Electricity market liberalization under the power of customer value evaluation and service model

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Abstract: After the power reform No. 9 was released in March 2015, the state officially released the Opinions on the Implementation of the Reform on the Power Sales Side. From this document, we can see that the openness of sales of social capital to the electricity business, the sales side of the market competition through multiple ways to train the main competitors, the result is more users have the right to choose, sales service quality and user energy levels will significantly improve. With the gradual promotion of the electricity sales market, the national electricity sales companies have been established one after another. In addition to power grid outside the power generation companies, energy-saving service companies and distributed power companies may become the main selling power, while industrial parks, commercial complex, large residential area, industrial and commercial users, large industrial users in the new electricity demand appearing The new changes, some power customers have also self-built distributed power supply, installation of energy storage devices or equipment to participate in the transformation of the electricity market. The main body of the electricity sales market has gradually evolved from the traditional electricity generation main body to the multi-unit main body and emerged new value points. Therefore, the electricity sales companies need to establish a power customer value evaluation method and service mode to adapt to the new electricity reform, Provide supportive decision support.

1 Introduction

Nowadays, the theories and methods of power customer value both at home and abroad are mainly focused on the definition of customer value, the index system of customer value evaluation, the model and method of customer value evaluation, and the classification of customer value. When defining customer value, customer value is generally evaluated in two ways: one is the value that the business provides to the customer and the other is the value of the customer to the business. In the power customer value evaluation model and method, a comparatively complete matrix model is formed both at home and abroad. The matrix model is compiled on the basis of a more complete data. This method is applied to segment the customer so that a better service In the high-quality customers. The classification of customer value is generally based on the evaluation results after the completion of the customer value rating based on the level of value, and finally divided into important customers, general customers and low value customers, different types of customers to adopt different marketing strategies.

When the electricity sales market is liberalized, the trading activities of both the main power suppliers and the main power suppliers will change. The services required by the customers are not limited to the power supply services with small differences in the past. The service demands of different customers on the power sales agents Not the same, at the same time liberalization of customer power options, you can choose to serve more high-quality electricity sales of the main. Therefore, the main power sales should pay more attention to customer needs, and strive to improve customer satisfaction in order to achieve a win-win situation. The customer value evaluation index system constructed in this paper integrates the value-added value of customers after the liberalization of the electricity sales market, designs two indexes of customer demand side value and energy management consulting service value, and the weight design of the index system adopts fuzzy analytic hierarchy process Entropy method of subjective and objective combination of methods, the use of TOPSIS evaluation method for comprehensive evaluation of customer value. In the service mode, the design of the customer stickiness index is considered considering the customer power option. The customer characteristics are analyzed according to the customer value rating result to better provide the decision support for the differentiated service of the power company.

2 Electricity customer value evaluation index systems

This article builds the customer value evaluation system

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as shown in Figure 1 below. The demand-side peak clipping potential depends mainly on the customer's load characteristics, which mainly reflects the customer's peak clipping potential during peak load periods, so as to provide reference for the selling company to implement the interruptible load service. The calculation method is as follows:

If the customer's load value at peak time $t_1, t_2, t_3, \mathrm{L}\ t_Z$ is $l^{t1}, l^{t2}, l^{t3}, \mathrm{L}\ l^{tZ}$, the potential demand response potential of the customer is:

$$f = (l^{t1} + l^{t2} + l^{t3} + \mathrm{L} + l^{tZ})\lambda / \mathrm{Z} \quad (1)$$

Where λ is the average load drop rate under the customer's demand response measure and the other is the ratio of the average load reduction to the maximum load when the demand response is implemented.

The value of energy management consulting services mainly includes customer's electricity management costs, distributed power supply commissioning and maintenance wishes, energy-saving solutions, commissioning of electricity engineering projects and purchase of electricity. Customer's energy management consulting commissioned demand reflects the added value of customers, the higher the commission will, the higher the value. Due to the different types of customers of the sales company, different types of customers are not the same in terms of characteristics, and evaluation of various types of customer value can't be made using a unified value evaluation index.

