

Energy-Saving Construction Technologies for Buildings

Jingjing Sun*

Chongqing Energy College, Chongqing 402260, China

*Corresponding author: Jingjing Sun, jiangwei001vip@126.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: The development of the construction industry is shifting towards low-carbon construction, so it is necessary to improve and optimize related construction concepts, methods, and processes. By improving resource and energy control efficiency in building projects, minimizing construction waste, and reducing environmental impact, a foundation for the sustainable development of the industry can be established. This paper mainly analyzes the significance of low-carbon energy-saving construction technology and the control factors of construction, summarizes the status quo of the development of building energy-saving construction, and puts forward strategies for applying building energy-saving construction technology. These strategies serve to achieve low-carbon and energy-saving goals to promote the healthy development of energy-saving construction.

Keywords: Low-carbon energy-saving concept; Construction; Energy-saving construction; Thermal insulation technology; Intelligent technology

Online publication: July 11, 2024

1. Introduction

Low-carbon building technology involves saving resources and reducing environmental pollution in construction by adopting energy-saving technologies and reducing the emission of pollutants. The construction industry accounts for a huge proportion of energy consumption in China. Therefore, it is imperative to improve energy conservation efforts by employing low-carbon energy-saving technologies ^[1].

The sustainable development of the construction industry can be ensured by optimizing construction technology at various stages of building projects and incorporating scientific insulation techniques alongside a green construction management system.

2. Significance of low-carbon energy-saving construction technology

Energy-saving construction technology for housing begins at the design stage, where adherence to energy-saving standards is crucial throughout all phases, including program design, material selection, construction,

and subsequent use. The utilization of advanced technology and careful selection of materials and equipment reduce material waste and environmental pollution. Using renewable energy sources and protecting the ecological environment contribute to energy efficiency and savings. Implementing low-carbon energy-saving construction technology not only conserves resources and energy during construction and use but also reduces carbon emissions and protects the environment^[2]. Therefore, building energy-saving construction technology is vital for the success of China’s sustainable development strategy. Given the country’s limited energy, land, and water resources, strengthening their protection is essential for their citizen’s survival and well-being.

Large amounts of carbon dioxide are released during building construction in China, which accounts for 50% of the total carbon dioxide emissions in the country. During the period from the 11th Five-Year Plan to the 13th Five-Year Plan, the carbon emissions from buildings have continued to increase. The details are shown in **Table 1**.

Table 1. Carbon emissions during the period from the 11th Five-Year Plan to the 13th Five-Year Plan

Carbon emissions/billion CO ₂	Building operation (billion tCO ₂)	Building materials production (billion tCO ₂)	Construction process (billion tCO ₂)
During the 11th Five-Year Plan period	11–15	12–18	22.3–32.5
During the 12th Five-Year Plan period	16–19	24–26	32.5–45.2
During the 13th Five-Year Plan period	2–23	27–29	45.2–52.2

Under the “dual-carbon” strategy of the “14th Five-Year Plan,” it is crucial to enhance environmental protection and achieve energy savings. The construction industry, one of the largest consumers of materials, contributes significantly to energy consumption, with construction materials accounting for over 13% of society’s total energy use, representing a substantial energy loss^[3]. Therefore, it is essential for building construction to ensure the rational use of energy and effectively address various issues within the industry.

3. Factors influencing low-carbon and energy-saving construction

3.1. Carbon emission control

Building construction releases huge amounts of carbon, which are contributed by building materials and the machinery used in construction and human construction. The accumulation of carbon waste will then lead to severe pollution. Furthermore, the demand for electrical energy in construction projects will further exacerbate the issue of carbon emissions and pollution. To achieve low-carbon and energy-saving construction, it is essential to establish a scientific management system, implement robust supervision and management of the construction process, and strengthen carbon emission controls. This ensures that carbon emissions remain within the prescribed limits^[4].

3.2. Conversion of carbon exchange rate

The conversion of the carbon exchange rate in construction projects is crucial. The carbon exchange rate refers to the reduction rate of carbon dioxide per unit space. During construction, managers and personnel can reduce carbon dioxide emissions, enhance the conversion rate of carbon dioxide in the ecological environment, and maintain the balance of carbon dioxide levels. This helps mitigate the impact of carbon dioxide on the surrounding climate, improve the greenhouse effect, and ensure the environmental quality around the construction site.

4. The current situation of building energy-saving construction

4.1. Flawed building energy-saving regulations

Under the background of sustainable development, China has introduced a series of policies and regulations for building energy-saving construction. However, there are still many shortcomings and deficiencies in these regulations ^[5]. Firstly, the regulations and systems are often not applicable to actual construction projects, and there is duplicity and conflict in the provisions, which leads to difficulties in the implementation. Secondly, some policies and regulations lack clarity, particularly regarding specific indicators for building energy conservation and energy consumption limits. Furthermore, the legal provisions for energy-saving design and construction are often weak, lacking enforceability and binding power. These provisions may also be superficial and one-sided, preventing effective implementation ^[6]. These factors are the primary reasons why building energy consumption cannot be effectively reduced.

