A Research on Profit Allocation of the Wind and Other Powers' Bundled Transmission

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Abstract

The lack of wind power's assimilative capacity has become a bottleneck of wind power's large-scale development in the future, while the bundled transmission model of wind power is highly recommended by many scholars at present. However, due to the distemperedness of China's current fiscal policy, the involved parties cannot get the corresponding policy incentives and the economic compensation for additional contributions, which restricted the implementation of the bundled transmission model. By discussing the basic theory of DEA Game, This paper built an excess profit allocation model based on DEA Game, and took an example to analyze the model's feasibility. Thus, it provides some theoretical basis for the distribution amount and practice distribution forms of the excess profits, and proposes a solution to the problem of the bundled transmission model's benefit distribution.

Keywords: DEA game, wind power digestion, wind power transmission, profit apportionment

1. Introduction

Currently, the lack of wind power's consumptive capacity has become the bottleneck of wind power development, so the utilization rate of many wind turbines is less than 30%. Therefore, to promote the wind power large-scale development in China, we must take measures to promote the wind power's consumptive capacity of power grid [1]. Liu Qi, the Deputy Secretary of National Energy Board, made an important speech in wind power grid connection and market consumption study meeting, which was organized and held by National Energy Board in Beijing in March 30, 2010: the development of wind power and other new energy industry is the major strategic task in China, strengthening the coordinated development of power grid and wind power is important foundation for the wind power large-scale development, and the research on wind power grid and market consumption is the top priority.

In order to expand the absorptive capacity of wind power, the literature [2-3] is referred to the use of bundled transmission model of wind power, in order to expand wind power consumptive regions and improve grid stability, and studies have shown that this approach is scientific and feasible. Bai Jianhua et al pointed out in "the research on major issues of China's wind power development dissolved and transmission": the adjustment ability of other power (fire, hydro, etc.) is the most important factor to determine power system accommodated wind power scale; concentrated distribution and developing of wind energy resources in China determines that we must construct a strong cross-interconnected grid, to achieve China's large-scale wind power development and utilization [4]. Therefore, the bundled transmission model of wind power requires effective coordination between other types of power and power grid group, to provide ancillary services; bundled proportion of wind power, peaking capacity of thermal power and hydropower, output characteristics of wind power, and long-distance power transmission are related to the depth of receiving end power peaking and other factors.

Currently, some other fiscal policy related to wind power constraints the implementation of bundled transmission model of wind power, Zhang Yunzhou mentioned the main issues in "the research on major issues of China's wind power development and consumption": at present, the subsidy standards of prescribed grid is low, there is no relevant policy for large-scale wind power base of long-distance power transmission project investment recovery, a variety of auxiliary services provided by other power plants and power grid after the large-scale grid-connected of wind power are not pricing and reimbursement mechanisms [5]. Therefore, to

smoothly carry out the wind power and other types of power bundled transmission, these issues must be resolved, and other fiscal policy related wind power must be supplemented and improved.

Thus, in order to smoothly implement the strategy of bundled transmission model of wind power, we must solve the problem of income distribution, that is, its participants - the region's hydropower, thermal power, pumped storage power generation, nuclear power, biomass power generation and grid enterprises, have access to appropriate compensation, in order to motivate its better co-ordination of this measures to achieve the ability to expand wind power digestion purposes. This article is to use the DEA game model to solve the problem of benefit distribution of each participant in bundled transmission of wind power, so as to provide a basis for countries to establish corresponding compensation and incentive mechanisms.

2. DEA Game Theory

Nakabayashi and Tone (2006) extended the efficiency analysis of multiplayer game from Golany and Rousseau (1992) [6], that is, they conducted attribute classification on DMU through an alliance between DMU, considered cooperative game between DMU, established the DEA Game model, and pioneered the applied research of DEA game. Nevertheless, the application of DEA Game was still limited, because Nakabayashi and Tone (2006) [7] considered that the number of players and the standard was generally less, and once this number expanded, it will increase the difficulty of solving the game solution. Therefore, how to design a reasonable algorithm to solve this problem is worth studying. Li Yongjun and Liang Liang et al (2008, 2009) [8, 9] considered the fixed cost allocation problems between a number of DMU based on DEA and league game, and designed two algorithms of linear programming and genetic inheritance to solve this problem.

