In this strategy, the retailer looks for the following items for earning optimal profit:

- Approximate forecast of day-ahead market electricity price that is derived from solving optimal power flow (OPF) problem in which objective function is minimizing cost function.
- Optimal purchase volume in day-ahead market with the objective of minimizing charges.
- A proper agreement with the third company.

Optimal Purchase Volume in Day-ahead Market with the Objective of Minimizing Charges: For problem modeling, we consider some suppositions that are as follows:

- The retailer is price maker in a way that regulating price depends on day-ahead and is a function of purchase volume from regulating market.
- The retailer purchases his all forecasted volume from day-ahead market and prepare difference between customers real demand volume and provided volume.
- Volume risk ignored.
- H is an accidental variable that shows customers real demand volume.
- π Is agreed price with the third company
- π^{DA}: Day-ahead price.
- X: purchase volume from day-ahead market.

In this way electricity purchase charges from day-ahead market is as follows with considering risk factor

$$\begin{aligned} &\cos t = x\pi^{DA} + E[(H-x) \\ &(\pi^{DA} + \delta(H-x))] + E[H(\pi - \pi^{DA})] \end{aligned} \quad (1)$$

$(\pi^{DA} + \delta(H-x))$ Shows regulating price.

With solving this problem, we have optimization with the objective of minimizing of energy purchase charges.
Meanwhile $\delta(y) = ay$ is considered.

$$\begin{aligned} &\frac{d\cos t}{dx} = 0 \\ &= \pi^{DA} - E[(\pi^{DA} + a(H-x)] - aE[(H-x)] \\ &= \pi^{DA} - \pi^{DA} - aE[H] + ax - aE[H] + ax \\ &2ax = 2aE[H] \;\; x = E[H] \end{aligned} \quad (2)$$

If day-ahead price is function of purchased load, we have the following formula.

$$\begin{aligned} &\pi^{DA} = bx \\ &\cos t = xbx + E[(H-x) \\ &(bx + \delta(H-x))] + E[H(\pi - bx)] \end{aligned} \quad (3)$$

With solving this problem, we have optimization with the objective of minimizing of energy purchase charges.

$$\begin{aligned} &\pi^{DA} = bx \\ &2bx - E[(bx + a(H-x)] + (b-a)E[H-x] - bE[H] \\ &2bx - bx - aE[H] + ax + bE[H] - bx - aE[H] \\ &+ax - bE[H] \; 2ax = 2aE[H] \;\; x = E[H] \end{aligned} \quad (4)$$

It is that in both states optimal purchase volume equals mathematical expectation of customers real demand volume.

Volume Risk: The second to whom the retailers face to related to volume deviation. If the retailer requests whole demands of market the retailer's demand volume in regulating market equals difference of customer's real final demand and prepared volume by the retailer from the day-ahead market and it is considered as risk amount called demand deviation [1].

It is supposed that the retailer is price maker to the regulating market that mean's the regulating price depends on day-ahead price and purchase volume from the day-ahead market. If it is supposed that the retailer is price-taker, the suggested methods with and/or with out the risk factor are similar to each other. (It is completely logical).

We consider a state in which whole producer suggest price of π^{DA} in day- ahead market and the market has only one purchaser that suggest x amount of the day-ahead price. In this way the accidental variable of H shows the customers real usage amount in the time of real distribution. Also the variable of ξ shows the retailer' forecast rate for his own customers' usage amount depending on the market condition the retailer deals his extra amount or rest of energy in the market.

The regulating price greatly depends on the requested power volume from the customers. We are modeling the regulating price with the functional $T(.)$.

Single Retailer Model with Fixed Purchase Price: If the retailer supplies whole volume of his customers forecast from the day ahead market, he prepares difference of customers real demands volume from the prepared the volume in day ahead market from the regulating market. In this section, we consider a case that all suppliers suggest in fixed price of π^{DA} in day-ahead market and the market has only one purchased that selects the amount of x for ordering in day-ahead market with this price.

