An Electronic Channel Operation Method for Power Marketing
Based on User Behavior Analysis

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Abstract: With the abolition of the national industrial and commercial catalogue electricity price, the competition in the electricity sales market has become increasingly fierce, and the importance of electricity marketing channels has become increasingly prominent. In order to solve the problem of single power marketing channels and low adaptability to power customer needs, a power marketing electronic channel operation method based on user behavior analysis is proposed. Firstly, based on the electricity consumption, files and other information of power users, user behavior analysis is carried out to obtain typical user characteristic behaviors. Secondly, based on Internet+, the potential index of electricity marketing electronic channels of power users is analyzed. On this basis, the operation model of electric power marketing electronic channel is established, and the operation cost of electricity is reduced and customer satisfaction is improved by formulating targeted operation strategies. Finally, the operation results of the proposed method in a city show that the operating cost of the method is reduced by 7.6% compared with the traditional method. The application results verify the effectiveness of the proposed method.

Keywords: User behavior analysis, Electricity marketing, Electronic channels, Operational methods, Catalogue electricity prices, Electricity sales market.

1   INTRODUCTION

With the deepening of China's new round of power system reform, the importance of power marketing is increasing [1]. In 2021, after China's National Development and Reform Commission issued a document abolishing the catalogue electricity price for industry and commerce, competition in the industrial and commercial electricity sales market will become increasingly intense [2]. How to improve the level of electricity marketing services and increase the ability of industrial and commercial users to acquire customers is a key element of the research of power supply companies and electricity sales companies [3]. In the traditional power marketing of power supply companies, the combination of offline business halls and online APP is used to provide marketing services for industrial and commercial users, but the operation mode is single, which cannot meet the growing demand for power supply services of industrial and commercial users. Therefore, power supply companies urgently need to carry

out electronic channel expansion services to improve the active service level of power supply companies [4].

In order to solve the problem of insufficient user incentive in power marketing channels, a power marketing electronic channel operation method based on user behavior analysis is proposed [5]. This method collects the non-adjustable load, adjustable load, transferable load and interruptible load of users, and adopts the multi-label classification method to establish the characteristics of typical electricity customers, which improves the granularity of user power consumption behavior analysis [6]. On this basis, the potential index analysis of the electricity customers targeted by this method is carried out, and different types of power services are provided for different types of electricity customers, so as to improve the satisfaction of electricity customers and enhance the stickiness of electricity customers.

2 ELECTRIC POWER MARKETING ELECTRONIC CHANNEL OPERATION MODEL

2.1 Establish the behavior characteristics of electricity customers

The purpose of establishing the behavior characteristics of electricity customers is to portray the characteristics of electricity customers from the aspects of the industry characteristics of electricity customers, the contribution value of electricity customers, the power demand of electricity customers, and the growth characteristics of electricity customers, so as to establish a portrait model of electricity customers in order to formulate accurate power marketing electronic channel operation strategies.

The data set used to establish the characteristics of electricity customers is shown in Table 1

Table 1 Electricity customer behavior collection data table

serial number	Collect data
1	Electricity customer files
2	96 points daily load curve
3	Factor
4	Electricity price information
5	User default records
6	Marketing inquiries

The multi-label classification method is a method of electricity customer portrait, which can extend the existing method and can process multi-label data [7], which is suitable for a large number of electricity customer data classification. Therefore, the multi-label classification method is used to classify Table 1.

In multi-label classification, the sample set of electricity customers G_a is:

$$G_a = \sum_{i=1}^{n_a}(U_i + O_i) \tag{1}$$

Formula: the n_a number of behavioral characteristics of electricity customers; U_i Electricity consumption behavior for different users; O_i For the needs of different users.

User mappings are categorized K_b as:

$$K_b = \sum_{i=1}^{n_b} \left(W_{ai} G_{ai} \sigma \right) \tag{2}$$

Formula: n_b map the number of classifications for electricity customers; W_{ai} Electricity customer labeling behavior for different mapping classifications; G_{ai}. A sample of electricity customers who classify different mappings. σ feature mapping function for electricity customers.