DEA Game model mainly considers how to reach an agreement between many people under the context of multi-standard. Assuming n players, each with m kinds of standard, and jointly allocating vested interest. Due to self-interest, all players want to maximize their own benefit standards and minimize adverse standard. It leads to vested interest in not enough allocating, and falling into the plight of those who self-interest. This will inevitably lead to every gamer cannot reach an agreement in determining the weight values of each index, while DEA can solve such problems. DEA Game is based on all the players are willing to participate in the game; all the players are willing to consult together, to reach a fair and equitable distribution assumption, and considering the alliance and distribution between players.

2.1. Alliance of DEA Game and Characteristic Function

N represents the whole players, $N = \{1,2,3,\cdots n\}$, any subset S of N is called a coalition, $S \subset N$. When gamers conduct benefits (costs) allocation, the listed agreed that an important indicator denoted as i, $i = 1,2,3\cdots m$.

Define the ith indicator value of coalition S as $x_i(S)$, $x_i(S) = \sum_{j \in S} x_{ij}$ $(i = 1,2,3\cdots,m)$.

(1) DEA max game

Define the characteristic function of coalition S as $C(S), (C(\phi) = 0)$, C(S) is the maximum benefit values of coalition S obtained, and C(S) expressed in the following linear programming:

$$C(S) = \max \sum_{i=1}^{m} w_i x_i(S)$$
$$s.t. \begin{cases} \sum_{i=1}^{m} w_i = 1 \\ w_i \geq 0 \, (i = 1,2,3\cdots,m) \end{cases} \quad (1)$$

Among them, w_i is weight value of index i under one of the coalition.

We use (N, c) expressing DEA max game whose participants is N and characteristic function is c, and it has transferable utility. The characteristic function of DEA max gamehas the following nature:

a) If $S \subset N$, $T \subset N$ and $S \cap T = \varnothing$, then $C(S \cup T) \le C(S) + C(T)$;

b) $C(N) = 1$.

(2) Same token for DEA min game, define the characteristic function of coalition S as $d(S)$,($d(\phi) = 0$), $d(S)$ is the minimum cost of coalition S paid, and $d(S)$ expressed in the following linear programming:

$$d(S) = \min \sum_{i=1}^{m} w_i x_i(S)$$

$$s.t. \begin{cases} \sum_{i=1}^{m} w_i = 1 \\ w_i \ge 0 \, (i = 1,2,3\cdots,m) \end{cases} \qquad (2)$$

Among them, w_i is weight value of index i under one of the coalition. We use (N,d) expressing DEA max game whose participants is N and characteristic function is d, and it has transferable utility. The characteristic function of DEA min gamehas the following nature:

a) If $S \subset N$, $T \subset N$ and $S \cap T = \varnothing$, then $d(S \cup T) \ge d(S) + d(T)$;

b) $d(N) = 1$.

2.2. DEA Game Benefit Apportionment and Apportionment Vector

Benefit (cost) apportionment is a core element of DEA game, and it plays a decisive role to the stability of cooperation alliance. Once the players found some being unfairly treated, the formed coalition would exist the risk of rupture. Therefore, to maintain the stability of cooperation, benefit (cost) apportionment should satisfy certain rationality.

Assume that cooperative cost-sharing can be simplified as transferred apportionment or utility, which has a side payment (or transfer payment). Side payment satisfied:

(1) All the players are using the same utility-scale to measure their apportion;

(2) Each apportion of coalition can be distributed to various collaborators in any way, that is to say, the apportion of players is transferable.

n-dimensional vector $z = \{z_1, z_2, \cdots z_n\}$ is the share of the players respective share of the coalition's apportion in DEA game, and it satisfies the following conditions:

a) Individual rationality: $z_j \ge C(j)$ or $z_j \le d(j)$, ($j = 1,2,3\cdots,n$).

b) Collective rationality: $\sum_{j=1}^{n} z_j = C(N) = 1$ or $\sum_{j=1}^{n} z_j = d(N) = 1$.

3. Model Construction of Profit Allocation of Wind Power's Bundled Transmission Based on DEA Game
3.1. Overview of Model Parameters

Profit apportionment is the difficulty of current research, which is directly related to vital interests of each participant in bundled transmission model of wind power.

