Research on Financial Post-Evaluation of Power Grid Project under the Background of Transmission and Distribution Electricity Price Reform

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Abstract: With the orderly advancement of the new round of electricity reform, China's electric power industry and market will enter a new stage of development. Against this background, on the basis of the traditional "stable growth to meet the demand and supply", the power grid enterprises should pay more attention to objective and effective evaluation of power grid operation. This paper follows the idea of calculating the internal revenue per unit of electricity, to make the financial post-evaluation of investment projects, and to provide reasonable guidance for future investment while evaluating the efficiency of past investment. On the basis of ensuring the reliability and safety of investment projects, good economic benefits can be obtained.

1. Introduction
Due to the power grid network structure characteristics, the power grid project creates the overall financial benefit of grid enterprises through the coordination of other new assets and current assets, thus great challenge is brought to the financial evaluation of power grid project, and the project financial post-evaluation work is affected. Based on the theories, such as the permissible income theory, combined with the original value of fixed assets, power supply of different voltage levels, and other data, it measures the internal income of unit electricity of different voltage levels; according to the project investment scale, power supply, operational costs, growth rate of electricity, and other parameters, it measures various financial indexes of the electricity transmission and distribution project (profitability, solvency, and sustainable development ability, etc.), and the project financial post-evaluation score is obtained by using the analytic hierarchy process (AHP), to judge the project feasibility, carry out the project post-evaluation, improve the leading ability in value creation of the financial department in power grid construction, and realize the closed-loop management of power grid project finance.

2. Theoretical Basis

2.1 Internal income of unit electricity
Firstly, according to the depreciation of total power transmission and distribution assets of previous year, operation and maintenance costs, and permissible income of effective assets (fixed assets, intangible assets, current assets), the total theoretical permissible income is calculated. Secondly, the theoretical permissible income of each voltage level is apportioned and collected, to calculate the proportion of theoretical permissible income of each voltage level in the total; and thus to calculate the proportion of load rate of each voltage level according to the annual power supply and transformation capacity of each voltage level in the previous year. Thirdly, according to the principle of 70% of theoretical permissible income and 30% of load rate proportion, the comprehensive apportionment weight of each voltage level of assets is calculated; to apportion the total power transmission and distribution net income (electricity sales income minus electricity purchase cost) in the Company’s financial statements of the previous year to each voltage level according to the comprehensive apportionment weight of each voltage level of assets. At last, the net income of power transmission and distribution of each voltage level divided by the power transmission and distribution of each voltage level is used to calculate the internal income of unit electricity of each voltage level.

2.2 Financial post-evaluation indexes

(1) Profitability evaluation index

① Financial net present value

This index refers to the sum of the net cash flow of the project in each year during the calculation period discounted to the present value at the beginning of the construction period according to the benchmark yield of the power industry. The calculation formula is as follows:

$$\sum_{t=0}^{N} \frac{(CI - CO)_t}{(1 + i_0)^t}$$

Where, CI is the actual or repredicted annual cash inflow of the project according to the actual condition; CO is the actual or repredicted annual cash outflow of the project according to the actual condition; $i_0$ is the power industry benchmark yield (generally as the five-year treasury bond rate); N is the number of years of the calculation period.

If the index of financial net present value of capital fund is greater than 0, it indicates that the project is financially feasible, otherwise it is not feasible. When comparing several plans, the plan with greater inancial net present value is relatively better.
② Financial internal rate of return

The financial internal rate of return (IRR) refers to the discount rate at which the accumulative net cash flow of each year equals to zero during the whole calculation period. The calculation formula is as follows:

\[ \sum_{t=0}^{n} (CI - CO)_t (1 + IRR)^{-t} = 0 \]

Where, CI is the cash inflow; CO is the cash outflow; \((CI - CO)_t\) for the net cash flow of the \(t^{th}\) year; IRR is the internal rate of return of investment finance; \(N\) is the number of years of the calculation period.

③ Static payback period

It refers to the time required to offset all investments (including the fixed assets, etc.) by the net income of the project, that is, the year when the accumulative net cash flow of the project equals to zero. The calculation formula is:

\[ P_i = m - 1 + \frac{|\sum_{i=0}^{m-1} NPV_i|}{NPV_m} \]

Where: \(m\) —— the year when the accumulative net present value appears the positive value.

\(\sum_{i=0}^{m-1} NPV_i\) —— the absolute value the accumulative net present value of last year.

\(NPV_m\) —— the net cash flow of current year.

When the static investment payback period is less than the industry benchmark investment payback period, it indicates that the project investment is recovered within the specified time, so the project is financially feasible, otherwise it is not feasible.

