Quantification Study of The Investment Carrying Capacity of Power Grid Enterprises

YongLi Wang [1], Miaomiao Xu [2*], HanKui Tian [3], XuanYi Lu[4], YiJiang Liu[5], YaNa Duan[6], Yue Lv[7]

[1]e-mail: wyl_2001_ren@163.com

[2*]Corresponding author. Email: xumiao34@126.com

[3]e-mail: 1692479445@qq.com

[4]e-mail: yuan15630495935@163.com

[5]e-mail：1424510319@qq.com

[6]e-mail：18804634472@163.com

[7]e-mail：1332892714@qq.com

[1] School of Economics and Management, North China Electric Power University. Beijing, China

[2] School of Economics and Management, North China Electric Power University. Beijing, China

[3] School of Economics and Management, North China Electric Power University. Beijing, China

[4] School of Economics and Management, North China Electric Power University. Beijing, China

[5] State Grid Economic Technological Research Institute Co., Ltd. Beijing, China

[6] Economic and Technological Research Institute of State Grid Inner Mongolia Eastern Power Co., Ltd Inner Mongolia China

[7] State Grid Tianjin electric power company economic and Technological Research Institute. Tianjin China

Abstract—In order to accurately know the upper and lower limits of the investment carrying capacity of power grid enterprises, it is of great significance to conduct quantitative research on the investment carrying capacity of power grid enterprises. This paper uses the theories of financial management and technical economy, and introduces concepts such as return on investment and operation coefficient to construct the investment carrying capacity of power grid enterprises. Capability quantification model. And the feasibility of the model is verified by an example, which provide a scientific basis for the rational planning of investment plans for power grid enterprises.

Keywords—power grid enterprises; investment carrying capacity; return on investment; operating coefficient

ICIDC 2022, June 17-19, Qingdao, People's Republic of China

DOI 10.4108/eai.17-6-2022.2322677

1 INTRODUCTION

With the rapid development of national economy, in order to cope with the rapid growth of power load demand, the infrastructure construction of power grid is very important. Accordingly, it is particularly critical to accurately and objectively evaluate all kinds of projects in the planning project library and make selective investment arrangements. Power grid investment decision-making is a continuous rolling phased behavior. The dynamic change of investment benefit should be in line with the long-term development strategy of power grid enterprises. At the same time, power grid investment decision-making is a multi-objective optimization problem, and the comprehensive benefits of investment behaviour must be measured from many aspects. The new round of power system reform has fundamentally changed the revenue mode of power grid enterprises. The unit electricity revenue of power grid enterprises has changed from the price difference between sales and on grid to the approved transmission and distribution price. Therefore, in the actual investment decision-making process, we must consider the feedback effect of investment behaviour on the maximum investment capacity of power grid (hereinafter referred to as investment capacity), as well as the impact of project investment timing on overall benefits. Scientific optimization and investment timing of power grid planning projects and reasonable overall analysis and comprehensive evaluation of power grid construction projects are of great significance to reduce the blindness and repeatability in the process of power grid construction, improve the sustainable development capacity of power grid, ensure the return on investment and improve the comprehensive benefits of power grid construction.

In the market economy, the investment carrying capacity of the enterprise determines the development power of the enterprise, so in the process of power grid construction and maintenance, power grid enterprises need to consider the enterprise operation status and social responsibility, and make reasonable investment planning [1-2]. At present, research has been conducted on making investment planning and optimizing investment methods, and investment planning models and investment suggestions have been proposed in different contexts, which provide references for the investment decisions of grid enterprises. However, the research on the investment carrying capacity of the grid enterprise itself is less [3-5]. In view of this, this paper, based on the previous analysis, introduces the concept of operation coefficient based on the theory of financial management, etc., quantifies the investment carrying capacity of the grid enterprise itself, and constructs a model that reflects the investment carrying capacity of the enterprise in an image and intuitive way, which lays the foundation for the effective formulation of investment planning of the grid enterprise.

2 ANALYSIS OF THE INVESTMENT CARRYING CAPACITY OF POWER GRID ENTERPRISES

2.1 The proposed investment carrying capacity model

The enterprise investment carrying capacity mainly depends on the enterprise operation status, and the main financial index reflecting the enterprise operation level is the operating income (main business income and other business income). Therefore, the introduction of grid enterprise operation coefficient α , It indicates the ratio of funds available for investment to the available funds of the enterprise under the premise of ensuring that the operation of the enterprise is not affected. The electric power industry is in a regulated state of return on investment due to its special characteristics and is subject to certain restrictions, so the investment carrying capacity model for grid enterprises is obtained as follows. The investment carrying capacity of the grid enterprise was discribed as follows:

$$I_t = \alpha S(1+y)^t / \beta \quad 0 < \alpha < 1 \tag{1}$$

I_t is the investment carrying capacity of the grid enterprise in year t, S is the business income of the enterprise in the initial year; is the proportion of the grid enterprise's own investment to the total investment, t is the investment year.

