

# Research on Power Supply Company Investment Scale Simulation Model and Strategy based on System Dynamics under New Electricity Reform

Li Zhao<sup>1</sup>, Junjian Zheng<sup>1</sup>, Jiawen Ye<sup>2</sup>, Wei Liu<sup>2</sup>, Jiaxin Zhao<sup>2</sup>

<sup>1</sup>Dongguan Power Supply Bureau, Guangdong Power Grid Corporation, Dongguan, 523000, China

<sup>2</sup>North China Electric Power University, Beijing, 102206, China

**Abstract.** Since 2016, the reform of power selling side has been coordinated with the reform of electricity price, trading system and power generation plan. With the improvement of the local power planning system, the planning power of power supply companies will be transferred to the government and the planning discourse power will be weakened. The investment scale and investment direction of power supply companies will be subject to stricter control. The investment scale of power supply company plays an important role in the healthy development of power industry. How to establish a simulation model of investment scale of power supply companies is particularly important. Based on the perspective of system dynamics, this paper analyses the investment demand of power supply companies in Dongguan area, considers the dynamic relationship between the adjustment factors of government transmission and distribution price, the interaction and interaction of various links (variables) in the calculation of transmission and distribution price, and establishes the simulation model of investment scale of power supply companies under the supervision mechanism of transmission and distribution price. The interaction between the government and the power supply companies in the regulation of distribution price is analyzed, and the optimization strategy of investment scale of regulatory power supply companies is put forward, to improve the social and economic benefits of the investment scale of regulatory power supply companies in the power supply bureau.

**Keywords:** Electricity transmission; distribution regulation; System dynamics; Power supply company; Investment scale; simulation model.

## 1. Introduction

All manuscripts must be in English, also the table and figure texts, otherwise we cannot publish your paper. Please keep a second copy of your manuscript in your office. When receiving the paper, we assume that the corresponding authors grant us the copyright to use the paper for the book or journal in question. Should authors use tables or figures from other Publications, they must ask the corresponding publishers to grant them the right to publish this material in their paper. Use italic for emphasizing a word or phrase. Do not use boldface typing or capital letters except for section headings (cf. remarks on section headings, below).

The reform of power transmission and distribution price is the most important part of this round of power system reform. The National Development and Reform Commission and the Energy Bureau have successively issued a series of documents, including provincial power transmission and distribution company power transmission and distribution price pricing method (Trial Implementation) and power transmission and distribution pricing cost supervision and examination method (Trial Implementation), to promote power transmission and distribution price reform, part of the reform tasks are clearly defined, and the most valued by the outside world are four "releases" and one independence and one enhancement. Iv. Opening of power supply business, operating electricity price outside transmission and distribution, public welfare and regulatory power supply plan and incremental power distribution business; Independence means the independence of the trading platform; Strengthening refers to strengthening planning [1-2]. Among them, under the supervision mechanism of electricity transmission and distribution, strengthening the investment scale planning of power supply companies is the most important.

In order to meet the strong demand for electricity in the development of national economy, also in order to meet the national electricity demand, power supply companies need to be scientific and rational power grid project construction, and ensure the project can support grid running, and then create a higher economic efficiency, promote the development of national economy, also make the power supply company good development [3]. As one of the main bodies of the power market, power supply enterprises undertake the main power supply task of the whole society, and their production and operation activities are related to the overall situation of economic development and social stability [4]. Therefore, the optimization simulation of the investment scale of power supply enterprises is of great significance for promoting the optimized allocation of power industry resources. Literature [5] introduced the real option theory into the security investment decision-making of power supply enterprises in view of the defects of traditional security investment decision-making methods, constructed the security investment decision-making framework of power supply enterprises based on the real option theory, and established the security investment decision-making model of power supply enterprises based on the binary tree model. Literature [6], combined with the application requirements of the post-evaluation of power grid investment benefits, studied and developed the key technologies in the informatization realization, and established the decision-making support system for the post-evaluation of power grid investment benefits. Literature [7] constructed a new indicator system suitable for the risk assessment of power supply enterprise's human capital investment, and applied the risk theory to the analysis of the enterprise's human capital investment behavior, and proposed a specific method to evaluate the human capital investment risk of power supply enterprise. In terms of the application of system dynamics, some domestic and foreign scholars and enterprises have tried to use system dynamics to build simulation models, to establish a set of scientific tools to accurately analyze enterprise operating conditions and provide decision support [8-10]. Literature [11] mainly expounds the current scientific and technological innovation management of power supply companies, and puts forward scientific strategies for the intensive management of state grid. [12], based on the perspective of performance excellence mode and professional management in harmony, to the chongqing electric power company on performance excellence mode power supply branch as an example, the application research and practice of building performance excellence of normalized management and evaluation mechanism, to carry out professional departments, the company two levels of self-evaluation, comprehensive evaluation, and promote the comprehensive improvement of management level.

Through the relevant research at home and abroad, we can find that the research on the optimization of investment scale of power supply enterprises in China is not in-depth. This paper focuses on the analysis of the investment situation, especially the investment scale of power supply companies in China, builds the investment scale model of power supply enterprises in China, and optimizes the investment decision-making of power supply enterprises by means of system dynamics and optimization calculation methods, aiming at putting forward an effective investment scale optimization method and providing investment rules for power supply enterprises. It provides reference and reference for the scientific and refinement of modules.