The feature mapping function of the electricity customer satisfies the following constraints:

$$\sigma \in \varphi \tag{3}$$

Formula: φ Classify boundaries for electricity customers.

According to the start and stop time, use time, power size, and power characteristics of the customer's electrical equipment, identify the user's electricity consumption behavior characteristics. Electricity customers usually include four categories: non-adjustable load, adjustable load, transferable load and interruptible load, and the behavior of electricity customers using electrical appliances is set by formula (2).

(1) The load cannot be adjusted, and the time and power of the electricity customer using such electrical appliances cannot be adjusted, such as televisions, electric lights, etc.

(2) The load can be adjusted, and the electricity customers cannot stop using electrical appliances, but the power can be adjusted, such as: water heaters, air conditioners, etc.

(3) Transferable load. Electricity customers' appliances can be stopped and adjusted to another time, such as office shredders, etc.

(4) The load can be interrupted. Loads that can be started and stopped at any time by electrical appliances of consumers, such as electric vehicles.

Taking agricultural and animal husbandry users as an example, according to the daily electricity consumption curves of four load types of electricity customers, a finity propagation (AP) was adopted Establish typical behavior characteristics of electricity customers, limited to space, the AP clustering process will not be repeated in the paper, and the AP clustering method is detailed in the reference. The power consumption curves of various types of load consumers are shown in Figure 1.
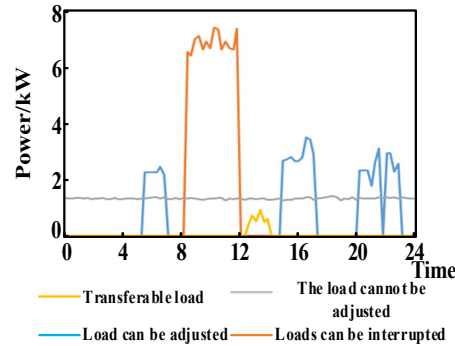
Figure 1 Power consumption curves of various loads of power customers

In Figure 1, the non-adjustable load of the agricultural and animal husbandry user is the aquatic oxygenation system, and the power consumed during 24 hours remains unchanged; The adjustable load is used in the morning, afternoon and evening time slots, and the power can be adjusted; The transferable load is the garbage removal robot, which is charged during the noon period; The interruptible load is an electric vehicle, which is charged during the morning time slot.

Establish the behavior characteristics of electricity customers and transmit various load curve information of electricity customers to the potential index analysis of electric power marketing electronic channels to carry out potential index analysis.

2.2 Analysis of the potential index of electronic channels for power marketing

The purpose of the analysis of the potential index of electronic channels of power marketing is to evaluate the potential index of electronic channels such as Pocket Power, State Grid Mall, Alipay, WeChat, 95598 and so on, so as to determine the promotion coefficient of that channel.

Internet + is the latest trend of the current Internet development, the power industry widely uses Internet + technology, and in terms of marketing channels, vigorously promote Internet + marketing, so as to reduce the processing pressure of power supply business halls, reduce the operating costs of power supply companies, realize the digital transformation of power supply companies, and improve the satisfaction of electricity customers.

Firstly, the power marketing electronic channel is divided into x two coordinates, y where the coordinates represent the acceptability of the power marketing electronic channel to electricity customers, the larger the x acceptability value, the higher the ability to be accepted, and the coordinates indicate the degree of attraction of the power marketing y electronic channel to electricity customers, the greater the degree of attraction. Explain that the more willing the user is to pay.

The analysis of the potential index of electronic channels for electricity marketing C_a is:

$$C_a = \sum_{i=1}^{n_{xy}} (\varpi B_i) \tag{4}$$

Formula: n_{xy} is the acceptability of electric power marketing electronic channels, and ϖ the potential analysis function of power marketing electronic channel potential index; B_i For different power marketing channels.