In this way charge amount is calculated with the following relation

$$\min_x C = x\pi^{DA} + E\left\{(\pi^{DA} + \delta(H-x))(H-x)\right\} \quad (5)$$

X: Day-ahead purchase amount
H: customer real demand amount (accidental amount)
X: Day-ahead price (fixed amount)
π^{DA}: A function that makes regulating price depended on difference between customers' real demand and day-ahead amount.

$$= x\pi^{DA} + E[\pi^{DA}H] - x\pi^{DA} + aE[H(H-x)] - aE[x(H-x)] \tag{6}$$

$$= x\pi^{DA} + E[\pi^{DA}H] - x\pi^{DA} + aE[H^2] - 2aE[xH] + aE[x^2]$$

$$\frac{dc}{dx} = 0 \Rightarrow -aE[H] - aE[H] + 2ax = 0 \; x = E[H]$$

Now the retailer looks for strategy. This strategy is in this way that retailer doesn't buy full amount of customers forecasted load from the day-ahead market for the reasons such as changing market clearing price or buys x_1 amount from the day-ahead amount. In this way we should buy the amount of (ξ - x_1) according to his own planning from regulating market. ξ is the forecasted load amount of the retailers' customers. In this section, we consider a case in which all suppliers suggest the fixed price of π_1^{DA} in day-ahead market and the market has only one purchaser that selects x_1 amount for ordering in day-ahead market with this price.

Now if customer real load amount is H the retailer has following purchase charge according to this strategy

$$\min_{x_1} C = x_1\pi_1^{DA} + \left\{(\pi_1^{DA} + \delta(\xi - x_1))(\xi - x_1) \;\right\} + E\left\{(\pi_1^{DA} + \delta(H - x_1))(H - \xi)\right\} \tag{7}$$

It is important to mention that $x = x_1 + \xi$ meanwhile π_1^{DA} is day-ahead new price.

In addition, H is accidental demand.

$$= x_1p_1 + p_1\xi + a(\xi(\xi - x_1) - x_1p_1 - a(x_1(\xi - x_1)) + E[Hp_1] + aE[H(H - x_1)] - \xi p_1 - a\xi E[H - x_1] \tag{8}$$

$$= a\xi^2 - 2ax_1\xi + ax_1{}^2 + E[pH] + aE[H^2] - axE[H] - a\xi E[H] + ax\xi$$

As a result optimal purchase amount from day-ahead market is as follows

$$\frac{dc}{cx} = 0 \;\Rightarrow -a\xi + 2ax - aE[H] = 0 \;\Rightarrow x = \frac{E[H] + \xi}{2} \tag{9}$$

In the new strategy, in fact you tolerate a type of risk or danger.

You submit bidding of less or more amount than what you forecasted to day ahead market hopping that electricity charges would be decreased.

In this state for minimizing charges he submits bidding of optimal amount of x1 despite this uncertainly an expect to minimize charges in comparison with the first state in this model the retail has risked for the size of (H-ξ).

Single Retailer Model with Variable Purchase Price: In this state if the retailer implement with out any risk i.e. with this objective that buy his entire forecasted amount in the day-ahead market. The charge is as the equation (10)

$$\min_{x} C = xbx + E\left\{(bx + \delta(H - x))(H - x)\right\} \tag{10}$$

bx: Day-ahead price related to load.

If we minimize cost function, it is suggested that the retailer buy the following amount

$$\begin{aligned} &= xbx + E[bxH] - xbx + aE[H(H-x)] - aE[x(H-x)] \\ &= xbx + E[bxH] - xbx + aE[H^2] - 2aE[xH] + aE[x^2] \end{aligned} \tag{11}$$

In this case, purchase amount from a day- ahead market equals

$$\frac{dc}{dx} = 0 \Rightarrow bE[H] - 2aE[H] + 2ax = 0 \; x = (1 - \frac{b}{2a})E[H] \tag{12}$$

Moreover, for the risk full state it is suggested that the retailer day-ahead purchase amount dose not equal the forecasted amount in fact the retailer buys with the knowledge of prefect or loss probability. In this case, we have the following equation

$$\begin{aligned}
&\min_{x_1} C = x_1 b x_1 + \left\{(bx_1 + \delta(\xi - x_1))(\xi - x_1)\ \right\} + E\left\{(bx_1 + \delta(H - x_1))(H - \xi)\right\} \\
&= x_1 b x_1 + b x_1 \xi + a(\xi(\xi - x_1) - x_1 b x_1 - a(x_1(\xi - x_1)) + E[Hbx_1] + aE[H(H - x_1)] - \xi b x_1 - a\xi E[H - x_1] \\
&= a\xi^2 - 2ax_1\xi + ax_1^2 + E[bxH] + aE[H^2] - ax_1 E[H] - a\xi E[H] + ax_1\xi \\
&\frac{dc}{cx_1} = 0 \ \Rightarrow -a\xi + 2ax_1 - bE[H] - aE[H] = 0
\end{aligned} \tag{13}$$

