Research on Development Path of "Three Types & Two Networks" of Grid Corporation Based on Normal Hypothesis

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Abstract. Under the analysis of the development concept of "Three Types & Two Networks", this paper puts forward the development indicators of current power grid companies, predicts the future development direction, and initially studies the development path of "three types and two networks" in power grid companies. In this paper, the normal curve method is used to optimize the index weight and transition probability, and then the Markov model is used to predict the index, and the development path of "three-type two networks" is proposed.

1. Introduction

On January 17, 2019, the State Grid responded to the country's call for "deepening reform" and proposed the development direction of building a world-class energy Internet company. The pursuit of goals has been clear. Based on the functional characteristics of the energy Internet and the company's responsibility mission, building a “three-type” (hub-type, platform-type, shared-type) enterprise is an important starting point for building a world-class energy Internet enterprise. The construction and operation of the "two networks" (strong smart grid, ubiquitous power Internet of Things) is an important material basis for building a world-class energy Internet company. Aiming at "world class" is the benchmark for building a world-class energy Internet company.

"Three types & Two networks" is an organic whole, "two networks" is the means, "three types" is the goal, and the two are the relationship between means and objectives, that is, the State Grid Corporation intends to achieve the "two networks" through construction and operation. "Three-type" enterprise transformation. In response to the discussion on the development model of “three types and two networks”, global scholars are also participating. Under the guidance of the "Three types & Two networks" development concept, analyzing the current development indicators of power grid companies and predicting the future development direction is the research content of this paper.

2. Literature review

Hu et al. studied ubiquitous electricity in the Internet of Things, and in the application environment of UPIoT, proposed an energy optimization algorithm based on opportunistic routing, which provides a reference for data transmission of UPIoT nodes [1]. Hu et al. used advanced LEACH and CH selection algorithms, in the ubiquitous electricity IoT scenario, to build a new algorithm for solving WSN sensor problems, and provided a new solution for related problems [2]. Wang et al. based on the perspective of ubiquitous power IoT, used MCNN model to study the recognition accuracy problem of GIS PD, the results show that the model performs well in terms of accuracy and time consumption [3]. Zeng et al. introduced the development strategy of China's smart grid in combination with the current
status of China's energy development, as well as the main difficulties and corresponding countermeasures for China to build a strong smart grid in the future [4]. Zhang et al. conducted a specific study on the social responsibility evaluation of the State Grid Corporation of China, and carried out a fuzzy comprehensive evaluation of the calculation examples based on 12 indicators using Delphi [5]. He et al., from the perspective of Internet +, analyzed the changes in the operating model of China's power grid in the future, and explored a new model of grid user management from the changes in the power marketing model [6]. Liu et al. analyzed the sales model of power grid enterprise users and constructed a feedback electricity sales strategy using big data technologies in the energy Internet to improve the competitiveness of power grid companies [7]. Zhang took the asset management of grid companies as the research object, and built an asset management model based on the entire life cycle from five dimensions, which has solved the problem of information exchange in management [8]. Zhao et al. summarized the innovation achievements of China State Grid in the UHV area during the 11th Five-Year Plan period, and objectively evaluated its construction achievements in terms of technological innovation status and management innovation system construction [9].

3. Development Index System of “Three Types & Two Networks” of Power Grid Corporation

3.1. The connotation of “Three Types & Two Networks”

The “hub type” reflects the industrial attributes of the grid company. The power grid company is the backbone that runs through the power generation side and the demand side. It is the place where the energy flow and information flow are most concentrated in the energy and power industry. The construction and operation of the “two networks” can provide long-distance transmission and large-scale new energy for the power generation side. The network and the demand side users provide effective support for safe power consumption and comprehensive energy efficiency improvement, thus highlighting the value role of power grid companies in ensuring energy security, promoting energy production and consumption revolution, and leading the transformation and development of the energy industry.

The “platform type” reflects the network properties of the grid company. The future national grid is a world-class energy Internet company with global competitiveness. It will be supported by “strong smart grid” and “ubiquitous power internet of things” to bring together various resources to promote supply and demand docking, factor restructuring, and innovation. The energy allocation platform, integrated service platform and new business, new business model, and new model development platform make platform value development an important way to cultivate the core competitive advantages of power grid companies.

The “shared-type” reflects the social attributes of grid companies. Through the construction and operation of a strong smart grid and ubiquitous power Internet of Things, support the grid company to interact with users and other entities, technical exchanges and business cooperation, and jointly build a co-construction and win-win energy Internet ecosystem, to achieve grid companies and Data sharing, results sharing and value sharing for users and other entities.

The focus of building a “strong smart grid” is on the supply side, supporting the reform of the energy supply side. Large-scale, long-distance stable transmission of electricity through UHV backbone grids to solve the problem of clean energy consumption of wind, light and water in the north and southwest; support the intermittent integration of intermittent distributed power sources through smart distribution networks, Solve the problem of difficult coordination of distributed power supply. The above two methods will be the means of optimizing the allocation of power resources in China and in the future.

