Performance Evaluation of New Energy Enterprises Based on Multi-level Gray Fuzzy Optimization Model

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***Abstract* — During the 13th Five-year plan in China it was felt that our economic development needed a new engine. As a strategic emerging industry, the new energy industry should meet the new opportunities. With the market opening ever wider, the competition among the new energy enterprises is getting fiercer, which imposes higher requirements on their management. A new performance evaluation system of new energy enterprise is proposed in this paper, including debt paying ability, operation ability, profitability and social responsibility. In order to better reflect the dynamic relationship between the indicators, an evaluation model based on the multi-level gray fuzzy optimization model is proposed, and five new energy listing Corporations' performance are evaluated. The results could provide scientific evidence to investors and owners to understand the enterprise competitive advantages and disadvantages. It is also better conducive to the development of China's new energy industry in the future and to promote the improvement of the new energy industry.**

Keywords - New energy enterprises; Performance evaluation; Multi-level fuzzy optimization model; Social responsibility; Energy management

I. INTRODUCTION

In the background of China's New Normal, the government introduced a series of macroeconomic policies to change high energy consumption and extensive economic growth mode. For realizing low carbon industrial structure transformation and China economic "Rebalance", this policy will have an important impact on the energy market [1, 2]. In particular, energy efficiency improvement and economic structure transformation to service industry implies that the energy consumption per GDP is going to reduce continuously. China's energy growth model is facing the "New Normal". During "13th Five-Year", the transition period of economic growth needs a new engine, and the new energy industry as a strategic emerging industry will usher in a new development opportunity [3, 4].

In the stage of China's "New Normal", especially in the "13th Five-Year" period, economic downward pressure is more obvious, resulting in the total energy demand slowdown. On the other hand, China's economy is in the transition period, in which the leading industry is changing from second to third industry and the extensive economic growth gradually transforming to intensive economic growth mode. Both of above factors are making the total energy demand slowing down. On this basis, the "New Normal" of energy displays a few new features, such as energy structure transformation, energy efficiency improvement and low-carbon and cleaning of energy consumption structure [5, 6].

Specifically, China's energy production and consumption is different in 2015. The production of primary energy is 3620000000 tons standard coal of a year in 2015, of which the output of raw coal is 3750000000 tons, oil production is 214556000 tons, natural gas production is 13410000000 cubic meters, electric power generation capacity reached 5810580000000 kwh. The amount of stored energy is so rich that can meet the national economic and social development [7, 8]. At the same time, solar energy, geothermal energy and wind energy and other new energy reserves continue to grow and develop. The consumption of coal decreased by 3.7%, while the consumption of oil, natural gas and electric power increased by 5.6%, 3.3% and 0.5% respectively. The proportion of petroleum, natural gas, hydropower, nuclear power, wind energy, geothermal energy and solar energy is in unceasing increase, and has increased 17.9%, as shown in figure 1. China's energy resources companies constantly expand the scale of business. While China's energy consumption structure adapts to the development of science and technology, constantly optimizes and makes progress [9].

As Figure 1 says, it shows a trend of consistent increase for the renewable energy in China. In 2014, the demand of the renewable energy in China increased almost 16%, which means that the total demand is equivalent to 380 million tons of standard coal. And it looks that the growth of the renewable energy in 2015 slows though totally, it still has 400 million tons of standard coal. It is expected that demand of the renewable energy in China will continue to increase to 550 million to 580 million tons of standard coal by 2020, which is about 11% to 13% of the total energy demand in China.

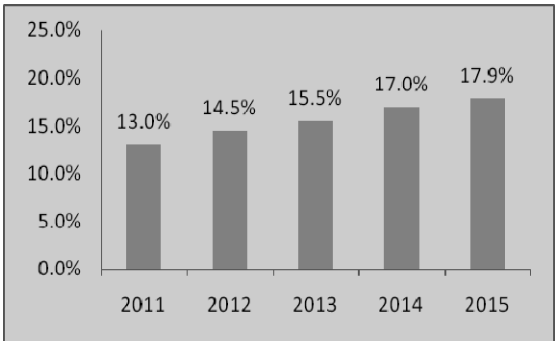

Figure 1. Figure 1. The proportion of clean energy consumption in total energy consumption of China from 2011 to 2015