2.2 Investment carrying capacity model coefficient determination

2.2.1 The operating coefficient of a grid enterprise can be derived from the ratio of the optimal cash balance to the operating income of the enterprise.

$$\alpha = 1 - k / s \tag{2}$$

K is the optimal cash balance and s is the operating income of the enterprise.

Based on the principles of financial indicators calculation[6], the factor analysis model was used to calculate k.

k=(Average cash employed in the prior year - Unreasonable occupancy amount)×(1±Projected percentage change in sales revenue) (3)

For specific application, the average and unreasonable amount of cash employed in the previous year can be obtained from the operating costs of the enterprise, and the change in sales revenue can be obtained from the sales data. To ensure the accuracy of this indicator, the average value over the study period is usually taken as the composite operating coefficient [8]:

$$\bar{\alpha} = \frac{1}{t}\sum_{i=1}^{t}\alpha_i \tag{4}$$

α_i is the operating factor in year i.

2.2.2 The ratio of the firm's own investment to the overall investment is solved as follows:

$$\beta = \mathrm{i} / \mathrm{I} \tag{5}$$

Where i is the amount of the enterprise's own investment and I is the total investment. In the power industry, the ratio is generally fixed.

2.2.3 To avoid risk factors, the return on investment is usually determined by the weighted average cost of capital (WACC) method [7].

$$y = \mathrm{K_w W / V + K_e E / V} \tag{6}$$

$$\mathrm{K_e = R_f} + \beta_{\mathrm{e}} \left(\mathrm{R_m - R_f} \right) \tag{7}$$

$$\mathrm{K_w = R_f} + \beta_{\mathrm{d}} \left(\mathrm{R_m - R_f} \right) \tag{8}$$

where V is the total assets of the enterprise, consisting of the enterprise's debt capital W and the enterprise's equity capital E; $\mathrm{K_w}$ is the cost of debt capital; $\mathrm{K_e}$ is the cost of equity capital; $\mathrm{W / V}$, $\mathrm{E / V}$ is the ratio of debt capital and equity capital, respectively, reflecting the capital structure of the enterprise; $\mathrm{R_f}$, $\mathrm{R_m}$ is the risk-free rate of return on assets and the average market rate of return, respectively; β_{e} , β_{d} is the risk factor of an equity asset and the risk factor of a debt asset, respectively.

2.3 Model solving process

2.3.1 Based on the operation of the company, the optimal cash balance value is determined by substituting the average amount of cash used in the previous year and the amount of unreasonable use, using the analysis year as the current year.

2.3.2 The operating coefficient of the enterprise is derived from the optimal cash balance and the operating income of the enterprise for the year. At the same time, the return on investment is derived from the data of total assets, debt capital and equity capital of the enterprise.

2.3.3 Combine the specific values of return on investment, operation coefficient, and the proportion of own investment to total investment, and substitute them into the investment capacity analysis model to find out the predicted value of investment capacity of the enterprise in the year t.

3 EXAMPLE ANALYSIS

3.1Build quantitative model of investment carrying capacity

3.1.1 Calculation of optimal cash balance

Table 1 Best cash balance of a provincial power company, 2011-2019

2011	157.440 Billion yuan
2012	188.440 Billion yuan

2013	216.387 Billion yuan
2014	260.774 Billion yuan
2015	341.942 Billion yuan
2016	392.832 Billion yuan
2017	422.654 Billion yuan
2018	488.264 Billion yuan
2019	526.359 Billion yuan

As can be seen from Table 1, as the company's operating income increases, the value of its optimal cash balance rises in order to maintain the company's normal operation and expand its reproduction.

3.1.2 Combining the best cash balance value and the main business income from 2011-2019, the operating coefficients for each year can be obtained as shown in Table 2, but the operating coefficients do not fluctuate much, so the comprehensive operating coefficients are introduced in the table.