The electronic marketing channels B are:

$$B = b_a \times b_c \tag{5}$$

Formula: b_a is the acceptability of electricity marketing channels; Degree of attraction b_c for electricity marketing electronic channels.

The electronic channel potential index of power marketing transmits the information of the user's electronic channel potential index to the establishment of the electronic channel operation model.

2.3 Establish an electronic channel operation model

The purpose of establishing the electronic channel operation model is to better formulate the marketing operation plan for electricity customers. First, the electronic channel operation analysis is carried out through data such as region, season, and electricity customer payment information, and then the design of power marketing power operation activities is carried out, and then the operation strategy of the electronic channel of power marketing is formulated.

Innovative diffusion analysis is a method for electronic channel operations, which obtains operational analysis results by simulating the perception of the electricity consumption process by simulating individual electricity customers.

The results of the operational analysis z_a are:

$$Z_a = \frac{1}{\{D_a + S_a \times e_a\}} \tag{6}$$

Formula: D_a the perceived information of electricity customers; S_a Estimated parameters for electricity customers; e_a is a linear parameter.

Then formulate the operation strategy of power marketing electronic channels. According to the user scope and characteristics covered by the electronic channel of power marketing, realize the promotion of the power grid company's own channels; The promotion methods include: advertising, posters, self-media publicity, etc., to promote the activity of existing electricity customers and promote the participation of new users.

Establish an electronic channel operation module to transmit electronic channel operation strategy and promotion method information to the operation evaluation of electric power marketing electronic channels.

2.3 Operation evaluation of electronic channels for power marketing

Through the Internet plus power marketing electronic channel operation service, the electronic channels of Pocket Power, WeChat, Alipay, State Grid Mall, and 95598 have been launched, and users use electronic channels to complete electricity consumption business such as payment, electricity information inquiry, and business expansion information handling. Therefore, the coverage of electronic channels for power marketing [8] will be increased, and the power supply service level of power supply companies and the satisfaction of electricity customers will be improved.

Linear regression is a mathematical statistical method used to evaluate the operational effectiveness of electronic channels in power marketing, which can determine the interdependence between multiple variables.

The evaluation relationship P_s is:

$$P_s = \varphi + \eta l_s + \tau \tag{7}$$

Formula: l_s Evaluation of independent variables for electricity customers; φ, η is a regression constant; τ is a random perturbation quantity.

3   EXAMPLE ANALYSIS

In order to verify the operation method of electric power marketing electronic channel based on user behavior analysis proposed in this paper, the method proposed in this paper is applied in a municipal power supply company. The number of electricity customers is 1.2 million, residential and agricultural users are 920,000, industrial and commercial users are 275,000, and large industrial users are 5,000. The number of servers in the model mentioned in the article is 10, running with F5 connection, running the operating system as win server, and the processor is Xeon 32-core 3.6G. The running memory is 128G.

3.1   Time-consuming analysis of electronic channel operation plan

The purpose of the time-consuming analysis of the electronic channel operation solution is to verify the operation performance of the proposed model. The indicator is calculated from the time the basic data is entered to the time when the operation plan of the electronic channel for power marketing is generated. The shorter the time of this indicator value, the better the performance of the electronic channel operation plan.

Selecting different user number test sets can verify the time-consuming electronic channel operation scheme of the model under different user numbers, so as to reduce the error caused by the use of a single test set. Select the number of electricity customers as 1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000, 10000, comparing the power marketing electronic channel

operation method based on user behavior analysis and the dimension decomposition method widely used in the industry, the comparison results are shown in the table 2 is shown.