## **2. System Dynamics Theory and Its Applicability Analysis**

Rest System Dynamics (SD) was founded in 1956 by JayW. Forrester), professor, is a discipline analyzing and studying information feedback system, a comprehensive discipline recognizing and solving system problems, and a branch of system science and management science [13]. System dynamics combines qualitative analysis and quantitative analysis, which is dominated by qualitative analysis and supported by quantitative analysis [14].

From the perspective of system theory, a system contains elements, connections, functions or goals. It is a whole that is composed of a group of interconnected elements and can realize a certain goal. System dynamics research object is mainly the social economic system, the analysis and the method to solve the problem is not a set of differential equations to solve, but through the analysis of the structure of the system and the interaction between system variables, feedback (driver), and in driving

relationships can quantify the delayed effect of resource driver, and intuitive model is established and computer simulation, so as to solve the problem.

The idea of system dynamics is introduced in the process of business simulation of an enterprise based on the following considerations: the consistency of system thinking and system analysis; Consistency of strategic map and system flow map; The complementarity between simple causality and complex causality; The complementarity between the static index and the dynamic index. The problems encountered in the investment scale planning of power supply enterprises are usually not isolated from each other, but affect each other and change dynamically, especially in the dynamic situation composed of a series of complex systems. In this situation, enterprise investment scale planning is not only to solve the problem, but also to explore the problem generation mechanism within the system with the system concept. The dynamic complexity of power supply enterprise investment can be fully considered by system dynamic modeling. Establish the cause-driven relationship between transmission and distribution price and the investment scale of power supply company by simulating various business behaviors; The investment scale management of power supply enterprises is transformed from the qualitative analysis to the systematic quantitative analysis and from the one-way drive to the closed-loop feedback.

### 3. Simulation Model of Power Supply Company's Investment Scale under the Supervision of Power Transmission and Distribution Price based on System Dynamics

### 3.1 Power Supply Company Investment Scale Optimization Target

The underinvestment of power supply companies and the overinvestment of power supply companies should be the situation that the power transmission and distribution price regulators and the regulated should avoid. The underinvestment of power supply companies is reflected in that the permitted investment scale of power supply companies cannot meet the load growth and the demand of users' power quality, and will lead to shortened equipment life, blockage of power market and even power production safety accidents. Excess investment can power supply company and electric power supply company investment scale is greatly advanced user load growth and quality of power demand, will lead to low utilization rate of equipment, power supply company investment utilization rate of decline, and will cause the next cycle regulation the user assumes the distribution of electricity price soaring, causing the next regulatory tightening cycle power supply company investment or insufficient investment situation.

Therefore, the optimization goal of the investment scale of the power supply company is to determine the investment scale of the power supply company to meet the goal of safe and economic operation of the power supply company based on the current asset status, operation status and power demand forecast of the power supply company.

### 3.2 Power Supply Company Investment Scale Optimization Logic Causal Diagram.

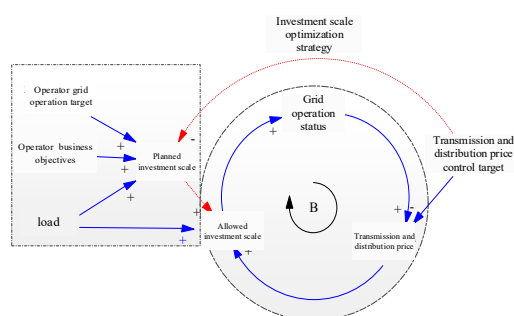


Fig. 1 Simplified optimization logic causal diagram

The simplified optimization logic causality is shown in figure 1. The traditional investment mode of power supply companies is in the rectangular point-and-line frame, and power enterprises independently make investment in power supply companies according to their operating objectives and load conditions. The circular stipulation line frame represents the investment system mode of power supply company under the electricity transmission and distribution regulation mechanism.

In the ideal state, the regulator is not affected by the operators of the power supply company. The operation mode of the investment system of the power supply company under the supervision mechanism of transmission and distribution price is a typical first-order oscillation system. The transmission and distribution price fluctuate with the target of transmission and distribution price control. However, the information between regulators and regulated persons is asymmetric, the original intention of the price regulators and regulatory policies of provincial power supply companies is inconsistent, and the scale of investment of power supply companies may be unreasonable, which may lead to insufficient investment or overinvestment. Judging from the current situation of transmission and distribution price approval, the problem of unreasonable investment scale is beginning to show.

After the implementation of the electricity transmission and distribution reform, the regulator becomes the decision maker of the investment scale of the power supply company, but the regulator cannot know the power supply company better than the power supply company itself. The investment scale optimization thinking of power supply company constructed in this paper is shown in figure 1. The dotted line linear causal connection line is established. The planned investment scale of power supply company relates to the permitted investment scale. Take the initiative to implement the investment scale optimization strategy of power supply company under the guidance of seeking reasonable investment scale; Actively exchange information with regulators to reconcile the contradiction between the permitted investment scale and the planned investment scale of the power supply company, so as to make the final permitted investment scale approach to a reasonable investment scale, and then improve the economic and social benefits of the power supply company's investment.

