Evaluation on the implementation effect of wind power policies in China

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Abstract. To promote the development of wind power generation, China has introduced a series of supporting wind power policies. However, it is difficult to quantitatively evaluate the implementation effect of these policies. In order to evaluate the implementation effect of these policies, this paper puts forward a comprehensive evaluation method of policy implementation effects; it firstly quantitatively evaluates the weak link of effect through the effect indexes, and then evaluates the policy implementation and the existing problems through the action weight of policies. The conclusion can provide a reference to improve the wind power policy-making.

1. Introduction

Wind is a rich, clean natural and renewable energy, with no environmental pollution problems. It is of great development potential, which has aroused widespread concern at home and abroad, so it is developing rapidly these years. In order to promote the development of wind power, our government plays an obvious role. In recent years, a large number of relevant policies have been issued to accelerate the innovation and development of wind power industry with the government's attention and promotion, and to access the industry backward advantages. Therefore, a scientific and rational policy evaluation can provide scientific basis for the further formulation of wind power generation policies, which is benefit to the rapid and ordered development of wind power.

In the development of wind power industry, problems and solutions are inseparable from the relevant government and policy. Government planning and management and policy have important impacts in the Chinese wind power industry. At present, most of the researches on the wind power industry policy are based on the analysis of the wind energy resources, the current situation and the difficulties of wind power industry, so as to put forward policy suggestions which is corresponding and can promote the development of the wind power industry [1-2], while studies on the quantitative evaluation of the effect of wind power generation policy are scarce. Literature [3] analyzes the characteristics of some national wind power industry policy, combined with the status of China's tax policy; it puts forward proposals to improve China's wind power industry tax policy. Literature [4] analyzes the wind power price policy at home and abroad, and evaluates the different policy types respectively. In this paper, the evaluation index system of wind power generation is established, based
on which the evaluation method of policy implementation effect is put forward. Then, the effect of policy implementation in recent three years is evaluated quantitatively, and the existing problems are found out, then the suggestions are put forward.

2. Wind power generation policy evaluation method

2.1. Evaluation index system
The principles of the evaluation index system should be comprehensive, hierarchical, relatively independent and operational. In this paper, the method of qualitative and quantitative analysis is used to construct the evaluation index system which is suitable for the evaluation of implementation effect of wind power policy from the four aspects of development speed, development order, cost efficiency and grid-connected operation. There are 3 levels, 4 aspects and 15 indexes in this system, as shown in Table 1.

Table 1. Evaluation index system of the implementation effect of wind power generation policies.

| Target layer | Criteria layer | Index layer                                | Index explanation                                                                 |
|--------------|----------------|--------------------------------------------|-----------------------------------------------------------------------------------|
| Development speed B1 | Wind power installed capacity C1 | Wind power total installed capacity / National power installed capacity Growth of Wind power installed capacity / Growth of power installed capacity |
|               | Production speed C2 | Domestic / Global production growth        |                                                                                   |
|               | Development level of wind power industry C3 |                                                                                   |                                                                                   |
| Development order B2 | Standard specification C4 | Experts score according to the standard number and improvement degree |                                                                                   |
|               | Technique level C5 | Fan conversion efficiency Deviation between actual layout and theoretical layout / Total development scale |                                                                                   |
|               | Layout coordination C6 | Deviation between actual installation and planning installed capacity / Planning installed capacity |                                                                                   |
|               | The deviation rate between planning scale and completion C7 |                                                                                   |                                                                                   |
| Implementation effect of wind power generation policy A | Wind power project yield C8 | Provincial weight x internal income of the province |                                                                                   |
| Cost efficiency B3 | Tax preferential margin C9 | Experts score according to tax preferential margin |                                                                                   |
|               | Financing level C10 | Experts score according to the financing preferential measures and financing difficulties |                                                                                   |
|               | Subsidy release C11 | Full payment ratio x proportion of the arrears |                                                                                   |
| Grid-connected operation B4 | Operation level C12 | Actual power generation / Theoretical power generation (Key provinces) |                                                                                   |
|               | Adequacy of power degree C13 | Total development scale / Acceptance ability |                                                                                   |
|               | Grid-connected service level C14 | Experts score according to grid service speed and quality |                                                                                   |
|               | Business model C15 | Experts score according to the maturity of business model |                                                                                   |
2.2. Comprehensive evaluation method of policy implementation effect

