Financial Benefit Evaluation Model of Power Grid Investment based on Information Entropy

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Abstract: As an infrastructure, power grid construction project is of great significance to ensure social and economic development. The basic status and development needs of the power grid determine that the power grid needs corresponding investment, and the investment benefits of the power grid are often both social and economic benefits. It is incorrect to pay too much attention to economic or social benefits. At the same time, the benefits obtained by the investment project itself generally can not recover the investment, and the power grid investment is mainly digested in the price increase. This is an important difference between power grid investment projects and general projects. Therefore, financial performance evaluation model of power grid investment based on information entropy is designed. Firstly, the characteristics of power grid investment benefit are analyzed. Secondly, the evaluation principle of power grid investment benefit is designed. Finally, financial performance evaluation model of power grid investment based on information entropy is constructed. The example analysis shows that the evaluation effect of the designed evaluation model is good and has certain application value.

1 INTRODUCTION

The operation of power grid enterprises is facing great pressure. First, the coal price remains high, which promotes the on grid electricity price of power generation enterprises to increase significantly. Second, affected by the national macro-economic regulation and industrial structure adjustment, the sales price is strictly controlled by the government. The adjustment is becoming more and more difficult, and profit margins of the company is double squeezed. Third, with the expansion of the company's asset scale, depreciation, power grid operation and maintenance costs rise rapidly. At the same time, large-scale financing and huge financial costs make power grid enterprises face unprecedented difficulties and pressure. Therefore, how to avoid inefficient and ineffective investment, scientifically arrange investment projects, reasonably grasp investment timing, pay attention to input-output benefits, effectively prevent and avoid business risks, and steadily improve the economic benefits of power grid has become an urgent problem to be deeply studied and solved.

Foreign research on investment benefit evaluation of power enterprises mainly involves engineering and technical problems such as power supply reliability and financial aspects such as electricity company financing and risk. For example, the analysis of competitive power generation market has been introduced in power market reform in Britain, Norway, Canada and the United States. Generation capacity planning, power trading, uncertainty and risk of power market are researched. For the loss of power revenue and the increase of overall cost and expenditure caused by non-technical losses in the operation of some national power grids, this paper puts forward the research on the methods of loss evaluation and management. The reliability and quality of power system, the cost of appropriate system safety and reliability level, and the degree of power generation facilities and transmission capacity required to meet the demand level of consumers are researched. The research on benefit evaluation of the power industry mainly focuses on the power generation. That is, the cost-benefit analysis, asset portfolio and risk management of power generation companies. For example, power generation evaluation studies capacity and fixed asset investment opportunities under irregular conditions in the power market. And investment opportunity decision analysis tools for hedging transactions and

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risk management.

In the research of benefit evaluation methods, domestic scholars have put forward many evaluation methods. For example, analytic hierarchy process, Delphi method, with or without comparison method, optimal combination prediction, fuzzy comprehensive evaluation and other methods are integrated and applied to the post evaluation of national rural power grid construction and transformation projects, and an evaluation method system composed of multiple methods and a comprehensive evaluation model integrated with multiple models are established. Evaluation index system of power grid investment project is constructed. Research on comprehensive evaluation model of power grid construction project investment based on improved analytic hierarchy process is constructed.

2 DESIGN OF FINANCIAL BENEFIT EVALUATION MODEL OF POWER GRID INVESTMENT BASED ON INFORMATION ENTROPY

2.1 Analyze the Investment Benefit Characteristics of Power Grid

Power grid investment refers to the investment in the new construction, expansion and technical transformation of power transmission and transformation projects. According to the current investment system, the power company only invests in the power transmission and transformation projects within the provincial network as project's legal person, including all power transmission and transformation projects of 500 kV ~ 110 kV. Power grid investment evaluation involves the whole process of power grid investment, and the impact of different stages on power grid investment is different. The process of power grid investment generally includes five stages, power grid investment planning, early stage, planning, construction and operation. In the stage of power grid investment and operation, two main tasks are mainly carried out, namely, the production and operation management of power grid investment projects and the post evaluation of power grid investment projects. After the completion acceptance of the power grid investment project, it can be put into production and operation and organize the recovery of investment after going through the necessary formalities. In the production process of the investment project, the daily operation of the project shall be carried out in strict accordance with the general objectives and other sub objectives determined in the investment plan. After the fixed assets are delivered for use, it is the productive stage or use stage of investment movement. The production results and the useful effect of fixed assets are the output form of this stage. The comparison between investment and the production results and use effect of this stage is the second level of investment benefit. The benefits of these two levels restrict each other and constitute the whole content of power grid investment benefits.

