Planning of the Power Distribution Network in the Industrial Area under the Liberalization of Incremental Power Distribution Business

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Abstract. The so-called incremental power distribution network is a newly added power distribution network serving the public. At present, the enhanced power distribution network is often used in industrial parks with voltage levels of 220KV, 110KV and below. The basic conditions for the construction of the incremental power distribution network are in line with the provincial planning of power distribution network, which avoids conflicts such as repeated construction and a cross power supply between the incremental power distribution network and the provincial power distribution network. This paper studies the ways to plan the power distribution network in the industrial area under the liberalization of incremental power distribution business to provide reference for relevant practitioners.

Keywords: Increment, The power distribution network, Industrial area, Planning, Research and analysis

The most basic condition in the planning of the incremental power distribution network in the industrial area is to meet the planning of the provincial power distribution network and to avoid conflicts. Therefore, the concept of the incremental power distribution network is different from that of the provincial power distribution network, and they are not attributed to each other. The incremental power distribution network can be said to be a local grid and a special large user of the provincial power distribution network supply [1 ~ 2]. In the planning of
the incremental power distribution network in the industrial area, the main problems are that
distribution network can meet the development needs of the industrial area, and control the
risk under the liberalization of the incremental power distribution business. To effectively
solve the above problems is an important basis for the rational planning of the power
distribution network in the industrial area.

1. Services of the incremental power distribution network
For operators of the incremental power distribution network, the services they can provide at
present include power supply, distribution network, guaranteed power supply and
value-added services. It can be clearly seen that the problems that need to be solved by
operators of the incremental power distribution network focus on investment, construction
and operation.

   (1) The problems that need to be solved urgently in investment

   Sufficient financial support is the basis for the effective operation of incremental power
distribution network, so operators of the incremental power distribution network need to do a
good job in the planning of financing and investment to ensure the normal profitability of the
incremental power distribution network. Funds can be invested in technology accumulation,
talent introduction and equipment construction [3]. In order to realize the effective operation
of incremental power distribution network, we must deal with the above investment factors
reasonably.

   (2) The problems that need to be solved in construction

   They are reflected in planning and construction. Reasonable planning can guarantee the
stability and safety of the operation of incremental power distribution network, reduce the
loss of power grid, and improve the quality and reliability of power. In terms of construction,
the most ideal situation is to use the minimum construction cost to achieve the best benefit.
Therefore, in the process of construction, it is necessary to provide advanced construction
technology for the experienced team to complete the construction to ensure the orderly
construction of the incremental power distribution network [4 ~ 5].

   (3) The problems that need to be solved in operation

   They are mainly reflected in the daily work of the operators of the incremental power
distribution network, such as power purchase, power sale, meter reading, settlement and
maintenance.

2. Project process and existing problems of the incremental power distribution network
The project process of the incremental power distribution network includes project planning,
business determination, project review, project construction, public network access, price
verification, application for permission, and distribution network operations. It can be seen
that the main concerns of incremental power distribution network are planning, cost, and
safety of the incremental power distribution network, which are also the factors that most
likely to cause disputes.

   (1) The operator of incremental power distribution network believes that the current
incremental power distribution network can meet the electricity demand of the industrial area,
but relevant personnel in the industrial area think that the planning of incremental power
distribution network cannot meet the actual demand of electricity.

   (2) An abnormality occurs in the public network access link of the incremental power
distribution network, leading to the occurrence of a fault.

(3) Grid enterprises have exerted too much control on the incremental power distribution network.

(4) The accounting system of incremental power distribution network price of power grid enterprises is not perfect and lacks the authoritative verification method recognized by the owner [6].

(5) It is failed to locate the incremental power distribution network effectively. Grid companies often think that the incremental power distribution network is a user, and the project owners think that the incremental power distribution network belongs to the category of power grid, and there are disputes about paying electricity and reserve capacity costs.

