

# Investment Capability Evaluation of Power Grid Enterprises Based on TOPSIS Method

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**Abstract:** Investment capability of power grid enterprises is the basis for formulating investment plans and implementing capital expenditure budgeting. Its excellence degree is not only related to the growing demand for development, but also closely related to the healthy operation of the company. This paper constructs the evaluation index system of investment capability of power grid from the perspective of investment capability structure and investment risk, and evaluates the excellent degree by TOPSIS method. Taking the actual data of a province as an example, this paper makes an overall and systematic evaluation of the investment capacity of power grid, and provides the direction of improvement for the company's operation management and steady development.

**Keywords:** investment capacity; TOPSIS method; investment risk; power grid; investment structure

## 1. Introduction

With the steady development of China's national economy, people's living standards are improving year by year, the demand for electricity and the scale of investment in power grid are also increasing. In recent years, the investment environment of power grid enterprises is becoming more and more complex, such as the control of fixed assets investment, the increase of loan interest rate, the change of mandatory energy-saving and consumption-reducing targets and other national macro-control measures [1]. Those will have a greater impact on the investment capacity of power grid and increase the uncertainty of power grid investment.

The investment capacity of power grid consists of depreciation, net profit and financing. The same size of investment capacity often has different capital composition and various level of cost expenditure and asset operations, accompanied by different risks [2,3]. A good investment capability should have reasonable capital composition and acceptable investment risk. If the proportion of financing in the investment capacity is large, the company's own capital is insufficient. In this case, the excessive debt scale of the company will lead to the rise of the asset-liability ratio, which will affect the financial stability of the company [4]. Besides, Affected by the higher asset-liability ratio, corporate financing will face

bottlenecks, which will form a vicious circle and affect the sustainable development of the company. This shows a lower level of investment capacity.

The investment capability of power grid is not only related to the ability to better meet the growing demand for development, but also closely related to the healthy operation of the company [5]. At present, the company has not yet established an evaluation system on the investment capability of power grid, lacking of research on the composition of investment capability and investment risk [6,7]. Therefore, it is necessary to conduct a comprehensive and systematic evaluation of the investment capacity of the power grid, objectively and comprehensively analyze and study the excellent degree of the investment capacity of the power grid, find out the reasons and provide the direction of improvement for the operation management and steady development of the company.

In order to scientifically reflect the excellent degree of the company's investment capacity and objectively describe and evaluate its variation, this paper firstly constructs the evaluation index system of investment capacity of power grid from the perspective of investment capacity structure and investment risk. Then the weight of subjective and objective indicators are calculated by using sequential relationship method and coefficient of variation method, respectively. In order to determine the final combination index weight, the combination weighting method based on the consistency of subjective and objective weighted attribute values is used. TOPSIS method is introduced to evaluate the investment capability of power grid. Through in-depth analysis of the evaluation results, the essential reasons that lead to poor investment ability can be found out, which will provide reference for managers.

## 2. Construction of Index System

### 2.1. Principles and Characteristics of Index System Construction

Investment capability evaluation of power grid is a complex system involving many related factors. Its evaluation should proceed from multi-dimensional and multi-perspective, and then build a multi-level comprehensive index system. The evaluation index should be concise, practical and operable, follow the

principles of scientificity, comparability, comprehensive systematicness and dynamics and combine qualitative and quantitative analysis with the characteristics of power industry.

(1) Principle of scientificity

The construction of index system should be on the basis of science. The selection of evaluation index, the determination of weight, the selection and calculation of data must be based on scientific theory. With fewer indicators, the basic connotation and requirements of investment capacity of power grid should be standardized and accurately reflected. The meaning, statistical caliber, classification method and calculation formula of each index should be standardized to ensure the authority of statistical data to achieve the purpose of scientific description and early warning.

(2) Principle of comparability

The principle of comparability requires that the evaluation results be comparable in time to reflect the historical changes of the investment capacity of power grid and carry out comparative analysis. Based on the analysis results, countermeasures are put forward according to local conditions.