### **3.3 Simulation Model of Investment Scale of Power Supply Companies under the Supervision of Transmission and Distribution Price based on System Dynamics**

Based on the analysis of the supervision mode of transmission and distribution price and the idea of optimizing investment scale, this paper determines the investment mechanism of transmission and distribution price supervision for power supply companies. On the one hand, it is necessary to establish the investment simulation model of transmission and distribution price-power supply companies, and calculate the allowable investment rules according to the basic conditions and constraints of current power supply companies' operation. On the other hand, it is necessary to establish a simulation model of power supply company's investment-transmission and distribution price. Based on the current basic economic situation of power supply company, the model invests according to the planned investment scale to simulate the change of transmission and distribution price under the planned investment scale and to formulate it. Investment scale optimization strategy. Through the two simulation models, the power supply enterprises can effectively grasp the interaction mechanism between transmission and distribution price and the investment of power supply companies, and provide an important basis for power supply companies to formulate a scientific investment scale.

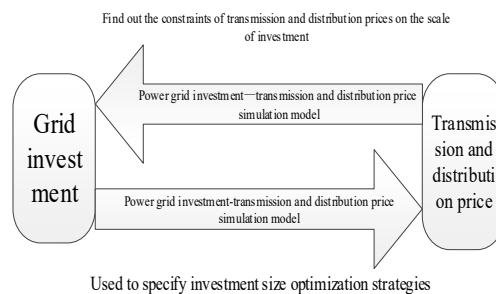


Fig. 2 Investment simulation model of power supply company

The calculation logic of the investment simulation model of transmission and distribution price-power supply company is that, firstly, the expected allowable income is calculated based on the forecast of electricity price and electricity quantity passing through the network; secondly, the allowable income formed by the previous assets is calculated based on the scale of assets, various rates and tax rates and the level of operation and maintenance fees; thirdly, the expected allowable income is deducted from the previous assets. Finally, the allowable investment scale is obtained by dividing the allowable income of new assets by the expected rates, tax rates and effective asset conversion rates. The calculation logic of power supply company investment-transmission and distribution price simulation model is based on the current planning report of power supply company, extracts the investment scale of power supply company in the supervision period, and calculates the change of transmission and distribution price according to the method of transmission and distribution price verification.

The basic equation of the model is as follows:

(1) calculation and calculation of effective assets and depreciation expense

$$\text{Current effective assets} = \text{ending effective assets} + \text{current working capital} \quad (1)$$

$$\text{During the period, new effective assets} = \text{current power supply company investment} * \text{effective asset conversion rate} \quad (2)$$

$$\text{Asset depreciation amount} = \text{ending effective assets} * \text{average asset depreciation rate} \quad (3)$$

$$\text{Ending effective assets} = \text{INTEG} (+ \text{new effective assets in the period} - \text{depreciation amount of assets, initial value of effective assets}) \quad (4)$$

$$\text{Depreciation charge} = \text{ending assets} * \text{average asset depreciation} \quad (5)$$

(2) calculation of operation and maintenance costs

Decommissioning of assets corresponds to the reduced amount of operation and maintenance expenses except labor costs, and it is reduced by reference to the rate of the historical asset scale of the unit. The calculation formula of asset decommissioning rate in the model is as follows:

$$\text{Decommissioning rate} = (\text{decommissioning net asset value} / \text{decommissioning residual asset value rate}) / \text{beginning effective asset} \quad (6)$$

$$\text{Reduction of operating maintenance amount} = \text{ending effective assets} * \text{asset decommissioning rate} * \text{historical operating maintenance fee} \quad (7)$$

The calculation formula of operation and maintenance costs other than employee compensation is shown in formula (8) - (13)

$$\text{New material fee} = \text{INTEG} (+ \text{new material fee} - \text{reduced material fee}, \text{historical material fee}) \quad (8)$$

$$\text{New repairs} = \text{INTEG} (+ \text{new repairs} - \text{reduced repairs}, \text{history repairs}) \quad (9)$$

$$\text{New additional expenses} = \text{INTEG} (+ \text{new additional expenses} - \text{reduced other expenses}, \text{historical other expenses}) \quad (10)$$

The calculation formula of employee salary and current material fee is shown in formula (16) - (20)

$$\text{Current salary} = \text{INTEG} (\text{growth of salary}, \text{historical salary}) \quad (11)$$

$$\text{Current operation maintenance fee} = \text{current repair fee} + \text{current other expenses} + \text{current materials fee} + \text{current employee salary} \quad (12)$$

$$\text{Working capital} = \text{current operating maintenance fee} * 0.25 \quad (13)$$

allowable earnings calculation

$$\text{Permitted rate of return} = \text{equity capital cost} * (1 - \text{asset-liability ratio}) + \text{debt capital cost} * \text{asset-liability ratio} \quad (14)$$

$$\text{Permitted return} = \text{current effective asset} * \text{permitted rate of return} \quad (15)$$

(4) tax calculation

$$\text{City construction and education surtax} = (\text{current permitted income} * \text{VAT rate} - \text{current materials fee} * \text{VAT rate}) * \text{education and surtax rate} \quad (16)$$

$$\text{Income tax} = \text{current effective assets} * (1 - \text{asset-liability ratio}) * \text{permitted rate of return} * (1 - \text{income tax rate}) * \text{income tax rate} \quad (17)$$

$$\text{Current tax} = \text{urban construction and education additional tax} + \text{income tax} \quad (18)$$

