

# *Application of intelligent building management system in green zero carbon building operation*

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**Abstract:** With the increasing global attention to environmental protection and sustainable development, green zero carbon building has become an important development direction of the construction industry. As an important part of modern building technology, the application of intelligent building management system (IBMS) in the operation of green zero carbon buildings not only improves the energy efficiency level of buildings, but also provides strong support for the realization of the zero carbon emission goal of buildings. Starting from the definition and function of intelligent building management system, this paper will deeply explore its application in the operation of green and zero carbon buildings, analyze its advantages and challenges, and put forward corresponding optimization strategies.

## 1. Introduction

Green zero carbon building means to minimize energy consumption and carbon emissions and achieve the goal of harmonious coexistence between the building and the environment through the use of energy-saving and environmental protection design concepts and technical means in the whole life cycle of the building. This concept aims to meet the challenges of global climate change and resource depletion, and promote the transformation of the construction industry to the direction of sustainable development. With the progress of science and technology, the application of intelligent building management system in green zero carbon buildings has become increasingly widespread, and has become a key tool to improve building energy efficiency and optimize operation management. This paper will discuss the definition, function and application of intelligent building management system in green zero carbon building.<sup>[1]</sup>

## 2. Functions of intelligent building management system

Intelligent building management system (IBMS) is an integrated management platform, which makes full use of the Internet of things, big data, cloud computing and other modern information technologies to carry out real-time monitoring, data analysis and remote control of various types of building equipment. Through this system, the intelligent management of building energy, environment, security and other aspects can be realized, so as to improve the operation efficiency and management level of the building.

The intelligent building management system has a variety of functions, which work together in all aspects of the building, making the building more intelligent, efficient and environmentally friendly. The following are the main functions of the intelligent building management system:

### 2.1 Energy Management

Energy management is one of the core functions of intelligent building management system. The system provides detailed energy consumption analysis report for managers by monitoring the energy consumption of buildings, such as electricity, water, gas, etc. These reports not only show the energy consumption and consumption trend, but also help managers identify abnormal points of energy consumption and put forward suggestions for energy-saving transformation. For example, the system can optimize the operation parameters of the air conditioning system according to the energy consumption data and historical records of the building to reduce unnecessary energy waste. In addition, the intelligent building management system can also be integrated with renewable energy systems (such as solar photovoltaic panels and wind turbines) to maximize energy utilization and self-sufficiency.<sup>[2]</sup>

### 2.2 Environmental Control

Environmental control is another important function of intelligent building management system. The system monitors indoor and outdoor temperature and humidity, light intensity, air quality and other parameters in real time by integrating environmental sensors. According to the preset comfort standard, the system can automatically adjust the indoor environment, such as adjusting the temperature and humidity of the air conditioning system, controlling the brightness and color temperature of the lighting system, and turning on or off the fresh air system. These measures not only improve the comfort of indoor environment, but also effectively reduce building energy consumption and carbon emissions. For example, when the light is sufficient, the system can automatically reduce the brightness of indoor lighting and make full use of natural lighting; When the air quality is poor, the system can automatically start the fresh air system to introduce fresh air.

### 2.3 Safety Management

Intelligent building management system also plays an important role in safety management. The system realizes the comprehensive monitoring of the internal and external environment of the building through the integration of video monitoring, intrusion alarm, fire early warning and other security systems. In case of abnormal conditions, such as intrusion or fire, the system can immediately trigger the alarm and notify relevant personnel for handling. At the same time, the system can also be linked with the fire protection system to automatically start the sprinkler, turn on the emergency lighting and evacuation instructions when a fire occurs, providing strong support for personnel evacuation and fire fighting.<sup>[3]</sup>

## 2.4 Equipment Management

Equipment management is another key function of intelligent building management system. The system improves the operation efficiency and reliability of the equipment through the remote monitoring and maintenance of various equipment in the building. The system can monitor the running status and performance indicators of the equipment in real time, and notify the maintenance personnel for maintenance once any abnormality is found. At the same time, the system can also predict the maintenance cycle and replacement time of the equipment according to the operation data and historical records of the equipment, so as to provide the basis for the preventive maintenance of the equipment. In addition, the system can also optimize and adjust the operating parameters of the equipment to improve the energy efficiency level and service life of the equipment. For example, the system can automatically adjust the operation parameters and modes of the air conditioning system according to the load changes of the building and the external environmental conditions, so as to achieve more accurate energy consumption control.