(2) Solvency evaluation index

① Loan payback period

The loan payback period refers to the time required to repay the loan principal of construction investment (including the unpaid interest of construction period) by the profit, depreciation, amortization and other incomes after the production in the fiscal and taxation policy and the enterprise financial conditions, which is generally expressed in years. The computation formula is:

Loan payback period = (the year with surplus when repaying the loan - 1) + (repayable loan amount of the year with surplus / the balance which can be used for repayments of the year with surplus)

② Asset-liability ratio

The asset-liability ratio, which is the ratio of total liabilities to total assets, reflects the degree of financial risks and solvency of the project in each year. The computation formula is:

\[ \text{Asset - liability ratio} = \frac{\text{total liabilities}}{\text{total assets}} \times 100\% \]

The asset-liability ratio can be used to measure the ability of project creditors to provide the funds to carry out business activities, and it also reflects the safety degree of loans issued by creditors. The base value is not determined.

(3) Sustainable growth capacity evaluation index

Net profit growth rate, which is the static index reflecting the investment growth capacity of the project, is calculated as follows:

\[ \frac{\text{Current net profit} - \text{previous net profit}}{\text{previous net profit} - \text{average net profit growth rate of the industry}} \]

Taking the average net profit growth rate of each year in the operation period of the project, if the average net profit growth rate is higher than the average net profit growth rate of the industry, the project is financially feasible; otherwise, it is not feasible.
3. Financial Post-evaluation Modelling

3.1 Modelling
On the basis of calculating the internal income of unit electricity of different voltage levels, this project reasonably predicts the income, cost and expense of each year during the project operation period, prepares the cash flow statement and income statement of the predictive period, and calculates the net present value of the project, internal rate of return, static investment payback period, total return on investment and other indexes.

![Modelling idea](image)

3.2 Construction of evaluation index system
According to the characteristics of project investment in power supply enterprises, the indexes are selected from the two aspects of financing and investment following the principles of comprehensive and systematic, key points highlighting and qualitative and quantitative combination.

Table 1. Project post-evaluation index system

| Index classification      | Index                                                                 | Calculation formula                                                                 | Standard for evaluation                                      |
|---------------------------|-----------------------------------------------------------------------|-------------------------------------------------------------------------------------|----------------------------------------------------------------|
| Post-process evaluation   | Differences between investment estimates and final completion settlement | (Estimated amount of investment − final completion settlement) / estimated amount of investment × 100% | If A is more than or equals to 0, score 100 points; If B is less than 0, score 0 point |
|                           | Difference between internal control target and final completion settlement | (Cost control target - final completion settlement) / cost control target × 100%         | If A is less than or equals to 0, score 0 point; If B is 0-10%, score 50 points; If C is more than 10%, score 100 points |
| Profitability evaluation  | Net financial present value of capital fund                           | Sum of net present value of annual net cash flow                                     | If A is less than 0, score 0 point; If B is more than or equals to 0, score 100 points |
|                           | Internal financial rate of return on capital fund                     | (Internal financial rate of return on capital fund - industry benchmark rate of return) / industry benchmark rate of return × 100% | If A is less than 0, score 0 point; If B is 0-50%, score 80 points; If C is more than 50%, score 100 points |
| Solvency evaluation | Sustainability |
|---------------------|----------------|
| Static payback period | Net profit growth rate |
| 1/ industry benchmark rate of return - static payback period | (Net profit of current year - net profit of last year) / net profit of last year *100% |
| Difference between total return on investment and industry average total return on investment | | If A. is more than 0, score 100 points |
| Profit before tax of annual interest / total investment – industry average total return on investment | | If A. is less than 0, score 0 point |
| Capital net profit rate and industry average capital net profit rate difference | | If A. is less than 0, score 0 point |
| Annual net profit / capital fund - industry average net profit rate on capital fund | | If A. is more than 0, score 100 points |
| Solvency evaluation | | If A. is less than 0, score 0 point |
| Loan payback period | | If A. is less than 0, score 0 point |
| Loan payback period – bank creditor required payback period | | If A. is more than 0, score 0 point |
| Interest coverage ratio | | If A. is less than 2, score 0 point |
| Earnings before interest and taxes / interest payable | | If A. is more than 2, score 100 points |
| Debt service coverage ratio | | If A. is less than 1.3, score 0 point |
| (Earnings before interest and taxes plus depreciation and amortization – enterprise income tax) / principal and interest payable | | If A. is more than or equals to 1.3, score 100 points |
| Asset-liability ratio | | If A. is less than or equals to 50%, score 100 points |
| Total liabilities / total assets*100% | | If A. is more than or equals to 50%, score 100 points |
| Liquidity ratio | | If A. is less than 1, score 0 point |
| Liquid assets / liquid liabilities | | If A. is more than 1.5, score 100 points |
| Quick ratio | | If A. is more than 1, score 100 points |
| Quick assets / liquid liabilities | | If A. is more than 1, score 100 points |
| Sustainability | | If A. is more than 0, score 100 points |
| Net profit growth rate | | If A. is less than 0, score 0 point |
3.3 Improvement to transitional project financial post-evaluation