(3) Principle of Comprehensive Systematics

The index system itself is a very complex system, which consists of various data indicators covering asset quality, operating performance, capital structure, financing cost and investment risk. The construction of evaluation index system should follow the principle of comprehensive systematization. The indexes should be clear, interrelated, coordinated and focused on each other to achieve a relatively complete description and explanation of the main problems, form an organic whole, and reflect the power grid from different angles and sides.

(4) Qualitative and quantitative analysis

To evaluate the investment capability of power grid comprehensively, many factors need to be considered, which is a complex system engineering. The overall construction of indicators needs qualitative analysis and then to be quantified. Some assessment indicators cannot be directly quantified, which needs to be combined with qualitative analysis methods. In a word, the principle of combining qualitative analysis with quantitative analysis should be followed in the setting of the whole system and in the analysis of indicators.

(5) Characteristics of Electric Power Industry

Electric power industry, the basic industry of national economic development, is an important factor affecting economic and social development and has its own unique characteristics. Therefore, the power characteristics should be taken into account in factor analysis and index setting.

(6) Principle of Dynamics

As a dynamic open system, the evaluation of investment capability of power grid is constantly changing. The index system should fully consider the dynamic characteristics of the power industry. It should not only reflect the current situation of investment capacity, but also reflect its future development trend, so as to facilitate prediction and management. At the same

time, the relative stability of the index system should be maintained for a certain period of time.

2.2. Selection and Explanation of Evaluation Index

The investment capability of power grid is mainly composed of depreciation, net profit and financing. Its superiority requires not only a larger value of investment capability, but also a more reasonable structure of investment capability and acceptable investment risk for managers. Therefore, this paper constructs the evaluation index system from the perspective of investment capacity structure and investment risk. A total of 14 three-level indicators are established. The evaluation index system of investment capacity of power grid is detailed in Table 1.

**Table 1.** Evaluation Index System of Investment Capability for Power Grid

Target Layer	First-level indicators	Second-level indicators	Three-level indicators
Investment Capability	Investment Capability Structure	Asset quality (depreciation)	Total assets
			Asset-liability ratio
			New investment
		Operating efficiency (net profit)	Current assets turnover rate
			Ratio of Profits to Cost
			Return on net assets
		Capital structure	Depreciation ratio
			Net Profit Ratio
			Proportion of financing
	Investment risk	Profit risk	Growth rate of electricity sales
			Profit Risk Degree
		Financing risk	Financing difficulty
			Interest rates of loans
			Financial expenses

The evaluation of investment capability starts with the evaluation of the structure of investment capability and investment risk. The structure of investment capability is mainly evaluated in three modules: asset quality (depreciation), operating efficiency (net profit) and capital structure. The investment risk is mainly evaluated in two modules: profit risk and financing risk. The meanings of each indicator are as follows.

(1) The total assets are selected as the total assets at the end of each year.

(2) Asset-liability ratio = total liabilities/total assets \* 100%.

(3) New investment is the actual amount of investment per year.

(4) Current assets turnover rate (sub) = net main business income / total average current assets.

(5) Ratio of Profits to Cost = total profit/total cost \* 100%.

(6) Rate of return on net assets = after-tax

profit/owner’s equity.

(7) Depreciation ratio = depreciation/investment capacity.

(8) Net profit ratio = net profit//investment capacity.

(9) The proportion of financing = the amount of financing / investment capacity.

(10) Electricity sales growth rate= (current year electricity sales - last year’s electricity sales) / last year’s electricity sales

(11) Profit risk degree and financing difficulty are subjective index, which is mainly judged by experts. The index is a number between 0 and 10. The bigger the value, the bigger the profit risk, the smaller the value, and the smaller the profit risk.

(12) The interest rate of the loan is taken from the current bank loan in that year.

(13) Financial expenses refer to the financing expenses incurred by an enterprise in the course of production and operation for funding.

**3. Principle of TOPSIS Method**

TOPSIS method is used for comprehensive evaluation. There are no strict restrictions on data distribution, sample size and index number. It is suitable for both small sample data and large system data with multiple evaluation units and indicators. It can be used for both horizontal comparison and longitudinal analysis. This method has the advantages of flexible application, simple mathematical calculation and objective results quantification [8,9]. It has been widely used in performance evaluation, economic benefit evaluation and other fields.

