

Research on Incremental Distribution Network Investment Strategy Considering Uncertainty of Income

Youzhong Miao¹, Feng Zhao¹, Hui Li^{2a*}, Guangbiao Wang², Xinjian Chen² and Ning Wang²

¹State Grid Jibei Electric Power Company Limited, 100054, Beijing, China

²Tianjin Tianda Qiushi Electric Power High Technology Co.,Ltd., 300392, Tianjin, China

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Abstract: In the market-oriented environment, the investment and operation of incremental distribution network faces multiple uncertainties. By analyzing the typical operation mode of incremental distribution network in China, this paper summarizes that the sources of income uncertainty of incremental distribution network mainly include power growth volatility, construction scheme, power grid investment, multi energy complementary, energy Internet construction. Finally, based on the real option theory, the investment decision-making elements of incremental distribution network under uncertain environment are proposed. This study can provide support for operators' investment decision-making.

1 INTRODUCTION

Since the notice on standardizing the pilot reform of incremental distribution business was issued in 2016. As of August 2020, five batches of 483 incremental distribution pilot projects have been approved (F, S 2018). With the investment and operation of a large number of incremental distribution network pilot projects, the investment and operation mode of incremental distribution network is gradually clear, and the relevant policies and construction specifications are more clear. However, the gradual deepening of China's power market-oriented reform has further intensified the competition in the incremental distribution market, and the uncertainty of operating income has led to the withdrawal of a large number of incremental distribution operators who get up early and enter the market (H, B, T, E 2020).

In the existing research, by referring to the relevant methods of power grid planning in China, the investment strategy of incremental distribution network is analyzed based on load forecasting, investment planning and benefit evaluation (Z, Y, W et al. 2020). In terms of load forecasting, regional saturated load forecasting considering load density is an important research method. This is due to the lack of historical data in the incremental distribution network Park, resulting in the poor applicability of

the traditional prediction algorithm based on historical data (T, P, W, et al. 2019). In terms of investment planning, the investment decision-making methods, principles and strategies are given mainly combined with the investment income model of incremental distribution network. Some literature have also constructed constant capacity optimization methods such as distributed generation and energy storage under incremental distribution network for specific scenarios. In terms of benefit evaluation, based on the existing project technical and economic analysis methods, the influencing factors of incremental distribution network investment benefit are analyzed by introducing DEA, VaR and other methods (Q, W, Y et al. 2021). This paper analyzes the uncertain factors in the market-oriented environment to adapt to the incremental distribution network operation scenario with great uncertainty and provide guidance for the investment decision-making of incremental distribution network operators.

2 OPERATION MODE OF INCREMENTAL DISTRIBUTION NETWORK IN POWER MARKET ENVIRONMENT

The service scope of incremental distribution network mainly includes two aspects: first, for distribution network, some basic services must be provided, including distribution network dispatching, operation, construction, transformation and providing power supply services to users. Second, special policy services under the background of power market reform can be carried out, which are defined here as value-added services, such as comprehensive energy services of cooling, heating and power, agent users to participate in market-oriented transactions, etc. the specific transaction types include power purchase and sale, auxiliary services, carbon trading, etc.

In terms of basic business, the distribution service fee will be the main revenue source of the power supply service of the incremental distribution network company. At the same time, the administrative measures for orderly liberalization of distribution network business points out that the distribution price of the incremental distribution area shall be formulated by the provincial (District, municipal) price competent department in accordance with the relevant provisions of the national transmission and distribution price reform and reported to the national development and Reform Commission for the record. Before the distribution price is approved, the transmission and distribution price of the provincial power grid shared network corresponding to the access voltage level of the power selling company or power users shall be deducted from the transmission and distribution price of the provincial power grid shared network corresponding to the access voltage level of the distribution network.

In terms of value-added business, by signing energy-saving service contracts with customers, we provide customers with a complete set of energy-saving services, including energy audit, project design, project financing, equipment procurement, engineering construction, equipment installation and commissioning, personnel training, energy-saving confirmation and guarantee, It is a business operation mode to recover investment and profit from the energy-saving benefits obtained by customers after energy-saving transformation. The operation modes of contract energy management mainly include:

equipment leasing type, energy-saving benefit payment type, energy-saving quantity (rate) guarantee type, energy-saving benefit sharing type and long-term trust type of energy cost.