(5) transmission and distribution price -- the investment model of power supply company allows the calculation of investment scale

$$\text{Anticipated power supply company investment increase income} = \text{anticipated permitted income} - \text{current permitted cost} - \text{current permitted income} - \text{current tax} \quad (19)$$

$$\begin{aligned} & ((\text{expected to allow new income} - \text{current worker pay} * \text{expected growth rate}) / ((\text{expected new} + + \\ & \text{expected new repair materials coefficient of expected new other expenses}) * 1.25 + + \text{average assets} \\ & \text{depreciation rate is expected to allow yields} + (1 + \text{expected asset-liability ratio}) * * \text{expected income} \\ & \text{tax rate is expected to allow yields} + (\text{expected to allow yields} - \text{expected new materials coefficient}) \\ & \text{VAT rates} * \text{expected education additional urban construction tax rate}) \end{aligned} \quad (20)$$

$$\text{Expected power supply company investment} = \text{expected effective asset increase} / \text{effective asset conversion rate} \quad (21)$$

(6) power supply company investment - transmission and distribution price model transmission and distribution price change calculation model

$$\text{Current supply company investment} = \text{planned supply company investment} * \text{effective asset conversion rate} \quad (22)$$



$$\text{Target power transmission and distribution price} = \frac{\text{expected power supply company investment}}{\text{income/electricity forecast}} \quad (23)$$

#### **4. Analysis of Investment Scale Optimization Strategy of Power Supply Company**

After the reform of power transmission and distribution price regulation is implemented, with the aid of the simulation model of power transmission and distribution price-investment of power supply company and the simulation model of investment-transmission and distribution price of power supply company, power supply enterprises can effectively grasp the constraints of the supervision target of power transmission and distribution price on the investment of power supply company and the influence of investment of power supply company on the change of transmission and distribution price, and then judge the permission. Whether the investment scale can meet the needs of the healthy development of power supply companies, and according to the corresponding investment scale optimization strategy to deal with, in order to optimize the allowable investment scale. In terms of investment scale optimization strategy, this paper mainly proposes that the power supply enterprises should optimize the investment scale on the premise of adhering to the basic rate of return.

##### **4.1 Case Judgment**

(1) Case 1: allowing the investment scale of the power supply company to be too small.

Under the target transmission and distribution price, the allowable investment scale of the power supply company is much smaller than the planned investment scale, which cannot meet the basic needs of the development of the power supply company. The calculation result in the investment simulation model of the power transmission and distribution price-power supply company is characterized by that the allowable investment scale is smaller than that of the power supply company under the target transmission and distribution price. The planned investment scale, after the planned investment scale is executed, the calculation result of the simulation model of the investment-transmission and distribution price of the power supply company is that the transmission and distribution price rises.

(2) Case two: allowing the investment scale of the power supply company to be too large.

Allowing power supply companies to invest too much is that regulators allow power supply companies to invest far more than the power supply companies' investment plans. This situation corresponds to the calculation results of the transmission and distribution price-supply company investment simulation model in the investment simulation model of the power supply company. The characteristics of the calculation results are that the expected investment scale of the power supply company is smaller than that of the permitted investment scale of the power supply company. The calculation results of the investment-transmission and distribution price model of the power supply company are characterized by the expected return rate and the allowable supply company. Under the investment scale of the company, the transmission and distribution price has risen sharply.

The situation that the transmission and distribution price rise and the allowable investment scale exceeds the planning expectation usually occurs after the transmission and distribution price supervision mechanism is mature, but it may also occur in the early stage of transmission and distribution price supervision. In the early stage of power transmission and distribution price regulation, regulators may expand the investment of power supply companies by lowering the allowable rate of return, or blindly expand the investment of power supply companies due to insufficient understanding of the mechanism of power supply companies' investment in power transmission and distribution prices; in the mid-and late stages of power transmission and distribution price verification, the transfer and distribution price supervision turns to incentives. Distribution price supervision system is more perfect, the information that regulators grasp is more comprehensive. After a long period of cost control, transmission and distribution price supervision, the assets structure of power supply companies continues to deteriorate, the operation is difficult, and the maintenance cost is too high. At this time, regulators will consider properly increasing transmission and

distribution price (allowable rate of return) and expanding power supply public. The scale of investment.

## **4.2 Coping Strategies in Different Situations**

(1) Allowed the small size of power supply company investment strategy: before the new regulatory period, power supply companies should play the role of "user representatives", pay attention to the right of voice in regional power planning, do regional power planning work, from the user's point of view, forecast the investment demand of power supply companies as scientifically as possible, and let regulators connect them. Receiving or approaching as close as possible the investment plan of the power supply company, the contradiction between the allowable investment scale and the planned investment scale of the power supply enterprise should be reconciled.

(2) The response strategy that allows the power supply company to invest too much: it needs to make a further judgment on the affordability of electricity price. If the price supervision department and power users can accept the rise of transmission and distribution prices, the power supply enterprises need to cooperate with the regulators to expand the investment scale of the power supply companies, plan, and tie up the operation and maintenance fees properly to the bidding of the power supply companies' construction projects. If the price power users cannot accept the increase of transmission and distribution price, then the power supply enterprises should adhere to the reasonable rate of return on state-owned capital, refuse to blindly expand the investment scale of power supply companies to reduce the actual rate of return, guide regulators to reduce the allowable investment scale to a reasonable level and maintain the normal rate of return. Level, so that the investment of power supply companies tends to be reasonable.