In this state the optimum purchase amount equals

$$x_1 = (1 - \frac{b}{2a})\frac{E[H]}{2} + \frac{\xi}{2} \tag{14}$$

N Retailer Model with Variable Purchaser Price: We have studied a model for a buyer so far now. We have extended the model for n buyer. In this case, each buyer submits accidental bidding of H_i and forecasted load amount of ξ_i in away that $i = 1,2........, n$. Here it is supposed that the day ahead price is variable and is derived from a linear relation.

$$\xi = \sum_{i=1}^{n} \xi_i \qquad H = \sum_{i=1}^{n} H_i \qquad x = \sum_{i=1}^{n} x_i \tag{15}$$

In this case, the objective function is as follows in risk less state we have

$$\begin{aligned}
&\min f_i(x) = x_i bx + E\left[(bx + a(H - x))(H_i - x_i)\right] f_i(x) = x_i bx + E[H_i bx + H_i aH - H_i ax - x_i bx - x_i aH + x_i ax] \\
&= bxE[H_i] + aE[H_i H] - axE[H_i] - x_i aE[H] + x_i ax \frac{\partial f_i}{\partial x_i} = E[H_i]b - aE[H_i] - aE[H] + ax_i + ax = 0
\end{aligned} \tag{16}$$

Consequently, we have

$$\begin{aligned}
x_i &= (1 - \frac{b}{a})E[H_i] + \frac{b}{a}\frac{E[H]}{(n+1)} \\
x_i &= (1 - \frac{b}{2a})E[H]
\end{aligned} \tag{17}$$

In the state of presence of risk factor we have

$$\min f_i(x^*) = x_i bx^* + \left[(bx^* + a(\xi - x^*))(\xi_i - x_i)\right] + E\left[(bx^* + a(H - x^*))(H_i - \xi_i)\right] \tag{18}$$

We simplification of above mentioned relation we have

$$f_i(x^*) = a\xi\xi_i - ax_i\xi + ax^* x_i + bx^* E[H_i] + aE[HH_i] - ax^* E[H_i] - aE[H\xi_i]$$

Now we have derived from the resulted function to x_1 variable.

$$\frac{\partial f_i}{\partial x_i} = -a\xi + ax^* + ax_i + bE[H_i] - aE\left[H_i\right] = 0$$

With this supposition that $x^* = \sum_{i=1}^{n} x_i$ and $H = \sum_{i=1}^{n} H_i$ the sum of above mentioned function with $i = 1,2,.....,n$ equals

$$-an\xi + anx^* + ax^* + bE[H] - aE\left[H\right] = 0$$
$$x^* = \frac{(a-b)}{a(1+n)}E[H] + \frac{n\xi}{1+n}$$

With replacement of resulted amount in above-mentioned relation, we get x_i amount from the following relation.

$$x_i = (1-\frac{b}{a})E[H_i] + \frac{b-a}{a(n+1)}E[H] + \frac{\xi}{1+n}$$

If n=1 is considered, we confirm correctness of section (2-2-2).

Therefore, altogether when buyers number increases in day-ahead market more demand is offered. When the number of buyers goes toward infinity, the limit of optimal bidding price for each buyer goes toward bidding for considered demand.

$$\sum_{i=1}^{n} x_i = (1-\frac{b}{a})E[H] + \frac{n(b-a)}{a(n+1)}E[H] + \frac{n\xi}{1+n} = \frac{(a-b)}{a(1+n)}E[H] + \frac{n\xi}{1+n}$$

The degree an amount to which the buyers decrease their price suggestion depends on a, b amplitude, practically we expect that $a \geq b$ in this state fluent and mild optimal conditions are used. It is necessary to mention parameters are determined by suppliers and probably in some conditions $b \geq a$.

Optimal Price Bidding with Market Distribution Function: In previous section, all previous purchaser and producer competed in a single-phase player. Supply and demand curve of all buyers and producer is similar, but practically it is not similar. Fore example a buyer many present his supply and demand curve under this supposition that supply curve and other buyers' demand curve is not fixed, however this behavior follows probability distribution function. Therefore, the buyer or retailer look for a price bidding curve to be able to minimize electricity charges for an accidental demand of next day by presenting it to the day ahead market.

In order to modeling above mentioned process the market distribution function of φ is defined in away that $\varphi(r,P)$ buying r quantity is probable in p price. [5]

r is purchase volume of retailer from day ahead market. This function is increasing in r and decreasing in distribution function of p market is a strong function to estimate optimal bidding in electricity market.