4.2. Building energy-saving policies are unreasonable

The energy-saving construction of housing buildings is still in its early stages. As a result, the technical level, management capabilities, and innovative thinking in construction are lacking. Additionally, building energy-saving technology has not received enough attention in China, and its application often increases construction costs. For instance, when energy-saving measures exceed 30%, construction costs can rise by about 5%. Strictly following national energy-saving standards can significantly raise these costs, which owners and constructors might find hard to accept, thereby hindering the adoption of low-carbon energy-saving technologies. To address this issue, economic subsidies should be offered to encourage the use of these technologies in future projects.

5. Low-carbon energy-saving concept of building energy-saving construction technology application strategy

5.1. Improving laws and policies on energy-saving construction

China has provided considerable support for building energy efficiency through the introduction of various policies and regulations. However, these efforts lack strong guidance and enforceable, targeted regulations for effective constraint and management. This absence of mandatory and standardized system constraints in applying energy-saving construction technology makes it challenging to effectively address environmental pollution and energy wastage in building construction ^[7]. Therefore, the State should enhance the optimization of technical standards, laws, and regulations related to energy conservation in housing buildings. This includes strengthening the implementation of the legal framework and ensuring effective supervision and management of the construction process for building energy efficiency. The impact of building energy efficiency extends directly to the living environment and the future development of the country. Therefore, it is crucial to formulate systems from the perspective of national strategic objectives to raise societal awareness and attention towards energy-saving policies ^[8]. For instance, specific carbon exchange rates and energy consumption standards can be set for buildings of various volumes. These standards should be dynamically monitored for strict implementation, with severe disciplinary measures enforced if the specified values are exceeded. The penalties should be designed to ensure that they outweigh any illegal profits gained by the enterprise, thereby serving as a strong deterrent. In addition to financial penalties, there should also be penalties affecting the construction qualifications of the involved parties.

5.2. Employing building insulation technology

The application of thermal insulation technology plays a crucial role in promoting energy-saving practices.

This technology focuses on reducing heat conduction through building materials, thereby preventing indoor temperature loss to the outside environment. One of the most commonly used insulation materials for building walls is polystyrene board, known for its insulating properties. In the summer, it effectively blocks external heat from entering the room, ensuring indoor coolness. In cold winters, it prevents indoor heat from escaping outdoors, maintaining a comfortable indoor temperature. In addition to enhancing indoor comfort and reducing energy consumption for heating or cooling, polystyrene board insulation also helps prevent wall cracks and protects the structural integrity of the building.

In addition to installing thermal insulation layers, incorporating shading facilities is essential for effectively managing building temperatures and ensuring a balanced indoor environment. This approach not only enhances comfort for building occupants but also improves overall quality of life. Shading facilities play a crucial role in reducing energy loss during building operations and promoting the adoption of low-carbon energy-saving principles in construction. Thorough environmental surveys should be conducted before implementing sunshade construction technology. These surveys should include assessments of the building's surroundings such as geological structures and climate conditions. Continuous optimization of building construction plans is also crucial to ensure their rationality and effectiveness in achieving energy-saving and consumption-reduction goals.

5.3. Applying intelligent technology in construction

In the context of low-carbon and energy-saving principles, the construction industry must address the challenges posed by energy consumption and environmental pollution. A key focus is ensuring the healthy development of low-carbon, energy-efficient buildings, facilitated by intelligent control technology. Building energy-saving construction technology utilizes automated equipment and computer technology to monitor and manage various systems and equipment during construction. This includes implementing automatic power-off or load-reduction management modes. These measures effectively control energy consumption, promoting sustainability and reducing environmental impact ^[9]. Intelligent technology also allows the automatic adjustment of indoor temperature, humidity, and other parameters, which reduces energy consumption while ensuring the comfort of users.

In the context of intelligent energy-saving control systems for buildings, the central component is the intelligent control system, which manages aspects like ventilation and lighting within the building. This system allows for precise control tailored to different needs and conditions. For instance, many households in our country face issues with inefficient electricity consumption due to poor habits in daily electricity use. By deploying intelligent control systems integrated with the Internet of Things (IoT) and wireless communication technologies, facilities such as lights can be automatically switched off when rooms are unoccupied, effectively reducing electricity consumption. Moreover, automatic detection and sensors can monitor and evaluate energy consumption within rooms, proposing corresponding energy control strategies. Remote monitoring of energy control operations ensures efficient energy utilization. Utilizing advanced technologies is key to achieving energy-saving and environmentally friendly construction outcomes. For heating, methods such as underground water source absorption and solar energy conversion can significantly reduce reliance on high levels of electricity. Ultimately, it is crucial to dynamically adjust building energy and environmental settings to meet energy conservation and emission reduction standards effectively.

