Study on Environmental Performance Evaluation Method of Waste Resource Multiple Utilization Industry

Yi Zhu[a], Dongfeng Gao[b], Yun Fu[c], Yuanyuan Teng[d], Shuang Ding[e], Yanxin Gao[f] and Rui Zhang[g]
China National Institute of Standardization, NO.4 Zhichun Street, Beijing, China

Keywords: Waste Resource Multiple Utilization, Environmental Performance, Evaluation.

Abstract: The scale of China's waste resource multiple utilization industry has been gradually expanded, the recycling and utilization system has been gradually perfected, and the technical level has been gradually improved. However, the standardized level of management still needs to be further strengthened. Through the study on the domestic and overseas environmental performance evaluation methods and indicator systems, this study constructs the framework for the environmental performance evaluation indicator system in the waste resource multiple utilization industry, gives the determination method of indicator weight and indicator reference value, proposes the calculation method and grading method of environmental performance indicator, and defines the applicable scenario of such method.

1 INTRODUCTION

With the rapid economic growth, the environmental problem has already become the most urgent task before us, which has seriously threatened the healthy survival of human beings and the sustainable development of the society, and caused a widespread concern in the whole society. At present, various industries and enterprises have sought methods and means to evaluate, verify and improve their environmental performances. Centered on the Circular Economy Promotion Law, and taking the improvement of resources utilization efficiency, environmental protection & improvement, and realization of sustainable development as the target, China has issued a series of laws, administrative regulations & departmental regulations in terms of clean production, pollution prevention and control, energy-saving & emission reduction, recycling of renewable resources, comprehensive utilization of bulk industrial solid wastes, ecological design of industrial products, etc., and the comprehensive utilization policy system of waste resources has been preliminarily established; it has broken through the comprehensive utilization technology of bulk industrial solid wastes, such as the fly ash, coal gangue, industrial by-product gypsum, etc., the producer responsibility extension system has been implemented in the waste electronics & electrical appliances, a group of professional enterprises that are engaged in the recycling, disassembly, and utilization of renewable resources has emerged, and the pilot projects and demonstration works of refabrication, standardization of circular economy, etc., have been steadily promoted.

At present, the scale of China's waste resource multiple utilization has been gradually expanded, the functions of recycling and utilization system have been gradually perfected, and the regional terminal markets have been preliminarily formed. Although the technical level has been improved, the standardized level of management still needs to be further improved. Therefore, it is of great significance to study the environmental performance evaluation method in the waste resource multiple utilization

[a] https://orcid.org/0000-0002-1951-471X
[b] https://orcid.org/0000-0001-9760-1512
[c] https://orcid.org/0000-0003-4789-5297
[d] https://orcid.org/0000-0002-5087-1993
[e] https://orcid.org/0000-0003-4858-2831
[f] https://orcid.org/0000-0003-0940-0636
[g] https://orcid.org/0000-0003-2251-5526

Zhu, Y., Gao, D., Fu, Y., Teng, Y., Ding, S., Gao, Y. and Zhang, R.
Study on Environmental Performance Evaluation Method of Waste Resource Multiple Utilization Industry.
DOI: 10.5220/0011185700003444
In *Proceedings of the 2nd Conference on Artificial Intelligence and Healthcare (CAIH 2021)*, pages 80-85
ISBN: 978-989-758-594-4

industry, guide the evaluation of environmental performance level in waste resource multiple utilization industry, the better enhancement of resources utilization efficiency, the realization of scientific recycling, high efficient collection, safe disposal and reasonable recycling of waste resources, and the active promotion of industrial healthy development.

2 THEORETICAL BASIS

The overseas study on environmental performance evaluation indicators might be traced back to 1970s, which was mainly concentrated on the external-stakeholder-demand-oriented indicator evaluation, the enterprise-environmental-management-and-risk-control-oriented indicator evaluation, and the enterprise-environment-and-enterprise-development-coordinated indicator evaluation (Asit 2015, Wagner 2005, Martinez 2012, Jiang 2020). Besides, the environmental performance evaluation processes and steps, evaluation principles, and the selection of evaluation parameters, etc. are specified in the international standard Environmental Management – Environmental Performance Evaluation - Guidelines (ISO 14031: 2013). This standard has provided the comprehensive guidance and support for the preparation of overall framework, selection basis of evaluation indicators and other contents of the environmental performance evaluation, and this standard is also adopted by China and converted into the national standard (Huang 2021).