Present probabilities can be known or can be estimated by the buyer. Suppose that the retailer presents the following parametric curve day-ahead market.

$$s = \left\{r(t), p(t), 0 \leq t \leq T\right\} \tag{19}$$

T parameter is selected in away that the curve is stretched from the left to the right.

Turning point of $\varphi = 0$ and $\varphi = 1$ with the diagram shows a probability of the retailer's purchase for r quantity in p price. Consequently, charge objective function is as follows:

$$\begin{aligned} &\min \int_s \left[rp + c(r,p) + c'(r,p)\right] d\varphi(r,p) \\ &s = \left\{r(t), p(t), 0 \leq t \leq T\right\} \\ &\frac{dr}{dt} \leq 0 \qquad \frac{dp}{dt} \geq 0 \qquad 0 \leq r(t) \leq q_m \end{aligned} \tag{20}$$

$c(r, p)$ is the retailer's purchase charge in regulating market. $c'(r, p)$ is risk or danger charge that threatens the retailer and q_m upper limit of r. Another type of market distribution function is called market standard distribution function that differs with above-mentioned function. Supposed that $q = q_m - r$ this function is as follows:

$$\psi(q, p) = \varphi(q_m - q, p) = \varphi(r, p) \tag{21}$$

This diagram state differs is as follows

$$\begin{aligned} &\min \int_{s'} \left[(q_m - q)p + c(q_m - q, p) + c'(q_m - q, p\right] d\psi(q, p) \\ &= \max \int_{s'} \left[-(q_m - q)p - c(q_m - q, p) - c'(q_m - q, p)\right] d\psi(q, p) \\ &s' = \{q(t), p(t), 0 \le t \le T\} \\ &\frac{dq}{dt} \ge 0 \qquad \frac{dp}{dt} \ge 0 \qquad 0 \le q(t) \le q_m \end{aligned} \tag{22}$$

Optimal answer should be correct in following condition[5]

$$Z(q, p) = \frac{\partial B}{\partial q} * \frac{\partial \psi}{\partial p} - \frac{\partial B}{\partial p} * \frac{\partial \psi}{\partial q} \tag{23}$$

A Model with out Risk Charge: In this model, risk charge that threatens the retailer has not been considered. Therefore, the objective function is as follows: [2]

$$\begin{aligned} &= \max \int_{s'} \left[-(q_m - q)p - c(q_m - q, p)\right] d\psi(q, p) \\ &C(r, p) = E_{H,H1,U}[(P + \delta(H - U(p) - r)(H_1 - r)] \end{aligned} \tag{24}$$

$U(p)$s all purchase demand in the day ahead market for other purchasers. Therefore, the first retailer buys($H_i - r$) amount from the regulating market in a way that H_i is haphazard demand of the first purchaser.

$$C(r, p) = pE[H_1] - pr + E[HH_1] - E[H]r - E[U(p)H_1] + E[U(p)r] - rE[H_1] + r^2 \tag{25}$$

We can solve the problem for a single purchaser for correctness of above-mentioned formula in order to create its price-bidding curve. In this way($H_i = H$) and $U(p) = 0$ as with this supposition that $\psi(q, p) = \frac{qp}{4}$ we have

$$\max \int_{s'} (-(q_m - q)^2 + (2q_m - 2q - p) * E[H] - E[H^2]) d\psi(q, p) \tag{26}$$

Conclusion of Optimization Condition

$$Z(q, p) = (-2E(H) + 2q_m - 2q)\frac{q}{4} - E[H]\frac{P}{4} \tag{27}$$

Now with the supposition of

$$E[H] = 1 \qquad E[H^2] = 2 \qquad q_m = 2 \tag{28}$$

We have

$$Z(q, p) = (2 - 2q)\frac{q}{4} + \frac{p}{4} = 0 \tag{29}$$

Consequently

$$p(q)=\begin{Bmatrix} 0 & q\le 1 \\ 2q^2-2q & 1\le q\le 1.6956 \\ 2.359 & q>1.6956 \end{Bmatrix}$$
$$b(r)=\begin{Bmatrix} 2.359 & r\le 0.3043 \\ 2q^2-2q & 0.3043\le r\le 1 \\ 0 & r>1 \end{Bmatrix} \tag{30}$$

A Model with Amount Risk Factor: In this section, we add amount risk factor to the objective function
In this way the objective function is as follows

$$C(r,p)=E_{\xi,\xi 1,U}[(P+\delta(\xi-U(p)-r)(\xi_1-r)]$$
$$C(r,p)=E_{\xi,\xi 1,U},\xi_1[(P+\delta(H-U(p)-r)(H-\xi_1)] \tag{31}$$