(1) The excess interests

The profit of allocation in this model refers to the excess interests of wind power's bundled transmission. Considering the actual planning and operation of power system, under the normal operation of bundled transmission mode of wind power, power companies will be in accordance with existing institutional for settlement with participants. Every six months, according to previous parameters, power companies estimate the excess returns combined with actual cost calculation table submitted by each participant. That is to say,

$M = PU - PD + PE$. Among it, M is the excess returns of wind power's bundled transmission, PU is the interests of wind power generation of consumptive bundled transmission, PD is the consumptive wind power's interests without being bundled transmission in the current grid development situation, and PE is the contribution amount of consumptive wind power generation to social benefits. PE mainly includes: environmental benefits, saving non-renewable energy resources and so on.

(2) The participants of profit allocation

Wind power plants - to provide wind power, and bear the cost of wind power.

Power grid enterprises - to build cross-regional power grid, and undertake the risks and costs of wind power grid stability after wind power consumption.

Grid power plant can be used for power stations of bundled transmission (including: thermal power plants, hydroelectric power stations, pumped storage power plants, gas turbine power plants, nuclear power plants, etc.) - in addition to the basic services provided including automatic generation control (AGC), paid peaking, standby, paid reactive power regulation, black start, etc., which should be compensated for ancillary services.

The ancillary services provided by grid station can be divided into basic ancillary services and ancillary services which should be compensated. Basic ancillary service is to protect the safe and stable operation of power system, and ensure power quality. The generators must provide this ancillary service, and it includes primary frequency, the basic peaking, and basically reactive power regulation. This ancillary service is not involved in the excess return distribution of wind power bundled outgoing. Only the ancillary services which should be compensated provided by other grid station in wind power's bundled transmission can participate in the distribution.

3.2. The Basic Model of Profit Allocation

In this paper, we mainly discuss the application of DEA game in profit allocation of bundled transmission mode of wind power, and put forward a new program by using DEA game model to conduct profit distribution.

First of all, noting the gamers is N, in other words, noting all of the interests distribution of the bundled transmission mode of wind power is N, $N = \{1,2,3\cdots n\}$. Any subset of N, S is called a coalition, and $S \subset N$. When the gamers allocate their interests, they list the important indicator which they are all considered very important, and mark it as i, $i = 1,2,3\cdots m$, and they collectively assess the index score for each indicator of each gamer, x_{ij} is index score for the jth gamer under the ith indicator, $j = 1,2,3\cdots n$. The greater the x_{ij} under an indicator is, the better the evaluation of the jth gamer is. The matrix composed by all of the index score is assumed to be X, $X = \{x_{ij}\}_{m \times n}$, and standardized the matrix X: $\sum_{j=1}^{n} x_{ij} = 1$ $(i = 1,2,3\cdots, m)$.

We define the ith index value of alliance S as $x_i(S)$:

$$x_i(S) = \sum_{j \in S} x_{ij} \quad (i = 1,2,3\cdots, m) \tag{3}$$

Define the characteristic function of alliance S as $C(S)$, $(C(\phi) = 0)$, $C(S)$ is the best interests value obtained by alliance S, and $C(S)$ is expressed by the following linear program:

$$C(S) = \max \sum_{i=1}^{m} w_i x_i(S)$$

$$s.t. \begin{cases} \sum_{i=1}^{m} w_i = 1 \\ w_i \geq 0 \, (i = 1,2,3\cdots, m) \end{cases} \tag{4}$$

In the formula, w_i is the weight of index i under an alliance. Obviously, $C(N) = 1$. Z represents the unit share of benefits: $z = \{z_1, z_2, z_3, \cdots z_m\}$.

3.3. Model Solution

In cooperative game, we can use a variety of methods to analyze and solve the game. The most significant methods are: bargaining sets, stable sets, core, nucleolus, and the Shapley value. As the solution of nucleolus must be unique and feasible, in this article, we use nucleolus to make every gamer obtained a fair and reasonable allocation of interest.

Let $e(S, z) = C(S) - \sum_{i \in S} z_i$, $e(S, z)$ is difference between the total excess benefit and actual excess benefit obtained by each apportionment, when those who benefit sharing formed coalition S. the greater the difference is, the worse the effect of this strategy is. There are 2^n subsets of N, so the number of $e(S, z)$ is 2^n. We can array them to a vector in ascending order: $\theta(z) = \left(\theta_1(z), \theta_2(z) \cdots \theta_{2^n}(z)\right)$.