Table 2 Comprehensive operating information of a provincial power company a provincial power company, 2011-2019

	Rate of change in sales revenue /%	Best Cash Balance / Billion yuan	Current year operating factor	Integrated Operating Factor
2011	0.148	157.440	0.12	0.120
2012	0.145	188.440	0.08	0.100
2013	0.174	216.387	0.10	0.100
2014	0.179	260.774	0.08	0.095
2015	0.326	341.942	0.09	0.094
2016	0.175	392.832	0.11	0.097
2017	0.076	422.654	0.11	0.098
2018	0.118	488.264	0.08	0.097
2019	0.139	526.359	0.13	0.100

The average values of deposit and loan interest rates of 3.63% and 6.57% in the medium and long term were chosen as the return on risk-free assets. By selecting 20 listed electric power companies as comparable companies and considering the influence of inflation rate on the return on investment, the changes in the consumer price index over 10 years were integrated so that the average value was the inflation rate, and the values of each parameter and the return on investment were finally obtained as shown in Table 3

Table 3 Results of solving for each parameter

Parameters	Unit	Minimum value	Maximum value	Median value
Risk-free interest rate	%	3.63	6.57	5.10
Inflation rate	%	6.00	6.00	6.00
Gearing ratio	%	50.00	60.00	55.00
Asset Risk Factor		0.40	0.67	0.54
Liability Risk Factor		0	0.16	0.08
Equity Risk Factor		0.64	1.68	1.16
Market price of risk	%	14.21	15.95	15.08

Cost of equity	%	7.41	19.52	13.47
Marginal return on liabilities	%	2.20	2.65	2.43
Cost of debt	%	5.83	9.22	7.53
Income tax rate	%	33.00	33.00	33.00
Return on investment (after-tax nominal)	%	7.70	17.29	12.50
Return on investment (pre-tax nominal)	%	11.50	25.81	18.66
Return on investment (pre-tax real)	%	4.26	17.10	10.64

According to the latest grid enterprise investment policy, the enterprise's own investment funds need to account for 25% of the total investment amount.

3.2Analysis of the investment carrying capacity of a power grid enterprise

As shown above, the parameters are substituted into the model to calculate the investment carrying capacity of grid enterprises, which is shown in Table 4.

Table 4 Investment carrying capacity values of a provincial power company from 2011 to 2019

Year	Investment carrying capacity/billion yuan
2011	60.880
2012	71.566
2013	77.572
2014	83.091
2015	92.272
2016	101.621
2017	125.153
2018	138.259
2019	151.650

It can be found that the investment carrying capacity with the increase of enterprise profitability is increasing trend year by year, the actual investment is due to the different situation of power grid construction, technical transformation, maintenance, etc. in each year and show a small fluctuation trend. Therefore, the investment carrying capacity not only depends on the enterprise's own operating conditions, but also on the market investment demand.

4 CONCLUDING REMARKS

This paper constructs the investment carrying capacity model of power grid enterprises, which shows the quantitative way of enterprise investment carrying capacity in a more intuitive way. The example shows that the model is more operative, convenient to calculate, and objectively reflects the investment structure and investment carrying capacity of the power company, and by appropriately adjusting the model parameters, the investment capacity model can be used to quantify the investment carrying capacity of most enterprises, with strong generality and feasibility.

ACKNOWLEDGMENTS. This paper is supported by the science and technology project of State Grid Corporation of China "Research on power grid investment efficiency and Investment Collaborative Optimization technology based on regional Economic growth Pole Mining" (SGSXJY00JJJS2100005).

REFERENCES

[1] Wu Hongliang. Power grid investment should be precise and effective under the new situation[J]. China Investment (in English and Chinese),2020(Z8):56-57.

[2] Chen Hongming, Zhang Yanyan,Xu Yimeng,Chen Jing. International comparison of the scale of indebtedness of power grid enterprises and countermeasures[J]. Business Research,2008(03):97-100.DOI:10.13902/j.cnki.syyj.2008.03.017.

[3] An Yuxing. Co-integration analysis of the relationship between power industry grid investment and economic growth [J]. Journal of Shenyang Engineering College (Social Science Edition),2021,17(01):43-49.DOI:10.13888/j.cnki.jsie(ss).2021.01.008.

[4] Tan Caixia, Geng Shiping, Tan Zhongfu, Wang Jing, Zhou Jinghan, Li Hanfang. Optimization model of investment model for grid company participation in incremental distribution network[J]. Power Grid Technology,2021,45(11):4375-4387.DOI:10.13335/j.1000-3673.pst.2021.0230.

[5] Huang K. Exploring the application of "asset wall" in the investment decision of power grid enterprises[J]. Time Finance,2017(36):234-235.

[6] Yang Xiaoyan. Power grid investment plan management based on the changing environment of power grid construction[J]. Science and technology wind,2017(24):196.DOI:10.19392/j.cnki.1671-7341.201724175.

[7] Cheng Lu,Zhu Yongyan. Exploring the path of investment effectiveness management of power grid enterprises[J]. Fiscal supervision,2016(01):78-80.

[8] Ma Qian,Chen Lijun,Wang Jing,Jiang Nian,Jiang Wenjian. Practice of annual investment plan preference of power grid based on Gini coefficient calibration[J]. Yunnan Electric Power Technology,2019,47(02):90-93.