## **5. Simulation Analysis of Investment Scale of Power Supply Company of a Prefecture-Level City Power Supply Bureau**

Firstly, based on the actual situation of a prefecture-level city power supply bureau, the allowable investment scale and transmission and distribution price changes in the past five cycles (15 years) are simulated. The characteristics of transmission and distribution price supervision mechanism are tested and analyzed, and the validity and rationality of the simulation model of power supply company investment scale under transmission and distribution price supervision based on system dynamics are verified.

### **5.1 Simulation Analysis of Permitted Investment Scale under the Constraint of Constant Transmission and Distribution Electricity Price**

In the simulation, the electricity transmission and distribution capacity were 70 billion KWH in 2017, with an annual growth rate of 3.4%; The initial value of electricity transmission and distribution protection is 115 yuan/KWH, and it remains constant. According to the asset size of the power supply bureau in 2016 and the historical operation maintenance fee rate level in 2014-2016, the investment shall be made according to the permitted investment scale, and the simulation output results are shown in the figure.

It can be seen from figure 3 that the calculation results of the permitted investment scale are consistent with the trend of the newly added effective asset scale. Under the stable growth of electricity transmission and distribution and fixed electricity price, the permitted investment scale is over 20 billion in the next two cycles, which can effectively meet the development needs of power supply companies in the region.



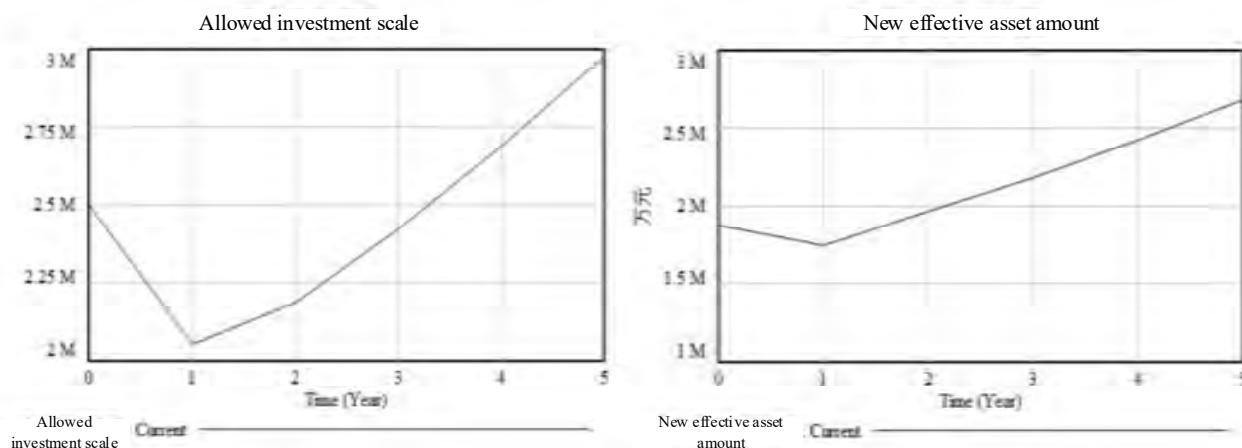


Fig. 3 Allowing investment scale and new effective asset amount

"Effective asset conversion rate" is an important variable influencing the permissible investment scale. The numerical value in the model is set to implement the "first regulatory cycle, new investment is included into the fixed asset ratio at the rate of not more than 75%", and the second cycle is set at 85%, and the subsequent cycle is set at 90%. The 75 per cent effective asset conversion rate during the first regulatory cycle resulted in a higher investment permitted during the first cycle. In addition, this policy on effective asset conversion rate reduces the rate of return on investment of the power supply company in the first cycle, reflecting the regulatory intent to restrain the investment impulse of the power supply company. The second regulatory cycle allowed investment to decline because of the combination of higher effective asset conversion rates and higher new additions to the first regulatory cycle.

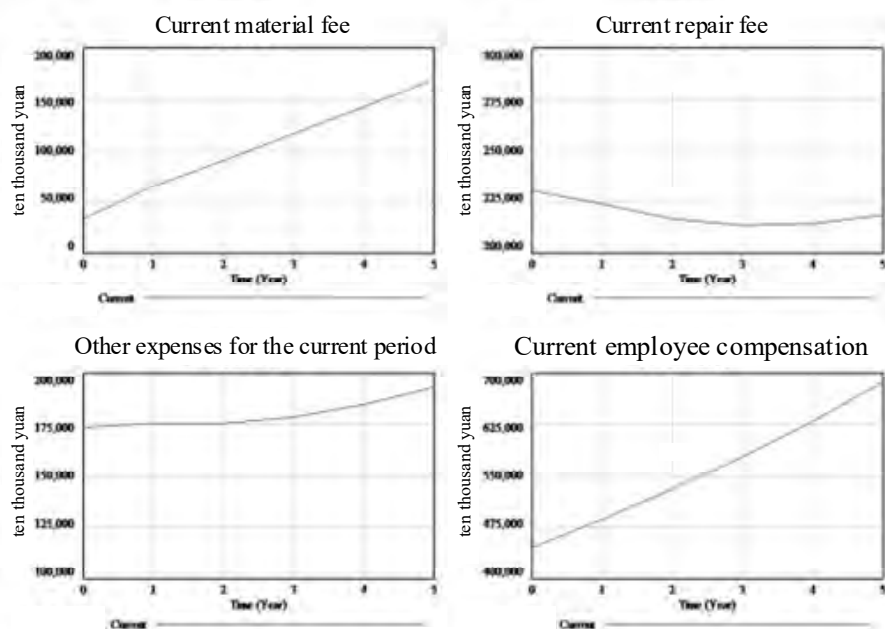


Fig. 4 Operation and maintenance charges

It can be seen from figure 5 and table 1 that the historical repair fee level of Dongguan power supply bureau is relatively high. The simulation results need to be reduced in the next two regulatory cycles to meet the regulatory requirements. Secondly, under the future transmission and distribution price regulation mechanism, the maintenance cost needs to be strictly controlled, while the control pressure of material cost and other costs is not great.