Nucleolus is defined:

$$N(V) = \left\{ z \in E(C) / \theta(z) \leq \theta(y), \forall y \in E(C) \right\} \tag{5}$$

Wherein, $E(C)$ is the collection of all allocation vectors.

From the above, the nucleolus is an allocation to make the exceeding vector minimal, possible coalitions have an exceeding value definition in the nucleolus of all cooperation, so we can solve the nucleolar solution problem by the following linear programming:

$$\min \varepsilon = e(S, z) = C(S) - \sum_{i \in S} z_i$$

$$s.t. \begin{cases} \sum_{i \in S} z_i + \varepsilon \geq C(S) \\ \sum_{i \in N} z_i = C(N) \end{cases} \tag{6}$$

In the formula, ε is an arbitrarily small real number, N is all of the interests distribution of the bundled transmission mode of wind power, S is all the non-empty sets of N. This is a standard linear programming problem, we can solve it by Matlab.

4. Empirical Research on Profit Allocation of the Wind Power's Bundled Transmission

In order to improve the absorptive capacity of wind power, N persons involve in bundled transmission model of wind power, and distribute its excess earnings. Take $N = 4$, respectively representing the four participants of the game. Assumptions: the power grid enterprises estimate the excess earnings in the first half of 2012 as 80 million Yuan by the formula: $M = PU - PD + PE$.

4.1. Example Analysis and Modeling

Firstly, determine the four gamers, the four gamers were: A-wind power plants which participate in bundled transmission mode of wind power; B-power grid enterprises which was established to maintain the grid stability and inter-regional power grid construction after the bundled transmission model of wind power established; C-the grid connected thermal power plant which participate in bundled transmission model of wind power; D- the grid connected hydroelectric power station which participate in bundled transmission model of wind power.

Secondly, four gamers A, B, C, D, list the important indicator which is all considered very important: power generation, grid stability maintenance, and excellent peaking standby power, automatic generation control (AGC), reactive power regulation workload, and additional

capital construction investment. We employ experts score for the above six indicators on the basis of the completion table of semi-annual generating capacity, tables of the peaking power reserve and use, analysis table of the reactive power regulation workload, and the additional information on capital construction investment and other materials. It should be noted that, in the distribution of continuous excess interests, six indicators' scores will change along with the different contributions of each participant. In order to ensure the accuracy of benefit distribution, it is necessary to score every six months depending on the changed materials. Provided by the 4 participants in the first half of 2012, we score for the above six indicators, as shown in Table 1.

Table 1. Each Index Score of every Player

	A	B	C	D
Generating capacity	*0.5*	*0*	*0.3*	*0.2*
Maintenance of grid stability	*0.1*	*0.6*	*0.2*	*0.1*
excellent peaking standby power	*0.1*	*0*	*0.5*	*0.4*
automatic generation control (AGC)	*0.2*	*0*	*0.4*	*0.4*
reactive power regulation workload	*0.1*	*0*	*0.5*	*0.4*
additional capital construction investment	*0.1*	*0.7*	*0.1*	*0.1*

Finally, calculating the interests allocation under all kinds of alliances, and the characteristic function value $C(S)$ under different alliances according to formula (3) and (4), as shown in Table 2:

Table 2. $C(S)$ in All Kinds of Alliances

Alliances mode		Notional amounts of excess interests
Independent	A	0.5
	B	0.7
	C	0.5
	D	0.4
Two collective alliances	AB	0.8
	AC	0.8
	AD	0.7
	BC	0.8
	BD	0.8
	CD	0.9
Three collective alliances	ABC	0.9
	ABD	0.9
	ACD	1.0
	BCD	0.9
Four collective alliances	ABCD	1.0

4.2. Solution for Example Model

Bringing the above characteristic function value into formula (6), we have:

$$\min \varepsilon = e(S, z) = C(S) - \sum_{i \in S} z_i \tag{7}$$

$$s.t. \begin{cases} z_A + \varepsilon \geq 0.5 \\ z_B + \varepsilon \geq 0.7 \\ z_C + \varepsilon \geq 0.5 \\ z_D + \varepsilon \geq 0.4 \\ z_A + z_B + \varepsilon \geq 0.8 \\ z_A + z_C + \varepsilon \geq 0.8 \\ z_A + z_D + \varepsilon \geq 0.7 \\ z_B + z_C + \varepsilon \geq 0.8 \\ z_B + z_D + \varepsilon \geq 0.8 \\ z_D + z_C + \varepsilon \geq 0.9 \\ z_A + z_B + z_C + \varepsilon \geq 0.9 \\ z_A + z_B + z_D + \varepsilon \geq 0.9 \\ z_A + z_C + z_D + \varepsilon \geq 1 \\ z_B + z_C + z_D + \varepsilon \geq 0.9 \\ z_A + z_B + z_C + z_D = 1 \end{cases} \tag{8}$$