Table.1. The index system of power customer value evaluation

Electricity customer value	A1 Sales economic contribution	A11 Annual sales of electricity
		A12 Average annual selling price
		A13 Annual electricity growth
	A2 Customer credit conditions	A21 The number of default electricity
		A22 Electricity pay timely rate
		A23 Contract compliance rate
		A24 Annual contract deviation of electricity
	A3 Customer management	A31 Assets and liabilities
		A32 Liquidity turnover
		A33 Total asset turnover
		A34 ol
		A35 Industry market share
	A4 Electricity management level	A41 Equipment reliability and operating conditions
		A42 Electricity safety management level
		A43 Work with the situation
	A5 Customer demand side value	A51 Demand side clipping potential
		A52 Energy storage capacity
		A53 Charging pile number
		A54 Controllable micro-source installed capacity
		A55 Electricity demand elasticity
	A5 Energy Management Consulting Services	A61 Customer electricity management costs
		A62 Distributed power consignment operation and maintenance wishes
		A63 Energy-saving solution needs
		A64 Electrical Engineering Commission situation
		A65 Purchase electricity willingness to consult

3 Customer stickiness index

Considering that customers have the right to choose in the electricity sales market, this paper designs the customer stickiness index, which reflects the satisfaction of different customers to the sales company and on the other hand, can reflect the persistence of customer value. Customer satisfaction is determined by two factors, namely, the customer's expectation and the customer's perception. The lower the customer's expectation, the

easier it is to satisfy. The worse the actual perceived customer is, the more difficult it is to satisfy. It can be deduced that customer satisfaction is inversely proportional to expectation, and customer satisfaction is proportional to perceived. The evaluation criteria of customer satisfaction can be described by a simple function as follows:

$$c = b / \mathrm{a} \tag{2}$$

Where, A represents customer satisfaction; B represents the customer's perceived value; C represents the customer's expectations. In evaluating the customer stickiness index, the sales company should take the initiative to understand the core needs of customers, whether their own products and service water products meet customer expectations, and the evaluation process is based on the judgment of the sales company itself and the customer questionnaire. The core requirements are different for different types of customers. This article lists only some of the indicators used to reflect customer stickiness (Figure 2). In practice, sales companies should strengthen customer interaction and understand the real core needs of customers.

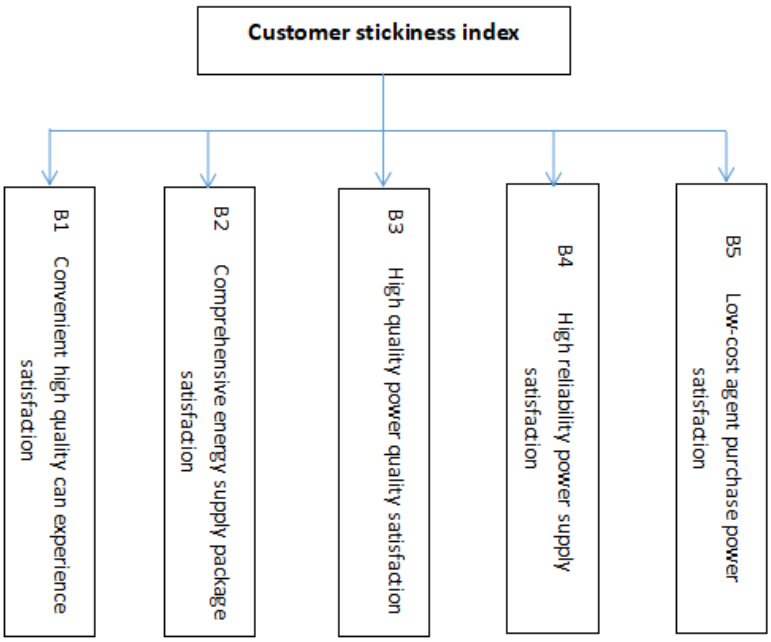

Figure.1. Customer stickiness index system

4 Electricity customer value evaluation model

In this paper, the design of customer value index weight is based on the combination of fuzzy analytic hierarchy process and entropy method, subjective fuzzy analytic hierarchy process for the second-level indicators, objective entropy method for the third-level indicators, subjective and objective A comprehensive weight, with some scientific rationality.