3. Risk analysis on the liberalization of incremental power distribution business

The power distribution network business generally includes two types of investment, that is, investment in capacity expansion of distribution network under mixed ownership, and the investment, construction, and operation of incremental distribution network. The difference is that the former's revenue is more from the user's electricity consumption, while the latter is reflected in the establishment of an integrated distribution system, which is more representative. During the planning process of incremental power distribution network, power supply enterprises will analyze the economic situation of the industrial area, such as the cost of power supply, the amount of electricity sold, the average price of electricity sold, and the occurrence of line losses. These uncertain factors together determine the risk of power distribution network investment. For example, when investing in an incremental power distribution network, it is necessary to perform a benefit analysis on the newly added assets, that is, the difference between the income and expenditure of the incremental power distribution network [7]. Assuming that $H_j$ is the total annual return on incremental power distribution investment, in which the income from increased sales of electricity and electricity price is the external investment income $H_j$, and the income from reducing the line loss rate and considering the increase is the internal investment income $H_j$. The following formula can be obtained as follows:

$$H_j = H_j, \text{external} + H_j, \text{internal}$$

$$H_j, \text{external} = \left( P_{1j} - \frac{P_{2j}}{1-\beta_j} \right) \Delta q_j$$

$$H_j, \text{internal} = \left( \lambda \text{ line loss } \Delta \beta_j \cdot P_{1j} + \Delta W_j \cdot (P_{1j} - P_{2j}) \right) \Delta Q_j$$

In the formula, $p_{1j}$ is the average selling price of power supply enterprises in the j-th year; $p_{2j}$ is the average purchasing price in the j-th year; $\Delta Q_j$ is the increased selling power in the j-th year; $\beta_j$ is the occurrence of line loss in the j-th year; $\Delta \beta_j$ is the reduction in the j-th year relative to the occurrence of line loss in previous years; $\Delta W_j$ is the incremental purchasing reliability in the j-th year; $\lambda$ is the verification coefficient of line loss rate.

4. Analysis of power demand in the industrial area

The reasonable planning of the power distribution network in the industrial area cannot be separated from the analysis of electricity demand. Accurate analysis of electricity demand can make power supply enterprises better make decisions on marketing, product production and product sales. It plays an important role in analyzing market conditions and forecasting electricity demand. The detailed contents can be summarized as follows: (1) Accurate and
effective user electricity consumption can provide a reference for the country to formulate
relevant electricity consumption policies [8]; (2) The operation and management of electric
power enterprises will be carried out on the basis of clarifying the electricity demand, which
has a positive impact on the enterprises to obtain more economic benefits; (3) Mastering the
electricity demand of users can allocate the electricity consumption time reasonably by using
the economic leverage principle of electricity price to control the electricity expenditure,
reduce costs and save funds.

The analysis method of power demand in the industrial area includes regression analysis
method, correlation analysis method, moving average method, exponential smoothing
method, grey prediction method, and artificial neural network method. The basic steps of the
above methods are as follows: (1) Modeling. It firstly needs to determine the content to be
predicted, then to mobilize the historical data, and master the local area by analyzing the
historical data to establish a reasonable mathematical model and lay a foundation for the
follow-up analysis [9-10]. (2) Data preprocessing. In the case of data preprocessing and
subsequent prediction steps, reasonable methods can be used to preprocess the data to meet
the needs of later prediction steps. (3) Identification of model parameters. Once the
identification of model parameters and prediction model is determined, the parameters of the
model can be calculated according to the actual data. (4) Significance of test model. It is
necessary to test the parameters of the model to ensure the applicability of the model. (5)
Prediction of the model. It needs to predict the behavior in the future by using the model to
further verify the accuracy and applicability of the model. (6) Evaluation of prediction results.
It needs to evaluate the verification results of the model and analyze the advantages and
disadvantages of the prediction results. When the prediction results do not meet the standards,
the model needs to be processed again until the ideal prediction results are obtained [11-12].

5. Management and control measures of the incremental power distribution network in
the industrial area

5.1 To clarify the essence
Incremental power distribution network has a natural monopoly attribute, which is different
from power grid sales. The nature of electricity sales is competitive and facing the public. The
incremental power distribution network supplies power to the industrial area in the form of
ownership to revitalize social capital. What’s more, the incremental power distribution
network also has responsibility of ensuring the safety of power supply, which can greatly
reduce the investment risk of social capital and maximize the benefits of social capital
investment [13].

5.2 Reasonable income
The country is responsible for the pricing of the incremental power distribution network to
regulate the investment behavior of incremental power distribution network to avoid blind
pricing. And the price is composed of allowable costs and reasonable benefits. On the other
hand, it can bring stable economic benefits to the operators of the incremental power
distribution network, which plays an important role in promoting the healthy and effective
development of the incremental power distribution network. Although the rules and
regulations in this area are still in the exploratory stage, they are moving in the right direction
with good development prospects.