This is a multi-objective programming problem, because the participants of bundled transmission model of wind power must have wind power plants, then the above alliances exist invalid alliances (invalid alliances weighting for 0). To deal with this part of the invalid alliance, we use linear weighted sum method of Matlab multi-objective programming problem to solve nucleolus. Each objective function and its given weights are shown in Table 3:

Table 3. The Objective Function and its given Weights

Number	Objective function	The weights
1	$\min \varepsilon = 0.5 - z_A$	0.05
2	$\min \varepsilon = 0.7 - z_B$	0
3	$\min \varepsilon = 0.5 - z_C$	0
4	$\min \varepsilon = 0.4 - z_D$	0
5	$\min \varepsilon = 0.8 - (z_A + z_B)$	0.1
6	$\min \varepsilon = 0.8 - (z_A + z_C)$	0.1
7	$\min \varepsilon = 0.7 - (z_A + z_D)$	0.1
8	$\min \varepsilon = 0.8 - (z_B + z_C)$	0
9	$\min \varepsilon = 0.8 - (z_B + z_D)$	0
10	$\min \varepsilon = 0.9 - (z_D + z_C)$	0
11	$\min \varepsilon = 0.9 - (z_A + z_B + z_C)$	0.15
12	$\min \varepsilon = 0.9 - (z_A + z_B + z_D)$	0.15
13	$\min \varepsilon = 1 - (z_A + z_C + z_D)$	0.15
14	$\min \varepsilon = 0.9 - (z_B + z_C + z_D)$	0
15	$\min \varepsilon = 1 - (z_A + z_B + z_C + z_D)$	0.2

Thus, we solve this problem by using linear weighted sum method of Matlab and multi-objective linear programming.

(1) To establish an evaluation function of linear weighted sum method:

$$\min h(F(x)) = \lambda_1(0.5 - z_A) + \lambda_2[0.8 - (z_A + z_B)] + \lambda_3[0.8 - (z_A + z_C)]$$
$$+ \lambda_4[0.7 - (z_A + z_D)] + \lambda_5[0.9 - (z_A + z_B + z_C)] + \lambda_6[0.9 - (z_A + z_B + z_D)]$$
$$+ \lambda_7[1 - (z_A + z_C + z_D)] + \lambda_8[1 - (z_A + z_B + z_C + z_D)] \qquad (9)$$

We can get the objective function $\min h(F(x))$ by putting the corresponding weights into the above equation:

$$\min h(F(x)) = 0.875 - (z_A + 0.6 \times z_B + 0.6 \times z_C + 0.6 \times z_D) \qquad (10)$$

(2) By Matlab, we can get:

$$z_A = 0.4162，\quad z_B = 0.2618，\quad z_C = 0.1852，\quad z_D = 0.1368 .$$

(3) The distribution of excess benefits:
A: 33.296 million yuan; B: 20.944 million yuan; C: 14.816 million yuan; D: 10.944 million yuan.

5. Model Analysis

As can be seen from the above model, according to the limited nature of non-renewable energy sources and their impact on the environment pollution, wind power will become mainstream of power development in the future, and the consumptive number by grid is the key. Therefore, in order to the power constitutions towards sustainable direction, a variety of ancillary services offered by all participants need to get correspondingly incentive compensation, so as to provide protection for the implementation of policies to encourage wind power digestion. The earnings distribution scheme provided above is only an allocation principle, and it shows us three key issues: Firstly, in determining the excess interests, we tentatively estimate once every six months involved in the materials provided by power grid enterprises, and the specific estimation methods for further study. Secondly, in scoring for the six important indicators, you must determine it according to the contribution extent of each participant, which is based on six indicators with relevant information, and thus we need to redefine the score once every six months. Thirdly, the model exists the weights determination, and all parties involved in the game think it is important to determine the index of subjective judgment. So we need to collect comprehensive information, and try to be comprehensive and rational. In short, the distribution of excess benefits in the bundled transmission model of wind power is difficult to study. In the actual work, we try to accurately estimate the excess interests strict accordance with the materials submitted by each participant, and we strictly determine the index scores to make sure the relative accuracy of allocation results.