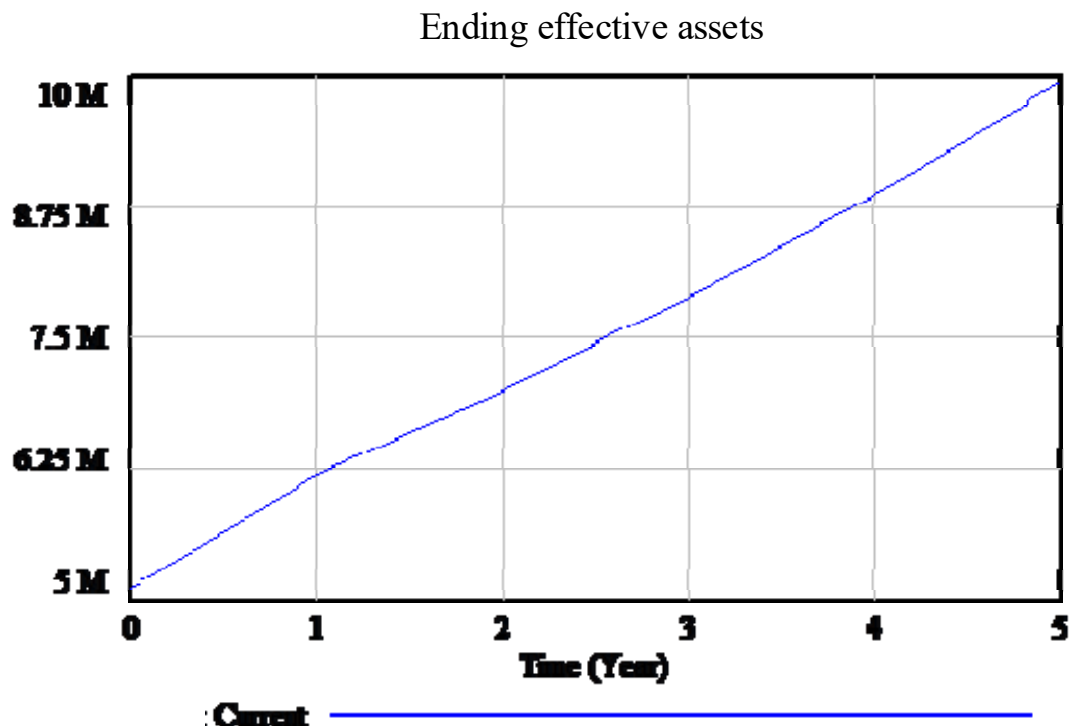


Fig. 5 Effective assets at the end of the period

Table 1. Calculation results of repair cost ceiling for different regulatory periods

| period                                 | 0       | 1       | 2       | 3       | 4       | 5       |
|--|---------|---------|---------|---------|---------|---------|
| Current repair fee (ten thousand yuan) | 230,400 | 224,000 | 216,500 | 213,600 | 214,300 | 218,400 |

## 5.2 Simulation Analysis of Planned Investment Scale and Power Transmission and Distribution Price Changes

In the simulation, the electricity transmission and distribution capacity was 70 billion KWH in 2017, with an annual growth rate of 3.4%; According to the data of the 12th five-year plan of the power supply bureau, the investment scale of the power supply company in the first cycle was set at 14.4 billion yuan, and the growth rate of load in each cycle was set at 3%, referring to the asset scale of Dongguan power supply bureau in 2016 and the historical operation and maintenance fee rate level in 2014-2016. The simulation results are shown in Figure 6.

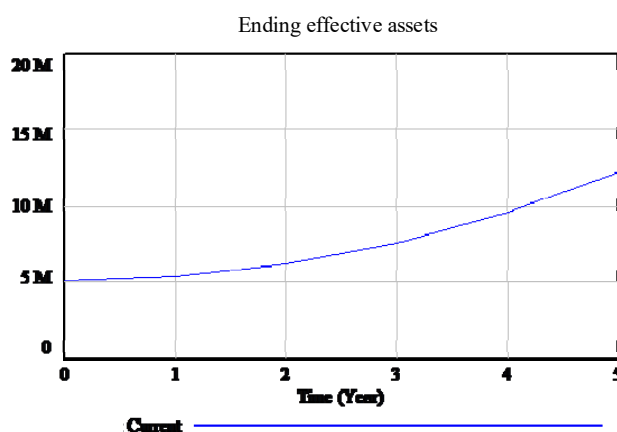


Fig. 6 Effective assets limit at the end of term

According to the planned investment scale, the effective asset quota of the power supply bureau keeps rising rapidly, mainly based on the assumption of the increase of the effective asset conversion rate and the investment scale of exponential growth.

