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# *Sustainable Development of Green Energy Efficiency of Enterprises Based on Circular Economy*

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***Abstract:*** With the development of social economy, energy and environmental problems are increasingly prominent. In this situation, green energy efficiency management of enterprises has gradually become a solution to energy and environmental problems. This paper aimed to study how to analyze and study the sustainable development (SD) of green energy efficiency of enterprises based on circular economy, and described the data envelopment analysis (DEA) method. The experiment in this paper analyzed the present situation of green energy efficiency in enterprises by conducting a survey of 200 enterprises with questionnaires. The traditional green energy efficiency evaluation model and the green energy efficiency evaluation model in this paper were used to evaluate and analyze enterprises X and Y. It can be seen from the data that the green energy efficiency evaluation of the traditional model and the model in this paper for Enterprise X in 2022 was 0.79 and 0.87 respectively, while the actual green energy efficiency was 0.88. The green energy efficiency evaluation of the two models for Enterprise Y in 2022 was 0.36 and 0.52 respectively, while the actual green energy efficiency was 0.51. To sum up, the enterprise green energy efficiency evaluation model proposed in this paper is feasible.

## 1. Introduction

Green energy efficiency management in enterprises is gradually becoming an efficient approach to solve energy and environmental issues. The green energy efficiency management of enterprises is mainly to transform all kinds of wastes generated in the production process of enterprises into products or resources that can be reused, and recycle them to other fields, so as to achieve a win-win situation of economic development and environmental protection. The green energy efficiency management of enterprises has some similarities with the circular economy, which refers to the reuse of waste generated in other fields after the recycling of resources and pollution control. However, compared with circular economy, green energy efficiency management of enterprises

needs higher technical support and policy support.

The research on green energy efficiency of enterprises has gradually increased. Tien Nguyen Hoang provided the current basic understanding of the concept and problems of green entrepreneurship in Vietnam and its relationship with relevant background concepts such as social entrepreneurship, social responsibility and SD [1]. Yi Gaofeng aimed to establish a hypothetical model of green entrepreneurial behavior to investigate the green entrepreneurial behavior of college graduates. He combined cognitive and behavior-oriented education, and created a favorable environment for green entrepreneurship by integrating university entrepreneurship support system and external institutional support system [2]. Anthony Jr Bokolo aimed to develop an agent-based collaborative network architecture and agent-based green information system evaluation tool, which can help information technology practitioners in data centers evaluate their current green information system practices, so as to achieve sustainability [3]. Although these studies have contributed to a certain extent to the green energy efficiency of enterprises, they have not been studied in a practical context.

The DEA method has gradually attracted widespread attention from the academic community. Stecula Kinga discussed the decision-making difficulties related to enterprise management and the mining enterprises that produce hard coal, and pointed out the importance of the awareness of employees and management for environmental protection production, which has reference significance for the use of DEA method [4]. Raharjo Kusdi aimed to analyze the impact of the relationship between stakeholder needs, resources, knowledge and product uniqueness on green marketing and its impact on sustainability performance, which would promote the depth of use of DEA method [5]. Although these research methods are innovative, a large number of experimental data are needed to prove the reliability of the methods.

Firstly, this paper analyzed the evaluation method of green energy efficiency of enterprises based on circular economy, and studied it from three aspects: circular economy and SD, green energy efficiency management of enterprises, and evaluation method of green energy efficiency of enterprises. Secondly, the status quo of green energy efficiency of enterprises was analyzed, so as to understand the problems faced by enterprises at present, and the green energy efficiency of enterprises was evaluated. At the end of this paper, some suggestions for improving green energy efficiency were given.

## 2. Evaluation Method of Green Energy Efficiency of Enterprises Based on Circular Economy

### 2.1 Circular Economy and SD

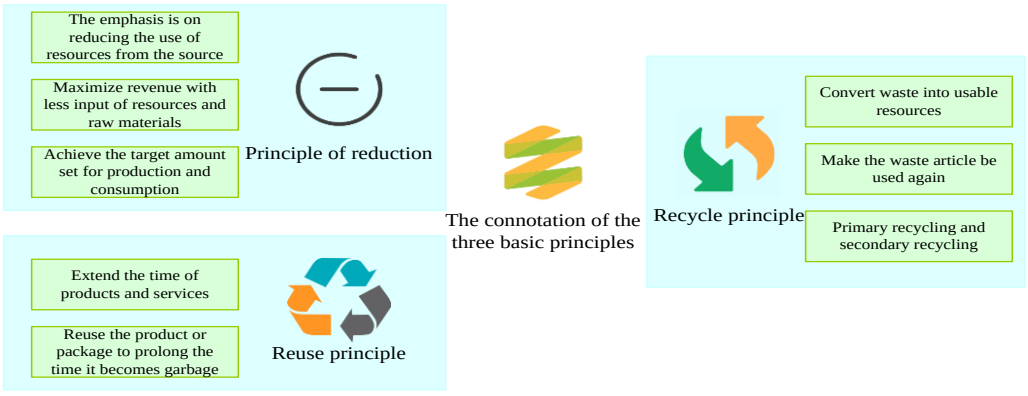



*Figure 1. The connotation of the three basic principles*

"3R" is the basic concept of circular economy development recognized by experts and scholars of all countries at present. "3R" refers to "reduction", "reuse" and "recycling" [6-7]. The connotation of the three basic principles is shown in Figure 1.

