Automatic Response Method of Grid Demand Under the Background of New Energy Consumption

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Abstract. Smart grid demand response can reduce the peak power demand of the grid, improve the stability and reliability of grid operation, especially the ability of the grid to accept intermittent renewable energy generation through demand response. In view of the abnormalities in the analysis of user demand caused by the traditional automatic response method of power grid demand, which caused large fluctuations in electricity prices, the automatic response method of grid demand under the background of new energy consumption was designed. Constructing a power grid model as the research object, constructing a time-of-use electricity price model according to the characteristics of power grid operation, and setting demand response incentive methods. Analyze the characteristics of user power consumption and grid load, and design the automatic response algorithm for grid demand. At this point, the design of the automatic response method for grid demand in the context of new energy consumption has been completed. Construct an experimental link, and the experimental verification shows that the new response method can effectively control electricity price fluctuations and improve user satisfaction.

Keywords: New energy consumption · Grid demand response · Incentive mechanism · Smart grid

1 Introduction

At the beginning of the 21st century, our country has experienced a rapid development stage in which the whole society and economy have developed rapidly and the people's living standards have improved significantly. At the end of the "Twelfth Five-Year Plan", my country's economy has entered a shifting period, and economic growth has slowed down. The environmental pollution caused by the production and use of electric energy under the traditional extensive energy use method has been closely watched by the public. With the advent of a new era of economic development, the growth rate of electricity consumption in the whole society has slowed down, and the overall supply and demand of electricity exceeds demand. The rational development of electric energy and efficient and clean utilization will become one of the first tasks to achieve the goal of structural transformation under the new normal of the economy [1]. In order to

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improve the power supply capacity of the power grid, it can be considered from two aspects: the transmission line of the power grid and the intelligent demand side response of the user side. Increase the current carrying capacity of the transmission line through the transmission line capacity increase technology, thereby improving the power supply capacity of the transmission line. By implementing demand response technology on the user side, researching smart load control technology on the residential side, effectively integrating user-side demand response resources, so as to improve the grid load curve, achieve peak shifting and valley filling, and improve the power supply capacity and operating efficiency of the grid.

Demand response related theoretical ideas were introduced into my country in the late 1980s. After more than 30 years of experimentation and exploration, it has been integrated into the characteristics of my country's electricity market. Now the peak-valley time-of-use electricity price mechanism has been implemented in most parts of the country, and peak electricity prices Mechanisms and interruptible load mechanisms are still in the exploratory period [2]. Intelligent and orderly use of electricity belongs to the power demand side management technology, which refers to the load forecast of all electrical equipment participating in the demand response based on the previous load data when the load is tight. Control the power status of the equipment. However, the traditional demand-side management and control methods are generally semi-automatic or manual control. Measures such as power-limiting and opening the switch cannot achieve intelligent power consumption, and have a negative impact on the normal production and life of power users. The development of the smart grid provides opportunities for the development of advanced measurement technology, load intelligent control, and grid communication technology. While providing technical support for the smart grid, it also provides intelligent services for end power users. The construction of smart grid has brought opportunities for the development of demand response technology, and has produced a series of new load control methods and measures. The use of smart grid two-way interactive technology to achieve flexible control of demand response resources and load dispatch through two-way communication between users and the grid is the development trend of smart grids in the future [3].

Based on the above research background, this study carries out research on the automatic response method of power grid demand under the background of new energy consumption. In this study, on the basis of in-depth understanding of the existing research results at home and abroad, the basic theory of demand response and new energy development is analyzed, and the typical load curve and power consumption characteristics in the current life are analyzed. On this basis, the paper summarizes the impact of new energy consumption on user load and its implementation. Then consider the government departments, power grid companies, power companies, such as user participation main body the best cost performance, and use for reference the experience of other countries successfully cope with the demand, put forward in accordance with the current development environment of electricity market incentive mechanism, and through building incentive effect evaluation index system and evaluation model to complete the design of the demand for power grid automatic response method.

2 Design of Automatic Response Method to Grid Demand Under the Background of New Energy Consumption

Based on the study of automatic demand response methods, this paper proposes a new type of automatic demand response method for power grids based on smart technology and the characteristics of the power grid. This method combines Internet technology and automatic demand response to construct an automatic demand response method. Through the analysis of the most commonly used information transmission methods, the automatic demand response method design of the grid under the background of new energy consumption is carried out. The research idea of this paper is shown in Fig. 1.