2.2 Evaluation Principle of Investment Benefit of Designed Power Grid

In the early 1950s, China's power design department learned from the experience of the former Soviet Union, and the economic comparison of construction projects adopted the compensation period method or recovery period method and calculation expenditure method. The calculation formula of this method is as follows (1).

$$T = \frac{K_2 - K_1}{C_1 - C_2} \tag{1}$$

In Formula (1), T represents the compensation period. K_1 and K_2 represent the scheme investment. C_1 and C_2 represent the annual fee of scheme investment. The code for kinetic energy design of thermal power plants issued in 1956 stipulates that T ≤10~15 years. The interim measures for economic comparison in power system issued in 1964 stipulates that T ≤6~7 years. The compensation period of hydropower projects is longer than that of thermal power and power transmission and transformation projects. With the shortage of funds, there is a decreasing trend of T. When comparing the two schemes, if the above discriminant is met, it is considered that the second scheme with more investment is economically reasonable. At this time, the expenditure formula is as follows (2).

$$H = C_1 + E_H K_i \tag{2}$$

In Formula (2), K_i represents the investment of a scheme. E_H represents the economic benefit coefficient. The following four aspects should be considered. Firstly, it is necessary to calculate the capital discount principle. The formula is shown in

Formula (3).

$$\begin{cases} F = P(1+i)^{y} \\ P = F(1+i)^{y} \end{cases} \quad (3)$$

In Formula (3), F represents the median value. P represents the present value. y represents the calculation period. i represents the period or discount rate. $(1+i)^{y}$ represents the compound interest coefficient. If the bank requires quarterly settlement, conversion is required. The calculation formula is as follows (4).

$$i = \left(1 + \frac{i'}{4}\right)^{4} - 1 \quad (4)$$

In Formula (4), i' represents the interest rate settled quarterly. The repayment method after the enterprise loan is determined according to the loan contract signed with the bank. It can be repaid in the same amount of principal and interest or the same amount of principal, or in other ways agreed by both parties. At present, the repayment of principal and interest is mostly equal, and the calculation Formula (5) is as follows.

$$A = P\left[\frac{i(1+i)^{y}}{(1+i)^{y} - 1}\right] \quad (5)$$

In Formula (5), A represents the equivalent repayment amount. At this time, the equivalent repayment coefficient can be calculated according to Formulas (1) ~ (5). The calculation formula is shown in Table 1 below.

Table 1: Equal repayment coefficient.

i/y	10	15	20	25	30
5.0%	0.130	0.096	0.080	0.071	0.065
7.5%	0.146	0.113	0.098	0.090	0.085
10%	0.163	0.131	0.117	0.110	0.106
12.5%	0.181	0.151	0.138	0.132	0.129
15%	0.199	0.171	0.160	0.155	0.152

It can be seen from Table 1 that due to inflation, the operating costs in some years increase year by year. In order to consider this factor, the leveling method needs to be adopted. The calculation results of the leveling coefficient at this time are shown in Table 2 below.

Table 2: Flattening coefficient.

b/y	10	15	20	25	30
2%	1.12	1.18	1.24	1.31	1.40
4%	1.25	1.39	1.55	1.73	1.94
6%	1.43	1.64	1.95	2.33	2.79

As can be seen from Table 2, inflation has a great impact on the annual interest rate. In recent years, due to the steady decline in prices, interest rates have also been greatly reduced. When forecasting is difficult, it is also stipulated to adjust interest rates accordingly with price changes. Under the condition of market economy, profit is the purpose of production and the most concerned problem of investors. Under the condition of planned economy, it is only the condition required to expand reproduction. It is a matter of concern to the state, and there are great differences due to the industry. Under the condition of market economy, investors attach great importance to the analysis of economic benefits. Under the condition of market economy, the time value of funds is fully considered and calculated by dynamic theory, while under the condition of planned economy, static calculation is adopted and only the impact on investment backlog is considered. Under the condition of market economy, the impact of inflation is fully considered. This factor is not considered under the condition of planned economy. Under the condition of market economy, the price is adjusted by the market and basically conforms to the value. Under the condition of planned economy, the price is determined by the state and often deviates from the value. Therefore, the shadow price should be considered for national economic evaluation. The schematic diagram of evaluation principles is shown in Figure 1 below.

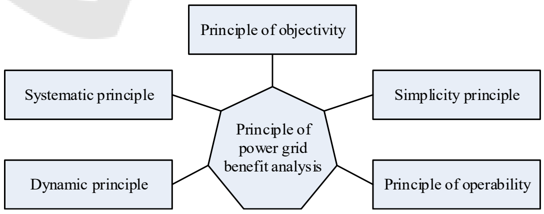

Figure 1: Schematic diagram of financial benefit evaluation principle of power grid investment.

It can be seen from Figure 1 that the evaluation characteristics mainly depend on the basis and essence of evaluation activities and cognition. From the evaluation concept and value characteristics, the main characteristics of evaluation are as follows. The purpose of evaluation is to understand and evaluate the objective value. The essence of value is a relationship between subject and object, which must include both sides of the relationship. Value is embodied in the interaction between subject and object. But evaluation is not to create value, but to recognize value and guide people to create value. Evaluation results are non-unique. Evaluation is a subjective activity of understanding and evaluating value, which varies with different subjects. Because evaluation is a subjective activity, and the evaluation subject varies and changes in interests, needs, values, choices, emotions and will. Evaluation always changes with the change and development of the evaluation subject. The evaluation result must be non-unique.

