Talking about the Building Energy-saving Design Ideas and Applications in Green Buildings

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Abstract. In many countries or regions today, the rapid social and economic development is often based on the large consumption of various types of resources and energy. In the end, the ecological environment within the region will therefore be damaged and polluted to varying degrees. With the continuous improvement and enhancement of environmental protection awareness in different industries in various countries around the world, in order to keep up with the development process and get rid of the current objective situation of excessive energy consumption, it is necessary to achieve reduction by creating green buildings and actively implementing energy-saving design. Based on the analysis of the basic concepts and design principles of green buildings and energy-saving design, this paper puts forward the key points of green building energy-saving design and analyzes and interprets the actual cases in order to look forward to the further development of green buildings.

1. Background and characteristics of green building development

With the acceleration of the process of urbanization in China and the rapid development of domestic construction and related industries, problems such as irrational use of resources and waste of materials have occurred in some areas, which has eventually led to environmental pollution and damage. According to statistics from relevant departments, the energy consumption of buildings in China accounts for about 25% of the total energy consumption [1]. High-energy-consumption buildings are common, and the energy consumption of buildings has increased significantly. In the face of the energy crisis and environmental pollution, the concept of “sustainable development” came into being. This concept was translated into the green building concept in the construction field, which is the energy-saving, low-carbon, environmentally-friendly, and New home.

In the design of residential buildings, green buildings have high requirements on building spacing, layout of units, daylight and heat insulation, and their design concepts are characterized by energy saving, environmental protection and ecological livability. Its design purpose is also to provide residents with more comfortable and ecological living conditions, promote the ecological construction of buildings, increase the urban green coverage rate, maximize resource and energy conservation, and achieve energy conservation, land, water, and material savings. Promoting the development of green building design concepts and improving the environmental protection of building energy-saving design are of great significance to the national sustainable development strategy.

In the actual project of green building energy-saving design, it is usually necessary to minimize the energy consumption of the building according to the actual needs of the indoor and outdoor environment of the building, according to technology and design concepts, reduce unnecessary load on the environment, and create a safe, healthy, Comfortable and good living space promotes the
harmonious and sustainable development of people and society. Inquiring into issues related to green building and building energy-saving design can make the building energy-saving design concept better applied to the process of green building construction.

2. Green building design-return to nature and sustainable development

In the past, the core of buildings in the design process was “people-oriented”, and one-sided pursuit of human needs and comfort. Only the factors of building quality, construction cost, and engineering time are considered when designing. This “idealistic” architectural concept is based on sacrificing the external environment and will be banned. The modern green building design concept breaks through the traditional concept, pursues the sustainable development goal of energy conservation and environmental protection, and proposes the concept of “ecological balance and environmental protection” in the new era, which has an effect on nature and also affects human behavior to a certain extent.

2.1. Goals of green building design

In the process of green building design, we must first set environmental goals. It must be able to save energy, improve the efficiency of using resources, reduce the use of traditional resources as much as possible, control the interference to the environment to a certain extent, and realize the coordinated development of man and nature; in addition, certain economic goals must be achieved. Without economics, all construction will become empty talk. It is necessary to constantly coordinate the contradiction between the economics of the building and environmental protection. Third, we must pursue the social goals of the building. In order to achieve certain environmental goals, construction projects must be combined with social development and people's psychological needs to build a harmonious society. Finally, there must be conceptual goals. The concept first manifests in the aspect of universal adaptability. Green buildings not only have to be individual examples and special cases, but also have to consider the overall situation and promote the improvement of human living environment.

2.2. Approaches to green building design

The green building design method can be roughly summarized as four points. First, it must be based on local buildings and synchronized with the urbanization process. Due to the vast area of China and the great cultural and geographical differences between regions, the timing of green construction should be tailored to local conditions and combined with geographical conditions, economic conditions and weather conditions. Second, the overall design of the plan should not be limited to The control of a single building should be based on urban planning within a certain range of building land, and comprehensively analyze factors such as topography, geology, hydrology, climatic conditions, and cultural economy. Third, energy-saving technologies should be adopted in the building. In the design process, the building area should be fully used reasonably to avoid waste of resources, energy and space, and new wall materials should be used to improve thermal insulation performance. Solar geothermal heat is used as indoor heat source, and roof solar panels are used as indoor power source. Finally, environmental greening should be strengthened For greening around the base, reduce hard paved roads, use ecological hole bricks to expand planting area, and for three-dimensional greening of buildings, increase roof planting area, increase greening rate of building facades, At the same time, avoiding the intensification of the urban heat island effect.

