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Ecological Architectural Design in Nature Conservation Environment Relying on Support Vector Machines

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Abstract: China is a large construction country, and the rapid growth of the construction industry is accompanied by high consumption and high emissions. The adoption of green building technology to effectively reduce building energy consumption and carbon emissions is an important measure to promote the transformation and upgrading of the construction industry and sustainable development, thus putting forward the concept of ecological architecture, and this paper studies ecological architecture in the hope of comprehensively promoting sustainable development of green and low-carbon buildings, prompting people to start reflecting on whether it is possible to address the demand for natural resources in architecture from the root without violating the ideal life. In this paper, we propose an ecological construction design scheme based on support vector machines for rural ecological buildings as an example, analyze the use of renewable energy in rural areas, and the impact of ecological buildings on rural environmental management costs and emission reductions. The results show that compared to traditional buildings, ecological buildings effectively reduce pollutant emissions and environmental management costs, and have high ecological benefits. Therefore, the use of ecological energy-saving technologies in rural areas can maintain the stability of the ecological environment.

1. Introduction

The design concept of green ecological architecture should be a holistic, comprehensive and integrated design concept, as well as a design concept that integrates with the surrounding natural environment. The designer should follow the basic principles of green ecological building design according to local conditions in building design, combine the ecological and climatic conditions of the site, natural environmental resources, economic and humanistic characteristics, etc., and carry out the building design in a holistic and comprehensive way to meet the functional requirements of users and reflect the unity of social, economic, cultural and environmental benefits of the building, so as to realize the harmonious development of architecture and nature [1, 2].

Research on energy efficiency in ecological buildings began early in China and has continued to this day. For example, some scholars point out that ecological architecture should increase the use of renewable materials, which is consistent with the national sustainable development strategy of "environment and development" and reflects the optimal state of human living environment, i.e., the gradual progress of social system, the rational use of natural resources, the scientific planning of living space and the virtuous cycle of ecological environment [3] . . Some scholars analyzed the building energy-saving measures applicable to a certain region through field research and study in three major aspects: building planning and layout design, envelope heat insulation and sun-shading design and ventilation design, and the results showed that rural houses should be planned and designed as a whole, and the building body coefficient and orientation should be designed according to the actual local conditions; improvements in heat insulation and sun-shading of building exterior walls, roofs and exterior windows need to be strengthened to reduce the energy consumption of building operation; try to adopt the principle of natural ventilation to regulate the indoor temperature of buildings, thus reducing the energy consumption of indoor air conditioning [4, 5]. Taking a village as an example, some scholars focused on the impact of the construction of a coastal wind farm on the economic development of the surrounding countryside, and found that the target requirements of economic efficiency, environmental sustainability, and security of supply can be achieved when the installation of wind and solar energy is configured in an optimal combination [6]. In summary, the development of ecological architecture has become a hot spot for research and practice.

In this paper, we first introduce the concept of eco-building and its characteristics, propose the algorithmic model of SVM, then analyze the energy use in a rural area, and discuss the eco-efficiency of five eco-building solutions in this rural area from two perspectives: ecological analysis and economic analysis. Finally, two eco-skill modification techniques are proposed to be applied to the rural eco-building design.

2. Basic Overview

2.1. Ecological Architecture

Ecological architecture is a representative green living concept that integrates architecture into the surrounding ecological environment, makes full use of local natural resources, and promotes the interplay between people, architecture, and the environment. In other words, with the idea of "unity of man and heaven" as the leading principle, the overall planning and design of the building, the construction process, the selection of building materials and the operation of the building, etc., should take the local ecological environment as the carrier and make full use of the rich local natural resources as much as possible, so as to reduce the energy consumption of building construction and operation, reduce the pollution of the surrounding environment, and realize "four sections and one environmental protection", to achieve the real sense of returning to nature and returning to the basics [7, 8]. The characteristics of ecological architecture are as follows.

(1) Systematic systemic nature of ecological architecture

Ecological architecture is a subsystem of the ecosystem, which is based on the study of people, buildings and the environment. The main task is to create a good environment for human settlement, to shelter human life from the wind and rain, and to provide a cozy living harbor. The construction process of ecological buildings should focus on reflecting the integration with nature, using the original topography and landscape as much as possible, and integrating with the surrounding ecological environment; at the same time, when choosing building materials, a large number of green and non-polluting local building materials should be used, and the completed ecological buildings should pay attention to the treatment of living waste and try to recycle and dispose of it by class classification, so as not to pollute the environment and not to destroy the integrity of the ecosystem [9, 10]. Even if the ecological building is dismantled, the waste produced can be recycled to achieve the effect of turning waste into treasure.