5.3 To manage the system
The effective operation of the incremental power distribution network cannot be separated from the regulation of relevant national laws and regulations. The main contents are summarized as follows: (1) The management system. The state has formulated a number of systems in the management of incremental power distribution network, including the unified planning, construction and operation system of the incremental power distribution network, which fully guarantees the stability and safety of incremental power distribution network [14]. (2) The revenue system. The state macro-controls the revenue of the incremental power distribution network and allows the incremental power distribution network enterprises to obtain sufficient economic benefits through cross-subsidies. (3) The supervisory mechanism. According to the requirements of the State Council to change the functions of government and streamline administration and decentralization, the supervisory mechanism is also set up in the incremental power distribution network. The public plays the role of a supervisor to make sure the healthy and sustainable development of incremental power distribution network. (4) The intervention and exit mechanism of market entities. The improvement of the intervention and exit mechanism can increase the enthusiasm of the incremental power distribution business, which is of great significance to enhance competition and encourage the development of high and new technology.

Conclusion
In the context of the liberalization of incremental power distribution business, to do a good job in the planning of power distribution network in the industrial area, it is necessary to make clear the current process and existing problems to avoid the risks of incremental power distribution business. And component planning can be carried out based on relevant national laws and regulations to do a good job in risk management and control of incremental power distribution network and better realize the planning of power distribution network in the industrial area.

References
[1] Ye Lingjie, Zhu Tinghan, Xu Yang. Research on the Policy Environment of Distribution Network Business under the Background of Electric Power System Reform [J]. Science and Technology Economic Guide, 2017 (4): 238-239.
[2] Li Zhenkun, Ren Yuliang, Wang fashun, et al. Investment Benefit Evaluation and Sensitivity Analysis of Incremental Distribution Network Based on Annual Time Series Simulation [J]. Grid Technology, 2019, 43 (6).
[3] Zhu Tinghan, Ye Lingjie, Yang Yunlu. Analysis of Financing Modes for the Construction and Transformation of Distribution Networks [J]. Science and Technology Economic Guide, 2017 (4): 11-12.
[4] Yang Nan, Dong Bangtian, Huang Yu, et al. Collaborative Planning Method for Source-Net-Load of Incremental Distribution Network Considering Uncertainty and Multi-Agent Game [J]. Chinese Journal of Electrical Engineering, 2019, 39 (9).
[5] Wu Guilian, Zhang Linyao, Hu Zhenda. Comprehensive Evaluation of Overall Planning Scheme for Medium and Low Voltage Distribution Networks [J]. Electric Power
Construction, 2015, 36 (11): 64-69.

[6] Liu Wenxue. Study on Dynamic Economic Dispatch and Reactive Power Optimization of Power System Based on Chance Constrained Programming [D]. 2016.

[7] He Jixiang. Analysis of Existing Problems and Improvement Measures in Kunming Urban Distribution Network Planning [C] / / 2015 Yunnan Electric Power Technology Forum. 0.

[8] Jiang Daozhuo, Xu Ning, Jiang Chongxi, et al. The Concept, Key Technology and Prospect of Honeycomb Active Distribution Network [J]. Power System Automation, 2019 (17).

[9] Li Yang, Liu Youbo, Huang Yuan, et al. Evaluation Method of Scale Incentive for Medium and Long-term Dynamic Planning Investment in Distribution Network [J]. Power Automation Equipment, 2018 (6).

[10] Zeng Huijuan, Liu Xuesong, Chen Weiwei. How to Release the Mist of Incremental Distribution Investment [J]. State Grid, 2017 (3): 58-63.

[11] Sun Chongbo, Yang Weihong, Song Yi, et al. Adaptability Analysis and Optimization of Distribution Network Planning and Design Standards in the New Situation [J]. Standard Science, 2019 (5): 59-63.

[12] Tan Zhi. Research on the Formation of Incremental Distribution Companies under the background of Mixed Ownership Reform [J]. Communication World, 2019 (6): 293-294.

[13] Junhui H, Hu L, Qi Z, et al. Research on the Combined Planning Mode of Distribution Network under the Condition of Incremental Distribution Opening-Up [C]// 2017 International Conference on Smart Grid and Electrical Automation (ICSGEA). IEEE Computer Society, 2017.

[14] Zhengxin L, Bei H, Meng N, et al. Research and Application of Multi-node Load Forecasting Algorithm under the Environment of Distribution Network's Big Data [J]. Power System Protection and Control, 2016.