Table2 Time table of electronic channel operation scheme

Number of electricity customer samples	Model running time(s).	
	User behavior analysis	Dimension decomposition
1000	1.19	6.26
2000	2.40	12.55
3000	3.64	18.85
4000	4.78	25.05
5000	5.96	31.51
6000	7.26	37.69
7000	8.35	43.84
8000	9.68	50.20
10000	11.87	62.59

It can be seen from Table 2 that under the number of different samples of electricity customers, user behavior analysis runs fast in the four parts of "establishing electricity user behavior characteristics", "power marketing electronic channel potential index analysis", "establishing electronic channel operation model" and "power marketing electronic channel operation evaluation", therefore The electronic channel operation method of electric power marketing based on user behavior analysis proposed in this paper takes less time than that of dimensional decomposition method, which shows that the proposed method has better performance in generating electronic channel operation scheme.

3.2 Efficiency analysis of electronic channel operation scheme

The efficiency analysis of electronic channel operation scheme is the core index of electricity customer analysis in the paper. In order to simplify the calculation, the satisfaction rate of electricity customers is used to replace the efficiency analysis of electronic channel operation scheme. If the electricity customers are satisfied with the electronic channel operation scheme, the electronic channel operation scheme is effective. The calculation method of the satisfaction rate of electricity customers is as follows: after the power supply company provides services to electricity customers according to the electronic channel operation plan, they collect whether the customer is satisfied online. If the customer is satisfied, the electronic channel operation scheme is effective, and the ratio between the two is the efficiency of the electronic channel operation scheme. When 10,000 users are selected in 5 regions of a city to compare the growth of electricity consumption in the same period, if the monthly electricity consumption of users is larger than the average level of the previous year, then the users are satisfied. The value range of this index is 0-100%. The higher the index value, the more satisfied the electricity customers are.

Compared with the customer satisfaction of the electronic channel operation method of power marketing based on user behavior analysis and the dimensional decomposition method widely used in the industry, the results are shown in Figure 3.
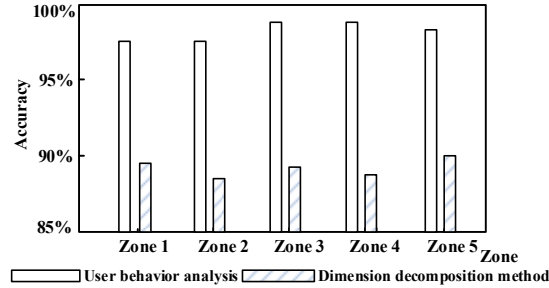
Figure 2 Analysis of satisfaction rate of electronic channel operation

As can be seen from Figure 2, in different regions of the city, the average satisfaction rate of the electronic channel operation method based on user behavior analysis is 98.3%, which is higher than the average 89.6% of the dimensional decomposition method. It can be seen that the proposed method in this paper has better effect.

3.3　Analysis table of electronic channel operating expenses

The purpose of the operating cost analysis is to measure the direct economic value brought by the method mentioned in the paper. The lower the cost, the better the economic benefit of the operating method.

Select two areas of a city and compare the operating expenses of the proposed method with the traditional method for one month. The comparison results are shown in Table 3:

Table 3 Analysis table of operating expenses of electronic channels for power marketing

region	Cost (ten thousand yuan)		amplitude of fluctuation
	Analysis of user behavior	conventional method	
region 1	23.62	25.35	-7.32%
region 2	24.73	26.67	-7.86%
subtotal	48.35	52.02	-7.60%

As can be seen from Table 3, after the operation of the electronic channel operation method of power marketing based on user behavior analysis mentioned in this paper, the operation effect of we-media publicity and advertising is good, and the operating cost supported by it decreases by 7.6% compared with the traditional methods.

4　CONCLUSIONS

In order to solve the problem of single power marketing channels and low adaptability to power customer needs, a power marketing electronic channel operation method based on user behavior analysis is proposed. On the basis of analyzing the behavior of electricity customers, the potential index of electric power marketing electronic channels is analyzed, and the

operation model of power marketing electronic channels is established accordingly, and targeted operation strategies are generated to reduce power operating costs and improve electricity customer satisfaction. Finally, the operation of a municipal power supply company verifies the effectiveness of the proposed method.

In the next step, the electronic channel operation method mentioned in the paper will be further studied in combination with the provincial electricity customer data.

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