In 2015, the nation explicitly proposed the idea of innovation, harmony, environmental protection, open and share. It means that, as the new energy enterprises, they need to pay more attention to the environmental protection and put it into practice combined with their own strengths [10, 11]. At the micro level, the generation of the wind power and photovoltaic power can be 150 million kilowatt. And it is hard to solve the consumptive problems of the new energy market only relying on the policies, considering that demand of the electric power increase slowly and less. As an emerging industry, the new energy owns a bright prospect with a continually increasing trend on one hand. And on the other hand, being different from those traditional industries, the new energy industry is greatly expected to ease the pressure of economy, society, environment and others.

At the same time, with the degree of the domestic market open and global economic integration deepening, there is the fierce competition among the new energy industries [12]. Together with the problem that the demand abroad decreases, it is time to undergo the industry shuffle, that is earlier than expected. Under this kind of situation, the new industries are supposed to achieve a higher requirement for their business performance. Then how could we evaluate the performance of those listed companies in the new energy industry scientifically? How could these national new energy enterprises improve their performance? These will be the key problems that need urgent solutions.

Thus this paper is going to establish the general indicators, the characteristic indicators in the new energy industry and the integrated performance system to evaluate the new energy industry. Also, it will structure an evaluation model based on multi-level fuzzy optimal model, in order to assess the listed companies' performance in our new energy industry.

II. THE MULTI-LEVEL GRAY FUZZY OPTIMIZATION MODEL

It is an applied mathematical discipline with uncertain phenomenon that studies information part clearly, part unclear. Expression form of grey system model reveals the continuous process of new energy enterprise performance. By using the grey model and the fuzzy comprehensive evaluation model provided by DPS software [13].This paper analyzed the energy performance of enterprises. The process of evolution included the following steps. The elementary process includes the use of fuzzy correlation degree to determine the weight of the indicator in the evaluation system and the fuzzy comprehensive evaluation model to evaluate the performance of each evaluation object.

A. Determining the indicator weight

Firstly, we make the basic assumption that the evaluation model includes m evaluation object and n evaluation indicator, and the weight of each indicator is determined by using the grey correlation degree.

① To collect the each indicator of each evaluation object, the i indicator data of the data evaluation object shows as(1);

$$X_i = \{x_i(1), x_i(2), \cdots, x_i(k), x_i(n)\},\ i = 1, 2, \cdots, n \qquad (1)$$

② Comparing the data of each indicator, select the best data in each indicator, which constitute the reference sequence as (2);

$$X_0 = \{x_0(1), x_0(2), \cdots, x_0(n)\} \qquad (2)$$

Where X_0 is the reference sequence. If the k indicator in the evaluation system, its value is the better, so $x_0(k) = \max_i (x_i(k))$; if the k indicator in the evaluation system, the smaller is the better, then $x_0(k) = \min_i (x_i(k))$.

③ The calculation of grey correlation coefficient is shown in the formula as(3).

$$\xi_i(k) = \frac{\min\limits_i \min\limits_k |x_0(k) - x_i(k)| + \xi \max\limits_i \max\limits_k |x_0(k) - x_i(k)|}{|x_0(k) - x_i(k)| + \xi \max\limits_i \max\limits_k |x_0(k) - x_i(k)|} \qquad (3)$$

Where $\xi_i(k)$ is the difference between the evaluation sequence X_i and the reference sequence X_0 for the k indicator. This value is correlation coefficient between x_i and x_0 for the k indicator. ξ is resolution ratio , $\xi \in (0,1)$, taking advantage of this parameter is to reduce the influence of extremism value on the computation. In fact, the value of ξ is set on the basic of the degree of the correlation coefficient among sequences. Generally, the appropriate value is less 0.5.

④ Calculate the correlation degree in accordance to the correlation coefficient. Because $\xi_i(k)$ shows the correlation degree between the i sequence and the reference sequence for the k indicator, the mean value indicates the correlation of the indicator and the optimal value, namely the weight of the corresponding indicator. Therefore, the weight $\omega(k)$ is shown as (4)

$$\omega(k) = \frac{1}{n} \sum_{i=1}^{n} \xi_i(k) \qquad (4)$$

⑤ Due to the hierarchical relation of the evaluation system, the weight of each hierarchical indicator is calculated according to $\omega(k)$. The process is shown as (5).

$$A_j(k) = \omega_j(k) / \sum_{j=1}^{n_j} \omega_j(k) \qquad (5)$$

Where $A_j(k)$ is the weight of the k indicator at the j hierarchy, $\omega_j(k)$ is the correlation degree of the k indicator at the j hierarchy, and n_j the sum of the indicator at the j hierarchy.

