Research On Power Grid Investment Carrying Capacity Based on Debt Ratio Limitation

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Abstract—With the deepening of the energy Internet and digital revolution, new business forms and requirements such as integrated energy services, electrochemical energy storage and business environment optimization are emerging. Power grid enterprises should comprehensively consider the operation status of enterprises and the needs of emerging business development, accurately grasp the upper limit of their own investment carrying capacity, and formulate investment planning scientifically. In order to avoid the influence of excessive investment on the sustainable and stable operation of grid enterprises, this paper uses theories of technology and economics and financial management to build a model for measuring grid investment based on the limitation of asset-liability ratio. The case verification shows that, using this model, grid enterprises can evaluate their maximum investment capacity more objectively, providing a scientific basis for grid enterprises to make reasonable investment plans, and also providing a reference for other enterprises to calculate their investment capacity under the debt ratio limit.

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1INTRODUCTION

With the steady development of national economy in our country, people's living standards increase year by year, the society's demand growing, at the same time as the energy of the Internet and the digital revolution was deepened, comprehensive energy services, electrochemical energy storage, optimize the environment of business and other new forms and new requirements are created, scale of investment in power grid enterprises are also further expanded[1]. Power grid investment scale, however, there is a cap, at the same time in order to avoid excessive investment, steady operation, further set up the biggest debt ratio, power grid enterprises under the limit of maximum load rate, carrying capacity analysis of the power grid enterprise investment, lower limit on measuring the power grid enterprise investment ability, help enterprise reasonable formulation of capital expenditure[2].

At present, there are many research results for distribution network evaluation methods at home and abroad, but relatively few studies for post-investment effect evaluation methods. The literature [3] studied the changes of the relevant index values due to the construction and transformation of the distribution network from the aspects of distribution network operation capacity, distribution network structure, safety and reliability, energy saving and environmental protection, reflecting the functional effect of the construction and transformation of the distribution network, but ignoring the research on the economic aspect of the investment effect.

The literature [4] constructed the evaluation index system of the distribution network investment benefit from two aspects of project benefit and management benefit, but The literature [4] established an index system and a comprehensive evaluation model for post-evaluation of distribution grid investment projects from five aspects: implementation process, operation effect, financial effect, social benefit and sustainability, but the index settings are too complicated, the underlying indexes are difficult to calculate, and the generality and operability are poor. However, the index settings are too complicated, the underlying indicators are difficult to calculate, and the generalization and operation are poor. The existing post-evaluation methods of distribution network investment effect lack a comprehensive consideration of investment effect, and the index system research is highly targeted and has a very small scope of application, meanwhile, the existing results lack in-depth research on the analysis method of distribution network investment rationality.

In view of this, based on the previous analysis, this paper introduces concepts such as operation coefficients based on theories of financial management, quantifies the investment capacity of grid enterprises, and constructs an image and intuitive model to reflect the investment capacity of enterprises, laying the foundation for grid enterprises to clarify their investment capacity and effectively formulate investment plans.

2ANALYSIS OF POWER GRID INVESTMENT CARRYING CAPACITY BASED ON ASSET LOAD RATIO LIMITATION

2.1Construct the power grid investment calculation model based on asset-liability ratio limitation

Upper and lower limits of investment carrying capacity of power grid enterprises. The investment capacity of enterprises. The sources of investment capacity of enterprises mainly include operating income and financing. Assuming that the investable assets of the company in the previous year are zero, the formula of follow-up investment capacity is as follows:

$$Y_i = L_i + Z_i + R_i - H_i - J_i \tag{1}$$

In Equation (1), Y_i is the investment capacity in year i; L_i is retained profit in year i (net profit deducted from profit paid); Z_i is the amount of depreciation in year i; R_i is the financing amount in year i, H_i is the repayment amount in year i, and J_i is the current assets retained by the company in year i.

2.2Calculation of parameters of power grid investment model based on asset-liability ratio limitation

L_i can be obtained according to the operating income and operating cost of power grid enterprises.

$$L_i = \sum_{j=1}^{t} D_j * P_j + \sum_{j=1}^{t} O_j - \sum_{j=1}^{m} Gd_j * Gp_j - \sum_{j=1}^{n} C_j - Ls_i \tag{2}$$

In Equation (2), D_j is the selling price of the j-th electricity selling type; P_j is the electricity sold of the j type of electricity sale; O_j is the JTH other operating income; Gd_j is the power purchase price of the j-th power purchase type; Gp_j is the purchased electricity of the j-th type of purchased electricity; C_j is the JTH cost type; Ls_i is the profit paid in year i.

Z_i According to the age distribution of the existing assets and the new investment each year, the depreciation life is calculated as 12 years.

$$Z_i = \frac{Jz_{i-1} - Z_{i-1}}{12 - i} + \frac{Az_i}{12} \tag{3}$$

Jz_{i-1} is the net fixed assets in year i-1, Z_{i-1} is the investment in year i.

R_i determine the maximum financing scale according to the company's asset-liability ratio limit.

$$R_i = \frac{F_i(\mathrm{Q}_{i-1}+\mathrm{L}_i)-\mathrm{S}_{i-1}}{1-F_i}+H_i \tag{4}$$

In Equation (4), F_i is the debt ratio in year i, and the asset load ratio of power enterprises is formulated by the competent unit. The maximum asset load ratio of power grid provincial enterprises is 68%, Q_{i-1} is the total assets in year i-1, and S_{i-1} is the total liabilities in year i-1.

J_i is according to the company's annual business expenses in a fixed proportion.