Before using TOPSIS method for evaluation, it is necessary to set a reasonable branch standard, that is, set an ideal system or sample point , Objects to be evaluated , the weighted distance between them is:

$$y_i = \sum_{j=1}^m w_j f(x_{ij}, x_j^*), i = 1, 2, \dots, n \quad (1)$$

Among them,  $w_j$  is weight coefficient,  $y_i$  is a distance between component. Usually, the Euclidean distance is taken as the composite function.

Assume that  $u_j^+$  is positive ideal system and  $u_j^-$  is negative ideal system. Then the Euclidean Distance between the objects to be evaluated and positive ideal is:

$$y_i^+ = \sqrt{\sum_{j=1}^m w_j (x_{ij} - u_j^+)^2}, i = 1, 2, \dots, n \quad (2)$$

The Euclidean Distance between the objects to be evaluated and negative ideal is:

$$y_i^- = \sqrt{\sum_{j=1}^m w_j (x_{ij} - u_j^-)^2}, i = 1, 2, \dots, n \quad (3)$$

The queuing indicator value is used to evaluate the system comprehensively. The specific formula for calculating the queuing indicator value is as follows:

$$C_i = \frac{y_i^-}{y_i^+ + y_i^-} \quad (4)$$

Among them, the higher the queuing indicator value is,

the better the investment capability of power grid is [10].

**4 Analysis of evaluation results**

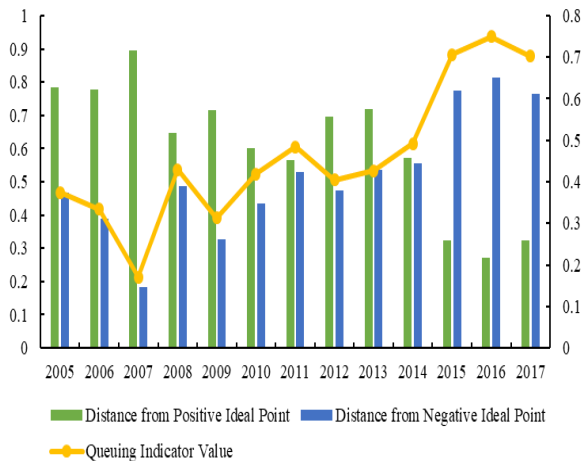
From the perspective of investment capability structure and investment risk, this paper uses TOPSIS method to analyze the excellent investment capability of a province from 2005 to 2017. The evaluation results are as follows: Table 2, Figures 1 and 2.

As can be seen from Figure 1, the rationality of investment capacity structure decreased in 2006, 2007, 2009 and 2012, while the overall trend of change is gradually rising. Among them, the ranking indicator value of the investment capacity structure in 2016 is the highest, which shows that the investment capacity structure is the most reasonable. In 2007, 2009, 2012 and 2013, the queuing indicators of investment capacity structure are low, which indicates that the structure of investment capacity is unreasonable. The reason is that in 2007, the ratio of financing, depreciation and net profit is not ideal, while in 2009, the ratio of current assets turnover, return on net assets and net profit is unreasonable.