As a result, the sum of the retailer purchase charge from regulating market and danger or risk charges to which the retailer in counter with equals:

$$=r^2+(-p-E[\xi]+E\big[U(p)\big]-E[H_1])r+E[\xi\xi_1]+E[H_1P]+E[HH_1]-E[U(p)H_1]-E[\xi_1 H] \tag{32}$$

It is reminded that ξ is purchase amount for other retailers from regulating market. Also ξ_1 is power purchase amount by the retailer number 1. H is risk or on prepared energy amount for other retailers in market and H_1 is the retailer number 1's risk amount.

We solve the problem for a single purchaser. It is reminded that following supposition should be considered:

$$H_1=H \quad E[H]=1 \quad E[H^2]=2 \quad q_m=2$$
$$E[\xi]=0.9 \quad E[\xi^2]=1.8 \quad E[H\xi]=0.9 \tag{33}$$
$$U(p)=0 \quad \xi_1=\xi \quad \psi(q,p)=\frac{qp}{4}$$

It is supposed that the retailer's purchase amount is in a way that up regulate the market. Therefore, optimization condition is as follows:

$$Z(q,p)=2.1q-2q^2+p=0 \tag{34}$$

As a Result We Have:

$$p(q)=\begin{Bmatrix} 0 & q\le 1.05 \\ 2q^2-2.1q & 1.05\le q\le 1.72 \\ 2.325 & q>1.72 \end{Bmatrix} \tag{35}$$
$$b(r)=\begin{Bmatrix} 2.325 & r\le 0.28 \\ 2q^2-2q & 0.28\le r\le 0.95 \\ 0 & r>0.95 \end{Bmatrix}$$

Optimal Price Bidding in this State Is as Follows: If it is supposed that the purchase amount of the retailer is in away that down regulate the market, optimization condition curve and the retailer's price bidding is as follows:

We conclude from the diagrams of figures 6 and 8 that loss or risk amount of the retailer when the market is up regulating is more than when the market is down regulating.