The focus of building a “ubiquitous power Internet of Things” is at the end of each link of the system “source-network-load-storage”, supporting data collection and specific business development. Through the extensive application of big data, cloud computing, Internet of Things, mobile internet, artificial intelligence, blockchain, edge computing and other information technology and intelligent technology, pool all aspects of resources for planning, production, operation, management, comprehensive services, new Provide sufficient and effective information and data support in all
aspects of the development of new business models and the construction of corporate ecological environment.

### 3.2. The development system of "Three Types & Two Networks" of power grid companies

Starting from the development concept of “Three Types & Two Networks”, the following indicators in Table 1 can be proposed.

| Target Layer | Criteria Layer | Weights | Indicator Layer                                                                 | Weights |
|--------------|----------------|---------|---------------------------------------------------------------------------------|---------|
| “Three Types”| “Three Types”  | 0.1283  | Senior talent ratio                                                              | 0.4213  |
| development  | development level B1 |         | Technical cooperation exchange ease                                               | 0.3344  |
|              |                 |         | Annual patent pass number                                                         | 0.0656  |
|              |                 |         | User side demand response                                                          | 0.1788  |
|              |                 |         | Number of intelligent substations                                                | 0.2636  |
|              |                 |         | Electric vehicle charging facility scale                                          | 0.4758  |
|              |                 |         | Voltage pass rate                                                                | 0.0538  |
|              |                 |         | Number of scientific research projects                                            | 0.0981  |
|              |                 |         | Comprehensive energy service investment                                           | 0.1087  |
|              |                 | 0.2764  | Per capita electricity consumption                                               | 0.4005  |
| “Two Networks”| “Two Networks”  |         | Macroeconomic development                                                         | 0.3261  |
| development  | development level B2 |         | Renewable energy consumption rate                                                | 0.1674  |
|              |                 |         | Electricity trading system                                                        | 0.0699  |
|              |                 |         | Market access                                                                     | 0.0361  |
| “Three Types”| Sustainable     | 0.5954  | Per capita electricity consumption                                               | 0.4005  |
| development  | development level B3 |         | Macroeconomic development                                                         | 0.3261  |
|              |                 |         | Renewable energy consumption rate                                                | 0.1674  |
|              |                 |         | Electricity trading system                                                        | 0.0699  |
|              |                 |         | Market access                                                                     | 0.0361  |

Entropy is a method for determining the weight of an index based on the size of the information load of each indicator. Entropy was originally derived from the thermodynamic concept in physics, mainly reflecting the degree of chaos in the system. It has been widely used in research fields such as comprehensive evaluation of social economy. The larger the entropy value, the more confusing the system is, the less information is carried, and the smaller the utility value, the smaller the weight. Conversely, the smaller the entropy value, the more orderly the system is, the more information is carried, the greater the utility value, and the greater the weight. For example, if the indicator values of an indicator are all equal, the indicator does not work in the comprehensive evaluation. Using the entropy method to determine the weight of the index can not only overcome the randomness and the disconnection problem that the subjective weighting method can't avoid, but also effectively solve the problem of overlapping information between multiple indicator variables.

The specific steps of the entropy method are as follows:

Set the decision matrix:

\[
X = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix}
\]  

(1)

Where \( m \) is the sample and \( n \) is the indicator.

\( X_{ij} \) is the index value of the \( i \)-th scheme under the \( y \)-th index attribute.

Calculate the feature weight or contribution of the \( j \)-th system under the \( y \)-th indicator.

Calculate the data after the consistent and standardized processing to calculate the proportion of each indicator

\[
y_y = \frac{x_y}{\sum_{i=1}^{n}x_y} (0 \leq y_y \leq 1)
\]  

(2)
Where: \(y_{ij}\) represents the contribution of the i-th scheme under the j-th index attribute. That is, the contribution matrix:

\[
\begin{bmatrix}
y_{i1} & \cdots & y_{ia} \\
\vdots & \ddots & \vdots \\
y_{im} & \cdots & y_{ma}
\end{bmatrix}
\]

(3)

Calculate the entropy value of the jth indicator \(e_j\)

The entropy value \(e_j\) represents the total contribution of all schemes to the j-th indicator.

\[e_j = -K \sum_{i=1}^{m} y_{ij} \ln y_{ij}\]

(4)

Where \(K\) is a constant and \(K=1/\ln m\). This guarantees \(e_{ij}\). When the contribution degree of each scheme under a certain attribute tends to be consistent, \(e_j\) tends to 1, and the weight of the target attribute is considered to be 0.

Calculate the difference coefficient \(d_j\) of the index \(x_i\)

The difference coefficient \(d_j\) represents the degree of inconsistency (also called the degree of deviation) of the contribution of each scheme under the j-th index.

Determined by:

\[d_j = 1 - e_j\]

(5)

Obviously, the bigger the \(d_j\), the more attention is paid to the role of this indicator.

Determine the weight coefficient.

\[w_j = \frac{d_j}{\sum_{i=1}^{m} d_j}\]

(6)

The weighting factor \(w_j\) is the normalized weighting coefficient, which is determined by the following formula:

Through calculation, the weights of each index of the “Three Types & Two Networks” index evaluation system are obtained, and the final weights are shown in Table 1.