5.4. Creating a healthy indoor living environment

The application of building energy-saving construction technology can ensure a healthy indoor living

environment. The application of building energy-saving construction technology plays a critical role in ensuring a healthy indoor living environment. Quality control during construction is paramount, focusing on well-designed ventilation systems to promote optimal indoor air circulation and efficient removal of pollutants. Selecting environmentally friendly materials is crucial to minimize indoor pollutants such as formaldehyde. Addressing noise issues involves using double or triple-layered glass for doors and windows, along with implementing sound insulation and noise reduction devices in areas prone to noise. Maximizing natural lighting by strategically locating and sizing windows reduces reliance on artificial lighting, enhancing visual comfort and conserving energy. Installing effective heating and insulation facilities maintains stable indoor temperatures and humidity levels, reducing the need for heating and cooling systems. Thoughtful interior layout and space planning ensure that different areas meet ventilation and lighting requirements, catering to diverse needs such as leisure, learning, and entertainment, thereby fostering a comfortable and energy-efficient indoor environment.

5.5. Adopting green construction management

Green construction management is pivotal in the effective application of building energy-saving construction technology. During the project's design phase, it is essential to depart from traditional design concepts and prioritize energy-saving and environmental protection. This involves comprehensive consideration of energy-saving details early in the design process to optimize efficiency and avoid material waste during later stages. Site selection and planning should meticulously account for daily, climatic, and terrain characteristics to prevent issues like building shading. Maximizing natural light and ventilation while avoiding designs that hinder airflow direction is also critical. It is imperative to educate construction personnel in green construction practices, ensuring they understand and implement environmentally friendly concepts and technologies throughout construction. Environmental protection should be core to construction practices, maximizing resource efficiency and improving the overall quality of green buildings. Implementing environmental protection technologies, such as dust reduction measures through regular site watering and effective dust shielding, is crucial. Furthermore, enhancing the utilization efficiency of construction materials involves prioritizing low-carbon, low-energy, and recyclable materials to minimize waste and promote sustainability in building projects^[10]. In addition to energy conservation, protecting water and land resources is crucial in construction practices. Building projects consume significant amounts of water, especially in concrete mixing and ongoing maintenance, necessitating stringent water resource management. Regular maintenance of water supply equipment is essential to prevent water loss from leaks caused by aging equipment. Effective land management involves strategic planning of construction spaces and environments to optimize material storage and functional area division, maximizing land resource utilization. External building design should prioritize reducing hard pavement and increasing green spaces to foster microclimate ecology and utilize natural resources like woodlands and water sources efficiently. Furthermore, enhancing the adoption of new energy sources and materials is essential. Utilizing natural energies such as solar and wind power in construction minimizes reliance on non-renewable energy sources, promoting sustainability and reducing environmental impact.

6. Conclusion

The application of building energy-saving construction technology within the framework of low-carbon energy efficiency contributes significantly to reducing carbon dioxide emissions and pollution associated with building construction. This approach also conserves non-renewable resources, protects the ecological environment, and fosters the sustainable development of both the construction industry and the environment. By integrating energy-saving and intelligent technologies, building energy-saving construction enhances living environments,

minimizes energy and resource consumption during construction, and promotes overall industry health and sustainability.

Funding

Research on Zero Emission Campus Construction Based on Plant Community Optimization (Project number: KJQN202305605)

Disclosure statement

The author declares no conflict of interest.

References

- [1] Wan Q, 2022, Discussion on the Application of Building Energy-Saving Construction Technology under the Concept of Low Carbon and Energy Saving. *Modern Decoration*, 510(13): 70–72.
- [2] Hu W, Wang P, Chu R, et al., 2024, Application of Energy-Saving and Environmental Protection Technology in Low-Carbon Building Construction. *Brick and Tile World*, 2024(1): 40–42.
- [3] Chen Z, 2023, Application of Energy Saving and Environmental Protection Concept in Residential Building Construction Technology. *China Building Metal Structure*, 22(10): 187–189.
- [4] Lu M, 2022, Energy-Saving Construction Technology of Building Engineering Under the Concept of Green Construction. *Building Materials Development Guide (Next)*, 20(2): 163–165.
- [5] Liu Y, 2022, Discussion on Building Design Method and Technology Under the Concept of Low Carbon and Energy Saving. *Brick and Tile World*, 2022(8): 16–18.
- [6] Dai X, Lin N, Wang J, 2022, Application Analysis of Aluminum Alloy Formwork System Construction Technology in Green Building Construction. *China Residential Facilities*, 2022(7): 148–150.
- [7] Chen Y, 2023, Discussion on the Integration and Application of Green Building Design Concepts in Building Design. *Construction Safety*, 38(7): 22–25.
- [8] Gu B, 2023, Analyzing the Application of Construction Technology of External Wall Insulation and Energy Saving in Civil Construction. *Building Materials and Decoration*, 19(6): 21–23.
- [9] He X, 2023, Construction Technology of Aluminum Alloy Formwork System in Green House Building Construction. *China Building Decoration and Decoration*, 2023(15): 76–78.
- [10] Yang Z, 2023, Application of Energy-Saving Technology in Curtain Wall Project of High-Rise Building. *Building Materials Development Orientation*, 21(19): 195–198.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.