The principle of decrement: the so-called decrement is dematerialization. Reduction is listed as the first of the three principles of circular economy. The fundamental reason is that it emphasizes reducing resource consumption from the source by starting with production and consumption links, thus reducing environmental pollution [8-9].

Reuse principle: The principle of reuse aims to extend the period of goods or services, and is a process method. That is to reuse commodities or packaging instead of disposable consumables, and prolong the time of turning them into waste.

Recycling principle: Recycling principle is to turn waste materials into useful materials, so that waste materials can play a role again and realize reuse. The most common method is to recycle waste materials in life.

The essence of circular economy lies in solving ecological and environmental problems and achieving harmonious growth of human and nature by building an ecological economic system [10-11]. It mainly refers to taking the whole society as a large "ecosystem", and requiring economic activities to follow the principles of resource development and utilization, waste generation and emission, and energy conversion and exchange, so as to achieve "reduction, reuse, and recycling" in the material cycle, thus realizing the virtuous cycle of the whole social production. Circular economy requires the adoption of green processes, technologies, materials and management modes in the production and operation process of enterprises, so as to improve energy efficiency and reduce waste production, which can achieve the purpose of improving the environment and saving resources [12]. Under the concept of circular economy, enterprises should not only treat and utilize the waste generated in their own production and operation process, but also consider the waste generated in the use of products [13].

The main contents of SD include: ecological, social and economic sustainability and coordinated development in three aspects [14]. This requires that in the specific development process, it should pursue good economic benefits, but also pay attention to ecological harmony, and pay more attention to social equity and fairness. Finally, it is necessary to achieve comprehensive and good human development. The specific content is shown in Figure 2.


*Figure 2. Specific content of SD*

Sustainable economic development: The improvement of national strength and the continuous

expansion of social wealth are inseparable from economic growth. Therefore, it is to encourage economic growth, not to hinder economic growth under the pretext of protecting the environment. It pursues the quantity of economic increase, and more importantly, the quality of economic increase.

Ecologically SD: The focus needs to be on a harmonious relationship with nature to ensure that the harmonious development of economy and society is within its carrying capacity. The pursuit of development and advancement of human communities must be within the limits of the ecosystem's ability to sustain it.

Social SD: it highlights social fairness and justice, and takes fairness and justice as the basis and goal of its development. At present, in the world, there are many countries with different development levels and goals because of their different environments.

SD is a complex system engineering, which involves multiple disciplines and fields. The researchers are based on different disciplines and have different understanding of SD [15-16].

Circular economy and SD are inextricably linked, but circular economy is not equal to SD. Under the guidance of SD strategy, the concept of developing circular economy came into being. SD is a higher level of development concept, which provides a theory basis for the development of circular economy, and is a very significant strategic task in China. Circular economy is a positive and beneficial development consistent with SD, the protection of environment and resources, and SD. Circular economy is the fundamental way of SD, and building a society of circular economy is the inevitable choice.

## 2.2 Enterprise Green Energy Efficiency Management

At present, most of the existing statistical indicators on energy efficiency and related research documents are based on the economic benefits of energy input, while ignoring the harm of pollution emissions from production activities to the ecological environment. To achieve the SD of "two types of society", it is necessary to start from the conservation of resources.

Green energy efficiency is the maximum output that an economic system can achieve after combining the cost of energy consumed in its production process with the cost of damage to the environment. That is, under a certain energy input, it can reach the maximum expected output and the minimum unexpected output, or under a certain expected output, it can reach the minimum output of both energy input and unexpected output, as well as the minimum expected output.

Green energy efficiency management refers to the management of energy use efficiency by enterprises. It is also an effective control of energy consumption and resource waste of enterprises. Its purpose is to reduce the energy consumption density of enterprises and improve energy use efficiency. The green energy efficiency management of enterprises consists of three parts, as shown in Figure 3.

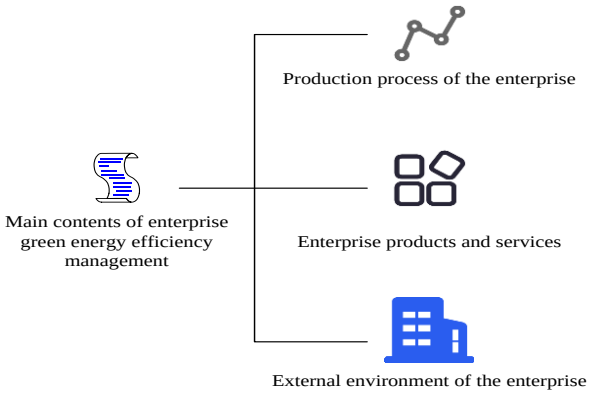



*Figure 3. Main contents of enterprise green energy efficiency management*

According to Figure 3, the main contents of enterprise green energy efficiency management are enterprise production process, enterprise products and services, and enterprise external environment. Due to the different pollutants produced in each production process, the waste produced in each link is also different. For wastes generated in different links, targeted management should be carried out and corresponding measures should be taken to deal with them. The pollutants produced in the production process can be treated by physical, chemical, biological and other methods. The waste generated in the production process needs to be treated by reuse or transfer to the outside.