As shown in figure 7, among all kinds of operation and maintenance expenses, material expenses, other expenses and employees' salary keep increasing, while repair costs first decline and then rise, which indicates that the level of historical maintenance fees is high and needs to be strictly controlled in the next two cycles.

Figures 8 and 9 are the changes of transmission and distribution prices under the planned investment scale. According to the investment plan, the initial transmission and distribution price of the power supply bureau in the first cycle is 89.82 yuan/kWh, the transmission and distribution price in the first cycle is reduced to 85.92 yuan/kWh, and the transmission and distribution price in the following several cycles rises moderately until the transmission and distribution price in the fifth cycle rises. To 112.6 yuan / 1000-watt hour.

According to the simulation results, the main conclusions are as follows:

First, the power supply bureau can expand assets appropriately. The calculation results show that the investment scale of the Power Supply Bureau under the expected transmission and distribution price exceeds 50% of the planned investment scale, and the asset expansion space is large. Under the planned investment scale, the transmission and distribution price rise moderately. The supervision of transmission and distribution price will not cause investment constraints to the power supply bureau, which can actively carry out upgrading and transformation of power supply companies.

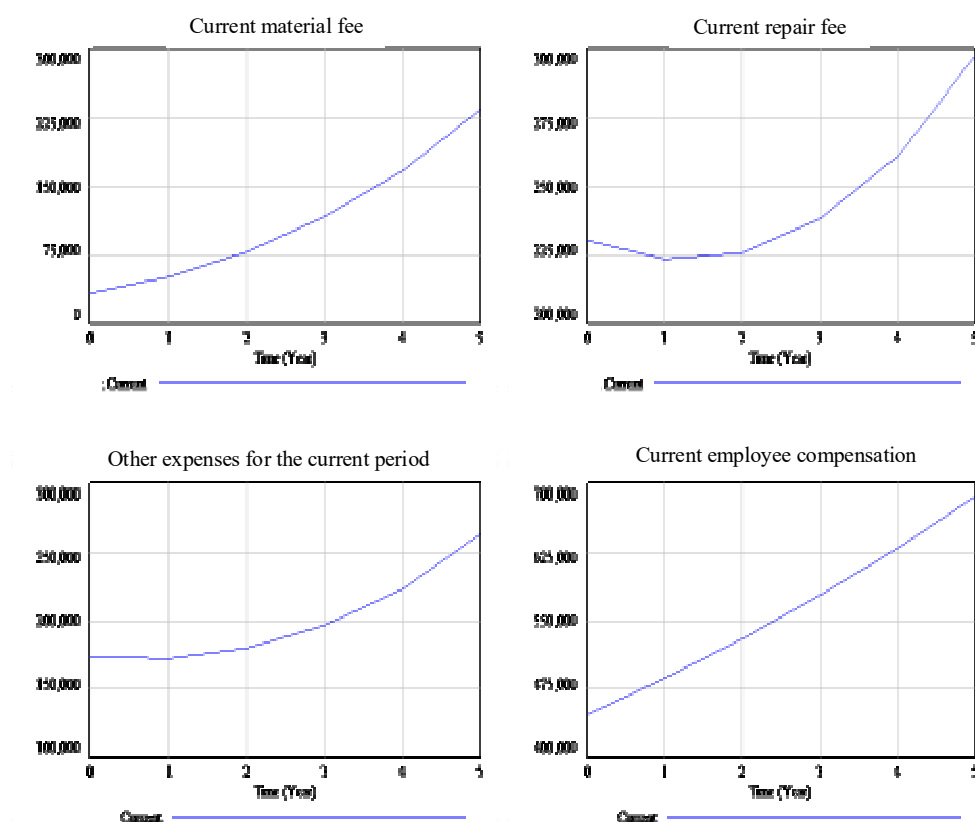


Fig. 7 Operation and maintenance charges

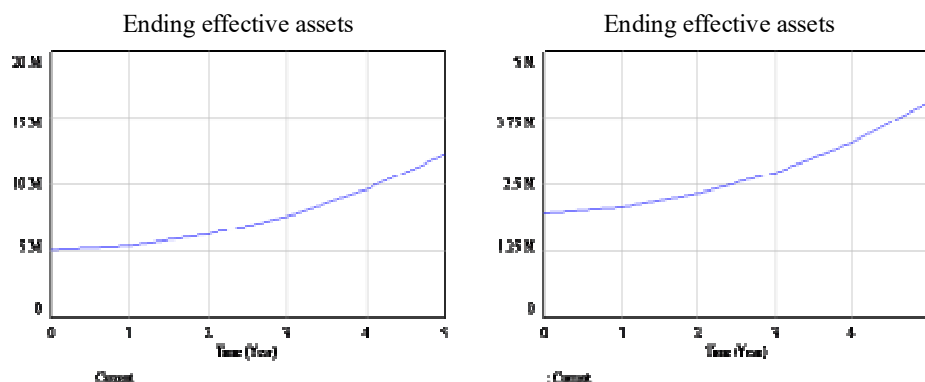


Fig. 8 Asset size and permitted income

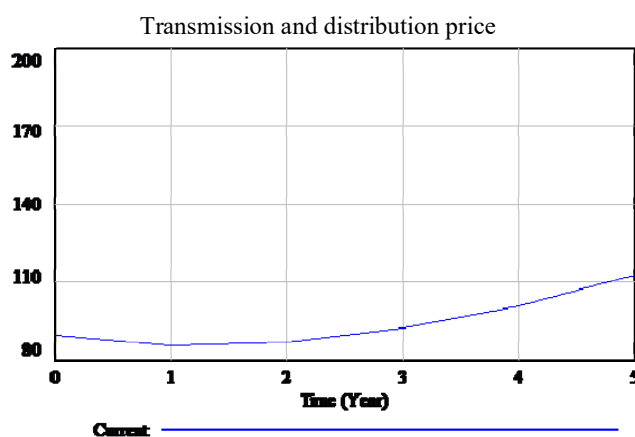


Fig. 9 Changes in transmission and distribution price

Second, the power supply bureau is currently more prominent problem is excessive repair costs. The power supply bureau needs to strictly control the repair cost. In the planning, some power supply company repair projects should be changed into power supply company renovation projects, and the repair cost within the regulatory cycle should be reduced to adapt to the regulatory constraints.

## 6. Conclusions and Recommendations

Combining with the above example of a power supply bureau, the simulation model of investment scale of power supply company based on system dynamics has two remarkable practical functions: one is that it can effectively apply the model to the operation practice of power supply enterprises; the other is that it can make timely and effective investment of resources according to the business objectives of enterprises. Effect adjustment. Therefore, the model is of great significance for improving the production and operation status of power supply enterprises and optimizing their resource allocation capabilities. At the same time, this paper argues that the "three establishment" optimization measures can improve the adaptability of power supply enterprises to transmission and distribution price regulation, and promote the positive interaction between regulation and supervision.

(1) Establish an investment planning and management system that integrates the investment planning and power transmission and distribution price regulation of the power supply company. The regulatory cycle is a "small cycle" starting from the economic regulation in the next few years, while the planning cycle of power supply companies is a "big cycle" starting from the overall regional power development and energy structure evolution. The difference between the regulatory cycle and the planning cycle of power supply companies is objective. Therefore, effective connection between supervision and planning is necessary to promote the positive interaction between supervision and regulated.