## 3. Application of intelligent building management system in green zero carbon building operation

With the increasing global attention to sustainable development and environmental protection, green zero carbon building has become an important development direction of the construction industry. As a key tool to improve building energy efficiency and optimize operation management, intelligent building management system plays a vital role in the operation of green zero carbon buildings.

### 3.1 Efficient Use of Energy

The intelligent building management system provides managers with detailed energy consumption analysis reports by monitoring building energy consumption data in real time, such as electricity, water, gas, etc. These data not only show the energy consumption and consumption trend, but also help managers identify abnormal points of energy consumption and put forward suggestions for energy-saving transformation. For example, in a green zero carbon office building, the monitoring of the intelligent building management system found that the energy consumption of the air conditioning system accounted for a large proportion of the total energy consumption. Based on this discovery, the system puts forward suggestions on adjusting the operation parameters of the air conditioning system, such as automatically adjusting the output power and wind speed of the air conditioning system according to the indoor and outdoor temperature difference and humidity. After the implementation of these recommendations, the energy consumption of the air conditioning system of the office building is reduced by about 20%, and the energy efficiency is significantly improved.<sup>[4]</sup>

In addition, the intelligent building management system can also be integrated with renewable energy systems to achieve maximum energy utilization and self-sufficiency. In a green zero carbon community, the intelligent building management system is connected with renewable energy equipment such as solar photovoltaic panels and wind turbines to monitor the power generation and operation status of these equipment in real time. The system automatically adjusts the energy use strategy of the building according to the energy consumption demand of the building and the supply of renewable energy, such as giving priority to the use of renewable energy and storing electric energy when renewable energy is sufficient. Through these measures, the green zero carbon community has achieved energy self-sufficiency and greatly reduced its dependence on traditional energy.

### 3.2 Environment Friendly Operation

In the operation process of green zero carbon building, environmental control is a crucial link. The intelligent building management system monitors the indoor and outdoor temperature and humidity, light intensity, air quality and other parameters in real time through the integration of environmental sensors, and automatically adjusts the indoor environment according to the preset comfort standard. These measures not only improve the comfort of indoor environment, but also effectively reduce building energy consumption and carbon emissions.

Taking a green zero carbon school as an example, the intelligent building management system of the school can automatically adjust the opening and closing angle of the curtain and the operating parameters of the fresh air system by monitoring the light intensity and air quality in the classroom in real time. When the light is sufficient, the system automatically reduces the brightness of indoor lighting and makes full use of natural light; When the air quality is poor, the system automatically opens the fresh air system to introduce fresh air. These measures not only provide students with a more comfortable learning environment, but also effectively reduce the school's energy consumption and carbon emissions. According to statistics, after the implementation of the intelligent building management system in the school, the average annual energy consumption has been reduced by about 15%, and the carbon emissions have also been reduced accordingly.<sup>[5]</sup>

### 3.3 Security and Emergency Response

Intelligent building management system also plays an important role in safety management. Through the integration of video monitoring, intrusion alarm, fire warning and other security systems, the system can realize the comprehensive monitoring of the internal and external environment of the building. Once an abnormal situation occurs, the system can immediately trigger an alarm and notify relevant personnel for handling.

In a green zero carbon hospital, the intelligent building management system is closely integrated with the fire protection system. In case of fire and other emergencies, the system can immediately start the sprinkler, turn on the emergency lighting and evacuation instructions, and provide strong support for personnel evacuation and fire fighting. At the same time, the system can also monitor all areas of the hospital in real time to ensure the safety of patients and medical staff. Through these measures, the hospital has effectively improved the level of security and provided a safer and more reliable medical environment for patients and medical staff.