### 2.3 Evaluation Method of Green Energy Efficiency Of Enterprises

In the analysis of the importance and necessity of green energy efficiency management in enterprises, the traditional production mode has caused serious ecological and environmental problems in the rapid development of China's economy. First of all, green energy efficiency management of enterprises can transform the traditional extensive production mode into intensive production mode, which is the key measure to realize the green transformation of enterprises. Finally, green energy efficiency management of enterprises can organically combine traditional industries and new industries, thus promoting coordinated economic development. To sum up, green energy efficiency management of enterprises is one of the key issues to be solved in the process of rapid economic development in China.

The simplest and easiest traditional evaluation method is the green energy efficiency evaluation method based on the concept of productivity. Its essence is a ratio analysis method, which takes the ratio of output and input as the efficiency evaluation index. Therefore, green energy productivity is the ratio of output in the production process to the required green energy input.

In order to make up for the defect of single factor analysis, a DEA method based on the assumption of constant return to scale is developed. DEA method can effectively deal with the situation of multiple inputs and multiple outputs, and it is more consistent with the green energy efficiency model of all-factor enterprises. Therefore, DEA method is the first choice of many scholars when conducting green energy efficiency analysis.

It is assumed that $X$ represents the input vector and $Y$ represents the output vector, then the following linear procedure can be used to solve the enterprise green energy efficiency value of the company in the $o$ decision unit:

$$\begin{aligned} & Min_{\phi,\gamma}\phi \\ & s.t. \quad -y_o + Y\gamma \geq 0 \\ & \phi x_o - X\gamma \geq 0 \\ & \gamma \geq 0 \end{aligned} \tag{1}$$

In Formula (1), $\gamma$ is a constant vector; $\phi$ is the green energy efficiency value of the all-factor enterprise in the $o$ decision-making unit, and $0 \leq \phi \leq 1$.

$\phi = 1$ indicates that the green energy utilization of the decision-making unit is technically effective; $0 \leq \phi < 1$ indicates that the decision-making unit is invalid, and there is a waste of resources and further reduction of investment space.

The researchers extended the traditional DEA model and proposed the DEA super-efficiency model. It can be expressed by the following linear programming formula:

$$
\begin{aligned}
&Min_{\phi^{\sup},\gamma}\phi^{\sup} \\
&s.t. \quad -y_o + \sum_{\substack{H=1 \\ H\neq o}}^{M} y_H\gamma_H \geq 0 \\
&\phi x_o - \sum_{\substack{H=1 \\ H\neq o}}^{M} x_H\gamma_H \geq 0 \\
&\gamma_H \geq 0, H = 1,2,...,M
\end{aligned} \tag{2}
$$

Among them, $M$ is the number of decision-making units. When evaluating the effective unit, the super-efficiency model removes the restriction of the utility value of efficiency value $\phi \leq 1$, so that it can obtain a higher utility value than 1. This is the efficiency value $\phi^{\sup}$ of DEA, which can be used to further distinguish the units with utility value of 1 in the conventional DEA model.

"Two-stage method" is a common method in the current research on the factors affecting green energy consumption of enterprises. It first uses DEA method to calculate the efficiency value of each decision-making unit. By taking the efficiency value calculated in the previous step as the dependent variable, and then taking various influencing factors as the independent variable, the various influencing factors are regressed. According to the regression coefficient of these factors, the direction and degree of their effect on the efficiency value are determined.

On this basis, this paper proposes an efficiency evaluation method based on DEA. If the sample of the measured variable is limited or truncated in the regression model, then the parameters obtained by the general least squares method would be biased and incompatible. Tobit regression model has the following representation:

$$
\begin{aligned}
&Y_p = \begin{cases} \alpha^T X_p + e_p & \alpha^T X_p + e_p > 0 \\ 0 & \alpha^T X_p + e_p < 0 \end{cases} \\
&e_p \sim M(0,\delta^2), p = 1,2,3,...,m
\end{aligned} \tag{3}
$$

Tobit model can also be expressed as:

$$
\begin{aligned}
&Y_p^* = \alpha^T X_p + e_p \\
&Y_p = \begin{cases} Y_p^* & Y_p^* > 0 \\ 0 & Y_p^* \leq 0 \end{cases} \\
&e_p \sim M(0,\delta^2), p = 1,2,3,...,m
\end{aligned} \tag{4}
$$

$Y_p$ is the dependent variable vector, and $X_p$ is the explanatory variable vector; $\alpha^T$ is the unknown parameter vector, and $e_p$ is the error vector.

