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Exploration of Energy-Saving Technologies in Building Electrical System Design

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Abstract: Green energy conservation is the mainstream trend in the current development of the construction industry. The application of energy-saving technology in building electrical system design can effectively reduce energy consumption, avoid unnecessary energy consumption, and truly achieve energy conservation and environmental protection. Based on this, the article elaborates on the principles of energy-saving design in building electrical systems, and actively explores the application of energy-saving technologies from different perspectives such as optimizing power supply and distribution system design, adopting high-efficiency energy-saving lighting equipment, applying renewable energy, promoting smart home technology, and improving the efficiency of building electrical equipment.

Keywords: Building electrical system design; Energy-saving technology

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1. Introduction

With the increasing global attention to environmental protection and sustainable development, green energy conservation has become a core issue in the development of the construction industry [1]. As an important component of building engineering, the application of energy-saving technology in building electrical design plays a crucial role in reducing building energy consumption, improving energy utilization efficiency, and reducing environmental pollution. This article aims to delve into the application of energy-saving technologies in building electrical design, to provide useful references for achieving green, low-carbon, and sustainable development in the construction industry [2].

2. Principles of energy-saving design for building electrical systems

The application of energy-saving technology in building electrical system design should follow the principles of economic practicality, practical demand, and environmental conservation [3].

2.1. Economic practicality

In energy-saving design of buildings, the first thing to pay attention to is the economy and practicality of electrical system design to ensure the economic benefits of the building project. Currently, with the continuous development of industrial technology, the types of electrical products on the market are not only diverse, but their functions are also becoming more complete, and their level of intelligence is also constantly improving [4,5]. However, when selecting electrical equipment, it is necessary to consider the actual needs of building design comprehensively and start from cost factors to choose electrical equipment and technology with higher cost-effectiveness [6].

2.2. Actual demand

In building electrical system design, the application of energy-saving technology also needs to meet the actual usage requirements of the building [7–9]. The purpose of electrical equipment and technology applications is to provide users with a better user experience, making people's work and life more convenient and efficient [10]. Therefore, in the energy-saving design of building electrical systems, full consideration should be given to the actual usage needs of the building, including stable circuit supply, public area lighting, etc. Based on meeting the basic application functions of the building, attention should also be paid to improving the production process, enhancing equipment performance, and reducing unnecessary energy waste.

2.3. Conservation and environmental friendliness

One of the important goals of building energy-saving electrical system design is to achieve effective energy utilization and reduce environmental pollution. Therefore, in the selection and application of energy-saving technologies, attention should be paid to environmental protection. This can be done by prioritizing the selection of renewable and clean energy sources, reducing reliance on traditional energy sources, and lowering carbon emissions. Additionally, it is necessary to optimize equipment layout and electrical system design schemes, reduce energy consumption and pollutant emissions, and achieve green and sustainable development of building electrical systems.

3. Energy-saving design measures for building electrical systems

3.1. Optimize power supply and distribution systems

The power supply and distribution system plays a crucial role in building electrical system design since its design quality directly affects the operational efficiency and energy consumption level of electrical equipment. To ensure the rationality and efficiency of the power supply and distribution system design, it is necessary to fully consider the actual needs and electrical characteristics of the building in building electrical design [11]. This can be done by selecting suitable transformers, cables, switches, and other equipment, and optimizing the distribution method to reduce energy loss in the transmission process. Firstly, understand the electricity demand and characteristics of the building. Different building uses and electrical equipment have different electricity demands, therefore, it is necessary to choose appropriate transformer capacity and distribution methods based on actual situations [12]. Simultaneously, it is necessary to choose cable types and lengths reasonably to minimize energy loss during power transmission. Secondly, optimize the distribution method. An effective distribution method can reduce power loss and energy waste. Techniques such as partitioned distribution, radial distribution, etc., can make power supply more flexible and efficient. Additionally, improving the automation level of the power supply and distribution system is crucial. Improving the level of automation can achieve intelligent