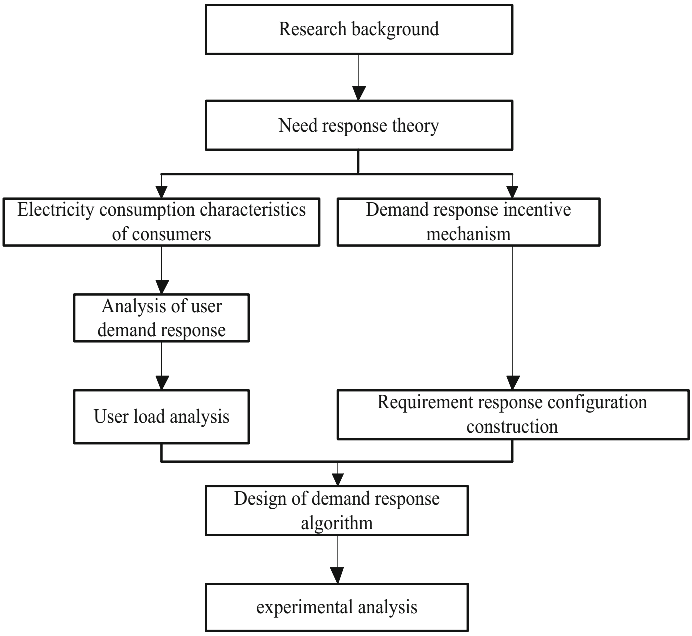

Fig. 1. Technical research route

According to the above images, the structure of the full text is arranged as follows:

First, explain the background and significance of the research of the thesis, then introduce the current domestic and foreign research status of demand response, and finally give the main work and content arrangement of this research.

Then, the related theories used in this research are mainly introduced. Including the basic theory of demand response, as well as the characteristics and key technologies of user management. The theoretical knowledge in this link provides the basis for the subsequent research and design of automatic demand response methods.

Then, design demand response incentive mechanism and simulation model. This link first comprehensively analyzes the interest linkage relationship between the participating entities, and on this basis, proposes a reasonable incentive mechanism; then, under the premise of comprehensively considering the costs and benefits of each participating entity, the incentive effect is constructed. Evaluation index system; Finally, the simulation analysis equation and model of the implementation effect of the incentive mechanism are proposed.

Finally, construct an experimental link to verify the effect of this method. Introduce the main research results of this research and the deficiencies in the research, and propose further research directions.

2.1 Grid Model Construction

There is no universally accepted unified definition of smart grid, and the focus of various definitions is different. According to the definition of the National Institute of Standards and Technology (KIST) [4], a smart grid is a network system that integrates a variety of digital computing, communication technologies and services into the power system infrastructure. It goes beyond the two-way flow of energy, two-way communication and control capabilities of smart meters in homes and businesses, and can bring new functions. The construction of smart grid can improve the robustness, self-healing ability and reliability of the grid. NIST proposed a conceptual model of the smart grid. This model supports the planning, requirements development, and documentation of the interconnected networks and equipment that make up the smart grid. NTST divides the smart grid into seven domains (including subdomains), including smart grid participants and applications. This conceptual model of the smart grid divides participants into participating equipment (such as smart meters and solar generators), systems (such as control systems), procedures, stakeholders who make decisions and exchange information to complete the application, as one or The application of tasks performed by multiple actors in a field (such as home automation, solar power generation, energy storage, and energy management). Based on the above content, the contents of the grid model construction in this study are set as follows (Table 1):

Table 1. Grid model elements

Element number	Element name	Content
1	Electricity users	Where electricity is used. Mainly for residential, commercial and industrial users. Participants can also generate, store and manage energy usage
2	Electricity market	The place where electricity is traded. Participants are operators and participants in the electricity market
3	Service provider	Provide service support for manufacturers, distributors and users. Participants are organizations that provide services to power users and utilities
4	Operator	Ensure the normal operation of the power system. Participants are managers of power transmission
5	Large power plant	Source of electricity. Participants are power plants that generate large amounts of electricity, and can also store energy for later distribution
6	Power transmission	It is a long-distance power operator that completes the batch transmission of electricity from generation to distribution, and can also store and generate electricity
7	Power distribution	Realize power transmission, consumption metering, distributed power generation and distributed storage to users. Participants are power distributors who manage the transmission of power to users or receive information from users

