Optimization of power rationing order based on fuzzy evaluation model

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Abstract. With the development of production and economic growth, China's electricity load has experienced a significant increase. Over the years, in order to alleviate the contradiction of power shortage, a series of policies and measures to speed up electric power construction have been made in china, which promotes the rapid development of the power industry and the power construction has made great achievements. For China, after large-scale power facilities, power grid long-term power shortage situation has been improved to some extent, but in a certain period of time, the power development still exists uneven development. On the whole, it is still in the state of insufficient power, and the situation of power restriction is still severe in some areas, so it is necessary to study on the power rationing.

1. Introduction

With the rapid development of national economy and the continuous improvement of people's living standard, the peak valley difference of power grid is increasing day by day. As the power in the current level of technology cannot be a lot of storage, and the power system of the hair, lose, power distribution needs to be carried out at the same time[1].Once there is any problem in the power system, it will spread to other links, and even cause irreparable damage. Therefore, switching power limit during overload of power grid has a great significance of ensuring the safe operation of power grid, guaranteeing the quality of power consumption and alleviating the peak power shortage. Making reasonable power rationing optimization scheme can not only increase the income of enterprises, but also optimize the allocation of resources, so as to realize the sustainable development of the country.

2. Analysis of influencing factors on optimization of power rationing order

Power rationing refers that on the basis of satisfying the constraint condition of the generator set or the power system operation, when the power grid is overloaded, the part of the load is cut off by the power supply enterprise, through the power cut load to ensure that the time to participate in the operation of the unit and the unit in the run-time output are under normal circumstances, so that the total operating costs of the system and the loss of social benefits at least. The power rationing is of

great significance to improve economy and reliability of power system operation and the utilization efficiency and comprehensive utilization level of the power system.

Many factors affect the power rationing order optimization scheme determined, these factors are uncertain, and mutually influence each other, which can be divided into economic, technological, social and environmental factors. Economic factors mainly include potential value of power customers, economic value of power customers, power supply interruption loss and other factors[2];technical factors include power market equilibrium, power market operation, power system trends and other factors; social factors include household electricity consumption, political electricity conservation, high risk customer power supply and other factors; environmental factors include social sustainable development, ecological environment and other factors. Specific factors are shown in the following figure 1.