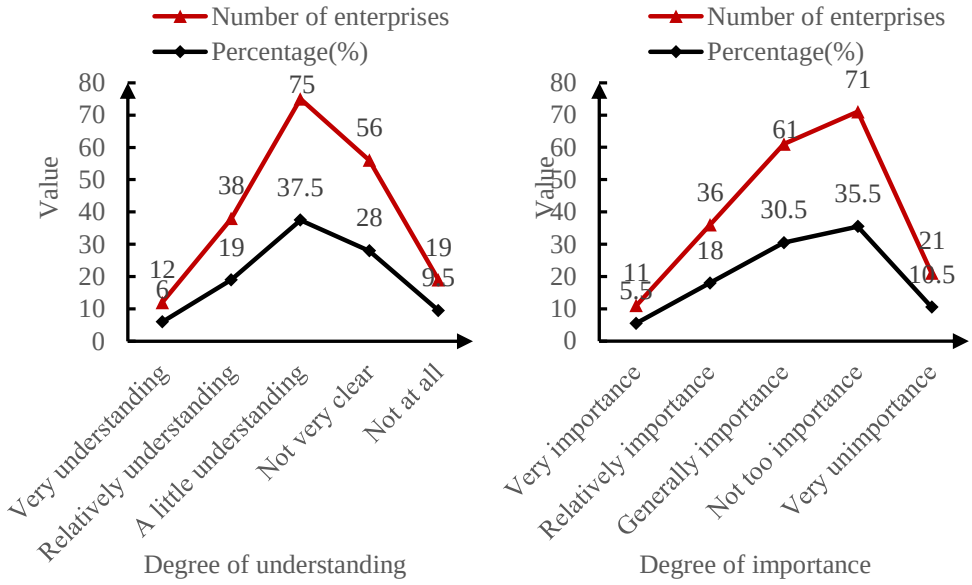
## 3. Enterprise Green Energy Efficiency SD Experiment

### 3.1 Current Situation of Green Energy Efficiency of Enterprises

This paper selected 200 enterprises from 5 cities for investigation.

Green energy efficiency refers to comprehensive energy efficiency, including energy utilization efficiency and energy environmental efficiency. In the context of building a "two-oriented society",

the improvement of green energy efficiency is a more comprehensive, reasonable and sustainable energy efficiency measure than the traditional energy efficiency index. Figure 4 shows the relevant survey data of enterprises' understanding and importance of green energy efficiency.




**(a)** Degree of understanding **(b)** Degree of attention

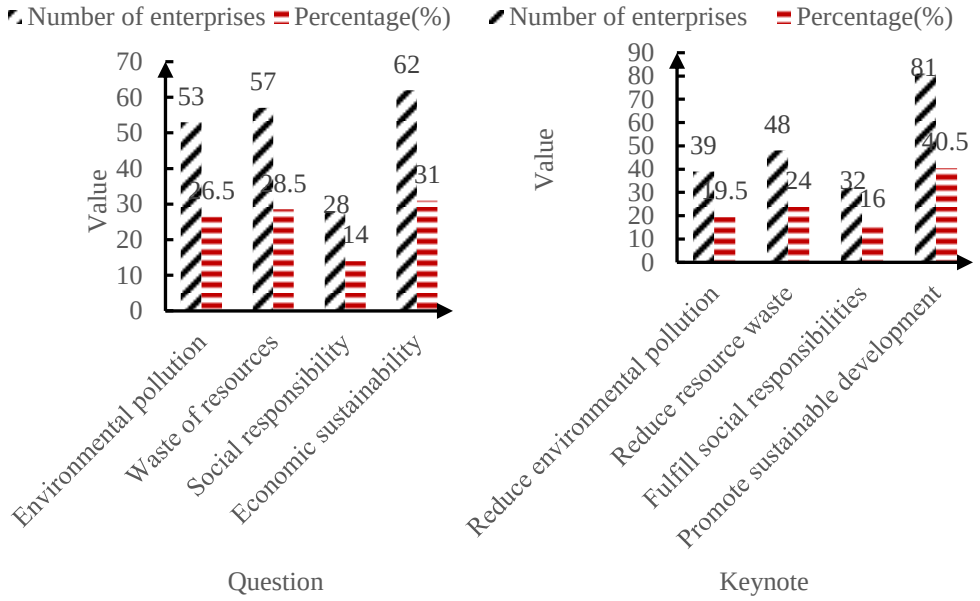
*Figure 4. Current enterprises' understanding and importance of green energy efficiency*

According to Figure 4 (a), at present, 12 enterprises were very familiar with green energy efficiency, accounting for 6.00%; there were 38 enterprises that knew more about green energy efficiency, accounting for 19.00%; 75 enterprises had a little understanding of green energy efficiency, accounting for 37.50%; 56 enterprises did not know much about green energy efficiency, accounting for 28.00%; 19 enterprises had no knowledge of green energy efficiency, accounting for 9.50%.

