ISSN: 2790-5209 DOI: 10.56028/fesr.1.1.55

Research progress of wind energy utilization in building environment

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Abstract

Against the backdrop of the increasing global clean energy crisis, the development and efficient use of clean and renewable energy has become an important theme in today's society. In the use environment of various urban public buildings, the main difference of wind energy is that it can not only be directly applied to the urban buildings itself, but also does not need any transportation tools. According to the development status of building wind energy environment research in china and abroad, the main characteristics of building wind energy environment using wind energy in china are analyzed. the feasibility of using main wind energy in building wind energy environment in china is discussed. the main utilization methods of building wind energy environment using wind energy including natural ventilation system exhaust and building wind energy comprehensive power generation in china are introduced. the comprehensive evaluation of the current building energy saving environment using wind energy comprehensive utilization efficiency is given. the theoretical research results and practical application examples about building energy saving environment using wind energy are summarized. On the basis of this paper, some current hot issues that need further study are proposed in order to provide the basis for the wider application of wind technology in the architectural environment.

Keywords

Building environment; Wind energy utilization; Research progress.

With the ongoing global crisis of renewable energy and natural environment security, it is important to develop renewable and clean energy sources, such as solar and natural wind. Wind energy is a clean energy source without any pollution. The integrated utilization of wind energy is mainly to convert existing wind energy resources into renewable energy sources of other energy types. The comprehensive utilization of wind energy has been widely concerned by the whole world because of its three advantages of no environmental pollution, sustainable access and low energy development cost. Wind power projects are an important form of promoting the integrated use of wind energy. Since the Danish government developed the wind power development plan in 1890 and successfully built the world's first intelligent wind turbine generator in 1891, wind power-related technologies have undergone several twentieth century high-speed development, gradually developed, and have been widely used [4]。Many developed countries in the world, especially in developed countries, attach great importance to the use of wind energy research and development. Since the 1980s, China has been actively exploring the development of new wind power generation, and the large-scale development of new wind power projects into this year's national "11th Five-Year Plan." With the development of modernization and urbanization, on the one hand, the improvement of the quantity and quality of urban buildings, the increase of wind energy in the construction environment, on the other hand, the increase of energy consumption of cities and buildings, the intensification of environmental crisis, the shortage of electricity, and the need to develop new and renewable energy sources make the study of building wind energy technology

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necessary and possible. Compared with other traditional building wind energy utilization materials, the wind energy materials that can be used in energy-saving buildings have great advantages of continuous pumping, and the natural energy utilization can be directly applied to energy-saving buildings themselves, providing a new development perspective for the sustainable development of green energy-saving buildings in China. Engineering science and technology workers at home and abroad have carried out many research projects and engineering science experiments around the concept of this new technology, and have obtained preliminary research results. Based on the in-depth introduction of the basic characteristics of wind energy utilization and the characteristics of comprehensive use of wind energy in the current energy-saving environment of buildings, this paper summarizes the main research results of the comprehensive utilization of wind energy in the energy-saving environment of buildings, and puts forward some hot issues that need further in-depth study, respectively, in order to provide reference for the wide application of wind power technology in buildings.

1. Wind energy characteristics and forms of utilization in the built environment

1.1. Wind energy characteristics in a built environment

This natural wind in the atmospheric boundary layer project, when faced directly with other ground drainage facilities, bypasses a portion of the entire building directly, causing major climate change in the natural landscape around the entire building. With the rapid development of agricultural modernization and industrial urbanization, the pressure of air wind farm in the interior environment of buildings ischanging more andmore. In particular, for high-rise cities with high roof height and population density, due to their rough roof cushion surfaces, may also lead to higher local mechanical velocity turbulence, other local water and wind speed changes may also significantly enhance such as urban high-rise areas with low mechanical speed and high mechanical turbulence relative to the suburbs and other remote areas of the city and relatively small local wind and other geographical characteristics, but high-rise cities may often see similar local wind winds, The roofs of high-rise buildings may often see large areas of local wind speed change, i.e. "roof flow", where a portion of the building's roof openings distinguishes between significant curved vents, and in the absence of strong winds, the wind rises up the top of the building and forms a vortex area around the building as it passes through both sides. Vortex fields are uneven, irregular, random, and sometimes even risky. Therefore, in order to use wind energy in the construction environment, we must first correctly understand the distribution characteristics of wind energy.