3. The main points of energy-saving design of green buildings—coordination of internal environment and regional environment

3.1. Temperature design

The temperature problem of the environment in the building is a fundamental problem of energy-saving design in green buildings [2]. Green buildings with reasonable window and roof insulation
design will greatly reduce the frequency of heating and cooling equipment, and thus save energy and energy consumption. It also reduces the use of thermal insulation fuel, so the temperature of the building environment should be the first consideration. Attention should be paid to the external thermal insulation design of the building exterior wall ‘Figure 1’, as it accounts for the largest proportion in the building outsourcing area. The heat transfer coefficient of the exterior wall should be controlled during the design, and the appropriate structure and material should be used to reduce the wall heat transfer performance.

Pay attention to roof insulation. For flat roofs, planted roof systems ‘Figure 2’ and conventional energy-saving systems are adopted. With energy-saving roofing, the temperature of the internal surface of the building in winter is higher than the dew point temperature of the indoor air, and no condensation will occur. Pay attention to energy saving of exterior windows. Focusing on the two aspects of heat transfer coefficient and shading coefficient, for the design of exterior windows of green buildings, the structure of the outer window must meet high thermal insulation performance and reasonable shading coefficient. The current way to properly control the heat transfer coefficient of outer windows is to increase the number of interlayer air layers ‘Figure 3’, increasing the thickness of interlayer glass layers, filling inert gas in windows, adding thermal insulation film, adopting vacuum glass structure and window frames with good thermal insulation performance ‘Figure 4’.

3.2. Microclimate design of the building community—lighting and ventilation

In order to maintain the ecological balance and make the building coordinate with the surrounding environment, it must have a holistic view when designing and planning. The control of the building location and building type must be determined according to the surrounding natural and human environment, etc. In addition, the designer must according to the site's climate, Terrain, landforms,
etc., deal with the layout relationship of the building group ‘Figure 5’, so that each building complements each other and forms a harmonious whole, and finally forms a good microclimate in the building group.

Control daylighting through building orientation. The sunny section is selected as the base. For the residential areas in severe cold and cold areas, the north-south orientation should be the main direction, and every resident should fully strive for the south-facing main rooms that are beneficial to the sunshine. For buildings with special requirements for width and height, a split-level solution can be adopted. For green building lighting, a combination of south-facing lighting and three-dimensional lighting can be used. The building lighting can be divided into 5 thermal zones according to the light climate conditions. Standard parameters, efficient enough to introduce enough natural light indoors to meet indoor sunlight requirements. The window-to-ground ratio is closely related to the uniformity of daylighting. Therefore, the three-dimensional lighting design should be based on the area and location of the specific doors and windows of the green building design. Floor-to-ceiling windows are used to expand the area of indoor windows. Glass to enhance the light perception of the room, and set up an auxiliary insulation wall to meet the indoor thermal insulation requirements.

![Figure 5](image)

**Figure 5.** Daylighting south Rotate 45° to increase lighting Courtyards penetrate and change.

The combination of building groups should facilitate internal ventilation. Through various combinations of different buildings to guide the air circulation, and then determine the plan and vertical layout of the building group, the plan layout ‘Figure 6’ can be divided into free-style, staggered, oblique, etc. Positive and negative wind pressures are formed before and after, and wind pressure can be used to organize ventilation. For vertical layout ‘Figure 7’, different building height differences should be reflected. The lower building is arranged at the front of the windward side of the summer monsoon and the higher building is arranged at the rear. Conducive to the gradual penetration of the monsoon [3].

