

# Research of orderly power consumption index system based on multiple factors of electric load

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**Abstract.** In recent years, with the continuous development of China's economy, electricity consumption is growing, and the power supply is lagging behind, power shortage situation often occurs. So the orderly power management is the current domestic power industry imminent task. Based on the analysis of the means of orderly power consumption and the classification of customers according to the importance of load, this paper establishes an orderly power consumption index system based on multi-factor of electricity load, which lays the foundation for the comprehensive evaluation of subsequent orderly electricity

## 1. Introduction

In recent years, Chinese economic develops rapidly, electricity supply is tight, and the supply gap continues to expand. So, in order to alleviate this situation, local governments use economic, technical and administrative measures and other means to establish the orderly power consumption index system and the corresponding assessment method. And according to the system and the method, orderly electricity work is carried out successfully and significant effect is achieved.

Orderly electricity consumption is using law, administration, economic and technical means to strengthen the management of electricity use, change the way users use electricity, and take staggering, peak, holiday, let the power and negative power control and a series of measures, which can avoid unplanned blackouts, regulate the order use of electricity, and minimize the adverse effects of seasonal, seasonal power supply and demand on society and enterprises. However, now, the power grid lacks theoretical guidance on customer selection, and there is no scientific indicator system as a support. So according to the above discussion, and facing the time and the structural shortage situation, how to integrate the interests of three parties including social, power grid enterprises and users and choose reasonable scientific index is important. And it is also important to make comprehensive evaluation of customer value and let users that have high value own high priority electricity, so that the limited resources can be used to minimize the loss of power supply enterprises, minimize the loss of users' groups and maximize social benefits. So, how to optimize the allocation of energy resources is the main content of this paper.

## 2. Fundamental theory

### 2.1 The concept of orderly power consumption

Orderly electricity consumption is using law, administration, economic and technical means to strengthen the management of electricity use, change the way users use electricity, and take staggering, peak, holiday, let the power and negative power control and a series of measures, which can avoid unplanned blackouts, regulate the order use of electricity, and minimize the adverse effects of seasonal, seasonal power supply and demand on society and enterprises. Orderly electricity

consumption is led and promoted by s at all levels and relevant government departments, which can fully mobilize the enthusiasm of power supply enterprises and power users participating in and cooperating. Facing the imbalance of power supply and demand, government insists on restricting electricity and not pulling electricity, and ensures that the city's civil electricity is not affected, the production needs of key enterprises, and the normal production and living in urban orderly.

## **2.2 Implementation means of orderly power consumption**

In order to complete the comprehensive resource planning and orderly power consumption, a variety of measures must be taken. These measures are based on advanced technology and equipment, taking economic efficiency as the center, guaranteed by the legal system, taking policy as the guide, adopt the market economy operation mode, and paid attention to contribution and benefit. We can summarize four kinds: technical means, economic means, guiding means, administrative means.

### **2.2.1 Technical means**

Technical means, according to the specific management object, and the electrical characteristics of production and living habits, uses advanced technology of electricity saving with mature technology and management techniques and corresponding equipment to increase the efficiency of the terminal or change the mode of power consumption. The technical means changing the user's power consumption and improving the efficiency of terminal use are different.

#### **(1) Changing the mode of user's power consumption**

Technical means of changing the mode of user power consumption include:

##### **1) Direct load control**

Direct load control is a method that the system dispatcher controls the user's terminal power consumption through the load control device during the peak load period of the grid. Direct load control is mostly used in industrial power consumption control. And the priority control is carried out based on the minimum loss of power outages

##### **2) Time control and demand limitation**

The use of time control, demand limitation and other means can achieve intermittent and cyclic load control, which are ideal ways to control the power grid peak.

##### **3) Trough and seasonal electrical equipment**

Adding trough power equipment. In summer peak, the power grid can appropriately increase winter electrical equipment. In winter peak, power grid can appropriately increase summer power equipment. During daily low load periods, the electric heater or regenerator apparatus can be used to electrical insulation. In winter after night, the electric heating or electric heating air conditioner can be used to fill the valley.