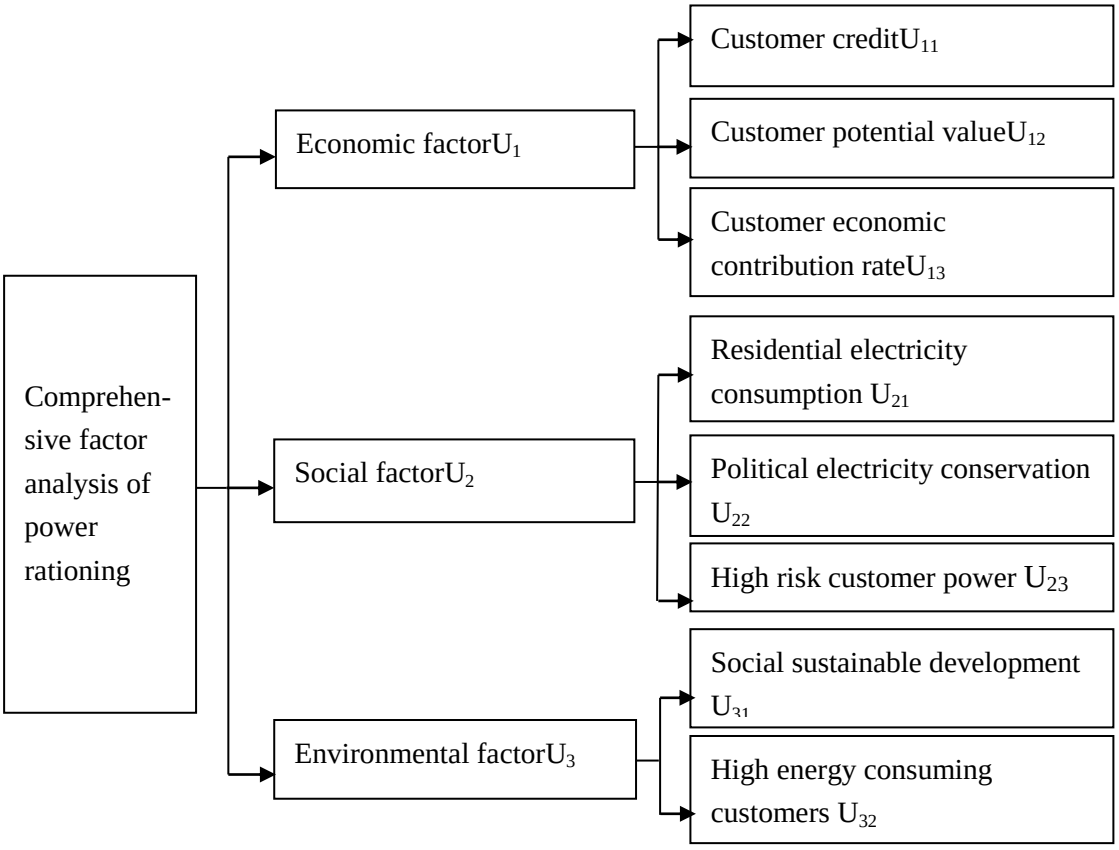

Figure 1. Hierarchical relationship of factors influencing power rationing

3. Evaluation model of power rationing order optimization

There are many factors or indexes involved in the power rationing, which requires the comprehensive evaluation of the things according to these factors or multiple indexes. So you can't judge things only from one factor. Fuzzy comprehensive evaluation decision is a very effective multi factor method for comprehensive evaluation of things affected by many factors [3].In this paper, the fuzzy evaluation model is used to study the comprehensive factors influencing the power rationing of the power system,

and the evaluation model of the power supply system is established, which provide us an evidence for developing a reasonable policy decision of power rationing order optimization.

3.1. Fuzzy comprehensive evaluation method

Fuzzy comprehensive evaluation refers to finding a weight vector A={a1,a2,…,ai,…,am}∈F(U), and a fuzzy transformation f from U to V, that is, to make a judgment of each factor ui individually. f(ui)=(ri1,ri2,…,rin)∈F(V), i=1,2,…,m, in view of the above, the fuzzy matrix is formed, that is R=[rij]∈F(U×V),among them,rij represent factor ui, which have the degree of comment vj.That is to say, the membership degree of vj in fuzzy set B.

Thus it can be seen that the mathematical model of fuzzy comprehensive evaluation involves three factors:

(1)Factor set U=$\{u_1, u_2, u_3, \dots, u_m\}$;

(2)Decision set V=$\{v_1, v_2, v_3, \dots, v_n\}$;

(3)Single factor judgment f: U→ F(V), $u_i| \rightarrow f(u_i) = (r_{i1}, r_{i2}, \dots, r_{in}) \in F(V)$.

F induced fuzzy relation:$R_f \in F(U \times V)$, among them, $R_f(u_i, v_j) = f(u_i)(v_j)$, so the R_f can form fuzzy matrix.

$$R=\begin{pmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{pmatrix} \quad (1)$$

A={a_1,a_2,…,a_i,…,a_m} is the weight fuzzy vector on factor set U, the fuzzy set R=A× R on decision set V is transformed by R transform, so (U,V,R) constitutes a comprehensive evaluation model.

3.2. Basic steps of power rationing order optimization evaluation model

In the index system of power rationing, due to the type of each index set carrying different information, each index subsystem and specific index items have different degrees of action in the description process. Therefore, the comprehensive index value of power rationing is a weighted summation relation, that is:

$$S = \sum w_i f_i(I_i) \ (i = 1,2, \dots, n) \quad (2)$$

Where:$f_i(I_i)$is index measurement value of the index Ii; wi is the weight coefficient of each index, meeting $\sum w_i = 1, w_i \in [0,1]$.$f_i(I_i)$ can be obtained through the collection, statistics, analysis and comparison of the original data.The weight value of the comprehensive index system is obtained through the model.