B. The multi-level fuzzy comprehensive evaluation model

Take the two subsystems for example, evaluation indicator set M, M is the total number of evaluation indicator of the whole system. According to the various properties of evaluation indexes, it can be divided into several subsystems, they are m. In the second system, the number i subsystem has several evaluation indicators meet the following formula:

$$\begin{cases} M = \bigcup_{i=1}^{m} m_i \\ m_i \bigcap m_j = \varnothing, i \neq j \end{cases} \qquad (6)$$

① Building evaluation set $V = \{V_1, V_2, \cdots, V_m\}$.

② The membership degree of each indicator is determined according to the triangular membership function, and the fuzzy comprehensive evaluation matrix of the single factor is established and denoted by $R = (r_{ij})_{n \times m}$.

③ The weight vector of each hierarchical indicator is calculated based on subsection 2.1, first-level fuzzy comprehensive evaluation vector is computed according to the formula $B_j = A_j \circ \mathrm{R}$, and then the vector is normalized in order to ensure that the sum of b_i is 1, namely $\sum b_i = 1$ ..Finally, first class evaluation matrix is established as $R' = (B_1, B_2, \cdots, B_s)^T$.

④ Establish the two class evaluation matrix in the light of $B = A' \circ R'$, this evaluation set is the final fuzzy comprehensive evaluation set for the evaluation object, and then the final evaluation results are obtained by using the center of gravity method.

III. A NEW PERFORMANCE EVALUATION INDEX SYSTEM OF NEW ENERGY ENTERPRISES

A. Common performance evaluation system of listing Corporation

The evaluation system of business performance has been matured after several decades, while that system for enterprises in new energy industry did not go further and are required to do more research due to the pressure of environmental protection and energy saving. The present literatures mainly focus on the investment and financing because of the requirement of huge investment and high risk [17]. But now investors ask for higher IRR (investment return rate), whether enterprise in new energy industry can satisfy that rate requirement requires more research on evaluation system of business performance in order to provide some guidance. The evaluation system of business performance in new energy industry involves three parts: the relationship between performance evaluation and policy support, technical progress, executive compensation; the research on the performance valuation of firms in the wind power and nuclear power industry; and the research of valuation system of business performance of new energy companies in different regions.

At present, the common performance evaluation system of enterprise contains three dimensions. They are debt paying ability, operation ability and profitability, as shown in Table I.

TABLE I. THE COMMON PERFORMANCE EVALUATION SYSTEM OF ENTERPRISES

Target	First-level	Second-level
Enterprise performance	Debt paying ability	Current ratio
		Equity ratio
		Debt-to-assets ratio
	Operation ability	Accounts receivable turnover
		Inventory turnover
		Total assets turnover
	Profitability	Operating profit ratio
		Return on net assets
		Profit rate to net asset

The above index system includes three dimensions. However, the energy enterprises are high energy consumption ones, which should take responsibility to the protection of environment and other social responsibility [18]. So, a new system is going to promote.

B. The new performance evaluation system emphasis on social responsibility

Energy conservation and low-carbon lifestyle not only play a key role in influencing the progress of global climate change but also is key point of promoting more healthy economy and building more harmonious society. New energy is clean and renewable and takes advantage of low cost, not like traditional energy making great damages on environment. New energy industry is one of seven strategic emerging industries, shouldering more responsibilities of alleviating pressure of environment and promoting sustainable development of economy.

Therefore, when evaluating business performance of listed firms in new energy industry, not only economic performance but also social responsibility should be taken into consideration. The enterprises in this industry create more economic value and solve local unemployment problem, fulfilling social responsibility. According to the new situation and the characteristics of energy enterprises, a new index system of Chinese energy enterprise performance is proposed, shown in Table II. The evaluation system in this paper includes four dimensions: debt paying ability, operation ability, profitability and social responsibility.