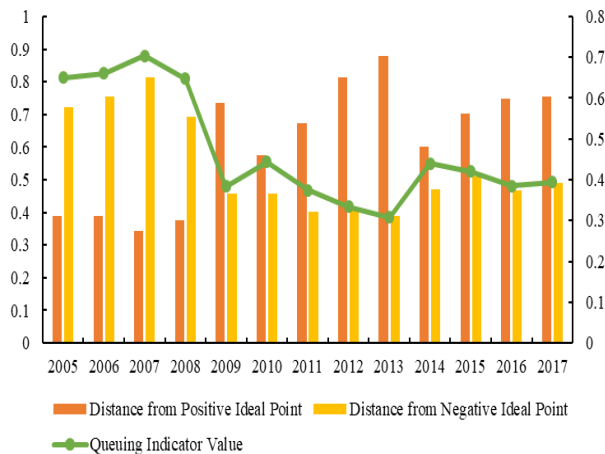
As can be seen from Figure 2, the investment risk of power grid fluctuates greatly from 2005 to 2017, and the queuing indicator value decreases as a whole, which shows a trend of repeated change. The investment risk in 2013 is the highest, and the degree of profit risk and financing difficulty are the highest in history, that is, it has high profit risk and financing difficulty. In addition, net profit in 2013 accounted for 0.37%, which is the lowest level in previous years, and shows the main reason why the difficulty of financing and the degree of profit risk in this year are higher than those in other years. In 2012, the investment in power grid also presents greater risks, and also has higher financing difficulty and profit risk. This is also related to the lower cost-cost profit margin and net profit ratio in 2012, which makes the profit risk in that year larger.

**Table 2.** Queuing indicators of investment capacity structure and investment risk from 2005 to 2017

Year	Investment Capability Structure			Investment risk		
	Distance from Positive Ideal Point	Distance from Negative Ideal Point	Queuing Indicator Value	Distance from Positive Ideal Point	Distance from Negative Ideal Point	Queuing Indicator Value
2005	0.7832	0.4677	0.3739	0.3884	0.7224	0.6503
2006	0.7760	0.3898	0.3343	0.3881	0.7549	0.6604
2007	0.8958	0.1840	0.1704	0.3435	0.8146	0.7034
2008	0.6461	0.4870	0.4298	0.3772	0.6919	0.6472
2009	0.7159	0.3255	0.3126	0.7347	0.4577	0.3838
2010	0.6010	0.4336	0.4191	0.5763	0.4588	0.4432
2011	0.5637	0.5295	0.4844	0.6717	0.4033	0.3751
2012	0.6959	0.4724	0.4043	0.8122	0.4083	0.3345
2013	0.7178	0.5346	0.4268	0.8773	0.3895	0.3075
2014	0.5731	0.5551	0.4920	0.6012	0.4712	0.4393
2015	0.3221	0.7729	0.7058	0.7039	0.5105	0.4204
2016	0.2728	0.8135	0.7489	0.7475	0.4679	0.3850
2017	0.3237	0.7643	0.7024	0.7534	0.4901	0.3941



**Figure 1.** Evaluation results of investment capacity structure of power grid from 2005 to 2017



**Figure 2.** Evaluation results of investment risk of power grid from 2005 to 2017

The evaluation results of investment capacity of power grid show that the investment capacity of power grid in 2007, 2009, 2012 and 2013 is low. This shows that the investment capacity of power grid is affected by weather, sudden disasters, power purchase cost and other factors, which leads to the decrease of main business income and the rise of cost expenditure, which makes power grid enterprises in a loss state. At the same time, the existence of external factors, such as the global financial crisis, also plays an important role in the company's operation. The high asset-liability ratio, high profit risk and financing risk are the main reasons for the low evaluation of investment capacity. Overall, from 2005 to 2017, the investment capacity of power grid shows an upward trend, in which the overall structure of investment capacity shows a more and more reasonable trend, and investment risk has fluctuated greatly in recent years. Therefore, power grid enterprises should focus on the control of investment risk.

## 5. Conclusions

In this paper, TOPSIS method is used to evaluate the investment capability of a provincial power grid enterprise. The following conclusions can be drawn from the analysis.

(1) TOPSIS method is simple and easy to operate, and has a good application prospect in the evaluation of investment capacity of power grid enterprises.

(2) The evaluation index system constructed from two aspects of investment structure and investment risk can evaluate the excellent degree of investment capability comprehensively and systematically.

(3) Through evaluation, the unfavorable factors affecting investment capacity can be further excavated. Besides, the structure of investment capacity can be further optimized, the investment risk of power grid can be reduced, and the excellent degree of power grid investment capacity can be comprehensively improved, so as to realize the rational and stable development of power grid investment.

## Acknowledgment

The authors would like to acknowledge the financial support from the National Natural Science Foundation of China (Grant No.71804045).

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