2.3 Construction of Power Grid Investment Benefit Evaluation Model based on Information Entropy

The internal benefits of the project reflect the benefits that can be captured by the project itself. Generally speaking, the financial benefit of the project is reflected at a reasonable price after adjusting the transfer cost, which is the internal benefit of the project. This is because intangible benefits are generally not measured at ready-made prices, but they do belong to benefits, because they can be reflected through the growth of national income. The investment benefits of power grid are mainly reflected in the benefits of increasing power supply, reducing network loss, loss free power and so on.

This factor should be considered in the power price increase. With the strengthening and improvement of provincial network and urban network, compared with these projects, the loss is likely to decrease, and this benefit should also be taken into account. Power loss further leads to the decline of power supply capacity, which involves whether compensation for installed capacity needs to be considered. Although this problem does not exist for the legal person of power transmission and transformation project, it does exist from the perspective of the whole network and can not be considered in the current financial evaluation method. Therefore, the benefit evaluation model of this method is shown in (6).

$$\Delta A=\frac{W^2}{nW^2_{\ H}}\Delta P\times\tau\times\Delta P_C\times T \qquad (6)$$

In Formula (6), n represents the number of transformers. W_H represents the rated capacity of the transformer. W represents the maximum load. ΔP represents the copper loss of the transformer with rated capacity. ΔP_C represents the iron loss of the transformer with rated capacity. T represents the operating hours of the transformer and τ represents the loss hours. Costs and expenses refer to material consumption, labor remuneration and various expenses incurred by project's legal person in the process of production and operation. The total cost includes product cost and financial expenses. The financial situation of the project is predicted during the calculation period, so as to comprehensively reflect the financial benefits of the project and provide investment decision-making basis for the project investor and financial department. Therefore, the correct financial evaluation of power grid construction projects is of great significance to improve investment benefits.

3 CASE ANALYSIS

3.1 Overview

In 2019, the maximum power supply load of a power grid in the whole society is 326,000 dry watts. The power of the whole region is mainly connected with the large power grid by four 220KV lines. With the deepening of investment attraction in Beilun District, extra large power users have settled in Beilun, and the power demand in Beilun will increase sharply. In 2020, Beilun district needs 739,000 KW of power supply from the large grid. The original 220 KV transmission line will be difficult to meet the rapidly rising power demand in Beilun District. Therefore, in order to ensure the sustainable economic development of Beilun District, meet the needs of the continuous and rapid growth of local power consumption level, ensure the safe and stable operation of power grid, and optimize the 220 KV power grid structure of Beilun District, it is necessary to build a 500 KV Yongdong power transmission and transformation project in 2020. At this time, the list of indicators involved in the calculation is shown in Table 3.

Table 3: List of indicators.

Indicator name	Attribute
Increased power supply per unit investment	Positive index
Power supply of unit fixed assets	Positive index
Income from fixed assets of new units	Positive index
Power loss reduction	Positive index
Capacity load ratio（220kv）	Moderate index
Capacity load ratio（110kv）	Moderate index
Power supply per unit substation capacity（220kv）	Positive index

As shown in Table 3, the current indicators are perfect and can be used for subsequent financial benefit model analysis and testing.

3.1 Application Effect and Discussion

The financial benefit analysis model of power grid investment designed in this paper and the traditional financial benefit analysis model are used for benefit analysis and test respectively. Compared with the standard benefits, the application effect is shown in Figure 2 below.

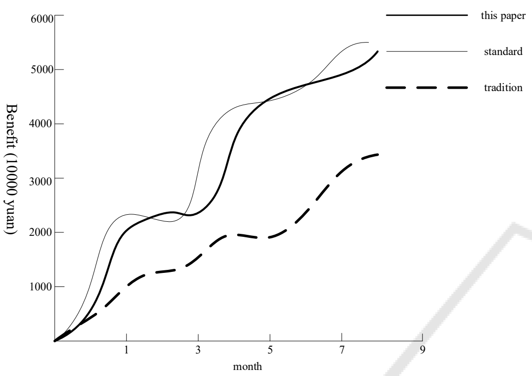

Figure 2 Application effect

It can be seen from Figure 2 that the benefit analysis method designed in this paper fits the standard better, which proves that the benefit analysis effect of the method designed in this paper is better and more accurate, so it has certain application value.

4 CONCLUSION

The methods discussed in this paper only supplement and improve the deficiencies existing in the current economic evaluation methods of power grid construction projects, and the factors and methods considered also have their specific environment. Although it has little impact on the financial indicators of the project itself, it also has little impact on the price increase of electricity. However, in terms of scope, the number of power grid construction projects is very large. Therefore, the small differences in price increase of each project are finally superimposed and reflected in the electricity price. Therefore, the benefit evaluation of power grid construction projects needs further in-depth research. It is hoped that a more scientific and comprehensive economic evaluation method of power grid construction projects in practice is further explored, so as to provide a basis for scientific decision-making of the project and a reasonable basis for price increase.

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