Debt paying ability: In order to maintain sustainable development, firms in new energy have to make risk management and debt paying ability shows clearly companies' risk management level. It is necessary to measure firms' short-term or long-term solvency.

Management ability: It reflects the asset management efficiency of enterprises and operation of capital turnover and also is an important index of agent assessment for bailors. These indexes include inventory turnover, total assets turnover and accounts receivable turnover.

Profitability: It reflects the ability of making profit and capital appreciation for enterprises. These indexes include operating profit ratio, return on net assets and profit rate to net worth.

Social responsibility: The social responsibility for new energy firms involves economic, environmental and social factors. Considering the accessibility of index, this paper uses rate of income tax paid to make characterization.

TABLE II A NEW INDEX SYSTEM OF CHINESE ENERGY ENTERPRISE PERFORMANCE

First-level index	Second-level index	Variable identifier	Calculating formula
Debt paying ability	Current ratio	X_{11}	Current assets/current liabilities*100%
	Equity ratio	X_{12}	Total liabilities/Shareholder equity*100%
	Debt-to-assets ratio	X_{13}	Total liabilities/ Total assets*100%
Operation ability	Accounts receivable turnover	X_{12}	Business revenue/Average accounts receivable balance
	Inventory turnover	X_{22}	Operating cost/ Average inventory balance
	Total assets turnover	X_{23}	Business revenue/ Average total assets
Profitability	Operating profit ratio	X_{31}	Net profit/ Business revenue*100%
	Return on net assets	X_{32}	Net profit/ Average balance of net assets*100%
	Profit rate to net asset	X_{33}	Net profit/ Average total assets*100%
Social responsibility	Income tax payment rate	X_{41}	Income tax paid in the year/ Net profit*100%

IV. THE EMPIRICAL ANALYSIS

The paper choose five new energy listed companies for example: Goldwind Science & Technology (002202), HT-SAAE (600151), XEMG (600416), Tianmao Industry Group Co., Ltd. (000627) and Shanshan Co.,Ltd. (600884). According to the determined 4 subsystems and 10 indexes in performance evaluation index system of the energy enterprises, the paper studied the values corresponding to energy enterprises' index respectively. It is listed in Table III.

A. Determine the indicator weight

According to the method of the determination of the weight presented in Section 2, Firstly, selecting the optimal sequence $X_0 = [1.4300, 2.0700, 0.8600, 15.800, 6.0500, 0.48, 0.1043, 0.1200, 0.3952, 0.3353]$, and seting $\xi = 0.5$. The correlation coefficient between the evaluation object and the optimal sequence shown in Table IV, and the indictor correlation degree is shown in Table V.

TABLEIII THE EVALUATION INDEX VALUE OF ENERGY ENTERPRISES' PERFORMANCE

Evaluation object		Indicator types									
Number	Company code	X11	X12	X13	X21	X22	X23	X31	X32	X33	X41
1	002202	1.2600	2.0700	0.6700	1.8300	3.8800	0.44	0.1200	0.1200	0.1000	0.1396
2	600151	1.1400	1.3200	0.5700	3.3800	4.4600	0.46	0.0100	0.0100	0.3952	0.3353
3	600416	1.0300	6.7600	0.8600	1.2700	2.0300	0.48	0.0104	0.0300	0.0395	0.0580
4	000627	0.6800	0.4300	0.2900	15.800	6.0500	0.38	0.1043	0.0600	0.0394	0.2952
5	600884	1.4300	1.1200	0.5200	3.2900	3.3600	0.44	0.0400	0.0800	0.0370	0.1200

TABLE IV CORRELATION COEFFICIENT BETWEEN ALL OBJECT AND OPTIMIZATION SERIES

Evaluation object		Indicator types									
Number	Company code	X11	X12	X13	X21	X22	X23	X31	X32	X33	X41
1	002202	0.7975	0.4029	0.6794	0.3462	0.5662	0.8489	1.0000	1.0000	0.3853	0.4451
2	600151	0.6978	0.3678	0.5813	0.3733	0.6405	0.9183	0.3381	0.3381	1.0000	1.0000
3	600416	0.6260	1.0000	1.0000	0.3374	0.4134	1.0000	0.3389	0.3843	0.3422	0.3615
4	000627	0.4717	0.3333	0.4140	1.0000	1.0000	0.6921	0.7817	0.4836	0.3422	0.7965
5	600884	1.0000	0.3595	0.5422	0.3716	0.5129	0.8489	0.4126	0.5841	0.3406	0.4217