According to the content in the above table, combined with the "partial" modeling idea [5] to complete the grid model construction process. The "partial" modeling idea is to model various types of equipment and various energy systems separately. This type of modeling idea first performs detailed modeling of various equipment components, and then lists the corresponding energy balance equations according to the system energy type. The typical representative of this modeling idea is the smart grid modeling idea based on the energy bus architecture proposed in the literature. This idea first classifies the bus according to the energy transfer medium, and divides the equipment into the source and the conversion device according to the role of the energy conversion process equipment., Energy storage and load; then analyze and model various types of equipment respectively; finally, write the energy balance equations according to the energy balance of various types of buses. The focus of this modeling idea is the internal structure of the system and the conversion relationship of energy flow. Assuming that the power grid is composed of N nodes and l transmission lines, the DC power flow equation after dimensionality reduction (one node is selected as the reference node) can be expressed as:

$$BW = I \tag{1}$$

Among them, W is the $(N-1)$ dimensional node voltage phase angle vector, when W is known, the power flow on any transmission line can be calculated, I is the $(N-1)$ dimensional node injected power vector, W is the $(N-1)(N-1)$ dimensional node voltage matrix, if $\partial(n)$ Representing the set of neighbor nodes of node n, there are:

$$B_n = \begin{cases} \sum h_n & n \in s \\ -h_n & h \in \partial(n) \\ 0 & otherwise \end{cases} \tag{2}$$

where h_n is the voltage of the transmission line between node $n-1$ and node n. Use this model as the basis of this research.

2.2 Time-of-Use Electricity Price Model Construction

According to the new energy consumption requirements, the grid model constructed in the above article is the carrier, combined with the time-of-use electricity price mechanism [6], to construct a demand response model. The principle of the time-of-use electricity price mechanism is to divide it into three periods of peak, flat, and valley according to the changes in the daily load curve within a day, and set reasonable electricity price levels respectively. Compared with before the implementation of time-of-use electricity prices, user load will be adjusted according to the electricity price level of time-of-use electricity prices. The ratio of the load change over a period of time to the electricity price change is called the elasticity of demand. Obviously, the user's response to the electricity price level includes not only the single-period response to the current period of electricity price and the multi-period response to other periods. Under the peak-valley time-of-use price mechanism, it is derived from the elasticity coefficient and the cross-elasticity coefficient, which respectively represent the user's response to the electricity price. Single-period response and multi-period response.

Based on the principles of economics [7], the elasticity coefficient α refers to the change in electricity demand caused by the fluctuation of the electricity price, and its mathematical value should be the ratio of the amount of electricity change to the amount of electricity price change, as shown below.

User's self-elasticity coefficient:

$$\alpha_{ii} = \frac{\Delta S_i / S_i}{\Delta D_i / D_i} \tag{3}$$

User's cross elasticity coefficient:

$$\alpha_{ij} = \frac{\Delta S_i / S_i}{\Delta D_j / D_j} \tag{4}$$

The calculation process of defining the amount of change in electricity consumption during a certain period of time is as follows:

$$\Delta S_i = \int \left[f_T(D_f, D_s, D_e) - f(D_i) \right] dt \tag{5}$$

$$\Delta D_i = D_T - D_i \tag{6}$$

In the formula: D_i represents the electricity price in the period i before the implementation of the peak-valley price; ΔD_i represents the change in the electricity price of the user during the i period before and after the implementation of the peak and valley price; ΔS_i represents the change in the electricity consumption of the user in the i period before and after the implementation of the peak-valley time-of-use price; D_T Represents the electricity price in the i period after the time-sharing management is implemented; D_f, D_s, D_e represents the electricity price in the peak, flat, and valley periods respectively; $f_T(D_f, D_s, D_e)$ represents the load in the i period after the time-sharing management is implemented, which is a function of the electricity price in each period of peak, flat and valley; $f(D_i)$ represents the implementation of the split When managing the user load in the first i time period, there is a functional relationship with the electricity price D_i at time i; if $\Delta D_i = 0$, the self-elasticity coefficient of the user in the i time period is 0; $\Delta D_j = 0$, the cross-elasticity coefficient of the user in the i time period is 0. The electricity price elasticity matrix is expressed as:

$$E = \begin{bmatrix} \alpha_{11} & \alpha_{12} & \cdots & \alpha_{1n} \\ \alpha_{21} & \alpha_{22} & \cdots & \alpha_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ \alpha_{n1} & \alpha_{n2} & \cdots & \alpha_{nn} \end{bmatrix} \tag{7}$$

