Evaluation Method and Practical Application Research of Green Building Energy-saving Design Scheme

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Abstract: In order to achieve sustainable development of the construction industry, green building has become a major development direction in architectural design. At the same time, in order to ensure that the green building design can achieve the desired energy-saving effect, it is necessary to adopt a scientific evaluation method to comprehensively analyze and evaluate the green energy-saving design. The fundamental purpose of green building energy-saving design and evaluation of its design scheme is to be applied in the construction project. Therefore, it is necessary to fully understand the evaluation methods and evaluation criteria of green building energy-saving design, and also apply these methods to engineering. The design and construction of the project will promote the development of China's construction industry towards green and low carbon.

1. Introduction
The construction industry is a traditional resource-consumption industry. With the intensification of environmental protection issues and the determination of the national green low-carbon development guidelines, the construction industry must also carry out industrial upgrading and transformation, which requires the integration of green energy-saving concepts in architectural design. To improve the energy-saving effect of construction projects, we can achieve the development goals of green buildings. At the same time, in order to ensure that the green building design can truly achieve its expected energy-saving goals, it is necessary to conduct a scientific evaluation and analysis of the energy-saving design. When evaluating the green energy-saving design plan, it is necessary to scientifically select the evaluation plan according to the actual situation of the project and the energy-saving goal, reasonably determine the evaluation index, and comprehensively evaluate the energy-saving design plan to promote the continuous improvement and optimization of the energy-saving design plan. This will create favorable conditions for the construction industry to achieve sustainable development.

2. Analysis of Methods for Evaluating Green Energy-Saving Design Schemes for Buildings
2.1. Scientifically Determine Evaluation Indicators
When evaluating the green energy-saving design plan of a construction project, the corresponding evaluation method should be determined according to its index system. At the same time, because the qualitative and quantitative indicators are included in the evaluation system, and the measurement standards of different indicators are not consistent, it is necessary to quantify the evaluation indicators through mathematical methods such as fuzzy functions to improve the objectivity and accuracy of qualitative analysis.
2.1.1. Scientifically Develop Indicator Evaluation Criteria

When evaluating the utilization rate of underground space of a construction project, the degree of achievement of the number of machine rooms, laboratory and underground parking should be used as the basis for scoring. When evaluating the open space, the public space and the setting of the overhead floor should be comprehensively analyzed as the evaluation criteria. For the greening design evaluation index of the project, the greening rate should be used as the evaluation standard. When the greening rate reaches 50% or more, it should be rated as excellent, a 30% greening rate can be evaluated as medium, and if the greening rate is above 10%, then it should be evaluated as inferior. When evaluating the project's renewable energy design, the application of technologies such as passive lighting in the program will have an important impact on the score [1]. In the evaluation of energy-saving design of building walls, when the heat transfer coefficient of the external wall exceeds 1W (m2·k), it should be rated as inferior, and when the heat transfer coefficient is within 0.61W (m2·k), it should be evaluated as superior.

When evaluating the green energy-saving design of the door and window department, when the airtightness of the door and window reaches 5, and the heat transfer coefficient of the outer window department does not exceed 2W (m2·k), it should be rated as superior. If the heat transfer coefficient of Class 1 or the external window exceeds 3.5 W (m2·k) and the airtightness of the square door and the window, it should be evaluated as inferior. When evaluating the green energy-saving design of the building roof system, the heat transfer coefficient should be rated as inferior when it exceeds 0.7w (m2·k), and when the heat transfer coefficient is controlled at 0.5W (m2·k), it should be evaluated.

The grade of the energy-saving design evaluation of the shading system of the construction project should be based on the shading coefficient. When the value exceeds 0.83, it is inferior, and when it is within 0.4, it is superior. When evaluating the energy-saving design scheme of the distribution lighting system, it is mainly based on the ratio between the energy consumption of the energy-saving equipment and the energy consumption of the general lighting equipment. When the ratio exceeds 70%, it should be rated as excellent, and if it is not reach to 20%, it should be rated as inferior If the heating efficiency of the air conditioning system is below 85%, it should be evaluated as inferior. Other green energy-saving design schemes such as water-saving system design, application of energy-saving materials, and application of intelligent energy-saving control equipment should be comprehensively evaluated and analyzed according to their corresponding evaluation index standards.

2.2. Scientifically Develop Indicator Ambiguity

In addition, mathematical methods should be used to determine the extent criteria for the evaluation indicators. Generally, it can be expressed as an interval real between 0 and 1, which is fully consistent with the representation of 1, and non-conformance with 0 [2]. The fuzzy indicators mainly include the actual membership degree, the reverse index and the moderate index of the indicator value.