TABLE V CORRELATION DEGREE OF THE FACTOR

Correlation degree	X11	X12	X13	X21	X22	X23	X31	X32	X33	X41
r_k	0.7975	0.4029	0.6794	0.3462	0.5662	0.8489	1.0000	1.0000	0.3853	0.4451

According to TableV, the weight coefficient of each index in the fuzzy comprehensive evaluation system is calculated, and the process is shown as follows.

The weight of the indictor at first level

$$A_1 = \sum_{i=1}^{3} r_k / \sum_{i=1}^{10} r_k = 0.3067 \quad A_2 = \sum_{i=4}^{6} r_k / \sum_{i=1}^{10} r_k = 0.3264$$

$$A_3 = \sum_{i=7}^{9} r_k / \sum_{i=1}^{10} r_k = 0.2669 \quad A_4 = r_{10} / \sum_{i=1}^{10} r_k = 0.1000$$

The weight of the indictor at second level

$$A_{11} = r_1 / \sum_{i=1}^{3} r_k = 0.3874 \; A_{12} = r_2 / \sum_{i=1}^{3} r_k = 0.2657$$

$$A_{13} = r_3 / \sum_{i=1}^{3} r_k = 0.3469$$

$$A_{21} = r_4 / \sum_{i=4}^{6} r_k = 0.2461 \; A_{22} = r_5 / \sum_{i=4}^{6} r_k = 0.3174$$

$$A_{23} = r_6 / \sum_{i=4}^{6} r_k = 0.4365$$

$$A_{31} = r_7 / \sum_{i=7}^{9} r_k = 0.3557 \; A_{32} = r_8 / \sum_{i=7}^{9} r_k = 0.3457$$

$$A_{33} = r_9 / \sum_{i=7}^{9} r_k = 0.2986$$

$$A_{41} = r_{10} / \sum_{i=10}^{10} r_k = 1$$

So at the second level index weights in the first subsystem are 0.3874, 0.2657and 0.3469; index weights of the second subsystems are respectively 0.2461, 0.3174 and 0.4365; the index weights of third subsystems are respectively 0.3557, 0.3457 and 0.2986; the fourth subsystems included only index , so the index weights of fourth subsystems are 1. Similarly, at first level the weights of every subsystem are respectively 0.3067, 0.3264, 0.2669 and 0.1000. According to the weight of the first level, the most important subsystem is the second subsystem, followed by the first and third subsystem, because this system indicted whether the company operated normally or not and this is the essential and primal condition for the company. The first subsystem manifested the company' credit capacity which impact the long term development of the company. Correspondingly the minimum weight is the fourth subsystem not merely because it included only one index but because the indictor reflected the company social responsibility which is basically the same for all companies.

B. Fuzzy Comprehensive Evaluation

According to section 3, , fuzzy evaluation set was established as $V = \{V_1, V_2, V_3, V_4, V_5\}$, set elements respectively indicate that the development potential of the relevant company is stronger, strong ,average, weak and the weaker. and the scores of each evaluation set elements respectively was set as 85, 75, 65, 55 and 45in order to quantify the fuzzification of the evaluation sets.

As mentioned in the second section, the triangular function was selected to determine the membership degree of each evaluation object so as to work out the fuzzy evaluation matrix of each factor. The fuzzy evaluation matrix of each factor in the first dimension for every evaluation object is shown as follows.

