

Development and Application of Green Building Technologies

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Abstract: As the global population grows, people's demand for residential land has gradually increased. A large number of people have poured into cities, resulting in an increase in various needs for resources, making the original traditional city design extremely burdened. To address this, engineers introduced the concept of smart cities, leveraging technological advancements to enhance urban sustainability and livability. This paper explores the integration of green building technologies into smart city development, aiming to optimize resource use and reduce environmental impact. The research methodology involves literature review and drawing inspiration from various scientific inventions, promoting the use of green technology in the construction of smart cities. This paper finds that green building technologies play a big role in the construction of smart cities.

Keywords: Smart City, Green Building, Solar Utilisation, Water Management, Smart Technology

1. Introduction

Although green buildings have become the mainstream of architectural design, their standards vary across regions. Smart cities aim to address issues such as rapid urban population growth, resource imbalances, inefficient transportation, and the need for technological advancements in city infrastructure[1]. The goal is to create a model of modern cities with high resource utilization, environmental friendliness, and convenient life. At present, this field has made rapid progress. Many new technologies have been used in intelligent transportation, such as real-time traffic management, autonomous driving technology, and improvement of urban transportation and accessibility. However, challenges remain. The lack of consistent standards for smart cities globally, coupled with the rapid pace of technological change, presents obstacles to sustainable management, maintenance, and upgrades of urban systems. The question explored in this paper is: some technologies and concepts in green buildings apply to smart cities and are converted to smart cities for implementation, making the energy utilization of smart cities more efficient and maintaining the environmental friendliness of smart cities. The significance of this study is achieving the goal of sustainable development. The application of green building technology in smart cities can effectively promote resource conservation and low-carbon environmental protection, and provide support for the realization of the Sustainable Development Goals (SDGs) proposed by the United Nations. The application of green building technology helps smart cities reduce carbon emissions, improve resource utilization, and achieve a green, low-carbon urban development model. It enhances the

efficiency of energy usage and supports environmental sustainability. In addition, smart cities can promote the construction of smart life and smart communities, creating a more comfortable and convenient environment for people's daily lives.

2. Application of Green Building Technology in Smart Cities

A smart city represents a modern urban development model compared to traditional cities. It mainly uses various new means such as big data, the Internet, artificial intelligence and other emerging technologies to improve the urban resource utilization, enhance management efficiency, and promote the goal of sustainable development. Ultimately, smart cities are for citizens to have a better living environment and quality of life. Green building, as an innovative construction approach, utilizes BIM (Building Information Modeling) design to reduce construction costs, making the process more economical. Engineers can enhance indoor lighting efficiency, lower a building's energy consumption, and incorporate green spaces around structures to create a comfortable living environment. For instance, roofs are often designed to capture solar energy, converting it into electricity. Green building takes resource conservation, environmental protection and human comfort as its core goals, combines science and technology with environmental protection concepts, and follows the principle of sustainable development from material selection to energy consumption management. It not only address to environmental protection practice but also help to foster a harmonious coexistence between people, buildings and nature.

2.1. Smart Cities Combined with Solar for Green Buildings

A common approach in constructing green buildings is to place solar panels on the roof to convert solar energy into electricity. During peak period of urban electricity consumption, the electricity is transmitted back to the power grid to increase the availability of resources. Similarly, solar panels can be installed along roadsides and on streetlights to collect solar energy and convert it into electricity to keep street lights and signal lights working during the day and night. This approach reduces the reliance on grid-supplied electricity, minimizes energy waste, and improves resource utilization. Currently, challenges exist with solar photovoltaic technology, as it remains relatively immature, with high production costs and low efficiency in converting solar energy into electricity. In addition, the high costs of preservation and maintenance make it difficult for solar technology to fully support the development of smart cities. Therefore, solar photovoltaic technology should be improved to reduce its production and maintenance costs for its widespread in smart cities.

2.2. Integration of Smart Appliances in Smart Cities and Green Buildings

Green buildings recommend that the entire home appliance be integrated through the Internet. For example, smart lights can control whether the light source is turned on by judging whether there is someone at home, while refrigerators can adjust temperatures based on the amount of food stored, resulting in significant energy savings. In smart cities, the convergence of the Internet of Things, artificial intelligence, internet connectivity, and big data is harnessed to integrate and streamline the city's infrastructure. In unpopulated or low-traffic areas, intelligent street lighting systems can automatically detect the presence of individuals to decide whether to illuminate the streets, thereby conserving energy. Additionally, by estimating the movement trajectories of residents, home air conditioning systems can be pre-activated, allowing for a gradual and energy-efficient of the living space, as opposed to the energy-intensive rapid cooling methods.

However, the development of smart home appliances is currently hampered by several challenges. One such challenge is the wide variety of appliance brands, which complicates the ability to control all devices through a single application. Another significant issue is data security. With the frequent

occurrence of data theft, the protection of personal information has become a major concern. To address this, the government should enact legislation to regulate against data theft and consider establishing specialized agencies to protect the data security of its citizens.