According to Figure 4 (b), at present, 11 enterprises attached great importance to green energy efficiency, accounting for 5.50%; there were 36 enterprises that paid more attention to green energy efficiency, accounting for 18.00%; 61 enterprises generally attached importance to green energy efficiency, accounting for 30.50%; 71 enterprises paid little attention to green energy efficiency, accounting for 35.5%; there were 21 enterprises that paid no attention to green energy efficiency, accounting for 10.50%. It can be seen from the data in Figure 4 that most enterprises did not know enough about and attach importance to green energy efficiency at present.

At present, the main problems faced by enterprises are environmental pollution, resource waste, social responsibility, and sustainable economic development. The solution to these problems is that enterprises should take measures to reduce environmental pollution, such as using renewable energy, reducing exhaust emissions and garbage emissions. Enterprises should reduce the consumption of resources by using energy-saving technologies, using recyclable raw materials and reducing the generation of garbage. In this process, enterprises should actively assume their social responsibilities, such as sponsoring public welfare undertakings, social development, and social welfare. In order to achieve sustainable economic development, enterprises must invest in new technologies to improve production efficiency and product quality. The implementation of the SD strategy should be carried out from the three aspects of environment, society and economy, and the corresponding countermeasures are put forward on this basis. The implementation of SD of enterprises requires a positive attitude and behavior. Enterprises should take effective measures and continue to improve, so as to maintain the trend of SD.

Figure 5 shows the problems faced by enterprises in SD and the key points to be solved.




**(a)** Question **(b)** Key points to be solved

*Figure 5. Problems faced by enterprises in SD and key points to be solved*

According to Figure 5 (a), 53 enterprises believed that the problem facing SD of enterprises was environmental pollution, accounting for 26.50%; 57 enterprises considered it a waste of resources, accounting for 28.50%; 28 enterprises considered social responsibility, accounting for 14.00%; there were 62 enterprises that considered economic sustainability, accounting for 31.00%.

According to Figure 5 (b), 39 enterprises believed that the focus of solution was to reduce environmental pollution, accounting for 19.50%; there were 48 enterprises that thought it was to reduce resource waste, accounting for 24.00%; 32 enterprises believed that they were fulfilling their social responsibilities, accounting for 16.00%; there were 81 enterprises believed that they were promoting sustainable economic development, accounting for 40.50%.

Energy management refers to the rational planning and use of industrial production enterprises in the process of expanding production, so as to achieve the purpose of reducing energy consumption per unit product, improving economic efficiency, and realizing information management and control. By using various methods, the enterprise managers can accurately grasp the proportion and development trend of the enterprise's energy costs, and allocate the energy consumption planning and tasks of the enterprise to each production unit and workshop, which makes the saving work more targeted, thus promoting the healthy and stable development of the enterprise.

Table 1 shows the relevant survey data of enterprises' means of energy management at present.

*Table 1. Means of energy management*

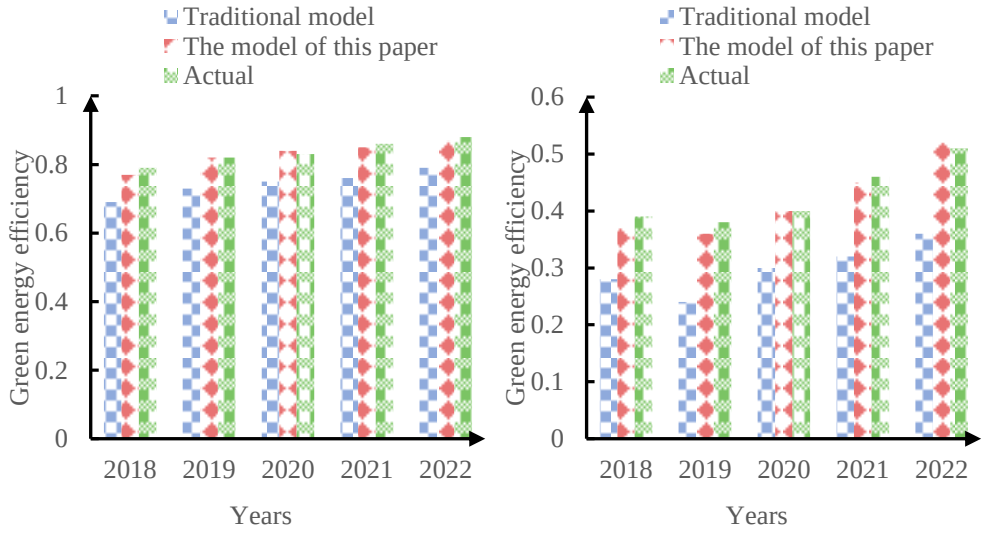
| Means of energy management | Number of enterprises | Percentage |
|---|---|---|
| Energy plan | 36 | 18.00% |
| Energy monitoring | 47 | 23.50% |
| Energy statistics | 40 | 20.00% |
| Energy consumption analysis | 53 | 26.50% |
| Energy metering equipment management | 21 | 10.50% |
| Other | 3 | 1.50% |

