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Research Article

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The empirical research of the comprehensive benefit evaluation on liaoning Shihu wind power project

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ABSTRACT

With a large number of the world's energy consumption and environmental issues have become increasingly prominent, wind power is becoming a hot spot of contemporary global energy growth, the whole society pay more attention to the development of clean energy. Although the wind power industry in Liaoning is still stay in the initial stage, more and more people know the importance and advantages of wind power, and the wind power industry in Liaoning shows a momentum of vigorous development. This study will focus on the comprehensive evaluation of wind power project of Liaoning Shihu. Via using AHP-fuzzy comprehensive evaluation to analysis the comprehensive benefits of the wind power project, this paper put forward some suggestions on the development of wind power project.

Keywords: Wind Power Project; clean energy; AHP-fuzzy comprehensive evaluation

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INTRODUCTION

Thermal power is the main power source of Liaoning province, and it's installed capacity is much higher than the national average. Energy consumption of this province can not get rid of coal all the time. With the revitalization of the old industrial base in recent years, the economy of Liaoning has entered into a new stage of rapid development. These triggered the energy supply and demand contradiction increasingly prominent.[1]With increasing energy worries, as soon as possible to get rid of the energy bottleneck constraints become a priority for the re-construction of Liaoning.

Based on the coastal wind resource analysis of northern Jiangsu province, Wei Ning studied the technological economic benefits of developing coastal wind power, analyzed the economical efficiency of wind power projects, did both qualitative analysis and quantitative analysis on investment, economical benefits and the operate value in 2006. Dong Xiaozhan and Zhao Daqing also studied a variety of impacts on the environment of the wind power in 2003 and 2005 respectively. They introduced both the advantage and disadvantage of wind farm construction; put forward some suggestions on the weather and natural condition for building a wind power station. Zeng Ming established the index system for evaluation of the feasibility study for the wind power project in 2008. Via using the AHP to confirm the index weight flexibility, he proved the index system, calculated the score of the feasibility of the wind power project, and then reflected its feasibility level visually with quantitative conclusions.

Located in the two wind band of China, Liaoning Province has abundant wind power resources in our country. Those wind powers are mainly concentrated in three zones: one is in northern Liaoning hilly region, the second is along the coast of Bohai sea area, and the third is the main ridge area of Changbai Mountains in eastern Liaoning. In addition, there are large areas of coastal and island in Liaoning Province where the wind power reserves are much more than the inland which has broad prospects for development and utilization. In recent years, wind power project in Liaoning province showing a rapid development momentum. Doing the preparation for the wind power development and accelerating the wind power project has become the key to achieve a comprehensive revitalization in Liaoning province.

2. Principle and steps of the AHP-fuzzy comprehensive evaluation

2.1Principle of fuzzy comprehensive evaluation

With considering the influence of a variety of factors, Fuzzy comprehensive evaluation use fuzzy mathematical tools to make social evaluation on something. It look for the fuzzy weight vector $\underset{\sim}{A}=(a_1,a_2,\cdots a_m)\in \mathrm{F(U)}$, and a fuzzy transformation $\tilde{f}$ from U to V, that is make a judgment on each factor separately $\tilde{f}(u_i)=(r_{i1},r_{i2},\cdots,r_{in})\in \mathrm{F(V)}$, （i=1, 2, …, n), and then construct the fuzzy matrix

$$R=\left[r_{ij}\right]_{m\times n}\in F(\mathrm{U}\times\mathrm{V}) \tag{1}$$

After that, we can get the fuzzy comprehensive evaluation results

$$\underset{\sim}{B}=(b_1,b_2,\cdots b_n)\in F(V) \tag{2}$$

2.2Steps of the AHP-fuzzy comprehensive evaluation

2.2.1Confirm the objects set, factors set and comment set of the evaluation

Confirm the objects set, factors set and evaluation set (judging set) of the evaluation According to the actual needs. Objects set: O= (o1, o2… on), factors set: U= (u1, u2… um), comment set: V= (v1, v2… vn).

2.2.2 Establish m evaluation factors' weight distribution vectors $\underset{\sim}{A}$.

Each evaluation factor has different position and role in "evaluation target", that means each evaluation factor occupy different proportion in social evaluation. [2]This is called weights.

2.2.3 Get fuzzy comprehensive evaluation matrix according to each single factor fuzzy evaluation.

$$\underset{\sim}{R}=\begin{bmatrix}R_1\\R_2\\\vdots\\R_m\end{bmatrix}=\begin{bmatrix}r_{11}&r_{12}&\cdots&r_{1n}\\r_{21}&r_{22}&\cdots&r_{2n}\\\vdots&\vdots&\cdots&\vdots\\r_{m1}&r_{m2}&\cdots&r_{mn}\end{bmatrix} \tag{3}$$

Each evaluation object should be established a social evaluation matrix, where Ri= (ri1, ri2, …, rin) is the single factor evaluation of ui(the i_{th} factor); r_{ij} is the frequency distribution on the comment set j(1≤j≤n) of ui. Generally, we normalized it to satisfy to the target.

$$\sum_{j=1}^{n} r_{ij}=1 \tag{4}$$

2.2.4Get social evaluation results via compound operation

$$\underset{\sim}{B}=\underset{\sim}{A}\circ\underset{\sim}{R} \tag{5}$$

2.2.5Calculate the comprehensive evaluation score for each object

The purpose of the comprehensive evaluation is to selected the winning object from the objects set, that needs to sort the comprehensive evaluation results of all the objects, and convert the comprehensive evaluation results to the comprehensive score M. Then we can sort based on the sores and select the best one.