Electricity demand after user response:

$$\begin{bmatrix} D_1^* \\ D_2^* \\ \cdots \\ D_n^* \end{bmatrix} = \frac{1}{n} \begin{bmatrix} D_1 & & & \\ & D_2 & & \\ & & \cdots & \\ & & & D_n \end{bmatrix} E \begin{bmatrix} \Delta S_1 / S_1 \\ \Delta S_2 / S_2 \\ \cdots \\ \Delta S_n / S_n \end{bmatrix} + \begin{bmatrix} D_1 \\ D_2 \\ \cdots \\ D_n \end{bmatrix} \quad (8)$$

The above is a typical basic model of demand response based on the time-of-use electricity price mechanism. The main principle is that users adjust their own electricity consumption according to price changes, reduce electricity in the current period, and perform load transfer during cross-period periods. Through the demand elasticity matrix of formula (8), users Based on the load change and power after the electricity price change.

2.3 Demand Response Incentive Mode Setting

The user's willingness to participate in demand response projects is based on the premise that the benefit of demand response is greater than the cost of demand response. The benefit of demand response is closely related to the demand response incentive method. Specifically, it is mainly the type of demand response incentive, the price of power products, and the price of power products. There are three factors in government subsidies.

At present, demand response incentives are usually divided into two types: price-based demand response projects and incentive-based demand response projects [8]. These two types of projects have their own advantages and disadvantages: price-based demand response projects have most control signals. The control cycle is based on "hours". The power user's power load cannot be adjusted quickly according to the changes in the output of new energy, and it cannot ensure the economic and safe operation of the new energy after it is connected to the power system; the demand response project based on incentives is basically It can directly control the power load, can respond to the volatility and randomness of new energy in a timely and accurate manner, and respond to system signals, which has more advantages in the integration and consumption of new energy.

According to the analysis result of the incentive type, analyze the demand response method and complete the selection process. At present, there are two most widely used demand response methods: one is the time-of-use price, and the other is the interruptible load. The electricity price level during peak, flat, and valley periods has a key impact on users' electricity bills. Only when the saved electricity bills are greater than the loss caused by load reduction, can users take the initiative to adjust their electricity consumption behavior [9]. Based on the above analysis results, construct an incentive mechanism for maximizing benefits and evaluate its use effects. The specific evaluation indicators are as follows (Table 2):

Table 2. Evaluation indicators of demand response incentive mode

Evaluation index level	Evaluation index number	Evaluation index
I	1	Demand response participation
I	2	New energy access ratio
I	3	Avoidable peak load ratio
II	4	Load rate increase ratio
II	5	Benefit sharing ratio
III	6	Government subsidies
III	7	User Earnings Ratio
III	8	Grid Company Earnings to Cost Ratio
III	9	Profit-to-cost ratio of power generation companies
III	10	Emission reduction benefits

In order to objectively and reasonably evaluate the incentive effect of the user demand response incentive mechanism, the selected evaluation indicators must not only reflect the demand response benefits and demand response costs of various stakeholders, but also reflect the consumption of new energy. Factors such as the impact of the impact on the power system. Based on the above research and combined with the principle of indicator selection, the following indicators are proposed to evaluate and analyze the implementation effect of the incentive mechanism constructed in the previous section.

2.4 Analysis of User Electricity Consumption Characteristics

According to the parameter requirements of the time-of-use electricity price model constructed above and the incentive mode, the user's electricity load is analyzed and used as the main content of the grid demand response. Electric load characteristic indexes are the basis for analyzing electric load characteristics. After long-term development, a complete load characteristic index system has been formed. These load characteristic indexes are commonly used in power grid planning and load forecasting. There are many indicators of power load characteristics, which are mainly divided into two types: numerical type and curve type. Some reflect the overall situation of power load characteristics, which are mainly used for horizontal comparison between domestic and foreign regions; some load characteristic indicators are mainly used for analysis and calculation of power system planning and design. In order to facilitate the analysis of load characteristics in practical applications, load characteristic indicators can be divided into three types: description, comparison and curve [10]. There are many power load characteristic indexes, and different load characteristic indexes have different functions, which reflect the different characteristics of electric load and are applied to different analysis needs. The following only analyzes and studies a few commonly used load characteristic indexes.