According to Table 1, 36 enterprises would use energy plans for energy management, accounting for 18.00%; 47 enterprises would use energy monitoring for management, accounting for 23.50%; 40 enterprises would use energy statistics for management, accounting for 20.00%; 53 enterprises would use energy consumption analysis for management, accounting for 26.50%; 21 enterprises would use energy metering equipment for management, accounting for 10.50%; 3 enterprises would use other means for management, accounting for 1.50%. Applying the above energy management methods to green energy efficiency management is an effective management method.

### 3.2 Evaluation of Green Energy Efficiency

In order to verify the effectiveness of the green energy efficiency evaluation model proposed in this paper, this paper selects the relevant data of enterprises X and Y in the past five years for evaluation and analysis.

Figure 6 shows the comparison and analysis of the green energy efficiency evaluation of enterprises X and Y by the traditional and the green energy efficiency evaluation model proposed in this paper.




**(a)** Enterprise X **(b)** Enterprise Y

*Figure 6. Evaluation of green energy efficiency of enterprises X and Y*

According to Figure 6 (a), the traditional green energy efficiency evaluation model and the green energy efficiency evaluation model in this paper evaluated the green energy efficiency of Enterprise X in 2018 as 0.69 and 0.77 respectively; the evaluations of green energy efficiency in 2020 were 0.75 and 0.84 respectively, and the evaluations of green energy efficiency in 2022 were 0.79 and 0.87 respectively. The actual green energy efficiency of Enterprise X in 2018 was 0.79; the green energy efficiency in 2020 was 0.83, and the green energy efficiency in 22 was 0.88.

According to Figure 6 (b), the traditional green energy efficiency evaluation model and the green energy efficiency evaluation model in this paper evaluated the green energy efficiency of Y enterprise in 2018 as 0.28 and 0.37 respectively; the evaluations of green energy efficiency in 2020 were 0.30 and 0.40 respectively, and the evaluations of green energy efficiency in 2022 were 0.36 and 0.52 respectively. The actual green energy efficiency of Enterprise Y in 2018 was 0.39; the green energy efficiency in 2020 was 0.40, and the green energy efficiency in 22 was 0.51.

The difference between the traditional green energy efficiency evaluation and the actual green energy efficiency was greater than that between the green energy efficiency evaluation and the

actual green energy efficiency in both X and Y enterprises. It can be seen that the evaluation model in this paper was more reliable.

### 3.3 Suggestions for Improving Green Energy Efficiency

This paper believed that corresponding measures can be taken from the following aspects to improve the level of green energy efficiency, as shown in Figure 7.

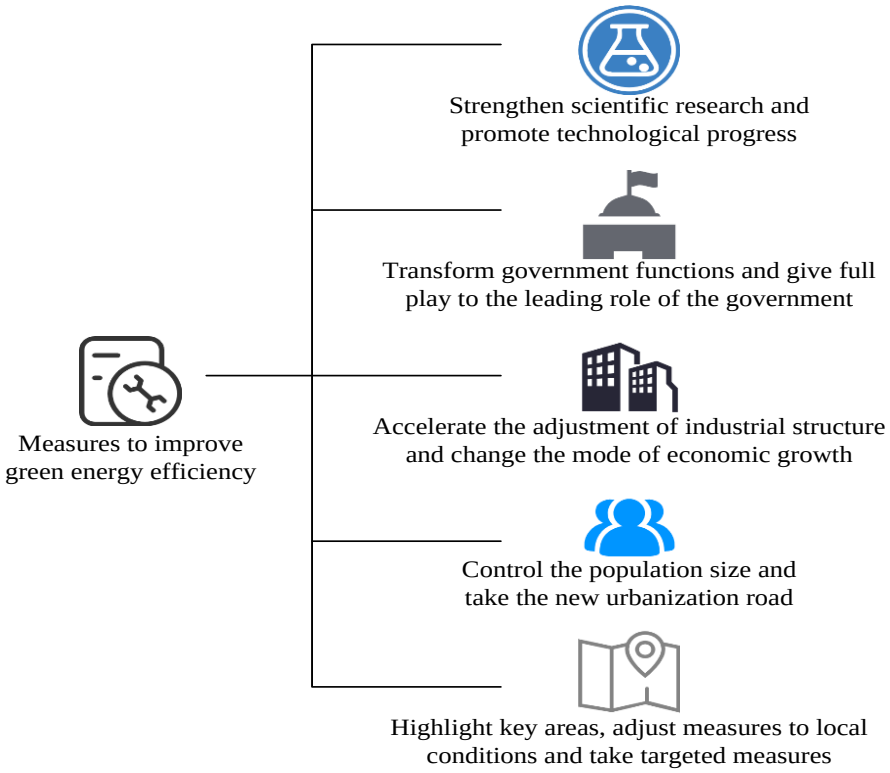



*Figure 7. Measures to improve green energy efficiency*

(1) Strengthening scientific research and promoting technological progress

First of all, the government should increase investment in scientific and technological development, and support the implementation of key research plans through financial funds, so as to promote the development of high-tech industries. At the same time, the proportion of direct scientific research investment in energy utilization technology should be increased. A special energy research fund should be set up to study key technologies in energy research and development, especially energy conservation and emission reduction technologies, application and promotion of new energy.