(2) Energy conservation of ecological buildings

The energy conservation of ecological buildings is mainly reflected in the selection of building materials and the full use of natural conditions (wind and solar energy, etc.). In terms of rational use of terrain, buildings should be far from gullies and valleys to avoid the "box hole" effect of buildings [11]; in order to strive for sunlight, it is advisable to arrange buildings on sunny lots and pay attention to the requirements of sunlight spacing; buildings should pay attention to wind avoidance to reduce heat loss; for areas with hot summers and warm winters, it is advisable to place buildings on high ground or in areas with high buildings. be constructed on the highland or with up to the side of the building, and at the same time, the place should be parallel to each other with the dominant wind direction in summer, so as to make full use of the artificial wind and avoid the blowing in of winter wind [12, 13].

2.2. Support Vector Machine

Support vector machine (SVM) is one of the more widely used mathematical models of artificial intelligence in recent years [14]. The basic principle of using SVM model for new sample prediction is to divide the sample space into two parts by a hyperplane, which should make the difference between the two parts being divided as obvious as possible, while dividing as many sample data of the same type as possible in the same space, so as to predict the probability of new samples falling in both spaces and achieve the purpose of classifying new samples [15, 16]. To improve the prediction accuracy and avoid large errors in the support vector machine model, two slack variables are introduced, so the optimization equation is.

$$\min \frac{1}{2}\|w\|^2 + C\sum_{i=1}^{l}(\xi_1 + \xi_i^*) \tag{1}$$

The constraints are:

$$\begin{aligned} &\langle w \cdot x\rangle + b - y_i \le \xi_i + \varepsilon, i = 1,2,\ldots,l \\ &y_i - \langle w \cdot x\rangle + b \le \xi_i^* + \varepsilon, i = 1,2,\ldots,l \\ &\xi_1, \xi_i^* \ge 0, i = 1,2,\ldots,l \end{aligned} \tag{2}$$

ξ_1 and ξ_i^* are the relaxation variables, C is the optimal classification surface, b is the bias, x is the input training sample, w is the mobilizable weight vector, and ε is a constant term.

In general, projecting data into a high-dimensional space is bound to cause a consequent increase in computational effort, so SVM introduces kernel functions, which use implicit kernel functions to replace the computation of inner products, and the kernel functions only calculate the results based on the size of the original input samples, so the overall computational complexity is greatly reduced as long as the kernel functions are properly chosen [17, 18].SVMs have also been widely SVM is also widely recognized and applied to many fields.