With regard to the domestic research, National Development and Reform Commission and other departments have jointly prepared the 2007 version and 2017 version of Circular Economy Development Evaluation Indicator System. Among them, the 2007 version specifies 22 evaluation indicators at the macro level and 14 evaluation indicators at the industrial park in terms of four aspects, namely, output of resources, consumption of resources, comprehensive utilization of resources, and emissions of wastes, while the 2017 version proposes 17 evaluation indicators (www.ndrc.gov.cn/fggz/hjyzy/fzxhjj/201701/t20170105_1202980. html 2017) from three categories, namely, comprehensive indicator, special indicator and reference indicator; Ministry of Environmental Protection, National Development and Reform Commission, and Ministry of Industry and Information Technology separately unite other departments to prepare the ecological industrial demonstration park and industrial park circular transformation and green industrial park evaluation indicator system(Fu 2019) according to the policy implementation and work conduct; National Development and Reform Commission and Ministry of Environmental Protection unite other departments to prepare the General Principles of Stipulating the Assessment Indicator Frame of Cleaner Production for Industries, which combines and revises the clean production evaluation indicator system, clean production standard, and clean production technical level evaluation system(www.mee.gov.cn/gkml/hbb/gwy/201306/t20130617_253853.htm 2013). In addition, many Chinese scholars have also studied how to establish the environmental performance evaluation indicator. For instance, Liu Jiansheng proposed the design principles and key design points of enterprise environmental performance evaluation indicator(Liu 2011) based on the circular economy framework; Zhang Yonghong et al., constructed the CBM enterprise environmental performance evaluation indicator system(Zhang 2018) based on the BSC and GEVA; Yu Huixian et al., constructed the petroleum enterprises environmental performance evaluation indicator system including 6 primary indicators and 32 secondary indicators, and utilized the analytic hierarchy process (AHP) to determine the indicator weight (Yu 2020).

The purpose of environmental performance evaluation is to evaluate the realization degree in terms of the energy saving and emission reduction, clean production, resources recycling, etc. of the enterprise. The industrial features, operation characteristics, business process, resources and energy consumption, etc. of different industries may vary, and the evaluation indicator system may be separately designed for the environmental performance evaluation according to the difference of industries. This paper carries out the high-frequency indicator and unique indicator analysis through the study on domestic and overseas environmental performance evaluation methods and evaluation indicator systems, especially in terms of the evaluation methods and evaluation indicator systems at the macro and micro levels within the sectors such as the circular economy, waste resources comprehensive utilization industry, etc., prepared by relevant departments in China, and conducts the study on environmental performance evaluation method of waste resource multiple utilization enterprises in combination with the features of this industry, and by adopting the ISO 14031 international standard as the guideline.

3 CONSTRUCTION OF EVALUATION SYSTEM

3.1 Evaluation Indicator System

3.1.1 Evaluation Indicator Framework

The segmentation fields of waste resource multiple utilization industry mainly include the comprehensive utilization of industrial solid wastes, comprehensive utilization of agricultural and forest wastes, recycling of renewable resources, resource utilization of restaurant and kitchen wastes, resource utilization of building wastes, Remanufacturing, and other fields. The environmental performance evaluation of waste resource multiple utilization industry shall mainly consider the output capacity of enterprise resources and energy consumption, the utilization efficiency of resources and energy, the multiple utilization capacity of waste resources, and environmental impact level, etc. The environmental performance evaluation indicator system of waste resource multiple utilization industry shall be including but not limited to the resources and energy output indicator, resources multiple utilization indicator, environmental emission indicator and other primary indicators that may reflect the environmental performance level of waste resources multiple utilization industry and segmentation fields. Every primary indicator may consist of several secondary indicators that may reflect the environmental performance level of waste resources multiple utilization industry and segmentation fields. For the evaluation indicator framework, see Table 1.

Table 1: Environmental Performance Evaluation Indicator Framework of Waste Resources Multiple Utilization industry.

No.	Primary indicator	Weight of primary indicator	Secondary indicator	Weight of secondary indicator	Benchmark value
1	Resources and energy output indicator		Yield rate of the land		
			Yield rate of the energy		
			Yield rate of water resources		
			… …		
2	Resource multiple utilization indicator		Comprehensive utilization rate of industrial solid wastes		
			Comprehensive utilization rate of agricultural and forestry wastes		
			Recycling rate of renewable resources		
			Resource handling rate of restaurant and kitchen wastes		
			Resource utilization rate of building wastes		
			Repeated utilization rate of industrial water		
			Reuse rate of reclaimed water		
			Refabrication rate		
			Comprehensive recycling rate of valuable element		
			… …		
3	Environmental emission indicator		COD emissions of unit product or unit output value		
			Total nitrogen emissions of unit product or unit output value		
			Ammonia nitrogen emissions of unit product or unit output value		
			SO2 emissions of unit product or unit output value		
			Nitrogen oxide emissions of unit product or unit output value		
			Particulate matter emissions of unit product or unit output value		
			… …		

3.1.2 Explanation of Evaluation Indicators

Resources and Energy Output Indicator. It is required to set the resources and energy output indicator from the perspective of facilitating the improvement of enterprise resources and energy output, the improvement of resources and energy utilization efficiency, etc. The secondary indicators shall be including but not limited to the yield rate of the land, energy, water resources, and other indicators, and the appropriate adjustments may be made according to features of different fields of resources comprehensive utilization.