Secondly, in addition to the government's direct investment in scientific research, the "tripartite" linkage effect of "government - enterprise - scientific research institution" should also be brought into play. Through the cooperation of the government, enterprises and scientific research institutions, a scientific and technological research and development system integrating production, learning and research with government departments as the guide, energy-using enterprises as the main body and scientific research institutions as the support has been gradually established. Through the formation of a long-term incentive mechanism to continue to promote independent research and innovation in the energy field, the technological progress in the energy field is gradually put on the track of sound development.

Finally, it is necessary to further carry out regional scientific and technological research and

development cooperation to achieve the goal of mutual promotion. Developing regional scientific and technological research and development cooperation can promote the sharing of resources and information, which can expand the source of scientific research funds and absorb advanced technology, thus reducing the cost and risk of enterprise research and development.

(2) The transformation of government functions and the play of government's leading role

First of all, government departments should change the previous practice of promoting energy conservation and emission reduction by administrative means, and transform the functions of the government as a major economic means. The administrative means are auxiliary, which can stimulate the behavior of the market subject and transform it into the power of energy conservation and emission reduction, so as to promote its conscious energy conservation and consumption reduction and improve its energy utilization efficiency. Among the economic incentives, the most direct and effective one is the fiscal and tax support policy. Among these methods, the government should increase financial support for major energy-saving projects and energy-saving technology development projects. For those enterprises that consciously take energy-saving measures, develop new energy-saving technologies and improve energy efficiency, they should be provided with financial and tax incentives. As a result, the enthusiasm of energy-consuming units for energy conservation has been improved, and they have become the main force to promote the improvement of energy efficiency.

Secondly, for those enterprises that cannot improve energy efficiency, compulsory measures should be taken to increase the punishment. Taxes such as energy and environmental taxes can be used to increase the cost of energy use by energy users, following the practice of developed countries. As a result, the energy-using units are encouraged to adopt advanced energy-saving technologies and equipment to improve energy efficiency, thus saving costs as much as possible and reducing energy consumption.

Finally, the government should strengthen the evaluation and supervision of energy. Local government departments should carry out real-time monitoring of the energy use of key energy-consuming units, and regularly assess the energy conservation situation. Appropriate rewards should be given to enterprises that can conscientiously implement the government's energy conservation and emission reduction policies and have achieved remarkable results in energy conservation. Those enterprises whose energy consumption or pollution exceed the standard should be warned and fined. Those enterprises that waste heavily and repeatedly fail to meet the standards should be resolutely banned, so as to ensure that the government's energy conservation and emission reduction policies can be effectively implemented.

(3) The acceleration of industrial structure adjustment and the transformation of economic growth mode

To reduce energy consumption and improve the utilization of green energy, it is necessary to strengthen the adjustment of industrial structure and change the sloppy way of economic development. On the one hand, the proportion of China's tertiary industry should be increased by restructuring the tertiary industry. On the other hand, the structural adjustment of various industries must be emphasized in order to fundamentally change the way of economic growth.

The adjustment of industrial structure includes changing from the industrial structure with low added value to the industrial structure with high added value, from the industrial structure with low technological content to the industrial structure with high technological content, and from the industrial structure with high environmental pollution to the industrial structure with low environmental pollution. Through the overall optimization and upgrading of the industrial structure, the economic development mode of "low input, low consumption, low emission and high efficiency" is formed, and the potential of promoting the improvement of green energy efficiency is excavated from the industrial structure.

(4) Population size control and new urbanization road

In terms of population development, a set of scientific and reasonable SD strategies should be developed to achieve the harmonious development of people, energy and environment. First of all, one-child policy should be implemented for a longer period of time and the population size should be kept stable continuously. By reducing the natural growth rate of the population, it would alleviate the huge pressure from the current overpopulation in terms of energy and environment. Second, the focus should be on improving the quality of the population, which means increasing the cultural quality of the province. This requires increasing investment in education and promoting changes in the education system. By mobilizing various resources to improve the quality of science, technology and culture, it is necessary to shift from a quantity-based development model to a quality-based development model.

The quality of urbanization development should be continuously improved. In the process of pursuing the speed of urbanization, it is necessary to continuously strengthen the infrastructure of the city and make intensive and effective use of the city's resources. By improving the quality of urban environment, the speed and quality of urbanization can be improved.