3. A Rural Eco-Building Situation

3.1. Analysis of Rural Energy Use

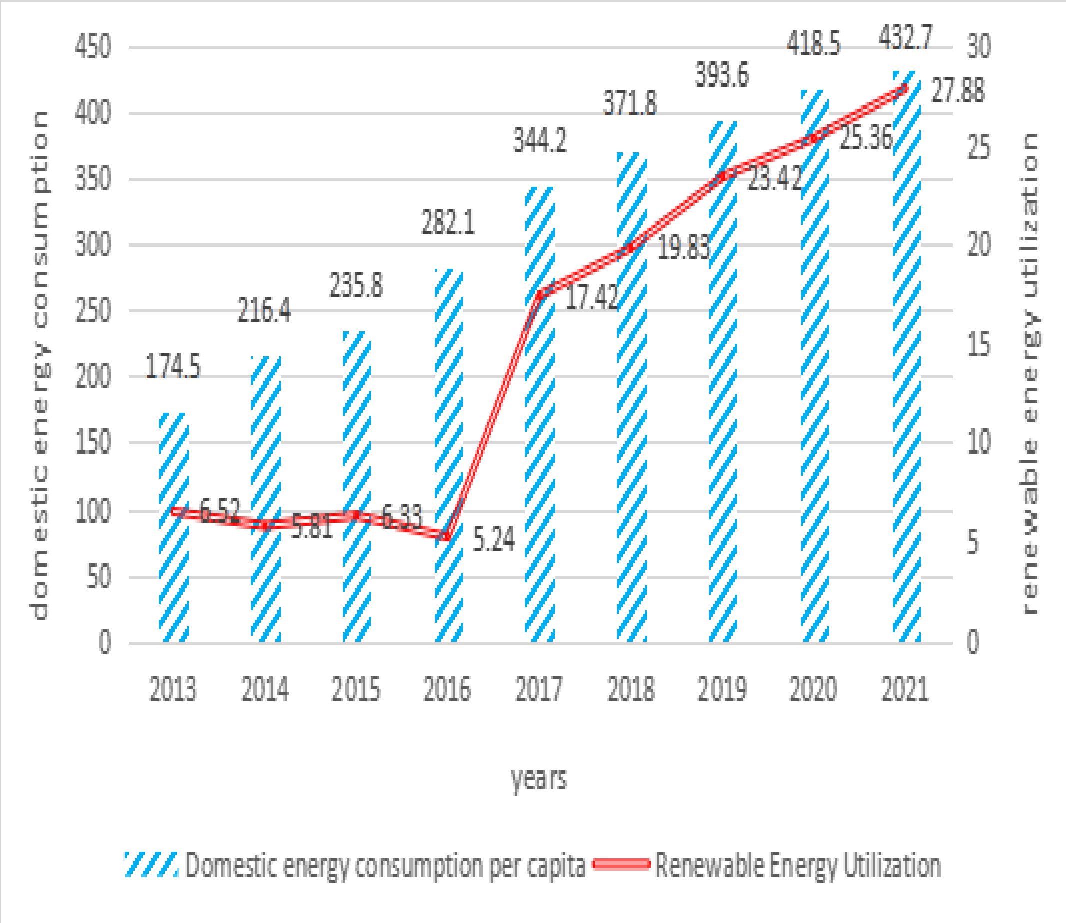

Figure 1. Per capita domestic energy consumption and renewable energy use

The basic situation of energy use in rural areas was obtained by compiling data related to the energy consumption situation of buildings by the rural farmers. As shown in Figure 1, the annual per capita domestic energy consumption in this rural area has been increasing, while the utilization of renewable energy has also increased rapidly in recent years. Since 2017, the rural area has emphasized the use of renewable energy, and its utilization rate has increased sharply and will show a steady increase in the future, but at present, it is still far from the requirements of the development target plan in the whole, and it still needs to continue to strengthen the use of renewable energy.

3.2. Analysis of Ecological Architectural Design under the Environment of Nature Conservation

For the five ecological building schemes adopted in this rural area, the ecological benefits of each scheme are analyzed, and the results are as follows.

(1) Ecological analysis

Table 1. Emission reduction and eco-efficiency of each eco-building scheme

	Option 1	Option 2	Option 3	Option 4	Option 5
Annual energy savings	51.32	54.17	52.68	50.74	52.45
CO_2 emission reduction	45.83	47.27	46.31	41.54	42.29
SO_2 emission reduction	2.41	2.38	2.66	2.53	2.42
NO_x emission reduction	1.07	1.24	1.15	0.95	0.91
Ecological benefits	42.56	47.35	46.21	44.78	43.46