$$R_{11} = \begin{bmatrix} 0.5245 & 0.4755 & 0.0000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 0.2249 & 0.7751 & 0.0000 \\ 0.1163 & 0.8837 & 0.0000 & 0.0000 & 0.0000 \end{bmatrix}$$

$$R_{12} = \begin{bmatrix} 0.1888 & 0.8112 & 0.0000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 0.0000 & 0.7811 & 0.2189 \\ 0.0000 & 0.6512 & 0.3488 & 0.0000 & 0.0000 \end{bmatrix}$$

$$R_{13} = \begin{bmatrix} 0.0000 & 0.8811 & 0.1189 & 0.0000 & 0.0000 \\ 1.0000 & 0.0000 & 0.0000 & 0.0000 & 0.0000 \\ 1.0000 & 0.0000 & 0.0000 & 0.0000 & 0.0000 \end{bmatrix}$$

$$R_{14} = \begin{bmatrix} 0.0000 & 0.0000 & 0.9021 & 0.0979 & 0.0000 \\ 0.0000 & 0.0000 & 0.0000 & 0.2544 & 0.7456 \\ 0.0000 & 0.0000 & 0.3488 & 0.6512 & 0.0000 \end{bmatrix}$$

$$R_{15} = \begin{bmatrix} 1.0000 & 0.0000 & 0.0000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 0.0000 & 0.6627 & 0.3373 \\ 0.0000 & 0.4186 & 0.5814 & 0.0000 & 0.0000 \end{bmatrix}$$

The fuzzy evaluation matrix of each factor in the secondary dimension for every evaluation object is shown as follows.

$$R_{21} = \begin{bmatrix} 0.0000 & 0.0000 & 0.0000 & 0.4633 & 0.5367 \\ 0.0000 & 0.5653 & 0.4347 & 0.0000 & 0.0000 \\ 0.6667 & 0.3333 & 0.0000 & 0.0000 & 0.0000 \end{bmatrix}$$

$$R_{22} = \begin{bmatrix} 0.0000 & 0.0000 & 0.0000 & 0.8557 & 0.1443 \\ 0.0000 & 0.9488 & 0.0512 & 0.0000 & 0.0000 \\ 0.8333 & 0.1667 & 0.0000 & 0.0000 & 0.0000 \end{bmatrix}$$

$$R_{23} = \begin{bmatrix} 0.0000 & 0.0000 & 0.0000 & 0.3215 & 0.6785 \\ 0.0000 & 0.0000 & 0.3421 & 0.6579 & 0.0000 \\ 1.0000 & 0.0000 & 0.0000 & 0.0000 & 0.0000 \end{bmatrix}$$

$$R_{24} = \begin{bmatrix} 1.0000 & 0.0000 & 0.0000 & 0.0000 & 0.0000 \\ 1.0000 & 0.0000 & 0.0000 & 0.0000 & 0.0000 \\ 0.1667 & 0.8333 & 0.0000 & 0.0000 & 0.0000 \end{bmatrix}$$

$$R_{25} = \begin{bmatrix} 0.0000 & 0.0000 & 0.0000 & 0.8329 & 0.1671 \\ 0.0000 & 0.2215 & 0.7785 & 0.0000 & 0.0000 \\ 0.6667 & 0.3333 & 0.0000 & 0.0000 & 0.0000 \end{bmatrix}$$

In the same way, the fuzzy evaluation matrix of each factor in the third dimension for every evaluation object is shown as follows.

$$R_{31} = \begin{bmatrix} 1.0000 & 0.0000 & 0.0000 & 0.0000 & 0.0000 \\ 1.0000 & 0.0000 & 0.0000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 0.0122 & 0.9878 & 0.0000 \end{bmatrix}$$

$$R_{32} = \begin{bmatrix} 0.0000 & 0.0000 & 0.0000 & 0.3333 & 0.6667 \\ 0.0000 & 0.0000 & 0.0000 & 0.3333 & 0.6667 \\ 1.0000 & 0.0000 & 0.0000 & 0.0000 & 0.0000 \end{bmatrix}$$

$$R_{33} = \begin{bmatrix} 0.0000 & 0.0000 & 0.0000 & 0.3464 & 0.6536 \\ 0.0000 & 0.0000 & 0.0000 & 1.0000 & 0.0000 \\ 0.0000 & 0.0000 & 0.0000 & 0.4000 & 0.6000 \end{bmatrix}$$

$$R_{34} = \begin{bmatrix} 0.4768 & 0.5232 & 0.0000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 1.0000 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 0.0000 & 0.3992 & 0.6008 \end{bmatrix}$$

$$R_{35} = \begin{bmatrix} 0.0000 & 0.0000 & 0.3333 & 0.6667 & 0.0000 \\ 0.0000 & 0.6667 & 0.3333 & 0.0000 & 0.0000 \\ 0.0000 & 0.0000 & 0.0000 & 0.3745 & 0.6255 \end{bmatrix}$$