2.3. Comprehensive Analysis and Evaluation of Green Energy-saving Design Schemes for Construction Projects

2.3.1. Comprehensive Evaluation and Analysis of Green Energy-saving Design Schemes

After the completion of the index quantification and the determination of the index weights, the weighting function can be used to comprehensively evaluate the energy-saving design scheme. First, the ambiguity of each indicator should be multiplied by 100 as the evaluation result, which is in line with the general counting habits. Its calculation formula is i(X)=I(X)×100[3]. According to the corresponding formula, the scores of each sub-item, classification and comprehensive index are calculated. At the same time, in the comprehensive evaluation of the building's green energy-saving design plan, it should also be based on the specific circumstances to reasonably choose the evaluation indicators, and through the proportional conversion or the final comprehensive score results. The evaluation level of the green energy-saving design scheme of the construction project can be seen in Table 1.
Table 1: Comprehensive evaluation level of green building energy-saving design scheme

| Indicator Score | Evaluation Level |
|-----------------|------------------|
| 0-60            | Failed           |
| 60-70           | Qualified        |
| 70-80           | Medium           |
| 80-90           | Good             |
| 90-100          | Excellent        |

2.3.2. Analysis of Basic Evaluation Contents of Green Building Energy Saving Design Scheme
When evaluating the green energy-saving design plan of the construction project, the selection criteria should be selected according to the basic objectives of the evaluation, and the main content of the evaluation should be determined according to the actual situation, the corresponding evaluation plan should be selected reasonably, the construction of the evaluation index system should be completed. Different evaluation objectives will have an important impact on the specific content and method of evaluation. At present, the evaluation mainly includes the expert evaluation method such as Delphi, the index formula method for technical and economic evaluation of the design scheme, the method of each yield rate, the cost analysis method and the net present value method. In addition, fuzzy matrix, network map and AHP can be used to perform comprehensive scoring [4]. Among them, the evaluation of energy-saving technology is mainly to comprehensively analyze the practical effects of energy-saving technology in terms of resource conservation, pollution prevention and control, application cost and technical feasibility. We should comprehensively consider the technological advancement of energy-saving design schemes, the realization of social and environmental benefits, and economic indicators.

3. Practical Application Research and Construction of Green Building Energy-saving Design Scheme Evaluation

3.1. Outline the Basic Situation of A Construction Project
A construction project is a multi-functional building that integrates academic research, experimentation, office and life. The total construction area is about 18,000 m², including 12 floors above ground and 2 floors. The area where the building is located has a mild climate, abundant sunshine and abundant rainfall. Green energy-saving design was carried out in conjunction with the city's development plan and the building's function.

3.2. Main Content of Green Energy-saving Design Plan for Construction Projects

3.2.1. Building Land Saving and Outdoor Environment Green Design
The construction site was originally a long-term abandoned quarry, which was used as a construction land to improve the utilization of land resources. At the same time, the first-floor overhead design was adopted in the design, which made the area a public open green space. At the same time, the greening design was carried out on the sixth floor of the building's upper part and the roof part of the building. In addition, the building uses a basement to carry out a three-dimensional parking space design, which realizes the full use of the building space.

3.2.2. Energy-saving Design of Construction Engineering
In the building energy-saving design, according to the simulation calculation, the energy-saving rate reached about 71%. Among them, the building's envelope structure adopts energy-saving doors and windows and insulation walls. At the same time, the energy-saving effect of the envelope structure is
improved by the rational use of green vegetation and the influence of new technologies such as external shading [5]. Depending on the function of the building, different forms of hot water systems are used and solar energy is used as a heating source. The different photovoltaic power generation systems used in the green energy-saving design of the construction project, combined with the application of the breeze-started wind power generation equipment, make full use of renewable clean energy as building energy. In the design of building air conditioning systems, the comprehensive use of different air conditioning methods to meet the diversified needs of different rooms in terms of use time and function. In addition, the energy-saving design method is fully utilized to improve the natural ventilation rate of the building.

3.2.3. Water Saving Design for Construction Projects
In this construction project, the centralized sewage collection and treatment system design was adopted to make full use of the medium water for green irrigation, and it was used as air conditioning cooling water and sanitary cleaning water and so on. Besides, its water saving rate reached about 44%, and the water saving appliance usage rate has achieved 100%.

