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Research on risk evaluation of rural household biogas regions in China

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ABSTRACT

With the continuous improvement of the biogas production technical system by straws and the development of new rural construction activities, making the most of the straw resources certainly becomes the development direction of the biogas in China. This paper deems that the risk factors of the household biogas regions focus on four aspects, involving raw material supply, institutional technological level, temperature guarantee, and social economic conditions. By building the index system, it makes the empirical analysis, obtains some conclusions, and puts forward the definite countermeasures and suggestions.

KEYWORDS

Rural household biogas; Risk evaluation; AHP.

America, Greece, Sweden, and some developing countries make a lot of research on the biomass energy production by straws as the biogas materials, with the extensive use, which plays a positive promotion role in the resource utilization. With the continuous improvement of the biogas production technical system by straws and the development of new rural construction activities, making the most of the straw resources certainly becomes the development direction of the biogas in China.

ESTABLISHMENT OF RISK EVALUATION INDEX SYSTEM OF RURAL HOUSEHOLD BIOGAS REGIONS IN CHINA

Establishment of index system

This paper abides by the principles of significance, dominance, qualitative and quantitative combination, accessibility, and operability, builds the risk evaluation index system of the household biogas regions in China based on the straw biomass resources (TABLE 1).

(1) Raw material supply risk level (B1) mainly means the risk arising out of the inadequate supply and instability of the fermentation raw materials, which is the primary index of measuring the household biogas risk.

(2) Temperature guarantee risk level (B2). The household biogas of China belongs to the normal temperature fermentation. The higher the annual average temperature is, the better the gas production is, and the smaller the corresponding temperature guarantee risk is.

(3) Social economic risk level (B3). It selects two indexes involving the annual per capita income of peasant household and the illiteracy rate of the population above 15 years old, to respectively reflect the economic support degree and acceptable level of the region for the household biogas industrial development. The higher per capita income and lower illiteracy rate is the key of determining whether the household biogas industry can be built and developed continuously.

(4) Institutional technological risk level (B4). Institutional technological level is a qualitative index, and can be abstractly replaced by the biogas production concentration ratio. Biogas production concentration ratio means the percentage of the regional biogas output in the total output of national biogas. The higher concentration ratio indicates the better industrial development of the regional biogas, and directly reflects the higher institutional technological level of the region.

Determination of index weight and marking criterion

This paper allocates the index weight by the analytic hierarchy process (AHP). The basic principle is to decompose the complex problems to be recognized into several layers. The expert and decision maker make the judgment and give the mark layer upon layer by the pairwise comparison of the importance degree for the listed indexes, determine the contribution of the lower layer to the upper layer by calculating and judging the eigenvector of the matrix, and accordingly gain the importance degree of the basic layer index for the general goal (TABLE 1).

TABLE 1 : Index system and weighted value

Target layer	Criterion layer	Index layer
Risk evaluation index system of biogas in China (A)	Raw material supply risk (B1) (0.423)	Total quantity of straw resources (B11) (0.76)
		Multi-year average growth rate of straw output (B12) (0.24)
	Temperature guarantee risk (B2) (0.226)	Annual average temperature (B21) (1)
	Social economic risk (B3) (0.227)	Annual per capital income of peasant household (B31) (0.676)
		Illiteracy rate of population above 15 years old (B32) (0.324)
	Institutional technological risk (B4) (0.124)	Biogas production concentration ratio (B41) (1)

Due to different dimensions of various indexes, the evaluation standards are also different, and it is necessary to make the dimensionless method for each index (i.e. comparing the index value with the standard value). According to the degree of risks, various basic indexes can be divided into six basic marking grades involving 0, 20, 40, 60, 80, and 100, standing for no risk, smaller risk, common risk, larger risk, very large risk, and maximum risk successively. The marking criterion of various basic indexes in the risk evaluation index system of the household biogas regions in China based on the straw biomass resources is determined as follows (TABLE 2).

TABLE 2 : Marking criterion of index

Index	Unit	Marking criterion					
		0	**20**	**40**	**60**	**80**	**100**
B11	10^4t	≥5000	4000	3000	2000	1000	0
B12	%	≥6	4	2	0	-2	≤-4
B21	℃	≥25	20	15	10	5	≤0
B31	Yuan	4500	4000	3500	3000	2500	≤2000
			5000	5500	6000	6500	≥7000
B32	%	0	5	10	15	20	≥25
B41	%	≥15	12	9	6	3	0

For the index mark between two adjacent criteria, it can be determined by the linear interpolation. The calculation is shown as Formula 1.

$$y = \begin{cases} y_{i+1} - \dfrac{x - x_{i+1}}{x_i - x_{i+1}}(y_{i+1} - y_i) & (x_i < x_{i+1}) \\ y_i + \dfrac{x - x_{i+1}}{x_{i+1} - x_i}(y_{i+1} - y_i)_{k,i+1} & (x_i > x_{i+1}) \end{cases} \quad (i=0,1,2,3,4,5) \tag{1}$$

Evaluation model

This paper adopts the multi-objective linear weighting function method to evaluate the risk of the household biogas regions in China, i.e. the index of the previous layer can be calculated by the index group of the corresponding next layer. The calculation formula is shown as Formula 2.

$$\vec{A} = \vec{B} \bullet \vec{W} \tag{2}$$

In Formula 2, A is the index value of the upper layer, B is the index vector value of the lower layer, and W is the index weight vector of the lower layer.