### 3.4 Equipment Operation, Maintenance and Optimization

The intelligent building management system improves the operation efficiency and reliability of the equipment through the remote monitoring and maintenance of various building equipment. The system can monitor the running status and performance indicators of the equipment in real time, and notify the maintenance personnel for maintenance once any abnormality is found. At the same time, the system can also predict the maintenance cycle and replacement time of the equipment according to the operation data and historical records of the equipment, so as to provide the basis for the preventive maintenance of the equipment.

In a green zero carbon data center, the intelligent building management system comprehensively monitors the air conditioning, cooling, power supply and other key equipment in the data center. The system monitors the operation status and performance indicators of the equipment in real time, such as temperature, humidity, voltage, current, etc., and predicts the maintenance cycle and replacement time of the equipment according to these data. Through these measures, the data center effectively avoids the risk of business interruption and data loss caused by equipment failure. At the same time,

the system can also optimize and adjust the operating parameters of the equipment to improve the energy efficiency level and service life of the equipment. For example, the system can automatically adjust the operation parameters and modes of the air conditioning system according to the load changes and external environmental conditions of the data center, so as to achieve more accurate energy consumption control.<sup>[6]</sup>

In addition, the intelligent building management system can also help green zero carbon buildings achieve more refined operation and management. Through real-time monitoring and data analysis of various equipment in the building, the system can provide detailed operation reports and energy consumption analysis for managers, and help managers better understand the operation status and energy consumption of the building. At the same time, the system can also automatically adjust the operation strategy and equipment parameters of the building according to the operation demand and energy consumption target of the building, so as to achieve more efficient and environmental protection operation effect.

## **4. Advantages and Challenges**

The application of intelligent building management system in green zero carbon building operation has brought significant advantages, but it also faces some challenges. This paper will deeply discuss the advantages of intelligent building management system in improving energy efficiency, improving comfort, enhancing security and reducing operation and maintenance costs, and analyze its challenges in technology integration, initial investment, data privacy and security, combined with specific cases.

### **4.1 Advantages**

#### **4.1.1 Improve Energy Efficiency**

The intelligent building management system can effectively reduce building energy consumption and carbon emissions through real-time monitoring and optimal control. In a green zero carbon office building, the intelligent building management system monitors the building energy consumption data in real time through the integrated energy management system, such as power, water, gas, etc. The system automatically identifies abnormal points of energy consumption based on these data, and puts forward suggestions for energy-saving transformation. For example, the system found that the energy consumption of the air conditioning system was high, so it proposed to adjust the air conditioning operation parameters. After the implementation of these recommendations, the energy consumption of the air conditioning system of the office building has been reduced by about 20%, significantly improving the energy efficiency level.

#### **4.1.2 Improve Comfort**

The intelligent building management system can automatically adjust the indoor environmental parameters according to the changes of indoor and outdoor environment, and create a comfortable and pleasant indoor environment. In a green zero carbon school, the intelligent building management system monitors the temperature, humidity, light intensity, air quality and other parameters in the classroom in real time through the integration of environmental sensors. The system automatically adjusts the indoor environment according to the preset comfort standard, such as adjusting the opening and closing angle of curtains, optimizing the control strategy of lighting system, etc. These measures not only provide students with a more comfortable learning environment, but also effectively reduce the school's energy consumption and carbon emissions.

### **4.1.3 Enhanced Security**

The intelligent building management system realizes all-round safety monitoring and emergency response by integrating a variety of security systems. In a green zero carbon hospital, the intelligent building management system is closely integrated with the fire protection system. In case of fire and other emergencies, the system can immediately start the sprinkler, turn on the emergency lighting and evacuation instructions, and provide strong support for personnel evacuation and fire fighting. At the same time, the system can also monitor all areas of the hospital in real time to ensure the safety of patients and medical staff.

### **4.1.4 Reduce Operation and Maintenance Costs**

Through remote monitoring and maintenance, the intelligent building management system can reduce the number of manual inspection and equipment failure rate, so as to reduce the operation and maintenance cost. In a green zero carbon data center, the intelligent building management system comprehensively monitors the key equipment in the data center. The system monitors the running status and performance indicators of the equipment in real time, and predicts the maintenance cycle and replacement time of the equipment according to these data. Through these measures, the data center effectively avoids the risk of business interruption and data loss caused by equipment failure, and reduces the operation and maintenance cost.