Daily load rate and daily minimum load rate:

Daily load rate and daily minimum load rate are used to describe the characteristics of the active daily load curve, indicating the unevenness of the power load distribution in a day, the daily load rate and daily minimum load rate and the nature, category, production shift and system of the power user Factors such as the proportions of various types of electricity consumption in the country are related to, and at the same time, related to the measures to adjust the load. It is defined as follows:

Daily load rate and daily minimum load rate:

$$U_1 = \frac{E_{all}}{E_{\max} \times 24} \times 100\% \tag{9}$$

$$U_{\min} = \frac{E_{\min}}{E_{\max}} \times 100\% \tag{10}$$

In the above formula, E_{all} represents the total daily power consumption; $E_{\max}$ represents the maximum daily power consumption; $E_{\min}$ represents the minimum daily power consumption; U_1 represents the daily load rate; $U_{\min}$ represents the minimum load rate.

Monthly load rate:

The monthly load rate is also called the monthly imbalance coefficient, which mainly reflects the influence of power users due to shutdowns, minor repairs of power equipment, or the addition of new power users. The change in the monthly load rate is mainly related to the composition of power users and the season of load. Sexual changes and holidays are closely related. The specific definition is as follows:

$$U_2 = \frac{M\overline{E}}{ME_{\max}} \times 100\% \tag{11}$$

In the above formula, $M\overline{E}$ represents the monthly average daily electricity consumption; $ME_{\max}$ represents the monthly maximum daily electricity consumption.

Seasonal load rate:

The quarterly load rate is also called the quarterly unbalanced coefficient, which is similar to the monthly load rate. It mainly reflects the seasonal changes in the electrical load of power users. For example, the factors that affect the quarterly load rate are mainly the seasonal configuration of electrical equipment and annual overhaul. Or the annual increase in power load, etc. The specific definition is as follows:

$$U_3 = \frac{ME_{\max}}{Y_{\max}} \tag{12}$$

In the above formula, $ME_{\max}$ represents the average value of the sum of the maximum monthly loads throughout the year; $Y_{\max}$ represents the maximum annual load.

Annual average daily load rate and annual load rate:

(1) The annual average daily load rate mainly reflects the influence of the power load of the tertiary industry. The specific definition is as follows:

$$U_4 = \frac{\frac{1}{12}\sum ME_{\max}}{24 \times \frac{ME_{\max}}{12}} \times 100\% \tag{13}$$

In the above formula, U_4 represents the annual average daily load rate.

(2) The annual load rate is a comprehensive load characteristic index, which is mainly related to the changes in the power load structure of the tertiary industry. Under normal circumstances, the annual load rate will increase with the increase in the proportion of electricity consumption in the secondary industry. Rising, on the contrary, will decrease as the proportion of electricity consumption by the tertiary industry and household electricity consumption increases [11]. The specific definition is as follows:

$$U_5 = \frac{\overline{Y}}{Y_{\max}} \times 100\% \tag{14}$$

In the above formula, $\overline{Y}$ represents the average annual load. Use the above formula to complete the calculation process of the load characteristics of the grid and grid users, and use this calculation result as the constraint condition of the grid demand response.

2.5 Demand Response Algorithm Setting

According to the analysis in the previous section, the essence of demand response for the optimization of social benefits is to make decisions for each power supply station/user within the scope of the power supply capacity of the power supply station and the user's basic power demand under the premise of meeting the basic constraints of power transmission. The power supply/power consumption is optimized to optimize social benefits. It can be seen that demand response should first ensure the safety and stability of the power grid, and then pursue the value of social benefits. If a power supply/power use decision-making scheme will cause one or more transmission lines to be overloaded and fail, then this scheme is unacceptable regardless of the social benefit value, because it will undermine the stability of the power grid [12]. On the contrary, if a power supply/power use decision-making scheme can avoid overloading of any transmission line in the transmission grid, then this scheme is acceptable even if the social benefit value generated by this scheme is not optimal [13]. In this study, the rapid demand response algorithm was used as the design basis to construct the demand response algorithm used in this study.