The evaluation index system above can fully reflect the effect of the wind power related policies, but it cannot reflect the effect of the specific policy implementation. The ultimate goal of the comprehensive evaluation of the wind power policy implementation is not only to analyze the overall implementation of the policy, but also to analyze and comb those specific policy which results in the ineffective aspects, so as to provide a direct reference for further developing of the policy.

Based on the reasons above, this paper presents a policy implementation effect evaluation method based on the AHP, called Assessment for Policy Implementation Effect (APIE).

1) Evaluation weight of policy. As is shown in Figure 1, the judgment matrix is used to calculate the weight of the policy importance degree, that is, according to the order of importance level, we get the importance of one aspect relative to the target layer (development speed, development order, cost-effectiveness, grid-connected operation), and the importance of one policy relative to the overall implementation effect. The policy classification covers 17 areas that promote development of wind power policies.

2) Index evaluation. According to the index system in Table 1, we select data in recent years to quantitatively calculate the index weight and index value, and then evaluate the changes and trends of the wind power policy in all aspects of wind power development.

3) Comprehensive evaluation. According to the implementation effect, we evaluate the calculation results, identify weaknesses, and compare with the importance order of policy evaluation, then sort out the existing problems, analyse the implementation situation and the difficulties, finally put forward suggestions.

3. Evaluation on the implementation effect of wind power policy

3.1. Evaluation of policy weight

Since the APIE method evaluates the importance of policy impact, it is necessary to firstly calculate the weight of the policy, including the weight of criteria layer and the weight of policy layer. The calculation of the criteria layer weight needs to list the judgment matrix of the development speed B1, the development order B2, the cost effectiveness B3, and the grid-connected operation B4 relative to
the objective layer A, and then calculate the maximum feature root and weight vector of the judgment matrix, with conducting a consistency test. The policy weight calculation is based on four judgment matrixes consist of 17 policy classifications relative to the 4 criteria of criteria layer in Figure 1, with calculation of the weight vector and consistency test. According to the calculated monolayer weight of the policy, we calculate the weight of each policy to the total target and sorts. In this paper, all the judgment matrixes of policy weight evaluation are formed of the tone method synthesized with the expert scoring results, as shown in Table 2.

Table 2. Weight of wind power policy.

| Policy layer | B1   | B2   | B3   | B4   | Total sorts \( \sum_{j=1}^{4} b_{j} f_{i} (i = 1, 2, \ldots, 17) \) |
|--------------|------|------|------|------|--------------------------------------------------|
| P1           | 0.205| 0    | 0    | 0    | 0.072                                            |
| P2           | 0.067| 0    | 0    | 0    | 0.024                                            |
| P3           | 0    | 0.20 | 0    | 0    | 0.070                                            |
| P4           | 0    | 0.071| 0.051| 0    | 0.035                                            |
| P5           | 0    | 0.157| 0    | 0.077| 0.064                                            |
| P6           | 0    | 0.048| 0    | 0    | 0.115                                            |
| P7           | 0.114| 0.214| 0    | 0    | 0.099                                            |
| P8           | 0    | 0.143| 0    | 0.231| 0.075                                            |
| P9           | 0    | 0.167| 0    | 0    | 0.059                                            |
| P10          | 0.259| 0    | 0    | 0.346| 0.129                                            |
| P11          | 0    | 0    | 0    | 0.346| 0.038                                            |
| P12          | 0.091| 0    | 0    | 0    | 0.032                                            |
| P13          | 0.132| 0    | 0.231| 0    | 0.090                                            |
| P14          | 0    | 0    | 0.154| 0    | 0.029                                            |
| P15          | 0    | 0    | 0.205| 0    | 0.039                                            |
| P16          | 0.132| 0    | 0.231| 0    | 0.090                                            |
| P17          | 0    | 0    | 0.128| 0    | 0.024                                            |

The size of the policy weight can reflect the relative importance of the 17 policies relative to the 4 criteria for evaluating the effectiveness of wind power policies and the overall target of implementation effect.