### **2.2.2 Economic means**

Economic means of orderly power consumption refers to a variety of price, direct economic incentive and demand side bidding and other measures. Through these measures, stimulating and encouraging consumers to change the consumption behavior and the way of using electricity, installing and using efficient equipment, and reducing the power consumption and power demand. The price is set by the supply side, belonging to the economy control means. So, the user can only passive response. Direct economic incentive and demand side bidding belong to incentive economic means. The demand side bidding joins the competition, and users can active response. The users who make positive use of these measures have made a contribution to society, but also reduce their production costs, and even gain some benefits. Users who do not participate in electricity saving are not given economically encourage, but their economic interests will not be damaged.

### **2.2.3 Guiding and administrative means.**

The main guiding means are: Energy-saving knowledge publicity, information release, free energy audit, technology promotion demonstration, government demonstration and so on. There are two

main ways. One way is using various media to pass the user information, such as television, radio, newspapers, exhibition, advertising, brochures, books, mail etc. Another way is having direct contact with user to provide a variety of energy services, such as training, research, diagnosis, audit etc. Experience has proved that guidance means can last long time, has low cost and strong vitality. The key is to choose the right direction and build trust credibility.

#### **2.2.4 Administrative means**

Administrative means of orderly power consumption is a management activities that the government and the relevant departments regulate electricity consumption and market behavior by laws, standards, policies and systems in order to promote energy efficiency, avoid the waste and protect the environment.

### **3. Establishment of orderly power consumption index system based on multiple factors of electric load**

#### **3.1 The starting point of index system design**

The design of orderly power consumption index system based on multi factor comprehensive evaluation of power load consider the factors as follows:

##### **(1) The importance of load**

Orderly power consumption is an important means to balance the power supply and demand. In case of heavy load during the peak period of the use of electricity, the normal power consumption of the whole area can be guaranteed by means of shifting peaks and averting peaks. Orderly power consumption, according to the user's work nature and reliability, makes power rationing measures. During the power gap, first of all, ensuring the party and government organs, residents, schools, troops, hospitals and other important units and urban infrastructure using electricity. Next, making flood control and drought and summer harvest of summer safe, and taking commercial power into account. Last, strictly limiting the high energy consuming enterprises that do not meet the state's industrial policies and strictly controlling the power consumption of enterprises without installation of load monitoring devices

Therefore, in order to do orderly power consumption well, we should classify the customers according to the importance of the load.

##### **1) First-class user**

First-class is the important customer that relate to national economy and people's livelihood. So, the power supply reliability requirements are very high. Generally, do not allow blackouts or brownouts. If the power outage happens, it will cause casualties, equipment damage, social disorder and major economic losses. So, these users are willing to pay high prices to ensure the reliability of their power supply and, when necessary, building self - contained security power supplies to address reliability issues.

##### **2) Second-class user**

The second-class user is also an important customer, and this kind of customers demand higher reliability of power supply. If the power supply is interrupted, it will lead to production stoppage, product abandonment, traffic jam, and greater economic loss.

##### **3) Third-class user**

The third-class user refers to all the other customers except first-class and second-class. These customers demand less reliability of power supply. If the power supply is interrupted, it will cause little damage. Power failure and poor power quality only affect product output and will not affect product quality and production equipment damage.

user's load is more complex, and it may have one, two or three kinds of load. Some users are mainly based on one kind of load. Some other users based on two kinds of load. And there are also some users based on three kinds of load. Load regulation and orderly power consumption are according to the three kinds load of the various users.

## (2) Optimal allocation of energy

The establishment of index system of orderly power is to assess the efficiency of electricity users and power consumption mode. So the energy efficiency improves, making customers with high gross output pay priority to electricity, and maximizing the effectiveness of limited power resources.

## (3) excitation mechanism

Orderly power consumption is mainly to solve the contradiction between supply and demand during the peak period of electricity consumption, and limits the load on the user who has a bad mode of use of electricity and electricity. The establishment of evaluation index is to encourage users to consciously off-peak. On the other hand, it is conducive to the improvement of the irrational part in electricity using and energy-saving equipment utilization. And it can make users actively participate in the demand side management measures to improve their electricity priority and avoid blackouts losses.