## **4.2 Challenges**

### **4.2.1 High Difficulty in Technology Integration**

The intelligent building management system involves the integrated application of multiple subsystems and technologies, which needs to solve the compatibility problem between different systems. In practical applications, due to the differences and complexity between different subsystems and technologies, it is a challenging task to realize the seamless integration and collaborative work between them. In order to solve this problem, it is necessary to adopt standardized interfaces and protocols to promote data exchange and sharing between different systems. At the same time, the system needs to be tested and debugged to ensure that each subsystem can work normally and coordinate with each other.

### **4.2.2 Large Initial Investment**

The construction and operation of intelligent building management system requires a large initial investment, which may be difficult for construction projects with weak financial strength. The intelligent building management system needs to purchase and install a large number of sensors, controllers, actuators and other equipment, and needs software development and system integration. These require a lot of money and time. In order to solve this problem, installment payment, government subsidies and enterprise cooperation can be adopted to reduce the economic pressure of construction projects. At the same time, open source intelligent building management system software can also be considered to reduce software development costs.

### **4.2.3 Data Privacy and Security**

With the increasingly wide application of big data technology, how to ensure the privacy and security of construction operation data has become an urgent problem to be solved. The intelligent building management system involves a large number of building operation data, including energy consumption data, environmental parameters, equipment status, etc. If these data are leaked or

maliciously used, it may have a serious impact on the safety and operation of the building. In order to solve this problem, we need to take a series of measures to protect the privacy and security of data. For example, encryption technology can be used to protect the transmission and storage of data; Establish a sound data access authority management system to ensure that only authorized personnel can access relevant data; Conduct data backup and recovery drills regularly to prevent data loss or damage.

## **5. Optimization Strategy**

In view of the challenges faced by the intelligent building management system in the operation of green zero carbon buildings, we can put forward optimization strategies from three aspects: strengthening technology integration and standardization, exploring diversified financing modes, and strengthening data security management.

### **5.1 Strengthening Technology Integration and Standardization: The Cornerstone of Building Intelligent Building Management System**

As the core of modern building operation, the importance of intelligent building management system is self-evident. However, this system involves the integration and application of multiple subsystems and technologies. The high difficulty and high cost of technology integration is a significant and urgent problem to be solved. In order to effectively reduce the difficulty and cost of technology integration and promote the seamless connection and efficient collaboration between different subsystems, it is very important to develop standardized interfaces and data exchange protocols.

#### **5.1.1 Develop Standardized Interface and Data Exchange Protocol: Break Technical Barriers and Realize Seamless Integration**

In the face of the high difficulty of technology integration of intelligent building management system, we should actively seek breakthroughs. Among them, it is a core task to promote relevant standardization institutions to formulate unified interface and data exchange protocol standards. These standards should comprehensively cover the communication protocol, data format, interface specification and other key aspects between subsystems to ensure seamless integration and data sharing between different subsystems.

The benefits of developing standardized interfaces and data exchange protocols are manifold. First, it can effectively reduce the difficulty and cost of technology integration. Under the unified standard, the communication and data exchange between subsystems will become simpler and more efficient, without cumbersome custom development, thus greatly saving the integration time and money cost. Secondly, standardization helps to improve the compatibility and scalability of the system. The subsystem following the unified standard can be more easily compatible and connected with other subsystems or newly added subsystems, making the whole intelligent building management system more flexible and scalable.

#### **5.1.2 Promoting Technology Integration Innovation: Leading a New Chapter of Intelligent Building Management System**

In addition to formulating standardized interfaces and data exchange protocols, we should also actively encourage technological innovation and promote the development of technological integration. In the integration process of intelligent building management system, we can make full use of advanced technologies such as Internet of things, cloud computing and big data to realize

intelligent interconnection and collaborative work between different subsystems.

The application of Internet of things technology can bring new changes to the intelligent building management system. Through the Internet of things technology, we can connect various equipment and subsystems in the building to achieve real-time data acquisition and monitoring. These data can be used to optimize building operations, improve energy efficiency, and improve indoor environmental quality. At the same time, the Internet of things technology can also realize the intelligent interconnection and collaborative work between different subsystems, making the whole building an organic whole.