3.2. Evaluation of Index

Based on the index system in Table 1, we use the judgment matrix to calculate the weight of the index layer relative to the criterion layer.
Table 3. Weight of wind power index.

| Criteria layer and its weight | Index layer | Monolayer weight | Total sorts |
|-----------------------------|-------------|------------------|-------------|
| B1 0.351                    | C1          | 0.429            | 0.151       |
|                             | C2          | 0.429            | 0.151       |
|                             | C3          | 0.142            | 0.050       |
| B2 0.351                    | C4          | 0.126            | 0.044       |
|                             | C5          | 0.234            | 0.082       |
|                             | C6          | 0.435            | 0.153       |
|                             | C7          | 0.205            | 0.072       |
| B3 0.189                    | C8          | 0.508            | 0.096       |
|                             | C9          | 0.079            | 0.015       |
|                             | C10         | 0.218            | 0.041       |
|                             | C11         | 0.195            | 0.037       |
| B4 0.109                    | C12         | 0.227            | 0.025       |
|                             | C13         | 0.434            | 0.047       |
|                             | C14         | 0.227            | 0.025       |
|                             | C15         | 0.112            | 0.012       |

We select three years of wind power development-related evaluation indexes from 2013 to 2015 to calculate and score, and then carry out uniformization and dimensionlessness on the calculated value, getting three-year evaluation value of each index. The evaluation value is multiplied by each value of the index and monolayer weight. The comprehensive evaluation value of the criterion is added by the value of each index in the criterion layer, eventually the evaluation value of the four criteria multiply its weight, which is the comprehensive evaluation value of year's wind power industry policy implementation effect, as shown in Table 4.
Table 4. Comprehensive evaluation results of the implementation effect of wind power policy.

| Criteria layer       | Index name                          | Criteria layer weight | Index layer weight | Evaluation result | 2013 | 2014 | 2015 |
|----------------------|-------------------------------------|-----------------------|--------------------|-------------------|------|------|------|
| Development speed B1 | Wind power installed capacity C1    | 0.351                 | 0.429              | 0.335             | 0.450 | 0.513 |
|                      | Production speed C2                 | 0.429                 | 0.277              | 0.299             | 0.314 | 0.370 | 0.365 | 0.423 |
|                      | Development level of wind power industry C3 | 0.142                 | 0.258              | 0.297             | 0.323 |
| Development order B2 | Standard specification C4            | 0.126                 | 0.018              | 0.023             | 0.034 |
|                      | Technique level C5                  | 0.234                 | 0.025              | 0.027             | 0.028 |
|                      | Layout coordination C6              | 0.435                 | 0.178              | 0.119             | 0.166 | 0.116 | 0.158 | 0.115 |
|                      | Planning scale completion the deviation rate C7 | 0.205                 | 0.165              | 0.170             | 0.173 |
| Cost efficiency B3   | Wind power project yield C8         | 0.508                 | 0.188              | 0.184             | 0.185 |
|                      | Tax preferential margin C9           | 0.079                 | 0.033              | 0.058             | 0.072 |
|                      | Financing level C10                 | 0.218                 | 0.055              | 0.074             | 0.089 |
|                      | Subsidy release C11                 | 0.195                 | 0.099              | 0.103             | 0.106 |
| Grid-connected operation B4 | Operation level C12                | 0.227                 | 0.086              | 0.072             | 0.060 |
|                      | Adequacy of power degree C13        | 0.434                 | 0.057              | 0.043             | 0.028 |
|                      | Grid-connected service level C14     | 0.227                 | 0.141              | 0.123             | 0.102 |
|                      | Business model C15                  | 0.112                 | 0.020              | 0.023             | 0.028 |
|                      | Comprehensive evaluation             |                      |                    | 0.180             | 0.203 | 0.221 |