2.3Step of model calculation

Step 1: Calculate the operating profit of the company in year i by calculating electricity sales revenue, other income, electricity purchase cost and other costs, and then calculate the paid profit. So let's figure out the net profit in year i.

Step 2: To calculate the depreciation of fixed assets, first calculate the depreciation of stock assets. According to the net value of fixed assets in the previous year, deduct the depreciation of each year, and calculate the depreciation of fixed assets in the remaining years on average (considering that the actual operation of the company is continuous, the depreciation of fixed assets in the research year from the beginning is calculated according to the depreciation life of 12 years). Secondly, the amount of depreciation of new assets is calculated. The original value of assets is calculated according to the actual investment amount for simplification [5].

Step 3: calculate the maximum amount of financing, and the repayment amount will be offset with the repayment amount in the overall formula in the subsequent calculation, so there is no need to calculate.

Step 4: Calculate the retained working capital for operation and the maximum investment capacity of the enterprise, calculate the investment carrying capacity of each year in the prediction stage by iterative method, and draw the investment carrying capacity curve.

3ANALYSIS OF POWER GRID INVESTMENT CARRYING CAPACITY BASED ON ASSET LOAD RATIO LIMITATION

3.1Construct the power grid investment calculation model based on asset-liability ratio limitation

According to the financial data of a provincial electric power company from 2012 to 2021, according to the requirements of the investment carrying capacity analysis model, according to the study of power supply and demand from 2022 to 2030 by relevant institutions and the forecast of planned investment of enterprises, the investment carrying capacity of each year is analysed according to Equation (1).

Calculate the optimal cash balance. Using 2001 as the initial year, determine the value of the optimal cash balance for that year according to equation (3).

Best cash balance = (139.06-1.92) × (1 + 0.148) = 15.744 billion

According to the electricity sales forecast for each price level from 2022 to 2030, the electricity purchase forecast for each price level (the price level of this year adopted by the price), and the income of other operations and transmission and distribution costs, the profit statement is shown in Table 1

Table 1 Profit forecast from 2022 to 2030

The annual	2022	2023	2024	2025	2026	2027	2028	2029	2030
profits	14	15	16	17	18	19	20	21	22

According to the actual investment forecast from 2022 to 2030 and the net asset value in 2021, the depreciation situation from 2022 to 2030 is analysed, the Depreciation forecast is shown in Table 2

Table 2 Depreciation forecast from 2022 to 2030

The annual	2022	2023	2024	2025	2026	2027	2028	2029	2030
depreciation	73	69	65	61	56	52	48	45	37

According to the expected investment and operating conditions of the company from 2022 to 2030, the maximum financing capacity of each year from 2022 to 2030 is predicted according to the requirements of the maximum asset-liability ratio. The results are shown in Table 3.

Table 3 Financing capacity under maximum ASSET load ratio constraints from 2022 to 2030

The annual	2022	2023	2024	2025	2026	2027	2028	2029	2030
Financing ability	102	110	120	124	127	127	136	138	144

According to the cost scale from 2022 to 2030, working capital is retained in the following two ways: The blue line is 5% of the power purchase cost plus 5% of the transmission and distribution cost; The orange line is 5% of the power purchase cost plus 10% of the transmission and the grey line represents the actual planned investment, and the graph is as follows figure1:

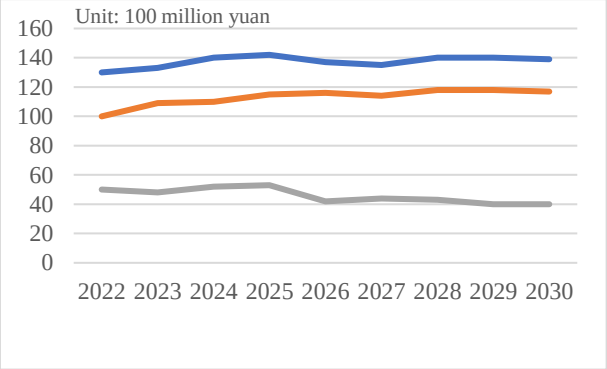

Figure 1. Analysis of enterprise investment carrying capacity and actual planned investment based on debt ratio from 2022 to 203

3.2Construct the power grid investment calculation model based on asset-liability ratio limitation

As can be seen from the above table and figure, the planned investment scale of power grid enterprises is still large, and its investment scale has approached the upper limit of the company's investment carrying capacity. In the case of 5% power purchase cost and 10% transmission and distribution cost as retained working capital, the investment in some years has even exceeded the upper limit of investment carrying capacity under the restriction of maximum load ratio. At this time, it is necessary to consider the risks that may be brought by excessive investment. The investment of power grid enterprises is characterized by a relatively large amount of capital and a long time of capital occupation. If the investment plan does not conform to the actual situation and the investment exceeds the debt repayment capacity, the loan may not be repaid on schedule, resulting in financing risks [6].

4 CONCLUSIONS

Through the analysis of the investment carrying capacity of power grid enterprises based on the debt ratio limitation, it can provide reference for the construction of the enterprise investment capacity measurement model. The example shows that this model has strong operability and convenient calculation, and can objectively analyse the power grid investment carrying capacity.

As the power grid enterprises have strong monopoly characteristics, their investment capacity is increasing year by year, and the investment carrying capacity is also gradually improving. Therefore, under the condition of sufficient capital, power grid enterprises should further consider optimizing investment structure, adjusting investment allocation, finding investment direction and maximizing investment benefits [7].At the same time, we should attach importance to the role of external funds and adopt diversified and efficient investment programs to ensure the sustainable development of enterprises.

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