Table 2. Improvement to transitional project financial post-evaluation

| Content                          | Traditional project financial post-evaluation | Financial post-evaluation of project based on electricity transmission and distribution price reform |
|----------------------------------|-----------------------------------------------|---------------------------------------------------------------------------------------------------|
| Evaluation index system         | Post-process evaluation index, profitability index, solvency index (this project can be excluded), sustainability index | Considering the requirements of power transmission and distribution price reform, in order to strive for the power transmission and distribution price, add the post-process evaluation indexes: whether the project is completed on time, whether the project is timely transferred to capital, electricity sales of RMB 10,000 yuan of assets, growth rate of electricity sales, etc. |
| Evaluation object               | Project (in rough estimates)                  | Asset group (substation asset group, circuit asset group)                                          |
| Evaluation method               | Calculate the average electricity price mode based on financial internal rate of return, that is, back calculating all kinds of electricity transmission and distribution price in the condition of expected financial internal rate, the assumption is that the electricity grid investment can be offset by raising the electricity price, but in fact, the electricity price adjustment is influenced by many aspects of factors, it is not realistic to dredge all investment through the price raising. | Based on the conduction between internal income of unit electricity of all voltage levels of total permitted income of electricity transmission and distribution price (to distinguish the transformation and line internal income of unit electricity without considering the transmission cost of all voltage levels) |
| Model prediction parameter     | Depreciation life: the actual depreciation life of enterprise Operation and maintenance cost growth rate: historical growth rate | Depreciation life: electricity transmission and distribution price cost supervision and audit required depreciation life Operation and maintenance cost growth rate: the average growth rate in the future regulatory cycle estimated according to the operation and maintenance costs required by the electricity transmission and distribution reform |

4. Application of Project Post-evaluation

4.1 Project key parameter setting

The financial post-evaluation mainly evaluates the operating results of the whole operation period of the project. Operation period refers to the period from the formal operation of the project to the end of the project life period. The operation period of power transmission and transformation project is usually calculated as 25 years, including the operation period and predictive period.

(1) Electric quantity in operation period. The electric quantity in operation period of the project is determined according to the actual incremental electric quantity from the completion of the project to the end of last year of financial post-evaluation.

(2) Depreciation expense. The depreciation expense is calculated according to the original value of fixed assets and the corresponding depreciation rate, and the depreciation rate is determined by the straight-line method. Depreciation life is divided into two schemes: the actual depreciation life and the fixed assets depreciation life.

(3) Operation and maintenance costs. To measure the substation, total substation capacity, circuit materials, repair, operation and maintenance costs under the corresponding voltage level according to standard costs; other operation and maintenance costs other than the material repair costs shall be calculated according to the company's historical level of corresponding operation and maintenance costs.

(4) Electricity sales growth rate. This project adopts the following two methods to calculate: ① According to the forecast of State Grid Corporation of China on the future power growth, the growth
rate of electricity sale quantity is set at 4% from 2015 to 2020, and 2.3% after 2020. ② According to the region of each project, the electric power growth rate of each project can be determined by referring to the average electric power growth rate of the companies in each region from 2011 to 2015.

(5) Internal income of unit electricity. The project electricity price is determined according to the calculation principle of internal income of unit electricity at different voltage levels, and the results are shown in the following table:

| Table 3. Calculation result of internal income of unit electricity at different voltage levels |
|-----------------------------------------------|
| Unit: RMB yuan/ thousand KWH |
| Internal income of unit electricity of 1.500kV and above | 2016 excluding tax | 2016 including tax |
| Internal income of unit electricity of 2.220kV | 17.83 | 20.86 |
| Internal income of unit electricity of 3.110kV | 21.29 | 24.91 |
| Internal income of unit electricity of 4.35kV and below | 63.00 | 73.71 |
| Internal income of unit electricity of 4.35kV and below | 110.89 | 129.74 |

(6) Operational cost growth rate. It is divided into two methods of 4.65% according to Handan Power Company’s average growth rate of the historical cost of operations and 3.96% according to the requirements for electricity reform.