5.1. To Determine the Generating Capacity Scores of Bundled Delivery

By the end of 2009, China launched a related research on wind power grid and market consumption. Related research shows that using a rational send method of wind power, hydropower and thermal power will help improve transport efficiency and operational stability, and conducive to the economy of both generation and transmission, and improve the stable security of the system equipment [10].

The bundled proportion of wind and fire is related to the minimum output capacity of sending end thermal power, output features of sending end wind power, power transmission curve and other factors, so we make the northwest territories with rich energy resources and diverse power constitution as the reference grid. We calculate the meritorious requirements of bundled outgoing cross-section of wind and fire in various modes of operation and running session, and arrange the output curve of unit plan. We determine the output of wind power and

thermal power units according to the ultra-short-term wind power prediction results, the meritorious requirements of bundled outgoing cross-section and the regulation characteristics of wind and thermal power units. We also consider the following factors in generating capacity assessment index score for four gamers:

(1) The thermal power ralated to bundled transmission of wind power, its annual generating capacity which should guarantee the achievement of based electricity, when approved its benchmark price.

(2) The ancillary services (such as peaking capacity) provided by thermal power to stabilize the wind power fluctuations, it will bring the cost of thermal power increased to some extent, and it will be further improved through additional renewable energy tariff policy to compensate.

5.2. The Form of Excess Benefit Distribution

The form of excess benefit distribution is varied, including policy guidance and bias, economic leverage, tax incentives and other systems. This paper presents the following for reference:

(1) Appropriation for capital construction investment. Appropriate for the capital construction investment of the participants in the bundled transmission model of wind power, and supporting with more advanced equipment and better working conditions.

(2) Tax incentives. The certain tax return must be given power stations which participate in bundled transmission of power. The specific returned amount should be calculated according to the amount of ancillary services which should be compensated and the generating capacity which participate in bundled transmission.

(3) Prime lending rate. Build power plants for generating electricity of bundled transmission of wind power, and establish grid for transporting electricity of bundled transmission. In this way, We can obtain the prime lending rate for investment and construction loans.

5.3. Select Participants of Wind Power Bundled to Local Conditions

We need local conditions when we select the type of bundled transmission, and we should combine the superiority of local topography and resources to co-ordinate arrangements. For example, in northwest territories, the energy resources are very rich, and the power constitution diversified. Different provinces have their own advantages of resource distribution, hydropower resources are mainly distributed in Qinghai, Gansu, especially the cascade hydropower stations in the upper reaches of the Yellow River, with a strong ability to regulate. Wind power is mainly distributed in Gansu and Xinjiang, thermal power is mainly distributed in Xinjiang, Shanxi, Ningxia. The energy resources between provinces exist an apparent complementary advantages of seasonality, and its potential is huge. Therefore, the complementarity and natural demand of joint operation of the grid characteristics in northwest provinces, which have determined that the bundled outgoing of power resources with different provinces, different types, different costs of electricity and different characteristics, is the inevitable choice of electricity sending in northwest provinces.

6. Conclusion

In this paper, according to the current status of wind power development, we propose to expand the absorptive ability of wind power, which is the key to the large-scale development of wind power in the future. At present, we all believe that the best way to expand the consumptive ability of wind power is the bundled transmission model of wind power. For the current status of some policies restricting the implementation of bundled transmission model of wind power, in this paper, we take advantage of DEA game to solve the distribution problem of excess earnings. All the players are willing to participate in the game and consult together, with this two assumptions to reach a fair and equitable distribution scheme, we established the distribution model of DEA game excess benefits. Through the example analysis, we verified the feasibility of the model. It provides a theoretical basis for the quantity and the practical form of excess benefits distribution in bundled transmission model of wind power, so that each participant can obtain appropriate compensation, in order to better motivate their participation in bundled transmission model of wind power, thereby expanding the consumptive capacity of wind power.

In the model design of excess benefits distribution of bundled transmission model of wind power, we need to combine a large number of related materials and spend certain amount of work, to estimate the excess interests and determine the scores of six important indicators. More concise and accurate method requires further research to explore.

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