### 3.2 Establishment of index system

Through consulting and researching the marketing staff of power grid enterprises and the experts and scholars, and according to the principle of the above index system, this paper establishes a set of index system for the comprehensive evaluation of orderly power consumption. It is shown in table 1. The index system is characterized by the full consideration of the impact of the social energy saving environment on electricity customers, society and enterprises.

Table 1. Index System of comprehensive evaluation of orderly power consumption

Index system of orderly power consumption based on multiple factors of electric load	Customer contribution rate D1	Power consumption of output value D11
		Purchasing power share D12
		Rate of return on electricity D13
	Line cost D2	Line loss rate D21
		Maintenance and operation cost D22
		Total investment of line body D23
	Substation cost D3	Total investment of substation D31
		Loss ratio D32
	Customer credit D4	Behavior of breach of contract electricity consumption D41
		The actual payment rate of this period is D42
		Cumulative contribution rate D43

The comprehensive evaluation index system of power ordered power supply involves 11 indexes, and the meanings and measures of each index are as follows:

#### (1) Power consumption of output value D11

Power consumption of output value refers to the electric energy consumed by electric power customers when they are engaged in production activities and produce products of certain value.

$$\text{Power consumption of output value D11} = \frac{\text{Customer monthly output value}}{\text{Monthly power consumption}} \quad (1)$$

#### (2) Purchasing power share D12

$$= \frac{\text{Actual electricity consumption this year}}{\text{Actual power consumption of all users this year}} \quad (2)$$

This index reflects the proportion of the user's electricity consumption. The higher the index value is, the greater the customer's current value is.

#### (2) Rate of return on electricity D13

$$= \frac{\text{Current annual electricity bills} - \text{current purchase price} * \text{current annual electricity consumption}}{\text{Current annual electricity consumption} * \text{current annual electricity consumption}} \quad (3)$$

The index reflects the contribution rate of the users to the grid enterprises. The higher the index value is, the higher the customer's current value is.

#### (4) Line loss rate D21

Line loss refers to the transmission and distribution of electrical energy (PSA) process, produced by the various components of the power grid in the power loss and power loss and other losses including coulometric from one side of main transformer in power plant (excluding electricity) to the user electric energy meter on all power loss.

$$\text{Line loss rate D21} = (1 - \text{power supply} / \text{power supply}) * 100\% \quad (4)$$

(5) Maintenance and operation cost D22

Maintenance and operation cost refers to the cost of the electric power company to maintain the safe operation and maintenance of the power grid. The higher the value index is, the lower the direct value that customer caused.

(6) Total investment of line body D23

Total investment in line body refers to the total investment of the line and its ancillary equipment in the process of power grid construction. The higher the value index is, the lower the direct value that customer caused.

(7) Total investment of substation D31

(8) Loss ratio D32

$$\text{Loss ratio D32} = \frac{\text{Transformer iron loss} + \text{copper loss}}{\text{Electrical energy flowing through a transformer}} \quad (5)$$

(9) Behavior of breach of contract electricity consumption D41

$$\text{Behavior of breach of contract electricity consumption D41} = \frac{\text{Frequency of breach of contract}}{10} \quad (6)$$

(10) The actual payment rate of this period D42

$$\text{The actual payment rate of this period D42} = \frac{\text{Current paid in electricity bill}}{\text{Current electricity bills receivable}} \quad (7)$$

(11) Cumulative contribution rate D43

$$\text{Cumulative contribution rate D43} = \frac{\text{Accumulated paid in electricity}}{\text{Accumulated electricity charge}} \quad (8)$$

#### 4. Conclusion

In this paper, the orderly power consumption index system based on multiple factors of electric load is constructed. Considering the influence of all the factors, the relationship between each index and customer value is analyzed. The index system not only contains the experience and knowledge of experts, but also combines qualitative analysis with quantitative calculation. It provides scientific decision-making basis for program staff. It has practical and practical significance.

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