(2) Establish a professional management team to strengthen the function of investment planning, management, supervision and response. To effectively carry out all aspects related to the regulatory work, ensure high quality and efficient complete regulatory assessment indicators, to maximize the company under the regulatory framework of the overall profits, power supply enterprises need to set up a task force of supervision department or team, set up distribution electricity price verification and reporting jobs, solicit experience in regulatory compliance, and even have regulators work experience of the staff, strengthen the investment management team of regulatory functions.

(3) Establish a fixed working mechanism facing regulators. In terms of approval and communication process, power supply enterprises need to maintain communication with regulators at all stages of the regulatory cycle, to ensure that the assessment objectives of the regulator and reasonable demands of power supply enterprises can be effectively coordinated and dealt with.

## References

- [1]. Zeng Ming. Key interpretation of the new electricity reform "No. nine". China electric power, 2015-05-06001.
- [2]. Zeng Ming. Key interpretation of the new electricity reform "No. nine". China electric power, 2015-05-06001.
- [3]. Zeng Ming. Power system reform and new energy power system. China electric power, 2015-07-07001.
- [4]. Li Yiman. Research on Project Financial Management and Cost Control of Power Supply Company. Value Engineering, Vol.37(2018) NO. 01, p.55-56.
- [5]. Chen Lei. An international comparative study of power industry regulation reform. Fujian Normal University, 2012.
- [6]. Ding Shi, Wang Zhijie, Xue Song, Zeng Ming. Security Investment Decision Model of Power Supply Enterprises Based on Real Option Theory. Hydropower Energy Science, Vol. (2013) No.08, p. 224-226.
- [7]. Duan Cheng. Research on Post-evaluation Theory and Decision Support System for Investment Benefit of Power Grid. North China Electric Power University, 2012.
- [8]. Zhang Nan. Human Capital Investment Risk Research of Power Supply Enterprises. North China Electric Power University (Hebei), 2009.
- [9]. Li Xueliang, Xue Wanlei, Peng Lilin, Chen Yingjie, Ni Hongfang, Li Chen, Zeng Ming. Application of System Dynamics Model in Business Decision Support of Power Grid Company. Hydropower Energy Science, Vol (2013) No.09, p.240-242+199.
- [10]. Chen Dexiang. Research on the simulation and application of third-party logistics enterprises based on system dynamics. Jiangxi University of Technology, 2013.
- [11]. Cai Yu. Simulation study on financial prediction of private universities based on system dynamics. Jiangxi University of Technology, 2009.
- [12]. Hu Xiaoqin. Application of Intensive Management Innovation Technology in Power Supply Company. Shandong Industrial Technology, Vol.02(2018): 165 + 191.
- [13]. Yang Yang, Zhao Ju. Application and Practice of Excellent Performance Model of Prefectural Power Supply Company --- Taking Nanan Power Supply Branch of Chongqing Electric Power Company as an example. Operation and Management, Vol. (2018) No. 03, p. 123-125.



- [14]. Wang Qi fan. Revised edition of system dynamics. Shanghai: Shanghai University of Finance and Economics press, 2009.
- [15]. Tan Zhongfu, Zhang Jinliang, Wu Liangqi, et al. Medium- and long-term load forecasting combined econometrics and system dynamics model. Power grid technology, Vol.35(2011) No.1, p.186-190.