According to the law of natural ventilation, the optimal design of the size and position of the doors and windows of the building is made. On the premise of meeting the requirements of natural ventilation, it is more reasonable to adopt a high-side window design for the shape of the window. it is good.
3.3. Architectural design

The green coverage of buildings in green building design is the key factor to ensure the success of their energy-saving design. Roof gardens and green corridors ‘Figure 8’ have become the first choice to improve the green coverage of buildings. Green buildings with high requirements for environmental protection and energy conservation will make full use of Greening design of corridors, balconies, roofs and other places to improve the green coverage of the building can not only purify indoor and outdoor air, improve the air quality inside and around the building, but also play a role in sun protection. Use green plants to adjust the building microclimate, improve the natural affinity within the building group, and then extend the stop time of the crowd, alleviate the urban heat island effect, and achieve a benign oxygen cycle. Trees and shrubs are selected by plants to provide sufficient oxygen, and lawns are selected to improve green coverage. Because of their poor oxygen supply capacity, the principle of combining trees and shrubs should be adhered to in the design of residential projects. It guarantees its ecological functions such as wind and sand prevention, noise reduction and pollution reduction, sterilization and disinfection, temperature control and oxygen release, humidification and water conservation, optimization of the building's wind environment, and microclimate adjustment [4].

Figure 6. Ventilation design building group distribution.

Figure 7. Building ventilation analysis.

Figure 8. Analysis of building vertical greening[a], Three-dimensional greening analysis of building[b].
4. Analysis of building energy saving case

4.1. Qingdao World Horticultural Exposition Comprehensive Service Center

The project starts with the combination of site and energy-saving design. The concept can be traced back to the ancient design strategies such as “sit north and face south”, “negative yin and yang,” and “back mountain and water”. In the 2014 Qingdao World Horticultural Exposition Comprehensive Service Center project ‘Figure 9’, the designer fully combined the internal topographic and landform features of the base, and the building was formed according to the terrain and higher than the terrain. The natural scenery was introduced into the interior facing the scenic area, and the low energy consumption standards of the building were controlled. Its main function is to dine indoors and landscape bridge outdoors. According to the characteristics of the site, the design concept of “hiding the building volume and letting the nature reveal” was proposed. To let nature reveal is to require the building to be humble in appearance, starting from nature and integrating with nature, while allowing indoor diners to enjoy the outdoor natural landscape.

![Figure 9. Aerial view of integrated service center.](image)

Based on the above design concepts, designers have adopted two design strategies[5]:

First, the internal terrain height difference of the base will be used to place the building part in a semi-underground to form soil cover to save building energy consumption. The building plane follows the contours of the surrounding roads and the base, making the building boundary harmoniously coexist with the natural terrain, and the roof part fluctuates according to the changes in the elevation of the road on the west side, symbolizing the form of the naturally generated leaves in the terrain ‘Figure 10’.

Second, because the north side of the building faces the valley and has a good view of the landscape, it is decided to use large-scale floor-to-ceiling glass to introduce landscape elements, and use software to simulate solar thermal radiation and shading area. It is learned that from 10 am to 3 pm daily, 80% of the floor-to-ceiling glass in the room will be in the shadow, so the shading measures on the north side are reduced to reduce the blocking of the landscape. At the same time, for the floor-to-ceiling glass windows with a large heat area, the design adopts a self-shading system with the roof folded down. Make the outdoor corridor bridge space style changeable.
Figure 10. General service center shape generation map.

Through the effective use of the terrain height difference, the building and the environment are designed as a unified whole, and the indoor functions are partitioned according to the different elevations. This minimizes the volume of the building and strives for the best landscape orientation. The building is divided into two upper and lower floors. The first floor meets the concept of hiding in the semi-underground space. The second-floor roof is flush with the pavement to weaken the sense of volume and reduce the oppression of the theme hall on the north side. At the same time, it can be used as a rooftop platform to admire the surrounding landscape.