(7) According to the above parameter setting difference, the project financial post-evaluation is divided into two plans, in which Plan 1 sets the key measuring parameters according to the actual condition of Handan Power Company; Plan 2 sets the key parameters according to the requirements of electricity reform. The details are as follows:

| Table 4. Key parameter setting list of project post-evaluation plans |
|-----------------------------------------------|
| Parameter type | Plan 1 | Plan 2 |
| 1. Transmission power | Apportion the newly increased electricity of the first year of completion according to the current project capacity ratio. | Same to Plan 1 |
| 2. Amount of depreciation | Measure according to the depreciation life provided by Handan Electric Power Company | Calculated according to the fixed depreciation period |
| 3. Initial annual operation and maintenance expenses | It is divided into the material repair and other parts. The material repair fee is calculated according to the project operation and maintenance standard cost; the other parts is calculated according to the ratio of historical expenses to the original value of fixed assets; | Same to Plan 1 |
| 4. Electric power growth rate | According to the company’s historical growth rate and future forecast, the short-term growth rate is 4% and the long-term growth rate is 2.3%. | According to the growth rate of the power supply company of each project, determine the growth rate of electricity quantity of each project |
| 5. Electricity price | Based on the calculation principle of internal income of unit electricity, the total income is apportioned according to the ratio of the original asset value of each voltage level, and the ratio of the income of each voltage level to the transmission electricity of each voltage level is the internal income of unit electricity of each voltage level. | Same to Plan 1 |
| 6. Growth rate of operation and maintenance expenses | Calculate by 4.65% according to average growth rate of the company’s historical operation and maintenance expenses. | According to the requirements of electricity reform, it can calculate the incremental operation and maintenance expense, and the ratio of 3.96% to the total historical operation and maintenance expenses shall be the growth rate of calculation. |

4.2 Project post-evaluation results
(1) Project feasibility result
Taking the calculation results of 220kV project as an example, the comparative analysis results of each project index under the two plans are as follows:
Table 5. Comparison of 220kV project of two plans

| Indexes | Plan 1 | Plan 2 | Plan 2 |
|---------|--------|--------|--------|
| Nature  | Newly built | Newly built | Newly built |
| Total investment (RMB 10,000 yuan) | 15,896 | 16,904 | 36,592 |
| Operational period (years) | 25 | 25 | 25 |
| Initial annual electricity (1,000 KWH) | 548,077 | 1,380,000 | 619,453 |
| Substation capacity (MVA) | 480 | 480 | 600 |
| Electric power growth rate | 4.00% | 4.00% | 4.00% |
| Internal income of unit electricity | 32.18 | 32.18 | 32.18 |
| Initial annual operation and maintenance cost (RMB 10,000 yuan) | 592 | 621 | 1,208 |
| Growth rate of operation and maintenance expenses | 4.65% | 4.65% | 4.65% |
| Discount rate | 7% | 7% | 7% |
| Load rate | 13.0% | 32.8% | 11.8% |
| Unit capacity investment scale | 33.12 | 35.22 | 60.99 |
| Increase power supply of RMB 10,000 yuan assets | 34.48 | 81.64 | 16.93 |
| Ratio of operation and maintenance expenses to original value of fixed assets | 3.7% | 3.7% | 3.3% |
| Evaluation result | Feasible | Feasible | Infeasible |
| Net financial present value of capital fund | 4,907 | 24,864 | -25,305 |
| Internal financial rate of return on capital fund | 12.3% | 20.6% | 0.0% |
| Static payback period | 8.97 | 6.09 | 28.00 |
| Return on investment | 9.3% | 25.9% | 12.9% |
| Return on equity | 7.0% | 19.5% | 18.5% |
| Net profit growth rate | 6.9% | 3.5% | -10.0% |

Through the analysis of the total operation and maintenance cost, annual depreciation amount and break-even point calculated under the two plans, as well as the comparison and analysis of the financial index values calculated under the two plans, it can be found that Plan 1 has better benefits in some projects and Plan 2 has better benefits in other projects, but in general, the feasibility is consistent.

(2) Break-even point

The comparative analysis of the break-even point of initial annual electricity sale quantity, initial annual operation and maintenance cost, and internal income of unit electricity under the two plans shows that the break-even point of operation and maintenance cost under Plan 2 is lower than that of Plan 1. From the perspective of electricity quantity and internal income of unit electricity, only 5 projects under Plan 2 have better benefits than those under Plan 1, and the electricity quantity and electricity price that reach the break-even are lower. However, comprehensively considering the electricity quantity, operation and maintenance, and the internal income of unit electricity, the feasibility of the two plans remains unchanged.

5. Conclusion

In the power grid project feasibility study stage, it shall overall develop the power grid project economic benefit calculation and evaluation, evaluate the financial feasibility of the project, indeed review the project reserve warehousing economy, optimize the project investment sequence, improve the investment precision, and strengthen the benefit guidance on power grid investment decisions.

It shall also implement the dynamic control for warehouse project, strengthen the financial investment plan and budget control, strictly control the unplanned project and over budget expenditure, strengthen the key financial indexes, financial status and business risk analysis, and find the weak link in timely manner.
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