3. Comprehensive evaluation of Liaoning Shihu wind power project comprehensive benefit

According to the Comprehensive Benefit Evaluation Index System of Liaoning Shihu wind power project, as well as the evaluation standard to confirm the weight of each comprehensive benefit evaluation index. [3]Then divided the weight A into two layers: the target layer and the rule layer. Each factor in different layer has different important degree, so they're given different weight as below:

The first layer: A = (A1, A2... Am)

The second layer: Ai = (Ai1, Ai2... Ain)

3.1The confirmation of the index weight of first layer

Comprehensive benefits include social benefits (A1), economical benefit (A2), environmental benefits (A3), and other benefits (A4).

Table 3-1 Evaluation Index Judgment Matrix
Weights after normalization:

Comprehensive benefits	A1	A2	A3	A4
A1	1	1/5	1/3	3
A2	5	1	3	7
A3	3	1/3	1	5
A4	1/3	1/7	1/5	1

$$\begin{pmatrix} 0.1856 \\ 0.4131 \\ 0.2769 \\ 0.1244 \end{pmatrix}$$

Consistency inspection:

The standardized matrix characteristic roots $\lambda max=4$.

$$CI= (\lambda max-m)/ (m-1) =0$$

While N=4, RI=0.9

$$CR = CI/RI=0.0<0.1$$

Pass the consistency test, and the index weight is reasonable.

3.2The confirmation of the index weight of second layer

Social benefits (A1) include two indicators: employment promotion (A11) and economic coordination (A12).

Table 3-2 Social benefits index weights

Social benefits	A11	A12	W	λ
A11	1	2	0.5498	2
A12	1/2	1	0.4502	2

Economical benefits (A2) include two indicators: input capacity (A21) and output capacity (A22).

Table 3-3 Economical benefits index weights

economical benefit	A21	A22	W	λ
A21	1	1/3	0.4013	2
A22	3	1	0.5987	2

Environmental benefits (A3) include two indicators: ecological environment (A31) and the conservation of resources (A32).

Table 3-4 Environmental benefits index weights

environmental benefits	A31	A32	W	λ
A31	1	1/3	0.3543	2
A32	3	1	0.6457	2

and other benefits (A4).

Other benefits (A4) including industrial clusters (A41) and radiation effects (A42).

Table 3-5 other benefits index weights

other benefits	A41	A42	W	λ
A41	1	1/3	0.5987	2
A42	3	1	0.4013	2

Thus the two layer index weight is:

$$W1= (0.5498\ 0.4502)$$
$$W2= (0.4013\ 0.5987)$$
$$W3= (0.3543\ 0.6457)$$

W4= (0.4502 0.5498)

The comprehensive evaluation of Liaoning Shihu wind power project comprehensive benefit (A) includes: the impact on social benefits (A1), the impact on the economic benefits of (A2), the impact of environmental benefits (A3), and the impact on other benefits (A4). Based on the confirmation of the first layer index weight, we get the judgment matrix:

$$\begin{pmatrix} 0.54502 & 0.45498 & 0 & 0 & 0 \\ 0.567017 & 0.29935 & 0 & 0 & 0 \\ 0.607832 & 0.392168 & 0 & 0 & 0 \\ 0.4751 & 0.5249 & 0 & 0 & 0 \end{pmatrix}$$

Synthesized according to AHP-Fuzzy comprehensive evaluation method:

$$\begin{pmatrix} 0.54502 & 0.45498 & 0 & 0 & 0 \\ 0.567017 & 0.29935 & 0 & 0 & 0 \\ 0.607832 & 0.392168 & 0 & 0 & 0 \\ 0.4751 & 0.5249 & 0 & 0 & 0 \end{pmatrix}$$

=（0.1856　0.4131　0.2769　0.1244）
=（0.562802　0.381995　0　0　0）

Thus we can get the conclusion based on AHP-Fuzzy comprehensive evaluation method: The fuzzy membership for (excellent, good, fair, poor, poor) of Liaoning Shihu wind power project is (0.562802, 0.381995, 0, 0, 0); At the same time, using the AHP-Fuzzy comprehensive evaluation method to evaluate the Yantai Rushan wind farm, fuzzy membership degree is obtained (0.573802,0.421386,0,0,0), so that the evaluation can be obtained in wind power project is the best comprehensive benefits. Via using maximum membership degree principle to analyze the resulting vector, the judgment on the comprehensive effects on society of this wind power project is excellent. Through the comprehensive evaluation of Liaoning Shihu wind power project comprehensive benefit can be seen, developing wind power in wind power resource-rich regions is an effective way to solve the energy problem and promote economic development.[4]Development and utilization of new energy sources can also achieve the comprehensive and coordinated development of economy, environment and society. What's more, compared with the situation of non-renewable energy damage to the environment, wind power is more economical efficiency, environmentally and sustainability.

CONCLUSION

With the gradual depletion of energy, the energy demand is continued growing. Government shall advocate the development and utilization of wind power and other new energy sources increase their R&D investment, in order to deal with the status of energy depletion, and ensure the sustained and healthy rapid development of national economy. But the new energy like wind power is facing a lot of unfavorable factors: weak market competitions, development difficulties at the early stages of industrial, beneficiaries have limited financial capacity, etc. So the development of wind power project need the government's policy and found support, for example, increased financial assistance and investment; expand the credit scale and provide low-interest l(5)oans; develop tax incentives, subsidies and incentives, in order to make it develop fast and contribute to economic construction. The comprehensive evaluation and analysis could provide theoretical support on the wind power project healthy development in Liaoning. [5]What's more, it can also provide a reference to the whole country's wind power project. It also make great sense on increasing the awareness of develop wind power, comprehensive understanding the importance of develop wind power and strengthening the confidence of develop wind power in some resource -rich area.

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