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Research on the method of power grid investment considering the difference and common points of binomial coefficient and variation coefficient

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Abstract: *In order to achieve multiple goals such as ensuring power security, stable operation, driving industrial development, and implementing the "carbon peak, carbon neutral" action plan, this paper builds a smart grid investment decision-making evaluation calculation method model, and expounds the derivative value of investment from an economics perspective. concept, constructs a multi-scenario-oriented derivative value investment criterion, and sorts out the smart grid investment method based on the promotion approach and industrialization method; puts forward the smart grid investment derivative value evaluation index system and its screening criteria; mixed binomial coefficient method and The coefficient of variation method constructs a subjective and objective fusion evaluation method of multi-objective dynamic balance. It has certain advantages in processing large-scale index data and can dynamically adapt to different evaluation scenarios and needs.*

Keywords: *Power Grid Investment, Smart Grid Investment, Mixed Binomial Coefficient*

1. Introduction

At present, the situation at home and abroad is complex and changeable, and power grid investment decision-making faces many challenges. On the one hand, there are various external factors to be considered for grid investment, such as supporting high-quality economic development, promoting energy transformation, ensuring power supply security, and enhancing the competitiveness of the state-owned economy; At the same time, the investment supervision of central enterprises in China has been continuously strengthened, and the supervision and examination of transmission and distribution pricing costs have become stricter. The pressure on grid operation assessment and investment capacity has doubled. On the other hand, the uncertainty of power grid investment increases, which requires dynamic balance between investment demand and investment capacity, long-term development and short-term demand. Therefore, it is very necessary to use the grid investment derivative value evaluation technology to quantitatively analyze the derivative value of the grid driving economic and social development under the multi-dimensional value expectation, promote the linkage of energy related industries, enable the grid to build related industries, cultivate new businesses and new formats with high investment value, and promote the formation of a new ecology of energy Internet. The evaluation model of smart grid investment derivative value is divided into two parts: indicator system and weighting method. Establish the unit level effective capital input and output evaluation system, and build an indicator system from four perspectives of assets, costs, benefits and efficiency; Literature [1-4] built an index system for the evaluation of the investment value of power grid planning projects in the current environment on the basis of three levels of technology, efficiency and project maturity. The construction of smart grid investment derivative value indicator system should combine the input-output theory and value evaluation methods, and link grid planning investment derivative value [5]. In addition, weighting methods can be divided into subjective weighting methods, objective weighting methods and combination weighting methods. The mainstream subjective weighting methods mainly include analytic hierarchy process, Delphi method [6], binomial coefficient method [7], etc. The binomial coefficient method stands out for its simple process and fast calculation, which is suitable for processing large-scale index data; The mainstream objective weighting methods mainly include entropy weight method, OPSIS method [8], coefficient of variation method [9-12], etc. Among them, coefficient of variation method has a fast calculation speed, which is flexible and convenient for programming; The mainstream combination weighting methods generally use multiplication synthesis

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and linear weighting to combine methods. Linear weighting can achieve dynamic balance of multiple evaluation objectives by adjusting the combination factor according to the needs of actual scenarios. This paper focuses on the quantitative analysis method of grid investment derivative value. Based on the demand of "carbon peaking[13-17], carbon neutralization", it explores the value derivative mechanism and comprehensive value evaluation method of power grid for economic society driven by investment, builds the evaluation model of grid investment derivative value, establishes the index system of grid investment derivative value, and puts forward the evaluation method of grid investment derivative value, so as to achieve coordinated service for the overall situation, ensure power security, stable operation Drive industrial development and other multiple objectives. Through the dynamic balance of multiple objectives, the derivative value of power grid to drive economic and social development is evaluated. Case analysis proves the rationality of the method proposed in this paper[18-20].

2. Grid structure

The rapid development of demand response technology has also made it possible to regulate such loads. The regulation of generalized energy storage through direct load control can effectively suppress power fluctuations caused by distributed power generation when the distribution network is operating in islands, and reduce traditional energy storage match. It is of great significance to improve the stability and economy of the distribution network. At present, scholars have carried out research on the control strategy of generalized energy storage. In the generalized energy storage control with heat storage characteristics, a temperature priority sequence control strategy is proposed to realize the orderly start and stop of the heat pump; on this basis, the minimum start and stop time blocking constraints are set to avoid the continuous control of the electric water heater; Considering the frequent start and stop of the heat pump, grouping constraints are set to reduce the number of start and stop of the heat pump[21].