Design index weight steps are as follows:

4.1. Design two indicators of weight

Establish a fuzzy consistency judgment matrix, U is a set of elements A_i (secondary indicators), that is $U = \{A_1, A_2, \mathrm{L}\ , A_n\}$, $i = 1 \sim n$,its fuzzy relation matrix expressed as

$$R = \begin{bmatrix} r_{11} & r_{12} & \mathrm{L} & r_{1n} \\ r_{21} & r_{22} & \mathrm{L} & r_{2n} \\ \mathrm{M} & \mathrm{M} & \mathrm{O} & \mathrm{M} \\ r_{n1} & r_{n2} & \mathrm{L} & r_{nn} \end{bmatrix} \tag{3}$$

r_{ij} indicates the importance of A_i relative to A_j. If $r_{ij} > 0.5$, then A_i is more important than A_j; if $r_{ij} < 0.5$, then A_j is more important than A_i. If there is consistency in the process of determining the degree of membership of an element that is more important than the other element, then when $r_{ij} > 0.5$, $\forall k(\mathrm{k} = 1 \sim n)$, $r_{ik} > r_{jk}$, then $r_{ij} = r_{ik} - r_{jk} + 0.5$. From the literature [3] that the two indicators weight:

$$w_i = \frac{1}{n^2 - n}(2\sum_{k=1}^{n} r_{jk} - 1), i = 1 \sim n \tag{4}$$

4.2. Design three indicators of weight

Select n power customers, m three under the two indicators, x_{ij} is the i th customer j index value($i=1\sim n, j=1\sim m$). Which can be quantified using the actual data of electricity customers, non-quantifiable values scored by experts, this article uses the percentage system.

1) The normalization of indicators

Because they can't unify the units of measurement of each indicator, they should be standardized before they can be used to calculate the comprehensive indicator. Processing calculation is as follows:

For the benefit index:

$$x_{ij}^{'}=\frac{x_{ij}-\min\{x_{1j},x_{2j},...,x_{nj}\}}{\max\{x_{1j},x_{2j},...,x_{nj}\}-\min\{x_{1j},x_{2j},...,x_{nj}\}}\times 100 \quad (5)$$

For cost indicators:

$$x_{ij}^{'}=\frac{\max\{x_{1j},x_{2j},...,x_{nj}\}-x_{ij}}{\max\{x_{1j},x_{2j},...,x_{nj}\}-\min\{x_{1j},x_{2j},...,x_{nj}\}}\times 100 \quad (6)$$

2) Calculate the i-th customer's j-th indicator of the proportion of the indicator

$$p_{ij}=\frac{x_{ij}^{'}}{\sum_{i=1}^{n}x_{ij}^{'}},(\ i=1,2...,n,\ j=1,2...,m) \quad (7)$$

3) Calculate the entropy of the j-th indicator:

$$e_j=-k\sum_{i=1}^{n}p_{ij}\ln(p_{ij}) \quad (8)$$

Where, $k=1/\ln(n)>0$, satisfy $e_j\geq 0$;

4) Calculate the information entropy redundancy of the j-th indicator:

$$d_j=1-e_j \quad (9)$$

$0\leq d_j\leq 1$ for the j-th index, the greater the redundancy of information entropy, the greater the effect on the evaluation program, the greater the entropy.

5) Calculate the weight of each indicator:

$$w_j=\frac{d_j}{\sum_{j=1}^{m}d_j},\qquad j=1,2,...,m \quad (10)$$

4.3. Comprehensive evaluation method based on TOPSIS method

1) Construct the matrix of weighted norms

By formula (4) and formula (5) respectively, the weight of the second-level index and the third-level index are obtained. The final weight of the third-level index can be obtained by multiplying

$$w_t=w_i w_j \quad (11)$$

We construct a weighting rule matrix $Y=(y_{ij})_{n\times m}$:

$$y_{ij}=w_t x_{ij}^{'},(\ i=1,2...,n,\ j=1,2...,m) \quad (12)$$

2) Determine the positive and negative ideal solution

The positive and negative ideal solutions are respectively the combination of the optimal value and the worst value of each solution.

Positive ideal solution:

$$x_j^{+}=\max_i x_{ij}^{'} \quad (13)$$

Negative ideal solution:

$$x_j^{-}=\min_i x_{ij}^{'} \quad (14)$$

3) Calculate the Euclidean distance between the solutions and the positive and negative ideal solutions

Distance to the ideal solution:

$$d_i^{+}=\sqrt{\sum_{j=1}^{n}w_j(x_{ij}^{'}-x_j^{+})^2} \quad (15)$$

Distance to negative ideal solution:

$$d_i^{-}=\sqrt{\sum_{j=1}^{n}w_j(x_{ij}^{'}-x_j^{-})^2} \quad (16)$$

4) Calculate the relative closeness between the index value and the ideal solution of each evaluation object

$$c_l=d_i^{-}/(d_i^{-}+d_i^{+}) \quad (17)$$

According to the relative close evaluation of the various programs (that is, each customer) the pros and cons, the closer the greater the greater the customer value, and vice versa lower.