The comprehensive evaluation results are affected by varieties of factors, the specific analysis is as follows:

1) During 3 years, evaluation values of the development speed index are the highest, and it shows an increasing trend year by year, indicating that in the development process of wind power industry, the development trend is relatively ideal, the implementation effect of relevant policies is well, which promote the rapid development of wind power industry and provides a basic guarantee for it.

2) The evaluation value of development order index is relatively stable, it mainly has declined in the layout coordination degree, while the growth of remaining several indexes is not obvious, indicating that the scale and speed of wind power development has a significant increase relative to the entire power system and has improvement in the quantity level, but the quality level did not reach the expected one, adjustment of relevant policies is needed.
(3) The valuation value of the cost-effectiveness index is slightly higher, indicating that the investment attractiveness level in wind power projects has become stronger. Under the positive policy, the tax concessions and financing levels of wind power projects have increased significantly, which has promoted the development of wind power projects and have a positive impact on the investment in wind power industry.

(4) The evaluation value of grid-connected operation index decreases obviously, indicating that there is a big problem in grid-connected operation. The remaining indexes have all declined except the business model, the main factor may be the contradiction between the rapid development of wind power industry and the planning and construction of the power grid, which results in a large number of nest abandoned wind. Therefore, supporting power grid construction and other relevant policies need to speed up.

3.3. Policy issues and related recommendations

According to the policy weight, it can be seen that in the policies development speed, "strengthening the supporting power grid construction" (P10) is the main influencing factor; in the policies of development order, "strengthening the planning and industrial policy guidance" (P7) is the main influencing factor; In the cost-effective policies, "perfecting price and subsidy policies" (P13) and "perfecting financial support policies" (P16) are the main influencing factors; in the grid-running policies, "strengthening the supporting power grid construction" (P10) and "perfecting the wind power grid-connected operation services" (P11) have significant impacts. Therefore, it is recommended that the relevant policy making departments focus on the following aspects:

1) Strengthening the guidance of development planning. Strengthening the national wind power in a coordinated way between overall planning and special planning, power planning and grid planning, national planning and local planning, enhancing the consistency, coordination and seriousness of the planning, and releasing information in advance to guide the wind power to a balanced and orderly development.

2) Innovating and perfecting the supporting policies. Establishing a dynamic adjustment mechanism of subsidy policies, which adjusts the standard of subsidies dynamically and utilizes the limited subsidies efficiently according to changes in power generation costs; focusing on the matching of the total amount of annual subsidies and the scale of development to prevent the delinquent subsidies, untimely payment and other issues; strengthening financial innovation and exploring new commercial development model.

3) Strengthening the construction of supporting power grids. Enhancing the overall capacity of wind power and establishing effective mechanisms for synchronous planning and simultaneous production of wind power projects and grid engineering; establishing and improving the technical standards and strengthening the operation and monitoring system to gradually realize the on-line monitoring of the wind power grid running and to control the running at a certain degree.

4. Conclusion

Aiming at the problem that implementation effect of wind power generation policy lack comprehensive quantitative evaluation, this paper puts forward a comprehensive evaluation method called APIE. The evaluation results show that in order to promote the development of wind power in China, we need to focus on the development planning, standard specification, grid operation and so on, to further improve or introduce relevant policies.

The APIE method proposed in this paper not only applies to wind power, but also can establish similar evaluation index systems as required to use on other forms of energy, comprehensively evaluating their implementation effect. What should be noted is that since the implementation of policy is cyclical, it is necessary to dynamically adjust the policy evaluation and index evaluation in this method according to the actual policy function.
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