Figure 11. Solar thermal radiation analysis chart.
The first and second-floor restaurants are arranged in a landscape-oriented direction. On the basis of obtaining sufficient sunlight, efforts are made to improve the best viewing experience for tourists. The auxiliary spaces such as shops and storage rooms are located under the roof platform to facilitate access and as much as possible. Retain the original landform and green vegetation, so that the building conforms to the environment and respects the environment ‘Figure 11’.

The organic combination of the three factors: the height of the terrain inside the site [6], the surrounding landscape, and the orientation of the building is the logical basis for the form generation of the scheme. The building shape is created by combining the north-facing shading requirements and introducing the natural landscape element. The operation of mass segmentation and combination, and then repeatedly established it, is not purely formalism.

4.2. Wang’s House in Nanjing

Wang Zhai ‘Figure 12’ is located in a natural village below Lukou Town, Nanjing. The owner requires that his house does not use air conditioning. He hopes that the indoor temperature of the building will be about 33°C in summer and about 10°C in winter, and it can maintain a stable temperature. Indoor thermal environment while minimizing building costs. According to the analysis of relevant data, the indoor comfortable temperature in Nanjing in the summer is 25-26 °C, over 32 °Cis the overheating temperature, and the winter room comfortable temperature is 18-25 °C, and below 12 °Cis the supercooling temperature [7]. In addition to the use of air conditioning and other mechanical equipment to control the temperature, the basic method of controlling the indoor temperature of the building is summer heat insulation, winter heat insulation, and spring, summer and autumn seasons to strengthen indoor ventilation. The renovation of the outer wall makes it relatively easy to control the heat insulation and insulation, and the effect of ventilation on heat is more difficult to control than the previous two. The architect judges based on the experience of orientation, wind direction, and shape, combined with the basic elements such as site landscape and functional layout Derive the basic physical layout, and form a final plan after fully cooperating with the energy-saving simulation team ‘Figure 13’.

Wang Zhai adopted the following three strategies in dealing with energy conservation and building design [8]:

First, in terms of building shape and functional layout, from the perspective of energy saving, the smaller the building shape coefficient, the lower the energy consumption. Therefore, the building layout should be as compact as possible. The main use functions will be arranged as concentratedly as possible, separating the guest and bedroom sections, and forming an inner courtyard with the main body to ensure a good view of the guest rooms.
Second, in terms of thermal insulation design, first of all, the north storage, stairwell, and bathroom functions are placed on the north side in the plan layout to form a thermal insulation buffer zone. Second, the external wall of the building is insulated with double-layer blocks XPS. The second method is to adopt the traditional overhead insulation roofing method ‘Figure 14’.

Thirdly, in terms of ventilation design, firstly, a patio is dug on both the east and west sides of the building in combination with the building orientation and the southeast dominant wind direction to guide the flow of wind in the outer area of the building. The wind leads from the ground floor space to the top floor space, and is finally discharged through the opening on the top floor of the activity room to complete the wind cycle of the public activity space. Secondly, for the privacy of the private bedroom space, the outer wall of the bathroom is retracted inward to form a facade recess. Windows are opened on the side to avoid the sun, and at the same time form the southeast to northwest convection ventilation with the main windows of the bedroom ‘Figure 15’.

Figure 14. Wang House thermal insulation design.

Figure 15. Ventilation and temperature analysis chart of Wangzhai bedroom.
5. Conclusion
In the context of a growing world population and an increasingly tense resource utilization situation, countries and regions around the world are facing resource crisis and environmental pollution problems to varying degrees. In order to achieve long-term sustainable development of the economy and society, we must persist in harmonious coexistence with the environment and achieve energy conservation [9]. As one of the industries with the most serious energy consumption problems in China's national economic system, the construction industry must actively promote energy-saving design technologies by building green buildings to reduce the consumption of various resources by the construction industry and achieve long-term sustainable development of the construction industry.

To sum up, establishing a green building energy-saving consciousness requires that architects take the green building design concept as the basic principle in the actual building design process, consider the energy consumption during the entire life cycle of the building, and design on this basis. The plan fits the local cultural environment. When designing energy-saving buildings, a variety of building energy-saving factors must be accommodated to effectively solve current environmental problems and promote the harmonious development of resources and the environment.

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