Set the initial search times $a = 0$, search factors $\beta = 0$, $\beta_i > \beta_j > 0$, and search accuracy coefficient $p > 0$. Regardless of the power transmission constraints, calculate the output power $\overline{k_j}$ of each power supply device j and the electric power $\overline{g_j}$ of each user i, that is, solve the following convex optimization problem:

$$\begin{aligned} &\min \beta_2 \sum l_j(\overline{k_j}\eta) - \beta_1 \sum l_j(\overline{g_j}\eta) \\ &\sum \overline{k_j} = \sum \overline{g_j} \end{aligned} \tag{15}$$

Calculate the voltage phase angle χ_n^t on each node n according to the following formula, and then calculate the power w_n^t flowing through each transmission line according to formula (15).

$$l_n\overline{k_j} - l_n\overline{g_j} - \sum (\chi_n^t - \chi_{n-1}^t)/u_{n,n-1} = 0 \tag{16}$$

According to the above formula, calculate the average violation degree Q of the transmission line load constraint:

$$Q = \frac{1}{N}\sum \max(|\chi_n^t| - \chi_n^{\max}, 0) \tag{17}$$

If $Q = 0$, and $y = 0$ or $\beta_u - \beta_l < e$., Each power supply station j uses EGC to set its output power in this period to $\overline{k_j^t}$, and each user i uses ECC to set its power consumption to $\overline{g_j^t}$, and then exits the calculation. If $Q > 0$, then update $\beta_l = \beta$ and calculate $f_1(\beta_u, \beta_l, Q)$; otherwise, update $\beta_u = \beta$ and calculate $\beta = f_2(\beta_u, \beta_l)$. Solve the following optimization problem, update the output power $\overline{k_j^t}$ of each power supply station j and the electric power $\overline{g_j^t}$ of each user i, then update $y = y + 1$, and turn to step 3. According to the content of the algorithm set above, the content set above is integrated into this calculation process, so as to realize the automatic response process of the grid demand. At this point, the design of the automatic response method for grid demand in the context of new energy consumption has been completed.

3 Experiment

3.1 Experimental Platform Construction

In this paper, an automatic response method to grid demand under the background of new energy consumption is proposed. In order to verify the effect of this method, in this study, an experimental link is constructed to analyze it. The simulation experiment form is used in this research to complete the experiment process. In order to achieve a high degree of simulation of the smart grid, CORE is used to simulate the operation of the smart grid. CORE has scalability, customization, and a good human-machine interface. It can construct various types of virtual network scenarios, and run applications and network protocols submitted by users without modification to test its performance and feasibility. CORE can also establish connections with virtual networks constructed by other network simulation software or even real networks. The structure of CORE usage process is set as follows (Fig. 2):

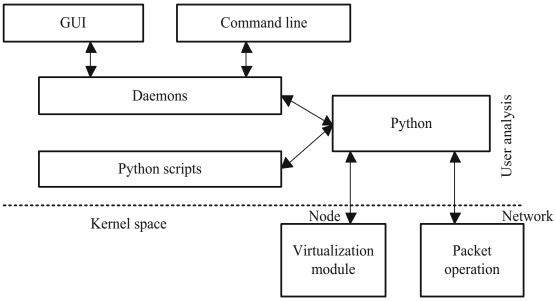

Fig. 2. CORE use process framework

Using the above framework to complete the simulation process of the smart grid, in order to test the feasibility of the method proposed in the article, a set of computer management software was developed for node configuration and visual analysis of the information collected by the coordinator device. Among them, the information collection subsystem The coordinator device transmits the collected information to the computer through the serial port, and uses this platform to complete the experiment comparison process.

3.2 Experimental Protocol Setting

In the course of this experiment, the experiment comparison index is set as the economic benefit growth rate after application, the fluctuation range of power price and the stability of the grid load. The comparison process between the new automatic response method and the traditional method is completed by the experimental comparison index set above. In the experiment, CORE was used to build a smart grid model, the new automatic response method and the traditional method were used to complete the response process according to the grid demand, and the method comparison process was completed according to the indicators set above. In the experiment, each group of indicators was tested 5 times, and the use effect of the new response method and the performance difference of different response methods were determined based on the results of these 5 experiments.