3.3. Practical Application of Green Energy-saving Design Evaluation Method in Construction Projects

3.3.1. Quantitative Evaluation of Various Indicators of Energy-saving Design Schemes
When evaluating the greening and energy-saving design plan of the building project, the evaluation indicators were first quantified by means of expert surveys, and the corresponding scoring results were obtained. The underground space utilization rate was evaluated as 80 points, and the grade evaluation was good. When evaluating the greening and energy-saving effect of the open space, by calculated the \( \frac{45\% - 30\%}{50\% - 30\%} \times 100 = 75 \), and the greening rate index is calculated and evaluated by \( \frac{48\% - 30\%}{50\% - 30\%} \times 100 = 90 \). The building's renewable energy utilization system design scored 85 points. Since the exterior wall of the building is made of mixed mortar, sintered porous brick, expanded thermal insulation mortar and anti-cracking mortar, the heat transfer coefficient is about 0.94 W/(m²·K), and the evaluation is 15 points. The door and window parts of the building were tested to determine that the air tightness of the doors and windows reached 6 levels, and the overall evaluation was 86 points, so it was rated as excellent. In the calculation and evaluation of the energy-saving design of the building roofing system, the quality performance parameters of each construction material were comprehensively analyzed and the heat transfer coefficient was calculated to determine that the heat transfer coefficient reached 0.63W (m²·K), so according to the calculation formula Its evaluation index score is 35 points. Since the shading parameter of the building project reached about 0.42, the \( \frac{0.55 - 0.42}{0.55 - 0.4} \times 100 = 87 \) score was calculated. The building's lighting distribution system design uses energy-efficient lighting equipment with an index score of 90 and a rating of superior. After a comprehensive evaluation by experts, the energy-saving design rating of the air-conditioning system of the building project was 95 points, and the water-saving system design score reached 100 points. This was mainly due to the comprehensive use of water-saving equipment in the building. In addition, the other evaluation indicators were comprehensively scored and the corresponding scores were obtained.

3.3.2. Comprehensive Evaluation of Green Energy-saving Design
Combined with the quantitative index evaluation scores and weights of the green energy-saving design scheme of the construction project, the classification indicators were calculated and analyzed, which were 81.25 points, 64.72 points, 88.06 points and 74.27 points respectively, and the final score of the
indicators was 88.45. According to the results of the scoring, the green energy-saving design scheme of the building project is rated as good, so there is still room for optimization and improvement.

3.3.3. Analyze the Evaluation Results of Green Energy-Saving Design Schemes
According to the evaluation results of the green energy-saving design scheme of the construction project, it has achieved good results in outdoor greening and saving construction land, and at the same time, the energy-saving effect in the application of energy-saving materials and water-saving design is also ideal, but there are still shortcomings in the full utilization of new energy. In this design scheme, the consumption of electric energy cannot be controlled within the scope of energy-saving design requirements. At the same time, the design of the envelope structure of the building project also has a problem that the heat transfer coefficient is generally high, which leads to a large energy consumption of the building project during use.

3.4. Optimize Energy-saving Design Based on Evaluation Results
Therefore, in the design and construction of the construction project, the application of green energy-saving technology should be increased, and the existing design scheme should be optimized and improved according to the comprehensive evaluation results of the design scheme. The design language should actively learn from the successful green energy-saving design cases at home and abroad, and actively understand the new energy-saving materials technology, and improve the design of the envelope structure of the building project according to the actual situation of the project to improve its energy-saving effect. At the same time, it should also strengthen the property management and user communication and coordination according to the evaluation structure, improve the property management level, enhance the user's awareness of environmental protection and energy conservation, and thus reduce the energy consumption of the building during operation. In addition, the designer should further optimize the greening layout of the building project. On the basis of planting green plants, it is also possible to design small bonsai on the terrace and balcony of the building, or use the vines to green the building façade. Which not only improves the building, shading greening effect, but also can improve the microclimate environment of the building area.

4. Conclusion
Green building has become one of the main directions for the development of China's construction industry. Therefore, in the stage of architectural design, we must actively integrate the concept of green energy conservation, and actively apply advanced green energy-saving design methods and technical materials to improve the energy-saving effect of construction projects. At the same time, the green Jean design plan should be scientifically evaluated and analyzed. Through the quantitative analysis of various index parameters, the energy-saving effect of the green energy-saving design plan can be comprehensively evaluated, and the inadequacies in the design plan can be accurately found. The optimization and improvement of the program provides scientific guidance. In addition, we should strengthen the promotion and application of green energy-saving design and evaluation methods in the design and construction practice of construction projects, and promote the transformation and upgrading of the construction industry in China.

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