Similarly, in the fourth dimension the fuzzy evaluation matrix of each factor for every evaluation object is shown as follows.

$$R_{41} = [0.0000 \quad 0.0000 \quad 0.6654 \quad 0.3346 \quad 0.0000]$$
$$R_{42} = [1.0000 \quad 0.0000 \quad 0.0000 \quad 0.0000 \quad 0.0000]$$
$$R_{43} = [0.0000 \quad 0.0000 \quad 0.0000 \quad 0.6919 \quad 0.3081]$$
$$R_{44} = [0.5215 \quad 0.4785 \quad 0.0000 \quad 0.0000 \quad 0.0000]$$
$$R_{45} = [0.0000 \quad 0.0000 \quad 0.4313 \quad 0.5687 \quad 0.0000]$$

Where R_{ji} is the fuzzy comprehensive evaluation result of the i object of the j dimension in the first class evaluation set.

According to the aforementioned weight of each factor, the first class fuzzy comprehensive evaluation vector B_{ij} is obtained as follows. B_{ji} is the first class fuzzy comprehensive evaluation vector of the i company in the j dimension.

$$B_{11} = \{0.2435 \quad 0.4908 \quad 0.0597 \quad 0.2059 \quad 0.0000\}$$
$$B_{12} = \{0.0732 \quad 0.5402 \quad 0.1210 \quad 0.2075 \quad 0.0582\}$$
$$B_{13} = \{0.6126 \quad 0.3414 \quad 0.0461 \quad 0.0000 \quad 0.0000\}$$
$$B_{14} = \{0.0000 \quad 0.0000 \quad 0.4705 \quad 0.3314 \quad 0.1981\}$$
$$B_{15} = \{0.3874 \quad 0.1452 \quad 0.2017 \quad 0.1761 \quad 0.0896\}$$
$$B_{21} = \{0.2910 \quad 0.3249 \quad 0.1380 \quad 0.1140 \quad 0.1321\}$$
$$B_{22} = \{0.3638 \quad 0.3739 \quad 0.0163 \quad 0.2105 \quad 0.0355\}$$
$$B_{23} = \{0.4365 \quad 0.0000 \quad 0.1086 \quad 0.2879 \quad 0.1669\}$$
$$B_{24} = \{0.6362 \quad 0.3638 \quad 0.0000 \quad 0.0000 \quad 0.0000\}$$
$$B_{25} = \{0.2910 \quad 0.2158 \quad 0.2471 \quad 0.2049 \quad 0.0411\}$$
$$B_{31} = \{0.7014 \quad 0.0000 \quad 0.0037 \quad 0.2950 \quad 0.0000\}$$
$$B_{32} = \{0.2986 \quad 0.0000 \quad 0.0000 \quad 0.2338 \quad 0.4676\}$$
$$B_{33} = \{0.0000 \quad 0.0000 \quad 0.0000 \quad 0.5883 \quad 0.4117\}$$
$$B_{34} = \{0.1696 \quad 0.1861 \quad 0.3457 \quad 0.1192 \quad 0.1794\}$$
$$B_{35} = \{0.0000 \quad 0.2304 \quad 0.2338 \quad 0.3490 \quad 0.1868\}$$
$$B_{41} = \{0.0000 \quad 0.0000 \quad 0.6654 \quad 0.3346 \quad 0.0000\}$$
$$B_{42} = \{1.0000 \quad 0.0000 \quad 0.0000 \quad 0.0000 \quad 0.0000\}$$
$$B_{43} = \{0.0000 \quad 0.0000 \quad 0.0000 \quad 0.6919 \quad 0.3081\}$$
$$B_{44} = \{0.5215 \quad 0.4785 \quad 0.0000 \quad 0.0000 \quad 0.0000\}$$
$$B_{45} = \{0.0000 \quad 0.0000 \quad 0.4313 \quad 0.5687 \quad 0.0000\}$$

By combining the first class fuzzy comprehensive evaluation vector B_{ji} and the weight of the first class indicator, the two class fuzzy comprehensive evaluation vector B_i is obtained, where $i = 1,2,3,4,5$, which is the result of the two class fuzzy comprehensive evaluation of each object.