EMPIRICAL ANALYSIS OF RISK EVALUATION

Data sources

The straw variety and type structural composition of 31 provinces and regions in China have huge difference. In view of the study characteristics, this paper mainly selects the agricultural products such as rice, wheat, corn, beans, potato, oil plants, cotton, and sugarcane, and the output data are from *China Statistical Yearbook* of 2003-2012. The data of the annual average temperature, annual per capital income of peasant household, and illiteracy rate of population above 15 years old in various provinces and regions are from *China Statistical Yearbook* of 2013. For the annual average temperature, this paper respectively selects three cities of each province and region for the average value as per the latitude from high to low, such as Shaanxi Province selecting three cities of Yulin, Xi'an and Hanzhong, and Henan Province selecting three cities of Xinxiang, Zhengzhou and Xinyang. The data of the biogas concentration ratio are from *China Agricultural Statistical Information of 2013*.

Evaluation result analysis of different risk levels

According to the marking criterion of index in TABLE 2 and the formula, calculate the specific mark of each index. Then calculate the evaluation result of different risk levels of each province and region by the index weight in TABLE 1, and conduct the forward sequencing. It can be seen that various risk factors show huge regional difference in China.

Raw material supply risk level (B1). The regions with smaller raw material supply risks focus on the central region and the northeast regions with the developed agriculture, while the regions with larger risks focus on the northwest agricultural and pastoral regions and the eastern coastal well-developed regions. It can be seen that the developed degree and concentration ratio of the agricultural production are the decisive factor of the raw material supply risk.

Temperature guarantee risk level (B2). It can be seen that, top 5 provinces and regions are respectively Heilongjiang, Qinghai, Gansu, Xinjiang and Inner Mongolia Autonomous Region, and then Liaoning, Tibet, Ningxia and Jilin etc. Tibet and Qinghai are located at Qinghai- Tibet alpine region, and the natural environmental conditions are relatively poor. The lower rankings of the temperature guarantee risk include Hainan, Guangdong, Guangxi, Fujian, Chongqing and other provinces in the low latitude, and then the southern regions such as Hubei, Hunan, Zhejiang, Shanghai, and Yunnan.

Social economic risk level (B3). It can be seen that, the top rankings include provinces with the economic backwardness such as Gansu, Guizhou, Tibet, Yunnan and Qinghai in the northwest and southwest regions, as well as the coastal well-developed regions such as Shanghai, Beijing and Zhejiang. The regions with smaller social economic risks are the regions with better economic development as well as relatively developed agricultural production such as Shandong, Liaoning, Guangdong, Fujian, and Hebei. Because in the regions with too high or too low social economic development level, the peasant household has lower cognition acceptance level for the biogas, which is not conducive to the development of the regional rural household biogas industry.

The institutional technological risk (B4) from the biogas concentration ratio has huge differences. It can be seen that, only five provinces and regions such as Guangxi, Sichuan, Hunan, Yunnan and Henan have smaller risks, indicating that the state of the household biogas industrial development in these regions is good, and the institutional technological progress level is higher. Moreover, the risk grade of multiple provinces such as Tibet, Shanghai, Tianjin and Qinghai is in proximity to 100, indicating that these regions are limited by the natural conditions or social economic conditions and are not suitable for the industrial development of the rural household biogas.

Comprehensive risk evaluation result analysis of regions

According to different risk evaluation results and formula, it can get the comprehensive risk (A) zoning of the household biogas regions based on straw biomass resources in various provinces and regions of China (as shown in TABLE 3). The regions with larger comprehensive risk are the regions with the backward agricultural production level such as Qinghai, Gansu, Tibet, Ningxia and Xinjiang in the northwest and southwest regions, and the regions with highly-developed economy such as Beijing, Tianjin, Shanghai and Zhejiang in the east, as well as Shanxi with the highly centralized conventional energy resources. The regions with smaller comprehensive risk are the provinces with abundant supply of raw materials, appropriate temperature conditions, and general social economic development level such as Henan, Shandong, Sichuan, Hebei, Hunan, Guangxi, Hubei, Jilin, and Jiangsu. The risk level of developing the rural household biogas in other regions is general.

TABLE 3 : Comprehensive risk zoning of household biogas regions in China based on straw biomass resources

Name of zoning	Standard of zoning	Region
Low risk region	≤45	Henan, Shandong, Sichuan, Hebei, Hunan, Guangxi, Hubei, Jilin, Jiangsu
General risk region	45-60	Chongqing, Hainan, Guizhou, Inner Mongolia, Yunnan, Fujian, Liaoning, Jiangxi, Guangdong, Anhui, Heilongjiang
High risk region	≥60	Qinghai, Beijing, Gansu, Tibet, Shanghai, Ningxia, Zhejiang, Tianjin, Shaanxi, Xinjiang, Shanxi

CONCLUSION

In order to avoid the risks, it puts forward the following countermeasures. Firstly, it seeks a sustainable development mode in favor of the society, economy and environment which is suitable for the national conditions. Secondly, it establishes the biomass energy innovation system with the enterprise as the main body. Thirdly, it quickens the commercialization and industrialization process, and meanwhile the government strengthens the macro-control, increases the support of the government on the development of the biomass energy and the guiding force of consuming the biomass energy, and reduces the market risk of the biomass energy consumption in the centralized purchasing of the energy.

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REFERENCES

[1] Yu Chen, Gaihe Yang, Yongzhong Feng; Establishment of Suitability Evaluation Index System of Household Biogas Regions and Research on Grading Standard [J]. Agricultural Research in the Arid Areas, **26(5)**, 228-232 **(2008)**.

[2] Xiaohua Chen, Hongguang Zhu; Research Progress and Prospect of Biogas Production by Crop Straw [J]. Transactions of the Chinese Society of Agricultural Engineering, **23(3)**, 279-283 **(2007)**.

[3] Wenbin Ding, Yapeng Wang, Yong Xu; Output Potential Analysis of Biomass Energy Material – Main Crop Straw [J]. China Population Resources and Environment, **17(5)**, 84-89 **(2007)**.