5 Case Analyses

In this paper, we choose five large industrial customers for empirical analysis, the statistics of the customer value data can be quantified after normalization of indicators, non-quantifiable data based on objective and reasonable experts scoring obtained by the formula (5) and (6) After processing the data shown in Table 2:

Table.2. Each indexes scoring of customer

Evaluation index		A	B	C	D	E
Sales economic contribution	Annual sales of electricity	92	68	40	68	98
	Average annual selling price	80	93	50	70	50
	Electricity growth rate	45	61	30	20	57
Credit conditions	The number of default electricity	95	47	30	90	70
	Electricity pay timely rate	96	60	34	98	80
	Contract compliance rate	92	70	36	99	78
	Contract deviation power	90	80	57	98	80

Operating conditions	Assets and liabilities	64	40	49	69	50
	Liquidity turnover	59	37	67	89	66
	Total assets growth rate	70	45	46	80	76
	ol	65	50	50	68	48
	Industry market share	34	21	14	40	69
Electricity management level	Equipment reliability and operating environment	67	80	59	70	40
	Safety management level	45	80	48	78	80
	Work with the situation	89	78	30	78	94
Customer demand side value	Customer demand side clipping potential	92	90	20	40	95
	Energy storage capacity	20	30	0	60	0
	Charging pile number	12	0	0	0	30
	Controllable micro-source installed capacity	0	40	0	0	45
	Electricity demand elasticity	44	67	40	70	30
Energy Management Consulting Services	Customer electricity management costs	78	30	20	30	80
	Distributed power entrusted operation and maintenance of the situation	66	45	0	80	70
	Energy-saving solution needs	88	20	30	20	90
	Electrical Engineering Commission situation	58	20	0	0	50
	Purchase electricity willingness to consult	80	10	0	20	40

For the second-level index element $\{A_1, A_2, A_3, A_4, A_5, A_6\}$, by contrasting the importance of each two, the experts form a fuzzy judgment matrix after empowerment, as follows:

$$R = \begin{bmatrix} 0.5 & 0.7 & 0.8 & 0.9 & 0.6 & 0.7 \\ 0.3 & 0.5 & 0.6 & 0.7 & 0.4 & 0.5 \\ 0.2 & 0.4 & 0.5 & 0.6 & 0.2 & 0.3 \\ 0.1 & 0.3 & 0.4 & 0.5 & 0.1 & 0.3 \\ 0.4 & 0.6 & 0.8 & 0.9 & 0.5 & 0.6 \\ 0.3 & 0.5 & 0.7 & 0.7 & 0.4 & 0.5 \end{bmatrix}$$

Using the consistency condition $r_{ij} = r_{ik} - r_{jk} + 0.5$, adjust the fuzzy matrix to form R_{new}

$$R_{new} = \begin{bmatrix} 0.5 & 0.7 & 0.8 & 0.9 & 0.6 & 0.7 \\ 0.3 & 0.5 & 0.6 & 0.7 & 0.4 & 0.5 \\ 0.2 & 0.4 & 0.5 & 0.6 & 0.3 & 0.4 \\ 0.1 & 0.3 & 0.4 & 0.5 & 0.2 & 0.3 \\ 0.4 & 0.6 & 0.7 & 0.8 & 0.5 & 0.6 \\ 0.3 & 0.5 & 0.6 & 0.7 & 0.4 & 0.5 \end{bmatrix}$$

Using formula (4) calculate the weight of two indicators are 0.167, 0.127, 0.087, 0.207, 0.167. Use formula (7-10) to calculate the weight of the third-level indicator. Enter the formula (11) and obtain the comprehensive weight of the indicator. As shown in table 3:

Table.3. The weight of customer value indexes

Secondary indicators	Secondary indicator weight	Three indicators	Three-level indicator weight	Comprehensive weight
Sales economic contribution	0.247	Annual sales of electricity	0.431	0.106
		Average annual selling price	0.416	0.103
		Electricity growth rate	0.154	0.038
Credit conditions	0.167	The number of default electricity	0.146	0.024
		Electricity pay timely rate	0.272	0.045
		Contract compliance rate	0.253	0.042
		Contract deviation power	0.330	0.055
Operating conditions	0.127	Assets and liabilities	0.181	0.023
		Liquidity turnover	0.240	0.030
		Total assets growth rate	0.264	0.033
		ol	0.190	0.024
		Industry market share	0.125	0.016
Electricity	0.087	Equipment reliability and operating	0.303	0.026