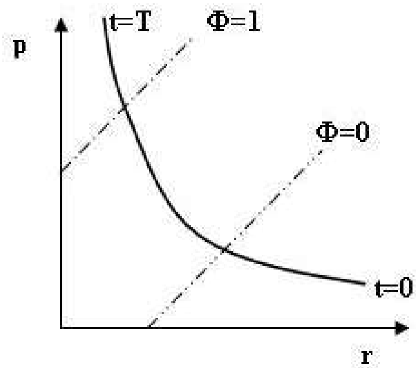

Fig. 1: Demand curve with use of distribution function

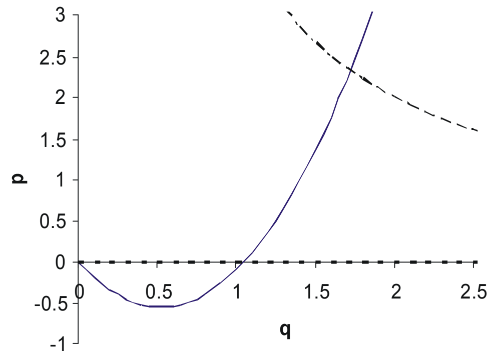

Fig. 5: Curve of $z(q, p) = 0$ for risk less condition

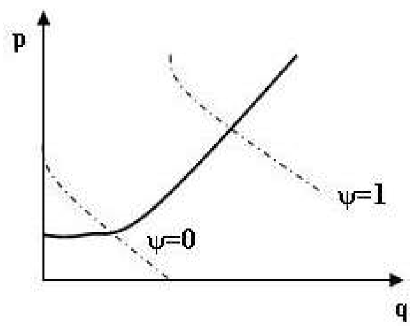

Fig. 2: Demand curve with use of standard distribution function

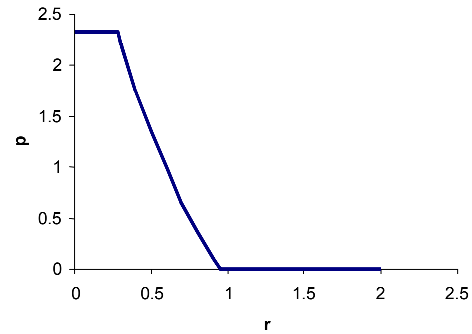

Fig. 6: Bidding curve for a retailer with risk purchase

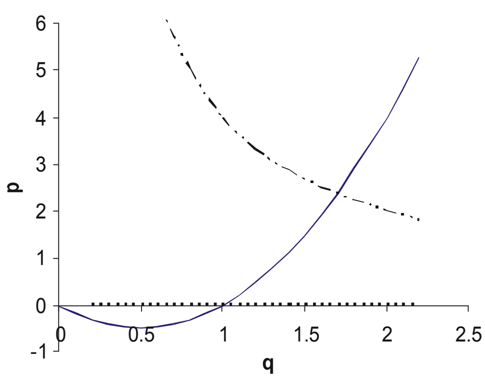

Fig. 3: $z(q, p) = 0$ curve for risk lees conditions

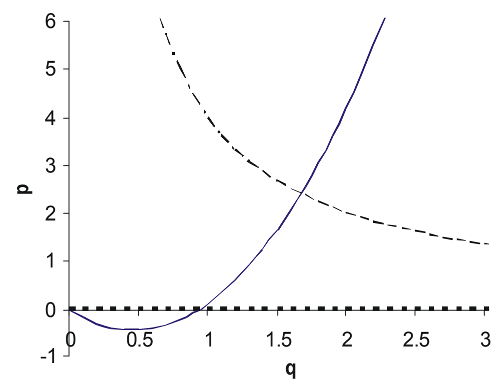

Fig. 7: Curve of $z(q, p) = 0$ for risk less condition

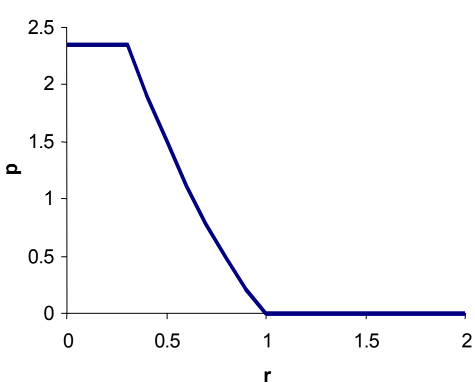

Fig. 4: Bidding curve of a retailer with out risk factor

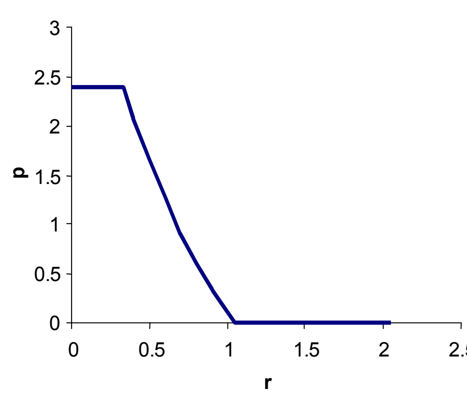

Fig. 8: Biding curve of a retailer with risk presence.

CONCLUSION

Competition of electrical industry has lead to appearance of participant such as retailers in demand side. Retailers as one of the demand side participants look for maximizing profit resulted form energy sale to their customers. There are uncertainties and risks in demand side, which influence on the retailers behavior.

In this paper risk problem in purchase bidding of a retailer in day-ahead market is studied. Regarding this fact, first two types of quantity and price risks are recognized and modelized. Price bidding of demand side and the effect of these uncertainties in electricity purchase volume by the retailer in day-ahead market are studied.

In this paper price-maker retailer's behavior idea are proposed.

In our all models both with and with out risk factors the buyer should submit bidding less than the expected demand in day-ahead market. In fact, the buyer is interested in buying the energy in two phases and with two different prices and this state can guarantee his profit in comparison with the state in which he buys with one phase and one price. This behavior is observed in previous section models.

It is necessary to say that if all retailers in the market submit a less bidding it causes that they supply less and subsequently the market-clearing price is less than expected spot price. In this state, the market goes toward unbalance. In many countries market operator does not allow the retailer to submit a less bidding.

Usually the retailers look for risk aversion for example to avoid facing with price risk the retailer contact with the third company.

In a way, that agreed price should be less than day-ahead price. In addition, the retailer to avoid amount risk looks for an exact forecast in a way that retailer customer's real demand equaled retailer purchase amount from day-ahead market and buy deviations from regulated market regarding a specific strategy.

Retailers usually do this work according to load management and planning demand response.

Since demand side and presence of actors such as retailers in electricity market is newly shaped in Iran, modeling these types of risk and uncertaintitis guarantees productivity increase in dealing between contract parties.

In future tasks we can consider the effect of planning in retailer behavior models.

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