(5) Highlighting of key areas and local adaptation of targeted measures

There are great differences in economic development, environmental quality and energy endowment conditions among cities and regions. Therefore, there are also significant differences in green energy efficiency and energy conservation potential. Therefore, if there are obvious differences in the level of economic development between different regions, the scope of application of the same energy conservation and emission reduction policies in different regions would also vary greatly. In the process of promoting energy conservation and emission reduction and improving the level of green energy utilization, the "one size fits all" approach should be avoided, and the economic development level, energy conservation and emission reduction capacity, energy conservation potential and regional characteristics of each city should be fully considered. According to the principle of "urgency, urgency and urgency", key areas for energy conservation and emission reduction should be established, and priority should be given to areas with strong energy conservation and emission reduction potential. In combination with the specific conditions of each region, targeted measures are formulated to promote the overall level of green energy utilization in each city by region, key points and measures, and to achieve the overall improvement of green energy utilization efficiency.

## 4. Conclusions

In order to achieve the improvement of production efficiency, the reduction of pollution emission of energy consumption in the production process, and the realization of resource saving, a complete enterprise green energy efficiency management system should be established. In the process of production, enterprises must strengthen the monitoring and management of energy utilization in all links. It is necessary to master the energy utilization of each link and take effective measures to control energy consumption, so as to improve energy utilization efficiency. Meanwhile, relevant laws and regulations, incentive policies and environmental management measures should be formulated and improved, thus building a green energy efficiency management system for enterprises. Due to the constraints of time, ability, objective factors and other factors, this paper still has many deficiencies, which need to be improved in future research. In the selection of influencing factors, due to the lack of effective data, this paper did not fully consider the impact of energy consumption cost and energy consumption structure on green energy efficiency, nor did it find effective indicators that can directly measure the impact of policies on energy efficiency.

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## References

[1] Tien Nguyen Hoang. "Green entrepreneurship understanding in Vietnam." International Journal of Entrepreneurship 24.2 (2020): 1-14.

[2] Yi Gaofeng. "From green entrepreneurial intentions to green entrepreneurial behaviors: the role of university entrepreneurial support and external institutional support." International Entrepreneurship and Management Journal 17.2 (2021): 963-979.

[3] Anthony Jr Bokolo, Mazlina Abdul Majid, and Awanis Romli. "A collaborative agent based green IS practice assessment tool for environmental sustainability attainment in enterprise data centers." Journal of Enterprise Information Management 31.5 (2018): 771-795.

[4] Stecula Kinga. "Decision-making dilemmas in mining enterprise and environmental issues, ie green thinking in mining." International Multidisciplinary Scientific GeoConference: SGEM 18.6.4 (2018): 357-364.

[5] Raharjo Kusdi. "The role of green management in creating sustainability performance on the small and medium enterprises." Management of Environmental Quality: An International Journal 30.3 (2019): 557-577.

[6] Geng Yong, Joseph Sarkis, and Raimund Bleischwitz. "How to globalize the circular economy." Nature 565.7738 (2019): 153-155.

[7] Keijer Tom, Vincent Bakker, and J. Chris Slootweg. "Circular chemistry to enable a circular economy." Nature chemistry 11.3 (2019): 190-195.

[8] Barreiro‐Gen, Maria, and Rodrigo Lozano. "How circular is the circular economy? Analysing the implementation of circular economy in organisations." Business Strategy and the Environment 29.8 (2020): 3484-3494.

[9] Geisendorf Sylvie, and Felicitas Pietrulla. "The circular economy and circular economic concepts—a literature analysis and redefinition." Thunderbird International Business Review 60.5 (2018): 771-782.

[10] Schroeder Patrick, Kartika Anggraeni, and Uwe Weber. "The relevance of circular economy practices to the sustainable development goals." Journal of Industrial Ecology 23.1 (2019): 77-95.

[11] Esposito, Mark, Terence Tse, and Khaled Soufani. "Introducing a circular economy: New thinking with new managerial and policy implications." California Management Review 60.3 (2018): 5-19.

[12] De Angelis Roberta, Mickey Howard, and Joe Miemczyk. "Supply chain management and the circular economy: towards the circular supply chain." Production Planning & Control 29.6 (2018): 425-437.

[13] Bressanelli Gianmarco, Marco Perona, and Nicola Saccani. "Challenges in supply chain redesign for the Circular Economy: a literature review and a multiple case study." International Journal of Production Research 57.23 (2019): 7395-7422.

[14] Malik Ranbir Singh. "Educational challenges in 21st century and sustainable development." Journal of Sustainable Development Education and Research 2.1 (2018): 9-20.

[15] Wang Xiaoming, Shi-Wei Liu, and Jing-Lin Zhang. "A new look at roles of the cryosphere in sustainable development." Advances in Climate Change Research 10.2 (2019): 124-131.

[16] Sharpley Richard. "Tourism, sustainable development and the theoretical divide: 20 years on." Journal of sustainable tourism 28.11 (2020): 1932-1946.