Table 1: Basic operation mode of contract energy management.

Basic mode	Concrete content
Equipment rental type	The customer leases energy-saving equipment from the service company. After the lease expires, the equipment is transferred to the customer free of charge. The customer pays the equipment rent to the service company on a monthly or quarterly basis.
Energy saving benefit payment type	When the customer entrusts the service company to carry out energy-saving transformation, a certain proportion of advance payment shall be paid first, and the balance shall be paid with energy-saving benefits.
Energy saving (rate) guaranteed	All investment in energy-saving projects shall be provided by the service company, and the whole process service shall be provided to ensure the energy-saving effect. The customer shall pay the cost of energy-saving transformation projects; If the promised benefits are not achieved, it shall bear the responsibilities and losses in accordance with the contract.
Energy saving benefit sharing	The initial investment of the project shall be paid by the energy conservation company. During the contract period, the energy conservation service company shall share the consumption reduction benefits brought by energy conservation transformation with customers. Upon the expiration of the contract, all energy-saving equipment and long-term income shall belong to the customer.
Energy cost long-term trusteeship	On the premise of ensuring the reduction of customers' energy costs, all customers' energy costs are managed by the energy conservation service company. The long-term operation, maintenance, renovation and re investment of energy-saving equipment are undertaken by the energy-saving service company.

3 UNCERTAINTY ANALYSIS OF INCREMENTAL DISTRIBUTION NETWORK INVESTMENT INCOME

The uncertainty of investment return comes from macro environment and micro environment. Specifically include:

(1) Growth fluctuation of load and electricity

Most of the revenue of incremental distribution network operation comes from power supply. On the one hand, this part of revenue depends on the transmission and distribution price, on the other hand, it is related to load and electricity. In the coming period of time, the transmission and distribution price will basically remain stable under the control of the government and will not fluctuate greatly. The fluctuation of electricity will affect the operation income of incremental distribution network, then affect its investment value, and determine the option value of incremental distribution network. There are many factors affecting power consumption, mainly including economic development, industrial structure, industry prospect, climate, energy substitution, etc.

(2) Investment uncertainty caused by different construction schemes

In the process of power grid planning, different power grid construction schemes can meet the future user load. Different construction schemes will have great differences in line structure and substation quantity. At the same time, the cost of materials and equipment used for different types of users is also different. Therefore, different construction schemes have differences in project investment cost. The project investment cost is uncertain, which leads to the uncertainty of incremental distribution network income. At the same time, technological progress will also affect the power grid construction scheme, thus affecting the investment cost.

(3) Uncertainty caused by the stimulation of power grid investment projects

Power grid investment and construction, on the one hand, is used to meet the needs of existing power users, and will have a positive stimulating effect at the same time. Especially for the industrial park, industrial enterprises have high requirements for the guarantee of power supply quality and safety. The complete power grid facilities in the park will facilitate investment attraction, so as to attract enterprises to settle in the park. The quality of distribution network and the length of construction cycle play an important role in this process.

(4) Uncertainty caused by multi energy complementary

The future power system will no longer be independent. Especially for enterprises with multiple energy needs, integrated energy services will better meet the needs of users. Therefore, the meaning of future incremental distribution network is not only the power grid, but also the pipelines for cooling and heating. In this context, the coordinated supply of multiple energy sources in incremental distribution network is very necessary, and the way of complementary, coordinated and optimal scheduling of multiple energy sources makes the income of incremental distribution network uncertain.

(5) Uncertainty caused by energy Internet related investment

In the context of energy Internet, the power grid will realize island operation in the form of micro-grid in the future, and the large power grid will be used as the auxiliary of micro-grid to maintain the stability of power grid. For specific projects, the investment in energy supply and consumption equipment such as distributed generation, energy storage and charging vehicle charging pile in incremental distribution network will not only increase the investment cost, but also bring additional benefits, which is uncertain.

4 INCREMENTAL DISTRIBUTION NETWORK INVESTMENT STRATEGY CONSIDERING UNCERTAINTY

Among many traditional evaluation methods, net present value method is the most commonly used method. However, considering that the power grid project has the characteristics of high cost, high technology, long construction cycle, large time span and many uncertain factors, at the same time, the materials for power grid construction are special, and it is very difficult to sell and realize power grid assets. Next, combined with the characteristics of the above power grid project construction, the traditional net present value method and real option method are compared in the economic evaluation of power grid investment.