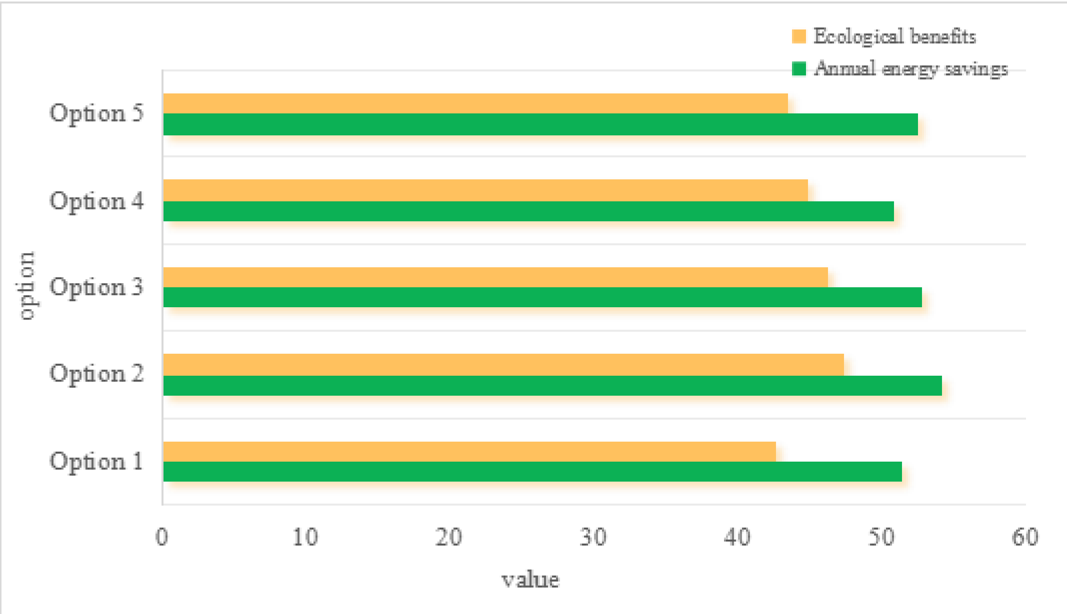

Figure 2. Comparison of ecological results

From Table 1 and Figure 2, it can be seen that Option 2 has the most obvious energy saving effect with the most significant emission reduction and ecological benefits, and Option 3 is the second most effective. The annual energy savings of scenarios 1-5 are 51.32kg/m^2 a, 54.17kg/m^2 a, 52.68kg/m^2 a, 50.74kg/m^2 a, 52.45kg/m^2 a, and the ecological benefits are 42.56kg/m^2 a, 47.35kg/m^2 a, 46.21kg/m^2 a, 44.78kg/m^2 a, 43.46kg/m^2 a. If the per capita floor area is 40m^2/person, the annual CO_2 reduction per capita for each scenario is 1.146t CO_2 for scenario 1; 1.182t CO_2 for scenario 2; 1.158t CO_2 for scenario 3; 1.039t CO_2 for scenario 4; and 1.057t CO_2 for scenario 5. It also shows that Improving the heat insulation and shading performance of rural buildings and making full use of renewable energy can not only reduce the use of conventional energy, but also effectively reduce the carbon emission and pollutant emission during the operation of buildings, and reduce part of the ecological environment management costs.

(2) Economic analysis

Although the initial investment and construction cost of the solar thermal photothermal technology, waste incineration and power generation technology, straw processing technology and manure centralized energy utilization technology used in the rural ecological building system program is high, its environmental benefits are significant and can largely reduce the costs required for environmental remediation (such as garbage cleaning fees, straw processing fees, manure emptying fees, etc.), and with the strong support of the state in terms of policy and related The proposed renewable energy utilization technology can meet the requirements of the economic development level of most rural areas; the use of assembly building technology to build ecological buildings, although its construction costs are slightly higher than traditional cast-in-place buildings, but its construction process produces less construction waste, noise, dust and other pollution, ecological benefits are significant; the choice of ecological and new energy-saving building materials as the building envelope structure materials and custom-made prefabricated energy-saving components in the factory, although the material cost is slightly higher than that of traditional rural building materials, the annual building energy consumption of each ecological building system scheme is lower, the annual operating cost of the building is low, the return on investment is high, and the ecological benefits are obvious. The economics of the options were analyzed for comparison as shown in Table 2.

Table 2. Comparison of the economics of each scheme

		Construction Phase Costs		Operation Phase Costs	
		Construction and safety costs	Increased cost of environmental management	Operation electricity cost	Emission reduction and incremental costs
Option 1	Traditional Architecture	1100-1450	42.58-47.13	36.71	38.69
	Ecological Architecture	1400-1600	/	12.56	/
Option 2	Traditional Architecture	850-1200	42.34-47.62	35.43	36.72
	Ecological Architecture	1200-1500	/	11.13	/
Option 3	Traditional Architecture	900-1250	43.24-47.93	31.28	33.47
	Ecological Architecture	1300-1600	/	8.45	/
Option 4	Traditional Architecture	1000-1350	41.57-45.84	34.62	37.94
	Ecological Architecture	1150-1550	/	9.79	/
Option 5	Traditional Architecture	1050-1400	42.16-46.37	32.65	38.72
	Ecological Architecture	1300-1700	/	10.81	/

As can be seen in Table 2, although the construction cost of each eco-building option is higher than its conventional counterpart, its operation cost is low and its ecological benefits are good. eco-building has no incremental cost of environmental management in the construction phase and no incremental cost of emission reduction in the operation phase. The promotion of eco-buildings in rural areas is beneficial to environmental protection.