3.3 Analysis of Results

Table 3. Economic benefit growth rate

Instructions	Comparison item	Calculation results/%
New response method	Highest economic benefit growth rate	5.14
	Minimum economic benefit growth rate	4.57
	Average economic benefit growth rate	4.89
Traditional method 1	Highest economic benefit growth rate	3.15
	Minimum economic benefit growth rate	2.27
	Average economic benefit growth rate	2.84
Traditional method 2	Highest economic benefit growth rate	2.15
	Minimum economic benefit growth rate	1.95
	Average economic benefit growth rate	2.07

It can be seen from the above experimental results that both the new response method and the traditional response method can increase the economic benefits of power enterprises, but there are certain differences. The results show that this method can enable power companies to obtain higher economic growth rates and higher economic benefits, while ensuring the stability of the power grid and user satisfaction, while improving the economics of power grid operation. Compared with the new response method, the economic growth rate of the traditional method is relatively low. Under the premise of pursuing economic benefits, its use effect is not as good as the new response

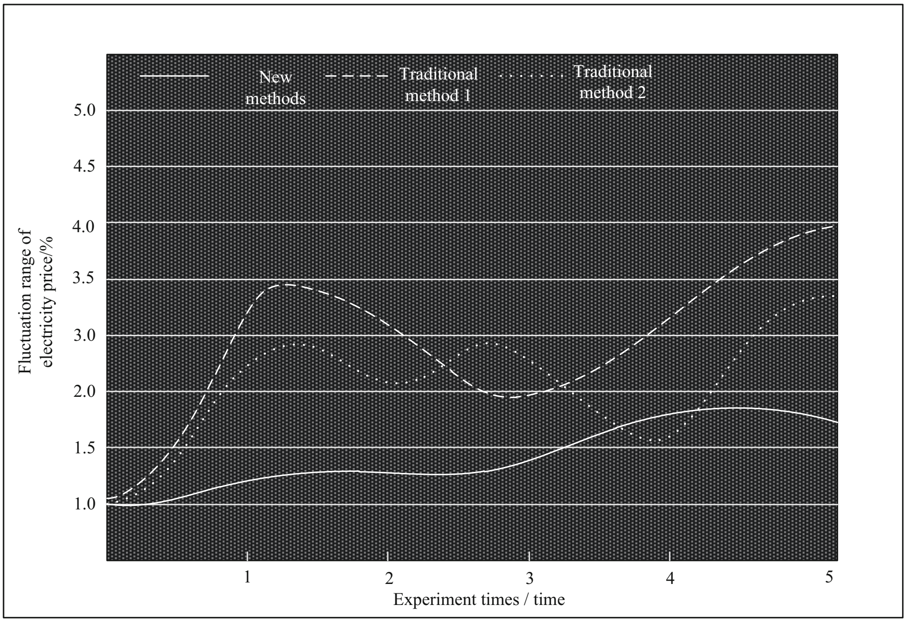

Fig. 3. Electricity price fluctuation range

method. Based on the above analysis results, the new response method is more effective (Table 3 and Fig. 3).

After analyzing the above experimental results, the fluctuation of electricity prices after the application of different methods is determined. According to the analysis results, it can be determined that the new response method has a control effect on the stability of electricity prices, and after it is used, it can ensure that users accept electricity prices. Changes to avoid a decline in user satisfaction. The traditional method of electricity price fluctuates greatly. This situation will cause the problem of increased user dissatisfaction, which is unfavorable to the management and operation of power companies. Therefore, the new response method can be used as the main demand response method in the subsequent development of power enterprises (Fig. 4).