The above literature provides a reference for realizing the orderly start and stop of the controlled equipment and reducing the number of starts and stops, but does not fully consider the difference in the number of times each equipment is controlled, and cannot guarantee the fairness and rationality of the load control, which will result in user satisfaction. In terms of generalized energy storage control with energy storage characteristics, a secondary frequency regulation model for electric vehicle clusters is established the power distribution strategy based on the state of charge of electric vehicles, but a model that accurately characterizes the energy storage capacity of electric vehicles has not been established; a complete evaluation model of electric vehicle cluster energy storage capacity has been established considering user needs, and a frequency control strategy based on state identification sorting is proposed[22].

In terms of generalized energy storage collaborative control, the current research mainly focuses on the collaborative control of generalized energy storage and traditional battery energy storage, while there are still few researches on generalized energy storage collaborative control strategies for different types (heat storage, electricity storage etc.).Considering the communication delay, a coordinated frequency control strategy of electric vehicle and electric heat pump is proposed, and the resource with large stability margin is preferentially selected to participate in the regulation. The coordinated control strategy of electric vehicle and temperature-controlled load is proposed, which is carried out according to the priority order of electric vehicle-temperature-controlled load regulation. The above-mentioned cooperative control of generalized energy storage only allocates power according to the capacity or type of generalized energy storage, without in-depth analysis of the power response characteristics of different types of generalized energy storage, and cannot fully realize the coordination of multiple types of generalized energy storage.

3. Simulation test

It is obviously that the influence of the moment of inertia is mainly in the high frequency band. With the increase of the amplitude margin increases and the system stability is improved. That is increasing can increase the inertia of the system and enhance the suppression of fluctuating power. It can be seen that the increase of the damping coefficient will increase the phase angle margin and improve the system stability, but the improvement is small. The magnitude of the moment of inertia and the damping coefficient have a great influence on the response time of the controlled object, so the design parameters should be reasonably selected according to the control requirements.

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That can be seen which under the traditional control strategy, it is difficult for the hybrid energy storage system to effectively suppress the power fluctuation on the bus when there is power fluctuation on the DC bus, resulting in a large fluctuation of the bus voltage. The simulation waveform of the hybrid energy storage inertial control strategy is adopted, in which the photovoltaic still adopts constant voltage droop control, and the battery and super capacitor adopt the droop inertial control strategy. It can be seen that under the hybrid energy storage inertia control strategy, each module of the DC microgrid maintains the original power distribution relationship, and the output power of the battery becomes smooth. At the same time, the hybrid energy storage system can better suppress the power fluctuation on the DC bus to keep the DC bus voltage stable.

It also issues power adjustment instructions to air conditioners and electric vehicle clusters to achieve smoothing of power grid power fluctuations. This process avoids the communication with the grid dispatch center and can realize the autonomous control of the generalized energy storage cluster. For example, after the load aggregator detects the frequency deviation of the power grid, the power adjustment signal is obtained through the PI controller, and then the low-frequency component of the power is allocated to the air-conditioning cluster and the high-frequency component to the electric vehicle cluster through the low-pass filtering link, so as to fully satisfy the Power Response Characteristics of Air Conditioning and Electric Vehicle Clusters. In addition, the air conditioner cluster responds to low frequencies of power.

4. Conclusion

Responding to the power fluctuation on the DC bus, reducing the fluctuation range of the bus voltage and maintaining the stability of the DC micro-grid system, it can also smooth the power output of the battery and prolong the service life of the battery. A distribution network cooperative control strategy considering the participation of generalized energy storage clusters is proposed. For air conditioning clusters, an improved temperature priority sequence control strategy is proposed. For electric vehicle clusters, a power distribution strategy based on SOC is proposed. Simulation examples verify the effectiveness of the proposed control strategy.

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