4. Application of Ecological Energy-Saving Renovation Technology for the Building Body

4.1. Ecological Planning and Layout Technology

The planning layout form of the building has obvious influence on the wind environment and thermal environment of the area where the building is located, which will affect the comfort of pedestrians. For example, when there is strong incoming wind outside the building, it is easy to make pedestrians in the building area feel uncomfortable and even cause certain injuries. When the outdoor thermal environment of the building is poor, it will produce "heat island effect" and increase the energy consumption of indoor air conditioning. At the same time, the outdoor wind environment will also affect the indoor ventilation, thus having a certain impact on the building energy consumption, such as natural ventilation measures in summer can reduce indoor air conditioning energy consumption, and windproof energy-saving measures in winter can reduce indoor heating energy consumption. Therefore, reasonable planning and layout of buildings is the key to improve the thermal comfort environment of human living, which should be integrated into the local ecosystem, planting green vegetation as much as possible to regulate the microclimate around the buildings, and planning and laying out the buildings as a whole according to the leading principle of "neat and uniform, according to local conditions", i.e., according to the topographical features of the village, the buildings should be arranged neatly and symmetrically along the axis. The buildings are arranged neatly and symmetrically along the axis according to the topographic features of the village, and the building spacing is controlled to be about 12m, and green plants are planted in the building area as much as possible to achieve the purpose of energy saving, environmental protection and health comfort.

4.2. Biomass Energy Utilization Technology

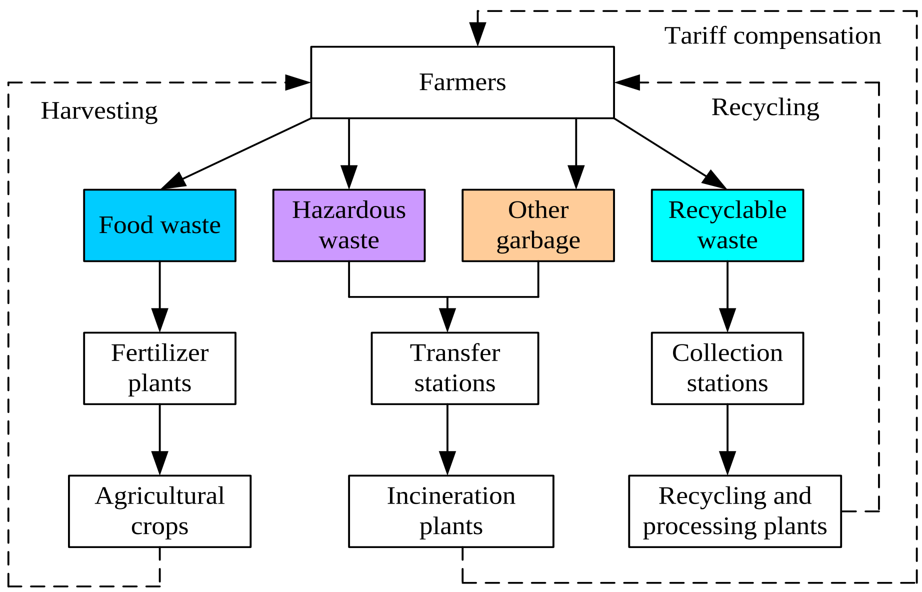

Figure 3. Domestic waste treatment model

The treatment mode of rural domestic waste is shown in Figure 3. In rural areas, it is not suitable to build waste incineration plants in villages due to the limitation of insufficient facilities, imperfect professional treatment institutions and inconvenient transportation. Therefore, the relevant departments should strengthen the mechanism of collecting and transferring domestic waste in rural areas, advocate the civilized consciousness of "separating garbage and not wasting resources", advocate farmers to put domestic waste into garbage collection stations, and transfer hazardous waste and other garbage from the collection stations to urban garbage incineration power plants for incineration on a regular basis. After that, we will install electricity compensation meters for waste incineration and power generation in rural households and give them a certain amount of electricity compensation according to the amount of waste provided by each household, so as to increase the motivation of farmers to put out waste in a separate manner. Food waste and recyclable waste from domestic waste are transported to fertilizer plants for fertilizer production and collection stations for processing and utilization, in order to improve the harvest of crop products and promote the recycling of resources.

5. Conclusion

From the research point of view, there is a lack of relatively comprehensive exchange and discussion between China and foreign research topics on green ecological design of buildings, and most designers only complete their own understanding of the concept of green ecological architecture through superficial cognition, without forming a set of theoretical strategy system in line with the characteristics of our own national conditions. Therefore, Chinese architects and related practitioners have the responsibility to make a comprehensive and systematic research and cognition of the concept of green ecological building design based on the actual national conditions in China, to vigorously promote the connotation of the concept of green ecological building, to propose design strategies and measures to promote resource conservation and coordination with the surrounding environment, and to actively use advanced green ecological concepts and some geographically Green ecological technology measures that are suitable for the region.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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