3.2.1. Determine the level of factors and levels of factors, establish evaluation index set

In this paper, the factors that influence the power rationing factor are divided into economic factors, social effects and environmental impacts. Systematic analysis is made on the power rationing influencing factors, and the factors are classified according to the hierarchy, and the hierarchical relation is established as shown in figure 1. According to the order picture we can establish the following power rationing index system.

First evaluation index set is U.

U = {U1, U2… Um} (m is the number of first indicators).
Second evaluation index set is Ui.
Ui={Ui1,Ui2,…Uin} (i=1,2,…,m) (n is the number of second evaluation indicators below first indicators).

3.2.2. Determine the weight set of each index of evaluation index

The commonly used methods of determining weights are Delphy Fa, AHP [4], factor analysis, and entropy method and so on. In these methods, each method has its own advantages and disadvantages. According to the characteristics of power limits, this has different influence on different users. First, we use the method of expert consultation to construct the two comparison matrix, and then use the root method or the sum product to find the eigenvector and eigenvalue of the matrix, and carry out the consistency test to get the weight of each index.

Set the weight set of the first level index: $A=\{a_1, a_2, \ldots, a_i, \ldots, a_m\}$, $(0 \le a_i \le 1, \sum a_i = 1(i = 1,2, \ldots, m))$;

Set the weight set of the second level index: $A=\{a_{i1}, a_{i2}, \ldots, a_{ij}, \ldots, a_{in}\}$, $(0 \le a_{ij} \le 1, \sum a_{ij} = 1(j = 1,2, \ldots, n))$;

3.2.3. Determine the rating scale of evaluation pointers

According to the requirements of power supply reliability and the degree of loss or influence caused by interruption of power supply in politics and economy, the evaluation of each factor can be divided into four grades, the standard set of degree evaluation can be expressed as: V={V1,V2,V3,V4}, the corresponding importance can be described as {lower, low, medium, high}, they are assigned to (4,3,2,1) respectively. If the pointer level is between two adjacent grades, the corresponding score is 3.5, 2.5, 1.5, and 0.5.

3.2.4. Score and construct evaluation matrix

Combined with the evaluation of r experts on the evaluation data, which can be noted as d_{ijk}(i=1,2,…,m; j=1,2,…,n; k=1,2,…,r). From above, we can get the evaluation matrix D:

$$D=\begin{pmatrix} d_{111} & \cdots & d_{11r} \\ \vdots & \ddots & \vdots \\ d_{mn1} & \cdots & d_{mnr} \end{pmatrix} \text{ (i=1,2,…,m; j=1,2,…,n; k=1,2,…,r)} \quad (3)$$

3.2.5. The grey number is determined, calculated and evaluated

In order to truly reflect the degree of belonging to a certain class, it is necessary to determine the evaluation grey class which is to determine the grey grade number, grey number and grey number of whitening weight function. According to the evaluation grade, the evaluation grey class is determined.

Calculate the grey number according to the method of empowerment based on function driven. Make a comprehensive evaluation of the evaluation index Uij, the comprehensive evaluation result is denoted as Bi. Then make a comprehensive evaluation of the first level index Ui, the comprehensive evaluation result is denoted as B.

3.2.6. Calculate the comprehensive evaluation value and evaluate the order

Finally calculate the comprehensive evaluation value according to the above evaluation grey class value vector; we can get the evaluation order that can provide guidance for us.

In the formulation of optimization scheme, for the evaluation of the importance of multiple power users, it can be sorted and analysed by comparing the influence degree of the size of comprehensive evaluation value, which is measured from the benefits of power supply enterprises and the impact on society. For the evaluation of electric power load, through comprehensive evaluation values determine the degree of importance. It can also evaluate the importance of value factors and focus on controlling customers with large load and little influence.

4. Conclusion

Influence factors of blackouts involve multiple factors or indicators, on the basis of the above analysis, a set of analysis and index system of power rationing is established from four aspects: economic factors, technical factors, social factors and environmental factors, which affect the power system power rationing. Through the evaluation model, a comprehensive qualitative evaluation on the factors that affect the power rationing of power system is made. And it provides a basis for the power supply enterprises to develop a reasonable optimization scheme for power rationing.

5. References

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