Research on Green New Energy Gymnasium under the Background of Environmental Protection

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Abstract. With society's development, large-span spatial structures such as grids and arch trusses have been widely used in public buildings such as stadiums and stations. Simultaneously, solar energy as a green new energy source has also been significantly developed and widely used. This shows that photovoltaic power generation technology to large-span spatial structures will have broader development prospects. Based on this background, according to the thermodynamic characteristics of the solar fresh air measurement and control system and experimental data, the paper constructs a mathematical model of the green new energy gymnasium system, simulates it, and finally realizes the intelligent control of the solar energy measurement and control system.

Keywords: Green environmental protection, new energy, stadium, photovoltaic power generation.

1. Introduction
Now countries in the world have raised the issue of sustainable energy development. The energy utilization in the 20th century was based on fossil energy, and 90% of the energy was also fossil energy. As far as primary energy is concerned, oil accounts for about 40%, coal, and natural gas each account for about 20%. With the development of the economy, human energy demand is increasing. It is not sustainable to rely on the fossil energy system; energy demand is still expanding, but it is mainly not solved by increasing fossil energy output but to establish energy sustainability. Develop the system and strive to reduce the share of fossil energy. The future energy development mainly depends on nuclear energy and renewable energy. My country's domestic energy resources are limited, and oil production is close to the upper limit of economic development, and it is difficult to increase production by a large amount [1]. At present, the output of natural gas is not much, and the per capita resource is far below the world average. Although the total amount of coal resources is quite large, the per capita resources are still lower than the world average. Besides, coal accounts for 2/3 of my country's primary energy, while oil and natural gas consumption in the world's primary energy structure account for 62.4%. The coal-based energy consumption structure is a fundamental reason for my country's low energy economic utilization efficiency, high product energy costs, and low market competitiveness. Solar energy is another new measure to solve energy supply in a period of tight energy supply.
The sports building is one of the leading public buildings in the city. It is an activity center for various sports and sports competitions. Sports buildings include outdoor stadiums, indoor stadiums, multi-functional comprehensive stadiums, gymnasiums, swimming pools, ice hockey halls, and various training halls. With the development of the national economy, the country's investment in developing sports and improving people's physical and mental health has increased year by year, which has promoted the development of various sports buildings. With the continuous expansion of the building scale of gymnasiums in my country, the research on gymnasiums' energy consumption has been promoted. The background information of related technologies used in this system is summarized and introduced as a whole, and the system explains the necessity of a solar fresh air system in the current social development and the feasibility of system realization. The solar fresh air system is based on the field bus technology iCAN bus, combined with the current intelligent control-fuzzy control, fuzzy PM control, neural network control, and interface production platform, which can effectively, wholly, and concisely realize a set of functions of the system.

2. Low-carbon sports venues and carbon recycling

2.1. Low-carbon stadiums

Low carbon refers to lower or lower greenhouse gas (mainly carbon dioxide) emissions. With the advancement of urbanization and industrialization, the world's climate is facing a severe test, carbon dioxide emissions have increased sharply, and the environment for human existence is seriously threatened. The concept of "low carbon" has warned of the crisis of human existence. Low-carbon society, low-carbon economy, low-carbon production, low-carbon life, low-carbon consumption, low-carbon cities, low-carbon communities, low-carbon households, etc. came into being, and low-carbon economy and low-carbon life became its core content [2]. A low-carbon economy is an economic model based on low energy consumption, low pollution, and low emissions. It is a fundamental change in energy technology innovation, institutional innovation, and the concept of human survival and development. It contributes to energy conservation and emission reduction, the development of a circular economy, and the construction of a conservation-oriented society. It provides a guarantee; a low-carbon life is to minimize the energy consumed during daily life, thereby reducing carbon dioxide emissions, saving electricity, solar terms, turning off the lights for one hour, planting trees, climbing stairs, etc. to achieve a low-carbon life.