Cloud computing technology provides powerful data processing and storage capabilities for intelligent building management system. By uploading data to the cloud, we can realize real-time analysis and processing of data, and provide more accurate and timely decision support for construction operations. At the same time, cloud computing technology can also realize data sharing and collaborative work, so that different subsystems can cooperate and cooperate more closely.

The application of big data technology can bring more in-depth data analysis and mining capabilities to the intelligent building management system. Through the analysis and mining of construction operation data, we can find the potential problems and optimization space in construction operation, and provide strong support for the continuous improvement and upgrading of buildings. At the same time, big data technology can also help us better understand the use of buildings and user behavior, and provide the possibility for personalized service and customized operation of buildings.

## **5.2 Explore Diversified Financing Modes**

The construction and operation of intelligent building management system undoubtedly requires a large initial investment, which is undoubtedly a big challenge for construction projects with weak financial strength. In order to overcome this problem, we need to actively explore diversified financing modes and raise funds through government subsidies, social capital cooperation (PPP) and other ways to reduce the initial investment pressure of construction projects.

### **5.2.1 Government Subsidies and Policy Support: Dual Roles of Guidance and Support**

The government plays an important role in promoting the development of intelligent building management system. By providing subsidies, tax incentives and other policy measures, the government can encourage more construction projects to adopt intelligent building management systems. This encouragement is not only reflected in financial support, but also in policy guidance and support. The government can set up special funds to support the R&D, promotion and application of intelligent building management system. These funds can be used to fund the R&D activities of relevant enterprises, and also can be used to subsidize the initial investment of building projects using intelligent building management systems. Through the guidance and support of the government, we can effectively reduce the initial investment cost of construction projects and enable more construction projects to adopt intelligent building management systems.

In addition to financial support, the government can also promote the wide application of intelligent building management system in the operation of green and zero carbon buildings by formulating relevant policies. For example, the government can issue relevant policies requiring new buildings to adopt intelligent building management systems to achieve the goal of energy conservation and emission reduction. At the same time, the government can also give some preferential policies to the construction projects using the intelligent building management system, such as reducing some taxes and giving priority to approval. These policies and measures can not only promote the development of intelligent building management system, but also promote the popularization of green zero carbon building operation.

## 5.2.2 Social Capital Cooperation (Ppp) Mode: Dual Introduction of Capital and Resources

In addition to government subsidies, we can also explore the social capital cooperation (PPP) mode to raise funds. PPP mode is a way of cooperation between the government and social capital. It supports the construction and operation of public projects by introducing funds and resources of social capital. In the construction and operation of intelligent building management system, we can actively introduce the cooperation of social capital to jointly promote the development of intelligent building management system.

Through cooperation with social capital, we can introduce more funds and resources to support the construction and operation of intelligent building management system. Social capital can provide financial support for the R&D, procurement, installation, operation and maintenance of intelligent building management system. At the same time, social capital can also provide advanced technology and management experience to promote the continuous optimization and innovative development of intelligent building management system. This cooperation mode can not only reduce the financial pressure of the government, but also improve the construction efficiency and operation quality of the intelligent building management system.

In the PPP mode, the government and social capital can jointly formulate the construction and operation scheme of the intelligent building management system, and clarify the rights and obligations of both parties. The government can be responsible for providing policy support, supervision and coordination, while the social capital side can be responsible for specific capital investment, technical support, management and operation. Through the joint cooperation and efforts of both sides, we can promote the wide application and development of intelligent building management system in the operation of green and zero carbon buildings.

In addition, PPP mode can also bring some other advantages. For example, through cooperation with social capital, we can introduce market competition mechanism to improve the construction efficiency and service quality of intelligent building management system. At the same time, we can also use the professional technology and management experience of social capital to promote the technological innovation and upgrading of intelligent building management system. These advantages can not only improve the performance and efficiency of intelligent building management system, but also promote the development and progress of the entire intelligent building industry.