management and control of power supply and distribution systems, and improve the stability of system operation. With the development of information technology and Internet of Things technology, the automation level of power supply and distribution systems has been greatly improved [13]. The intelligent management system can monitor the status of the power supply in real-time, and provide early warning and handling of abnormal situations, thereby ensuring the stability of the power supply. Finally, pay attention to the safety of the power supply and distribution system. In the design of building electrical systems, it is necessary to fully consider the protective measures of equipment, such as setting overload protection, short circuit protection, etc., to ensure that the system can cut off power promptly in case of faults and avoid the expansion of accidents. On this basis, attention should also be paid to the grounding treatment of electrical equipment to ensure personal safety.

3.2. Adopting efficient and energy-saving lighting equipment

Lighting equipment plays an important role in electrical energy consumption. Therefore, when designing building lighting, attention should be paid to the application of efficient and energy-saving lighting equipment and technology. Specifically, the following aspects can be taken into consideration: Firstly, the use of efficient and energy-saving light sources, such as light emitting diode (LED) and other new light sources, has advantages such as high light efficiency, long lifespan, and low energy consumption, which can significantly reduce energy consumption under the same brightness conditions [14,15]. Moreover, the color temperature of LED light sources is adjustable, which can adjust the lighting effect according to different scenes and needs, thereby meeting both comfort and energy efficiency. Secondly, apply intelligent lighting control systems. The application of intelligent control systems can accurately control the brightness and color temperature of lighting equipment according to actual needs, to effectively reduce energy consumption while meeting lighting requirements. Furthermore, the application of intelligent lighting control systems can also achieve automatic switching of lighting equipment, avoiding energy waste caused by human negligence [16]. Thirdly, fully utilize natural light sources. When designing buildings, full consideration should be given to lighting performance, improving the building's lighting area and natural light intensity. This can reduce the usage of lighting equipment, reduce energy consumption, and bring more comfortable natural light into indoor spaces. Fourthly, a reasonable lighting layout. In the energy-saving design of building electrical systems, a reasonable lighting layout can avoid blind spots and excessive lighting, and reduce unnecessary energy waste. Additionally, when selecting lighting equipment, spatial functionality, and needs should also be considered to achieve personalized lighting effects and improve lighting quality. Finally, strengthen the maintenance and management of lighting equipment. Regularly inspect, repair, and replace lighting equipment to ensure its optimal operation, thereby effectively extending its service life and reducing energy consumption.

3.3. Application of renewable energy

In building electrical system design, efforts should be made to increase the application and promotion of renewable energy, such as solar energy, wind energy, etc., in order to achieve the goals of green, environmental protection, and sustainable development. The application of renewable energy in building electrical system design can not only reduce the dependence of buildings on traditional energy, reduce energy consumption and environmental pollution, but also effectively reduce the operating costs of buildings and improve economic benefits. Precisely the application of renewable energy can take the following measures: First, install solar photovoltaic panels on the roof of buildings to fully utilize solar energy resources. Solar photovoltaic panels can directly convert solar energy into electricity for internal use in buildings, effectively reducing

the building's dependence on traditional electricity resources, reducing carbon emissions, and achieving environmental protection goals. Furthermore, installing photovoltaic panels on the roof of a building can also provide insulation, reduce the temperature inside the building, and further reduce the energy consumption of air conditioning and other equipment. Secondly, actively promote wind power generation equipment in areas with abundant wind resources. Wind power generation is a clean and renewable energy source with broad application. By installing wind power generation equipment, wind energy resources can be fully utilized to provide electricity for buildings. Moreover, installing wind power generation devices in buildings can also beautify the environment and enhance the ecological quality of the surrounding areas. Thirdly, taking into account factors such as geography and climate, comprehensively utilizing multiple renewable energy sources. For example, in cold regions, geothermal energy can be used for heating whereas in the southern region, solar hot water systems can be used to provide hot water for buildings, thereby effectively reducing energy consumption and achieving energy conservation and emission reduction while meeting the actual needs of buildings. Finally, in the architectural design stage, full consideration should be given to the integration and utilization of various renewable energy sources. By optimizing architectural design, improving the insulation and thermal performance of buildings, and reducing building energy consumption. In addition, the reasonable layout of renewable energy equipment is essential to ensure the efficiency and reliability of equipment operation [17].