2.2. Carbon recycling in stadiums

The carbon cycle refers to a series of processes of mutual transformation of organic and inorganic carbon-containing compounds in nature under the action of organisms and non-biological organisms. The production of sports products in the stadium and the operation and transportation of the stadium, the processing of petrochemical fuels, stadium construction and stadium maintenance materials, the breathing of the population such as athletes and spectators, construction activities and sports activities, etc. and the wetland, soil, vegetation, etc. in and around the stadium together to maintain the concentration of carbon dioxide around the stadiums and stadiums. The energy consumed by construction activities and sports activities mainly include the energy consumption of the human body during the construction process and the energy consumption of the building itself; the energy consumption of sports activities includes the body energy consumption of sports participants and the energy consumption of sports products, such as sports. The loss of sports equipment and sports products by event participants [3]. In short, on the one hand, the carbon cycle ensures the reuse of carbon dioxide resources inside and outside the stadiums and enables the continuous production of plants in and around the stadiums; on the other hand, it removes organic waste in the stadiums and maintains the balance of carbon in the stadiums. The carbon cycle of stadiums is shown in Figure 1:
3. Design of the roof photovoltaic system of the sports center

3.1. Design of photovoltaic system

The photovoltaic system has a small installed capacity and can be absorbed on-site. To reduce the cost and operating expenses, a 0.4kV grid-connected reversible photovoltaic system is adopted. Photovoltaic modules should be selected according to technical conditions such as type, peak power, conversion efficiency, temperature coefficient, module size and weight, power irradiance characteristics, and performance parameter verification should be carried out according to environmental conditions such as solar irradiance, working temperature, etc. Areas with high solar radiation and large direct components should use crystalline silicon photovoltaic modules or concentrating photovoltaic modules; regions with low solar radiation, large scattering components, and high ambient temperature should use thin-film photovoltaic modules [4]. In this system design, select domestic high-quality and high-efficiency 250Wp polysilicon modules. The module parameters are shown in Table 1.

Table 1. Component parameter table

| Cell type       | 156×156 | Peak voltage (V) | 30.4 |
|-----------------|---------|------------------|------|
| Number of cells | 60      | Peak current (A) | 8.24 |
| Size (mm)       | 1650×990×40 | Open circuit voltage (V) | 38.4 |
| Component efficiency | 15.9% | Short circuit current (A) | 8.79 |
| Operating temperature | -40℃ to 85℃ | Peak power (W) | 250 |

In the northern hemisphere, the plane corresponding to the maximum amount of insolation radiation is toward the south. After the inclination of the square array is determined, a reasonable distance between the north-south square arrays should be left to avoid shadows. The distance between the front and rear is the winter solstice (the day where the longest shadow of an object is under the sun in the year) 9:00-15:00, there is no shadow occlusion between the components north-south direction. According to formula (1):

$$D = L \cos \beta + L \sin \beta \left[ 0.71 \tan \varphi + 0.43 \right] / \left[ 0.71 - 0.43 \tan \varphi \right]$$

In the formula: $\varphi$ represents the local latitude (positive in the northern hemisphere, negative in the southern hemisphere); $\delta$ represents the solar declination, the solar declination on the winter solstice represents 23.45°; $\omega$ represents the hour angle, and the hour angle at 9:00 am is 45°; $\beta$ represents the
array inclination; D represents the distance between two rows of arrays; L represents the length of the array slope.

In this system design, domestic high-quality and efficient 250Wp polycrystalline silicon photovoltaic modules are used. When calculating the number of modules in series, the modules' operating voltage and the DC input voltage range of the inverter must be considered, and the open-circuit voltage temperature coefficient of the modules must be considered. According to the grid-connected inverter's performance parameter table, the maximum voltage is 880V, the maximum MPPT voltage is 820V, and the minimum MPPT voltage is 450V. For example, the open-circuit voltage of polysilicon modules is 38.4V, the peak working voltage is 30.4V, and the temperature coefficient of the module open circuit voltage is -0.34%/℃. According to formula (2) and formula (3), the number of modules in series is 20-22.

\[
N \leq \frac{V_{dc_{max}}}{V_{oc}[1+(T_1-25)K_{vo}]}
\]

\[
\frac{V_{mppt_{min}}}{V_{pm}[1+(T_h-25)K_{vw}]} \leq N \leq \frac{V_{mppt_{max}}}{V_{pm}[1+(T_h-25)K_{vw}]}
\]

In the formula: \(K_{vo}\) represents the temperature coefficient of the open-circuit voltage of the photovoltaic module; \(K_{vw}\) represents the temperature coefficient of the working voltage of the photovoltaic module; \(N\) represents the number of photovoltaic modules in series (\(N\) rounded); \(T_1\) represents the shallow temperature (℃) under the working conditions of the photovoltaic module; \(T_h\) represents the too high temperature (℃) under the working conditions of the photovoltaic module; \(V_{dc_{max}}\) represents the maximum allowable DC input voltage (V) of the inverter; \(V_{mppt_{max}}\) represents the maximum MPPT voltage of the inverter (V); \(V_{mppt_{min}}\) represents the MPPT voltage of the Minimum inverter value (V); \(V_{oc}\) represents the open-circuit voltage (V) of the photovoltaic module; \(V_{pm}\) represents the working voltage (V) of the photovoltaic module.