4. Grid company’s "Three Types & Two Networks" development indicators forecast

4.1. Application of Markov Model under Normal Hypothesis

The construction of "Three Types & Two Networks" is the transformation direction that power grid companies are proposing for the reform of the power system. The purpose is to adapt to the regulation and control of relevant national policies. As the regulatory factors of the policies change, the grid enterprise strategy also changes, but not all policy factors. All will inevitably affect the formulation of corporate strategy, and the regulatory factors are also divided into two major and secondary factors. The strategic change of the grid company determines the path of grid development. Therefore, based on the research on related planning policies, reasonably inferring strategic changes in power grid companies is the focus of research on the development path of the power grid. According to the National 13th Five-Year Plan, this article selects several main factors that influence the formulation of corporate strategies, and takes them as the main points of strategic changes (scenario assumption factors) for grid companies. At the same time, since the policy is released for future plans, the regulation of the policy is uncertain. Therefore, by setting the state transition probability between the strategic change points (scenario hypothesis factors) of the grid company in each case assumption, the randomness of the strategic change points of the grid company is introduced. Therefore, this paper will analyze and model the policy scenarios by using the concept of state transition probability \(P_{ij}\) in
the Markov chain model, combine the policies with the operation of the grid companies, and determine the development strategy of the grid enterprises under different policy scenarios.

Due to the short implementation time of the "Three Types & Two Networks", the calculation of the formula using the traditional Markov transfer matrix will cause errors and need to be artificially set. This paper adopts a new method of setting the transition probability through sample distribution. The transition probability setting is more objective. Firstly, according to the network relationship constructed in the previous article, calculate the weights of development factors in the past three years, and then calculate the difference between the weights of the regulatory elements in each year. Use the Matlab fitting toolbox to perform the distribution fitting and find that it conforms to the normal distribution. Probability theory knows that when the theoretical distribution of state probability is unknown, if the sample size is large enough, the sample distribution can be used to approximate the theoretical distribution of the state, and X is the difference between the weights of the regulatory elements of each year.

Using the normal curve method mentioned in the previous section, the difference between the weights of different regulatory elements can be graded, corresponding to different state transition probabilities $P_{ij}$, see Table 2.

**Table 2. State Transition Probability.**

| $P_{ij}$ | X       |
|----------|---------|
| 0.2      | $x>1.512$ |
| 0.5      | 0.374<$x<1.512$ |
| 0.8      | -1.254<$x<0.374$ |
| 0.5      | -2.392<$x<-1.254$ |
| 0.2      | $x<-2.392$ |

Finally, considering that the transmission of information has an attenuation effect in the time dimension, the weights of the state transition probabilities of 0.2, 0.3, and 0.5 for three years are respectively given, and the weighted comprehensive state transition probability $P_{ij}^*$ is obtained, as shown in the following table.

**Table 3. Comprehensive State Transition Probability.**

| Indicators | $P_{ij}^*$ | Indicators | $P_{ij}^*$ |
|------------|------------|------------|------------|
| B1         | 0.8        | B23        | 0.8        |
| B2         | 0.8        | B24        | 0.8        |
| B3         | 0.65       | B25        | 0.56       |
| B11        | 0.8        | B31        | 0.8        |
| B12        | 0.8        | B32        | 0.8        |
| B13        | 0.65       | B33        | 0.8        |
| B14        | 0.74       | B34        | 0.44       |
| B21        | 0.8        | B35        | 0.65       |
| B22        | 0.8        |            |            |

After adding the comprehensive state transition probability, the specific prediction formula is as follows:

\[
W'_{ij} = \begin{cases} 
P_{ij} \times W_{ij} & , \ i = j \\
1 - P_{ij} \times W_{ij} & , \ i \neq j \\
N-1 & \end{cases} 
\]  

(7)

Among them, $W_{ij}$ is the intra-group weight of the j-th indicator in the i-th layer in Table 3, and N is the total number of non-scenario hypothesis indicators in the i-th layer.

4.2. Results

Taking the index layers B1, B2, and B3 as examples, the forecast results for the next three years are as follows:
Table 4.  Prediction Results.

| Indicators | 2020    | 2021    | 2022    |
|------------|---------|---------|---------|
| B1         | 0.2017  | 0.2498  | 0.2460  |
| B2         | 0.3118  | 0.3296  | 0.3632  |
| B3         | 0.4865  | 0.4206  | 0.3907  |

5. Conclusion

The forecast results show that the weights of indicator B1: Market and Sustainable and indicator B2: Safety and Operations are rising steadily. It is foreseeable that the impact of the “three-type and two-network” concept is far-reaching. The “Three-type” will focus on the power market, the grid. Definition, positioning, supervision and examination of enterprise benefit costs. The strong smart grid on the supply side and the ubiquitous power Internet of Things on the demand side are “one supply and one demand”, which are closely related and cannot be separated. In the long run, it will promote the coordinated interaction of source-network-load-storage, reduce “three abandonment”, and effectively make up for the shortcomings of renewable energy development.

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