Resource Multiple Utilization Indicator. It is required to set the resource multiple utilization indicator from the perspective of facilitating the improvement of waste resources recycling, quantity & efficiency of recycling, and the improvement of high value-added utilization level of waste resources, etc. The secondary indicators shall be including but not limited to the comprehensive utilization rate of industrial solid waste, recycling rate of renewable resources, comprehensive utilization rate of agricultural and forest wastes, resource utilization rate of restaurant and kitchen wastes, resource utilization rate of building wastes, repeated utilization rate of industrial water, reuse rate of reclaimed water, refabrication rate, comprehensive recycling rate of valuable element, etc. The appropriate adjustments can made according to features of different fields of waste resource multiple utilization industry.

Environmental Emission Indicator. It is required to set the environmental emission indicator from the perspective of facilitating the reduction of generation and emission of environmental pollutants, etc. The secondary indicator shall be including but not limited to the COD, total nitrogen, ammonia nitrogen, SO2, nitrogen oxide, particulate matter emissions, and other indicators of unit product or unit product output value. The specific indicators shall be set according to the pollutant features of various sectors of waste resource multiple utilization industry.

3.2 Determination Methods of the Weight and Indicator Benchmark Value

3.2.1 Weight Determination Method

Different fields of waste resource multiple utilization industry shall separately determine the weight of primary indicator and secondary indicator according to the features of its own field. The environmental performance evaluation indicator weight of waste resource multiple utilization industry may be determined according to the analytic hierarchy process, Delphi method and principal components analysis method.

3.2.2 Determination Method of Indicator Benchmark Value

If the results of environmental performance evaluation used as the lateral comparison, the indicator benchmark value shall adopt the principle that top 5% enterprises in the domestic ranking at present may reach such benchmark value as the value-taking principle; If the results of environmental performance evaluation used to conduct the vertical comparison of enterprise environmental performance itself, the indicator benchmark value shall adopt the medium-and-long-term target of such indicator determined by the enterprise as the value-taking principle.

4 EVALUATION METHOD

4.1 Calculation Method of Environmental Performance Index

The environmental performance evaluation in the waste resource multiple utilization industry may adopt the index evaluation method, constructing the environmental performance index calculation equation (see equation (1)) of waste resource multiple utilization industry, based on the environmental performance evaluation indicator. The dimensionless of indicator value will be realized with the indicator benchmark value, and dimensionless method of the positive indicator (the greater, the better) and negative indicator (the smaller, the better) values separately adopt the indicator value/ indicator benchmark value and indicator benchmark value/ indicator value. The environmental performance indicator score will be obtained through the weighted composite calculation.

$$EP = \sum_{i=1}^{n} \eta_i \sum_{j=1}^{m} \theta_{ij} \frac{X_{ij}}{Xb_{ij}} \left(or \frac{Xb_{ij}}{X_{ij}} \right) \times 100 \quad (1)$$

Where,

EP - refer to the environmental performance index of waste resource multiple utilization industry;

η_i - refer to the weight of number i primary indicator;

n - refer to the quantity of primary indicators;

θ_{ij} - refer to the weight of number j secondary indicator of the number i primary indicator;

m - refer to the quantity of secondary indicators;

X_{ij} - refer to the number j secondary indicator value of the number i primary indicator;

Xb_{ij} - refer to the number j secondary indicator benchmark value of the number i primary indicator.

4.2 Grading of Score Results

The total score is 100 points and the grade is subject to the environmental performance indicator score, namely, three grades from low to high, "★★★", "★★★★" and "★★★★★". Various fields in the waste resource multiple utilization industry will set the grade score range according to the evaluation indicator system and indicator benchmark value.

5 APPLICABLE SCENARIO OF EVALUATION METHOD

5.1 Vertical Comparison

The enterprise in the waste resource multiple utilization industry may use this method to self-evaluate environmental performance, which may be used to conduct the vertical comparison between environmental performance evaluation results of the enterprise's various evaluation periods. The relevant competent authority or enterprise in the industry may carry out the dynamic monitoring on the enterprise environmental performance through the evaluation results.

5.2 Lateral Comparison

The relevant competent authority or industrial organization in the industry may use this method to compare or rank the environmental performance results of enterprises in the waste resource multiple utilization industry or various fields of it, and the results may be used to carry out the lateral comparison between enterprise environmental performance evaluation results within different evaluation periods and measure or evaluate the environmental performance level of enterprises in the industry or field.

6 CONCLUSION

The waste resource multiple utilization industry covers many specific fields. After each field determines the secondary indicator, indicator weight, indicator benchmark value and score grade according to its own features and development conditions, this method may be used to carry out the environmental performance evaluation. This method will provide the technical support for the industrial management and standardized & healthy development in the waste resource multiple utilization industry.

ACKNOWLEDGEMENTS

This work is supported by the Foundation of President of China National Institute of Standardization（542019Y-6659）.

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