$$B_1 = \{0.3569 \quad 0.2566 \quad 0.1309 \quad 0.2126 \quad 0.0431\}$$
$$B_2 = \{0.3209 \quad 0.2877 \quad 0.0424 \quad 0.1948 \quad 0.1542\}$$
$$B_3 = \{0.3303 \quad 0.1047 \quad 0.0496 \quad 0.3202 \quad 0.1952\}$$
$$B_4 = \{0.3051 \quad 0.2163 \quad 0.2366 \quad 0.1335 \quad 0.1086\}$$
$$B_5 = \{0.2138 \quad 0.1765 \quad 0.2481 \quad 0.2709 \quad 0.0908\}$$

In order to determine the final level of each evaluation object, the defuzzification processing of B_i is needed. For the sake of comprehensively considering the influence of various factors on the evaluation result, the center of gravity of method was selected to complete the defuzzification process. Finally, the quantitative value of the fuzzy comprehensive evaluation for every company is obtained as follows.

$$v_{01} = \sum_{i=1}^{5} B_{1i}V_i / \sum_{i=1}^{5} B_{1i} = 71.7158$$
$$v_{02} = \sum_{i=1}^{5} B_{2i}V_i / \sum_{i=1}^{5} B_{2i} = 69.2625$$
$$v_{03} = \sum_{i=1}^{5} B_{3i}V_i / \sum_{i=1}^{5} B_{3i} = 65.5472$$
$$v_{04} = \sum_{i=1}^{5} B_{4i}V_i / \sum_{i=1}^{5} B_{4i} = 69.7576$$
$$v_{05} = \sum_{i=1}^{5} B_{5i}V_i / \sum_{i=1}^{5} B_{5i} = 66.5166$$

The results indicated that the development potential of every company are stronger than the ' average' level, and in addition to the evaluation results of XEMG with slightly higher score than the 'average' level, the evaluation of the other four companies is closer to the 'strong' level. The greatest potential company is the Goldwind Science & Technology. The reason why the Goldwind Science & Technology got the highest score is in every subsystem the score of every indictor of it is relatively average which demonstrated that various business of it operated very successfully and got a balanced development. The followed one is Tianmao Industry, because the company got a highest score of accounts receivable turnover and inventory turnover in the secondary subsystem. The better evaluation result of HI-SAAE owed to the higher score of inventory turnover total assets turnover in the secondary subsystem and the highest score of profit rate to net asset in the third subsystem. The XEMG and Shanshan got a inferior evaluation result due to the unbalanced score of the indictors. The XEMG got one maximum score of Equity ratio but the other score was lower compared with other companies. Obviously, the result of Shanshan is mainly due to the relatively lower score of all indictors.

. CONCLUSION

In the "13th Five-Year" period, China faces the "New Normal", such as the adjustment of energy structure, energy saving and emission reduction. So, in the next period of time, the new energy industry is still full of vitality, and new energy enterprises will hold the sustainable competitive

advantage. On the other hand, the market demand is becoming more and gentler; the market competition is becoming increasingly fierce, which also brings new challenges to the development of new energy enterprises. In the establishment of performance evaluation system of new energy enterprises, it is not only financial capacity should take into account, but also social responsibility. Therefore, we propose a new system including debt paying ability, operation ability, profitability and social responsibility. In order to better reflect the dynamic relationship between the indicators, an evaluation model based on the multi-level gray fuzzy optimization model is proposed, and five new energy listing Corporations' performance are evaluated.

According to the results, we can get the conclusions as followed. (1) The performance of new energy listing Corporation is generally higher, which depend on the continued support of China's economic and social development. (2) All of the four subsystems should be considered when evaluate the performance, but operation ability is most important, according to the weight of the first level. (3) Policy support is still important to the development of new energy enterprises, so is the innovation of new energy technology; meanwhile these enterprises should pay more attention to coordinate the interests of all parties and take social responsibilities.

Study on Evaluation of the performance of new energy enterprises, could provide scientific evidence to investors and owners to understand the enterprise competitive advantage and disadvantage. It also conducive to the development of China's new energy industry in the future better, promote the improvement of the new energy industry.

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