3.4. Promote smart home technology

With the rapid development of technology, smart home technology is gradually maturing, bringing unprecedented possibilities for building electrical energy conservation. In recent years, smart home technology has become an indispensable part of family life with its unique advantages [18]. The application of advanced technologies such as smart devices, sensors, and network communication has provided new solutions for building electrical energy conservation in China. Smart home technology can achieve intelligent management and control of household electricity consumption, significantly reducing energy consumption. For example, through smart sockets, smart switches, and other devices, users can achieve remote control of household appliances, timed switches, and other functions. Energy waste is effectively avoided when household appliances are in long-term standby and ineffective operation. In short, smart furniture technology has brought tangible energy-saving benefits to users through reasonable management and effective control of household electricity consumption. Smart home technology can also combine users' electricity habits and actual needs to provide personalized electricity solutions, thereby improving energy efficiency and providing users with a more comfortable and convenient living experience. In this process, smart home technology provides users with accurate electricity advice through the analysis and processing of a large amount of data, helping them develop good electricity habits and further reduce energy consumption.

3.5. Improve the efficiency of building electrical equipment

Improving the efficiency of building electrical equipment is an important link in building energy-saving electrical systems design. By selecting efficient and energy-saving electrical equipment and optimizing the operation of electrical equipment, energy consumption can be effectively reduced and energy utilization efficiency can be improved. Specifically, the following aspects can be taken into consideration: Firstly, selecting efficient and energy-saving electrical equipment. When selecting equipment, full consideration should be given to the energy efficiency indicators of the equipment, and electrical equipment with high efficiency and energy-saving performance. For example, in an air conditioning system, variable frequency air conditioning can be selected to achieve stable indoor temperature control and effectively reduce energy consumption by intelligently

adjusting the operating frequency of the compressor. Moreover, in the selection and procurement process of electrical equipment, the cost-effectiveness of the equipment should be fully considered, and products with high cost-effectiveness should be selected to ensure equipment performance while reducing investment costs. Secondly, optimize the operation mode of electrical equipment. By optimizing the operation mode of electrical equipment, the operational efficiency of the equipment can be improved and energy consumption can be reduced. For example, in the lighting system, an intelligent lighting control system can be used to accurately control the brightness, color temperature, etc. of lighting equipment according to actual needs, to effectively reduce energy consumption. Additionally, during the operation of electrical equipment, regular maintenance and upkeep should be carried out to ensure that the equipment operates in its optimal state, thereby effectively extending the service life of the equipment and reducing energy consumption. Thirdly, strengthen the energy efficiency management of electrical equipment. By establishing a sound energy efficiency management system and energy efficiency monitoring system, the energy consumption of electrical equipment can be monitored in real time, and abnormal energy consumption problems can be detected and solved promptly. Meanwhile, by analyzing and processing equipment operation data, data support can be provided for the energy efficiency improvement of electrical equipment, promoting the continuous improvement of equipment energy efficiency.

4. Conclusion

The exploration of energy-saving technologies in building electrical system design is of great significance for achieving green and sustainable development of buildings. In the energy-saving design of building electrical systems, measures such as optimizing the design of power supply and distribution systems, adopting efficient and energy-saving lighting equipment, applying renewable energy, improving equipment energy efficiency, and promoting smart home technology should be taken based on adhering to the principles of economic practicality, practical demand, and environmental conservation. This can effectively reduce energy consumption and environmental pollution in building electrical systems, improve energy utilization efficiency, and achieve a win-win situation for economic and social benefits. In the future, with the continuous progress of technology and the expansion of application fields, the energy-saving design of building electrical systems will pay more attention to technological innovation and system integration, promoting the green transformation and sustainable development of the building electrical industry.

Disclosure statement

The author declares no conflict of interest.

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