## 5.3 Strengthen Data Security Management

With the rapid development and wide application of big data technology, the privacy and security issues of construction operation data have become increasingly prominent, which has become a major challenge to be solved. In order to effectively meet this challenge, we must take effective measures to strengthen data security management and ensure the privacy, integrity and availability of construction and operation data.

### 5.3.1 Adopt Advanced Encryption Technology and Strict Access Control

In data security management, encryption technology and access control are two important technical means. We should adopt advanced encryption technologies, such as AES and RSA, to protect the transmission and storage security of building operation data. Through encryption technology, we can ensure that the data will not be stolen or tampered in the transmission process, and can effectively prevent illegal access or disclosure even in the storage process. At the same time, encryption technology can also provide a strong guarantee for the integrity of the data, ensuring that the data will not be destroyed or tampered with in the process of transmission and storage.

In addition to encryption technology, we also need to implement strict access control policies. Only

authorized personnel can access relevant data to ensure data privacy and security. To this end, we can establish a role-based access control mechanism to allocate access rights according to the roles and responsibilities of personnel. At the same time, we can also use advanced technologies such as multi factor authentication to improve the security and reliability of access control.

### **5.3.2 Establish a Sound Data Management System and Emergency Plan**

In addition to technical means, the establishment of a sound data management system and emergency plan is also an important measure to strengthen data security management. We should formulate a sound data classification and confidentiality level management system, classify different confidentiality levels according to the sensitivity and value of data, and take corresponding protection measures. For example, for highly sensitive data, we can adopt stricter encryption technology and access control policies to ensure its security and privacy.

At the same time, we should also establish an emergency plan to deal with potential data security risks. The emergency plan should include the reporting process of data security incidents, response measures, recovery plans, etc. Once a data security incident occurs, we can respond quickly and take effective measures to deal with it, so as to minimize the loss and impact.

### **5.3.3 Strengthen Data Security Training and Awareness Raising**

In addition to technical means and management system, it is also essential to strengthen data security training and awareness raising. We should regularly carry out data security training and education for relevant personnel to improve their data security awareness and skills. The training content can include data security laws and regulations, encryption technology, access control strategies, emergency plans, etc. Through training and education, we can enable relevant personnel to better understand the importance and urgency of data security, and master the necessary data security knowledge and skills.

At the same time, we should also encourage relevant personnel to actively participate in data security management and supervision. They can participate in the formulation and implementation of the data security management system and put forward valuable opinions and suggestions. Through joint participation and efforts, we can jointly maintain the security and privacy of building operation data and provide more reliable and powerful support for the operation of green zero carbon buildings.

In addition, in order to further strengthen data security management, we can also consider adopting some advanced data security technologies and services. For example, we can use data desensitization technology to protect the security and privacy of sensitive data; Adopt data backup and recovery technology to ensure data availability and integrity; Data security audit service is introduced to regularly evaluate and supervise data security management. These advanced technologies and services can provide us with more comprehensive and effective data security.

## **6. Conclusion**

The application of intelligent building management system in green zero carbon building operation is of great significance. It not only improves the energy efficiency and comfort of buildings, but also enhances the safety and operation and maintenance efficiency of buildings. However, there are still some challenges in the practical application. We need to continue to optimize and improve the application strategy of intelligent building management system from the aspects of technology integration, fund raising and data security, so as to achieve the sustainable development goal of green zero carbon building. In view of the challenges faced by the intelligent building management system in the operation of green zero carbon buildings, we can put forward optimization strategies from three aspects: strengthening technology integration and standardization, exploring diversified financing

modes, and strengthening data security management. By formulating standardized interfaces and data exchange protocols, facilitating technology integration innovation through government subsidies and collaboration with social capital, and employing encryption technology, access control mechanisms, and other methodologies to mitigate the complexity and expense associated with technology integration, this study aims to alleviate the initial investment burden of construction projects while ensuring the privacy and security of both construction and operational data. At the same time, we also need to establish a sound data management system and emergency plan, and strengthen data security training and awareness raising to comprehensively deal with potential security risks. It is believed that with the joint efforts of all parties, the intelligent building management system will play a more important and positive role in the operation of green zero carbon buildings.

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