management level		environment		
		Safety management level	0.357	0.031
		Work with the situation	0.340	0.029
Customer demand side value	0.207	Customer demand side clipping potential	0.297	0.061
		Energy storage capacity	0.163	0.034
		Charging pile number	0.111	0.023
		Controllable micro-source installed capacity	0.125	0.026
		Electricity demand elasticity	0.304	0.063
Energy Management Consulting Services	0.167	Customer electricity management costs	0.255	0.043
		Distributed power entrusted operation and maintenance of the situation	0.217	0.036
		Energy-saving solution needs	0.289	0.048
		Electrical Engineering Commission situation	0.110	0.018
		Purchase electricity willingness to consult	0.129	0.021

Use formula (12-17) to determine the positive and negative ideal solutions, and calculate the Euclidean distance of each customer, and finally get the relative closeness of each customer, as shown in Table 4 below.

Table.4. The weight of customer value indexes

Electricity customers	Proximity		The relative post progress
	Positive	Negative	
client1	2.611	9.150	0.778
client2	5.071	6.691	0.569
client3	11.124	0.638	0.054
client4	4.949	6.813	0.579
client5	3.794	7.968	0.677

Through the relative closeness of the size of the customer value can be drawn as A> E> D> B> C. Close to the value of more than 0.6 for the high value customers, 0.4 to 0.6 for the value of the customer, 0.4 following the low value customers, according to grading standards A ~ E customers were high value, medium value, low value, medium value, high value. As all five electric power customers are large industrial users, the core customer needs are as follows: (1) in the research, we use the satisfaction of low-cost agent purchase as the index to evaluate the customer's viscosity. According to the sensitivity of 5 electric power customers to the price, The customer's viscosity is high viscosity, medium viscosity, medium viscosity, high viscosity, low viscosity. The resulting two-dimensional customer evaluation chart 5, as shown in Figure 2

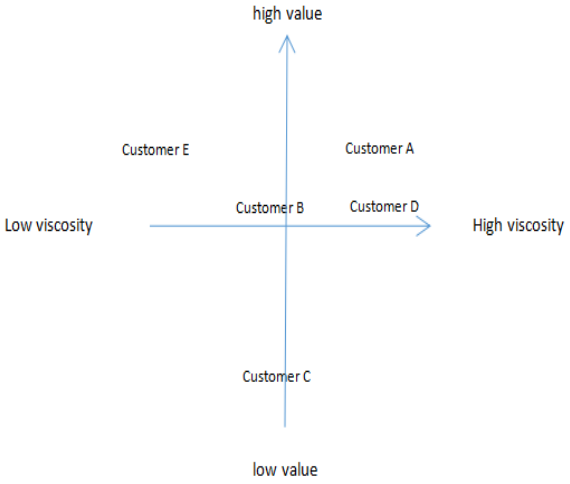

Figure.2. Customer two-dimensional evaluation chart

For customers with high value and high viscosity, such customers are the best customers of the sales company and achieve a win-win result. The service company of the sales company should maintain a good relationship with the customers and provide high quality VIP service. For high-value low-viscosity power customers, sales companies should continue to improve their product and service quality, as much as possible to improve customer satisfaction and achieve win-win results. For low-value but highly-viscous customers, the main strategy of a sales company is to increase customer value by tapping customer value added. For the low-value and low-viscosity customers, the sales company needs to analyze the reasons that cause its low value while providing the basic services, and in what ways can help the enterprise improve its own value, meanwhile, it should pay attention to prevent the operation risk.

6 Conclusion

With the liberalization and gradual maturation of the electricity sales market, sales companies are increasingly important to customer relationship management. This paper mainly constructs the power customer value evaluation method. This method mainly adapts to the current electricity market environment, and puts forward the customer evaluation method of customer value and customer stickiness. It not only evaluates the customer value from the perspective of the enterprise, but also from the perspective of the customer Analysis of customer satisfaction, more specific reflection of the characteristics of customers, for the sale of electricity companies to provide more comprehensive management information. After the market is further matured, the sales and after-sales service company can realize the accurate positioning and marketing of customers by observing the customers in more dimensions from customer value evaluation, customer demand identification, customer stickiness identification, customer transaction monitoring, etc., and realize customer-centric , The ultimate power company and customers achieve a win-win situation.

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