3.2. Energy efficiency analysis of the system
After the completion, according to the average power supply standard coal consumption of thermal power units of 326 g/kWh, the annual standard coal savings are shown in Table 2 for energy-saving and environmental benefits.

| 25-year total power generation (MW·h) | Save standard coal (t) | Reduced CO2(t) | Reduced SO2(t) | Nitride emission reduction (t) | Reduced dust (t) |
|--------------------------------------|------------------------|----------------|----------------|------------------------------|-----------------|
| 12926.2                              | 4,213.94               | 10,956.24      | 92.7           | 42.14                        | 71.6            |

4. Establishment of the solar energy system for the stadium

4.1. Hardware platform
This system's hardware platform uses the CAN bus-based iCAN system to build the field bus data acquisition network. The hardware structure is mainly composed of water pumps, motors, inverters, sensors, electric valves, iCAN series functional modules, PC-CAN interface cards, CAN bus (cable),
on-site host computer, remote host computer, and other components. Figure 2 below shows the overall scheme of the hardware platform of the solar fresh air measurement and control system [5].

![Diagram](image)

**Figure 2.** The overall scheme of the hardware platform of the solar fresh air measurement and control system.

As shown in the figure above, the on-site host computer is connected to the CAN bus through the PC-CAN interface card, and the iCAN function modules distributed on the site are also connected to the CAN bus, so that the host computer and different iCAN function modules are interconnected through the CAN bus. Data communication and control. The iCAN function module can collect various sensor signals and valve feedback signals collected on-site to the host computer, such as pressure signals, temperature signals, valve switching signals, opening signals, etc. The host computer will need to send the control command data again. It is sent to the iCAN function module connected to the actuator through the CAN bus, which will realize the expected control purpose [6]. Between the on-site host computer and the remote host computer, based on the TCP/IP protocol, the remote computer can monitor and control the on-site situation.

4.2. iCAN function module

The iCAN series function module adopts the CAN-bus communication interface and conforms to CAN2.0B protocol specification. It can be used in DCS/SCADA (data acquisition and monitoring system) based on CAN bus as a remote I/O module to collect industrial field data. The iCAN series functional modules are designed for industrial applications and are suitable for various industrial control fields [7]. The iCAN series functional modules are powered by an isolated power supply. The module uses photoelectric isolation between the internal input and output units and the control unit. It takes filtering measures for input signals, which significantly reduces the impact of industrial field interference on the regular operation of the module and makes the module good. The reliability fully meets the needs of industrial applications. As shown in Figure 3.
The iCAN series functional modules adopt corresponding input and output circuits according to the modules’ different functions. The CAN interface is used to realize the sending and receiving of network communication messages. The microprocessor is responsible for controlling input/output modules, data processing, and the realization of network communication [8]. To provide the anti-interference ability of the system, the module is powered by the isolated power supply, the photoelectric isolation measure is adopted between the microprocessor and the input and output modules, and the operation of the module is monitored by the hardware watchdog to prevent the module from crashing, which effectively improves the module Reliability.

5. Conclusion
The distributed photovoltaic system is built on the roof of the stadium, with small capacity, low voltage level, close to the load, and little impact on the grid; low transmission and distribution costs, no need to modify the grid, and can be directly used for the energy demand of the stadium itself. Effectively reduce a large amount of power transmission and transformation losses; it can also play a better role in peak shaving during the peak summer period and reduce peak power demand; at the same time, effectively use the roof and curtain wall of the stadium to reduce land use, and the integration of photovoltaic components and the stadium Installation, with gymnasium function, and can improve the shading and heat insulation performance of the gymnasium. Therefore, distributed photovoltaic systems are an inevitable trend in the development of photovoltaic systems. Promoting the application of solar photovoltaic stadiums is an integral part of promoting energy saving in stadiums. It is of great practical significance for alleviating the energy demand in urban and rural construction and adjusting the energy structure.

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