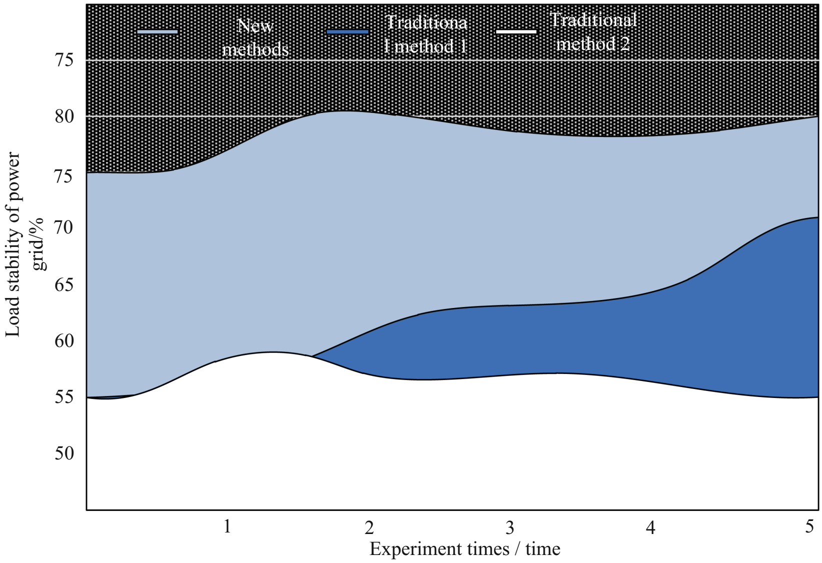

Fig. 4. Grid load stability

After analyzing the above experimental results, it can be seen that the new response method proposed in the article can effectively ensure the stability of power grid operation. After using this method, the operating state of the power grid can effectively ensure that users' power demand is met, while improving the power grid operation effect, reducing power price fluctuations, and improving users' evaluation of the power grid. Compared with the new response method, the traditional method cannot achieve the use effect of the new response method. The load rate of the power grid fluctuates greatly and the stability of the power grid operation is poor. Therefore, it can be determined that the new response method is more effective.

4 Discuss

Electricity demand response is that electricity users change their inherent electricity consumption patterns through electricity price signals or policy incentives in the electricity market, thereby adjusting load demand, optimizing electricity consumption behavior, saving energy, and optimizing resource allocation. At the same time, it contributes to the stability of the electricity market and the grid. Reliability has played an effective role in promoting. Based on the power demand side response, this research mainly studies three aspects: typical power user load characteristic classification technology, typical power user load characteristic analysis and power demand response algorithm. Based on the classification of power users' load characteristics and the analysis of typical power users' load characteristics, this research analyzes and studies the demand response of typical power users. In general, this topic has basically completed the scheduled tasks, but due to limited time and energy, there are still many areas that need to be improved. If you continue to conduct in-depth research, the main aspects are as follows:

The research in this paper uses numerical simulation to verify the effectiveness of the proposed method. To make the demand response method effective for the actual power grid system, it is necessary to build the actual physical environment of the simulated power grid and carry out physical simulation research. In this way, the proximity of the simulation environment and the actual working environment can be more reflected, and various factors of the power grid can be more fully and truly reflected. It is recommended to carry out physical simulation research in the follow-up research.

The demand response problem needs to consider the interests of both power supply companies and power users, which involves a number of indicators and parameters. When the demand response problem is transformed into an optimization problem, how to select the corresponding weight of each parameter remains to be further studied.

In future research, the energy optimization of typical power grids with distributed power sources and energy storage should be carried out to demand response models based on multi-dimensional grid systems to reflect continuity and integrity. Genetic algorithms should be used to simulate the bidding process, and only smart grids should be considered. The cooperation model for the non-cooperative model is not reflected. Future research should integrate the power grid control theory with demand response more deeply, explore the analysis process of the status of each user's main body on the demand side, and realize the optimization of the interests of each user main body.

5 Conclusion

In response to the energy crisis and environmental degradation, the construction and research of the Energy Internet is currently in full swing around the world. In recent years, my country has also issued a series of favorable policies to support and promote the construction of the Energy Internet. As the end energy supply system of the Energy Internet, the smart grid integrates a variety of energy sources and is equipped with various energy conversion and energy storage equipment. It is a complex comprehensive energy utilization, conversion, storage and distribution system. In this study, the automatic response method of power grid demand under the background of new energy consumption was studied. In this study, the construction of power grid model as the research object, according to the characteristics of power grid operation to build a TOU price model, and set up the demand response incentive method. The characteristics of power consumption and power grid load are analyzed, and the automatic response algorithm of power grid demand is designed.

However, the method proposed in the article is implemented in a hypothetical future integrated energy market. The current energy market is independent, a multi-energy market has not yet been established, and the development of the future multi-energy market will be greatly affected by national policies, and it cannot be used in the actual energy market. The verification of the practicability and accuracy of the proposed model is still at the stage of theoretical analysis. Therefore, in the following research, in order to ensure the application effect of the method in this paper, the method in this paper should be put into use and further optimized through more data.

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