Furthermore, the issue of after-sales service for smart appliances cannot be overlooked. The lack of comprehensive post-purchase support means that if a smart home appliance is damaged, it may not be as easily operable via mobile devices, thus complicating its use. Many brands do not offer free services and warranties for an extended period, which diminishes citizens' willingness to invest in high-cost smart home appliances and, consequently, hinders the advancement of smart cities. It is imperative that relevant policies be developed to guarantee the quality of after-sales service, thereby fostering consumer confidence and promoting the growth of the smart home appliance market.

2.3. The use of wind energy in green buildings for the development of smart cities

According to an evaluation report by the China Meteorological Administration, the wind resource in the country is 0.7–1.2 billion kW, of which 0.6–1 billion kW is inland, and 0.1–0.2 billion kW is offshore. Wind power generation can therefore reach 2.21×10^{12} kW h per year, which is almost 17% of total national electricity generation in 2050, the third largest power source in the country [4].

The advancement of wind turbine technology over the next decade is poised to focus on increasing power output, which will involve scaling up the size of turbines. This progress will also be complemented by incremental design enhancements, including refined aerodynamics of rotor blades, the adoption of innovative materials, and the development of segmented rotor blades for ease of maintenance. Control systems are evolving to offer real-time control, monitoring, and management of wind turbines, enhancing their overall performance.

It is anticipated that the combination of increased power and size, along with improvements such as smart rotor blades and enhanced aerodynamics, will expand the operational range of wind farms (by adjusting the cut-on and cut-off points on the power curve). These developments are expected to boost the efficiency of wind farms and, subsequently, reduce the cost of the electricity they generate. This progress will also enable the economic viability of wind turbines in regions with lower average wind speeds[5].

The integration of wind energy in green buildings is a key component in the evolution of smart cities. In the northern parts of my country, where heavy snowfall in winter leads to a significant demand for heating and, consequently, a high demand for electricity, wind energy can play a crucial role. The fundamental principle of wind power generation involves using wind to rotate the impeller of a windmill, converting wind energy into mechanical energy, which is then transformed into electrical energy by a generator—a process analogous to a hand-cranked flashlight generating electricity through manual rotation.

In China, some new skyscrapers, such as the Shanghai Tower, have incorporated large wind power installations atop their structures, with over 270 wind turbines providing an annual output of 1.19 million kilowatt-hours. This serves as an inspiration for smart cities to harness wind power more extensively. The strong winds that often accompany snowfall in the north present a valuable wind power resource that should not be overlooked. Wind turbines can be installed at the ends of streets to capture various wind resources and convert them into electricity, thereby alleviating the pressure of high winter electricity demand in the north.

Currently, one of the primary challenges facing wind power generation is its relatively low efficiency in converting wind energy into electrical energy, necessitating significant technological breakthroughs. Additionally, similar to solar power generation, the high costs associated with widespread deployment and maintenance outweigh the benefits, making large-scale implementation impractical. Nevertheless, wind energy remains a vital renewable energy source. It is imperative that

we continue to improve technology to increase the conversion efficiency of wind energy and reduce the production costs of wind turbines to facilitate their widespread deployment.

3. Conclusion

A smart city is an ideal city created by considering various factors. It has the possibility of sustainable development. It can not only realize the use of wind energy and solar energy mentioned in this article to use renewable energy to produce electricity and alleviate the pressure on urban electricity consumption, but also use smart appliances to reduce the city's electricity loss. Moreover, through the development of science and technology, the construction cost of smart cities will gradually decrease, and the maintenance cost will also gradually decrease, so that any country can build smart cities, which can achieve environmental protection, better protection of the ecology, slow down or even stop the trend of global warming, and our country can also achieve the great goal of carbon neutrality.

References

- [1] Qi Fazhi. (2024). *Application and performance analysis of solar photovoltaic technology in green buildings*. *Foshan Ceramics*(08),125-127+157.
- [2] Han, Chunlei. (2022). *Solar photovoltaic power generation technology status quo and development discussion*. *Light Source and Lighting*(03),95-97.
- [3] Gao YF. (2019). *Research on the innovation path of promotion in physical retail industry--Taking M Smart Home Appliances Company as an example*. *Modern Business Industry* (34), 39-41. doi:10.19311/j.cnki.1672-3198.2019.34.019.
- [4] Sebestyén, V. (2021). *Renewable and Sustainable Energy Reviews: Environmental impact networks of renewable energy power plants*. *Renewable and Sustainable Energy Reviews*, 151, 111626.
- [5] [Bošnjaković, M., Katinić, M., Santa, R., & Marić, D. (2022). *Wind turbine technology trends*. *Applied Sciences*, 12(17), 8653.