The decision-making suggestions obtained by traditional methods are limited to investing now or not. The option method can provide a variety of investment strategy suggestions, including when to invest, the choice of investment scale, when to exit, whether to invest step by step and so on. Under the traditional method, investment decision-making only

makes unilateral consideration, that is, according to whether the net present value is greater than zero, it appears in the decision-making suggestions of investment and no investment at present, but entrepreneurs or managers rarely make such a simple conclusion, so such a quantitative method is difficult

to meet the needs of investment decision-making. The real option method should not only consider the traditional net present value, but also consider the increase or decrease of enterprise options caused by investment. Therefore, a variety of decision-making suggestions can be obtained.

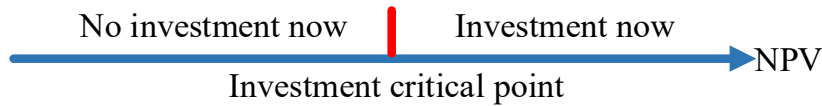


Figure 1: Discounted cash flow investment decision.

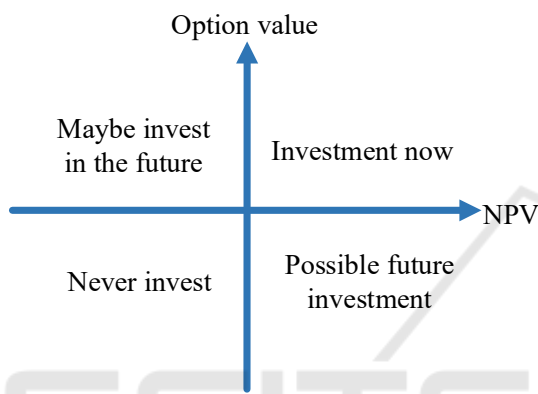


Figure 2: Real option model investment decision.

Using the real option method, we can also get more specific and meaningful decision-making suggestions. For example, according to the company's resources, changes in investment and operating costs, technological progress, demand change forecast, competitor investment strategy, etc., consider the "best" investment opportunity, investment order, investment "best" scale, whether to make (forward or backward) integrated investment, whether to diversify (invest in original business or new business), Whether to make international investment.

The investment and operation of incremental distribution network is multi-stage, which can be divided into the stage of obtaining investment right and each stage of power grid investment. According to the policy requirements of incremental distribution network, the investor of incremental distribution network investment and operation needs to be determined through public bidding. Therefore, in the initial stage of incremental distribution network investment and operation, the investment right needs to be obtained through bidding and other means, so as to generate the option of investment in the first stage. When obtaining the operation right, the

investment expenditure to be borne by the investor is the net fixed asset value of the stock assets of the distribution network in the park. This part of assets can be accounted into the incremental distribution network assets by purchase or price as shares. Different investment strategies will affect the investment amount and income distribution of the distribution network.

The investment income of distribution network in typical parks is affected by many factors. From the perspective of income source, its investment income is determined by the transmission and distribution power and transmission and distribution power price. Under the condition that the transmission and distribution power price of each voltage level is approved, the investment income of distribution network comes from the price difference between the transmission and distribution power prices of different voltage levels. When calculating the income, it is necessary to predict the power consumption of users in the park. This result is the transmission and distribution power. Therefore, from this point of view, the uncertainty of distribution network investment income in typical parks mainly comes from the price difference of transmission and distribution price and user power consumption. Under the control of the government, it is difficult to adjust the price difference of transmission and distribution price significantly. Therefore, the fluctuation of distribution network investment income in typical parks is mainly affected by the accuracy of power consumption prediction. From the perspective of power grid investment, under the condition of energy Internet, power grid companies gradually change to comprehensive energy service providers. In this situation, power grid companies become more flexible in the investment process.

5 CONCLUSION

Under the market environment of the liberalization of incremental distribution network and the gradual introduction of competition in the distribution market, the incremental distribution network investment faces great uncertainty and the investment income is at risk. Considering the defects of the traditional net present value method under the new situation, the venture capital theory is used to reasonably evaluate the risk value caused by various uncertainties based on the real option model, so as to estimate the investment value more comprehensively. At the same time, it should be pointed out that with the gradual deepening of market-oriented reform, the applicability of real option theory and model will be greatly increased, which also needs further research.

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