1.2. The form of wind energy utilization in a built environment

The main uses of natural wind energy in building wind energy environments can be broadly subdivided into: passive energy use - including natural ventilation and automatic exhaust - depending mainly on natural geography and monsoon climate; Building wind power in the ventilation environment of high-rise buildings, i.e. the installation of a typhoon turbine generator on top of high-rise buildings, which in itself is a direct source of power to save power for construction projects, in order to reduce the maintenance investment in building distribution system lines and the loss of energy for electricity, as well as to promote the future development of green energy-efficient buildings or zero-resource energy-consuming green buildings. Provides a variety of energy sources for building wind joint generator operation in large building environments: stand-alone fan operating mode - the residual energy generated by all wind joint generator operation can be accumulated and stored through the entire

ISSN: 2790-5209 DOI: 10.56028/fesr.1.1.55
battery system and reassembled to other users; The combination of pneumatic hybrid fuel and battery combined power generation, and the wind grid system combined with wind power grid system, are mainly used to power the wind joint generator in small buildings to meet the comprehensive demand for electricity consumption in large buildings and as a backup wind power supply for buildings. When the units of international wind farms are at the peak of wind power use, excess international electricity can enter the international grid and be sold, bringing a certain profit to the user. In the absence of wind power capacity, electricity can be obtained from the grid. This maintenance model does not require maintenance equipment such as power batteries, and the relatively low maintenance costs of subsequent systems significantly reduce the maintenance costs of the power supply system, which is much more economical than the other two models.

1.3. The current research status of wind energy utilization in the construction environment

Compared with the suburbs and the sea, wind farms in the built environment are characterized by increased turbulence and reduced wind speed. In order to improve the efficiency of wind energy utilization in the construction environment, building environmental planning, specific design of building shapes and structures, solve the problem of wind power, strengthen and concentrate wind power is the main issues studied.

According to the local climate characteristics and building types, domestic and foreign researchers analyzed the aggregation effects and factors of various buildings on wind energy, and put forward many models conducive to wind strengthening and concentration, the most representative of which are three centralized models. From 1999 to 2001, British researchers, supported by the network, conducted an in-depth study of diffusion concentrators. Using THED numerical simulation and blow-sweeping test method, the effect of wind power generation in different building types was analyzed and evaluated, and a diffusion concentrator model was established. From 2001 to 2012, delft University of Technology in the Netherlands and the Netherlands Energy Research Centre launched a "Wind Energy Solutions for the Built Environment" research project, thus establishing an architectural model of a flat panel concentrator. Research on wind energy use in China's construction environment is just beginning. 2005 Scholars began to study the wind gain effect and calculation method of high-rise building complex, put forward the concept of wind farm and wind shield, and provided a new way of thinking for the architectural design and reconstruction of the city, that is, how to improve the utilization rate of wind power. In 2008, researchers at the University of Hong Kong used numerical analysis to study the wind energy environment in one, two and more buildings and to analyze the effects of sloping roofs on wind energy use. From 201to the present, researchers from Shandong University of Architecture, represented by Chen Baoming, combined with the climatic characteristics of Jinan, China, combined with the CFD combination, have studied and analyzed the wind power accumulation effect of the three capital construction concentrations and the factors affecting various construction forms.

1.4. Suitable for wind turbine research

Due to the characteristics of the wind environment of the building, the wind used will be different from the traditional wind, because the wind environment of the building is comfortable, the structural wind protection design requirements, the building wind enhancement and accumulation effect is limited to a certain extent. How to improve the efficiency of wind energy in the building environment, wind design is very important.

The use of large-scale wind power is limited to some extent, taking into account the characteristics of wind energy in the construction environment. The development and research of small and medium-sized wind power generation suitable for the construction

ISSN: 2790-5209 DOI: 10.56028/fesr.1.1.55
environment has become a hot topic. Wind power research in building environments focuses on increasing production capacity, reducing noise and vibration, safety and aesthetics. Wind power capacity is proportional to wind speed cubic and wind power efficiency, so wind speed improvement and wind wind efficiency are key technologies.

Currently, the wind turbines available in the construction environment are horizontal shaft wind turbines, vertical shaft wind turbines, centralized wind turbines and improved wind turbines. Among them, horizontal shaft wind power is the most widely used, compared with horizontal shaft wind power generation, vertical shaft wind power has the advantages of convenient installation and maintenance, simple blade design and low cost. And wind can be generated in any direction with a slight noise. In general, centralized wind turbines place a single wheel of a wind turbine in a centralized device (increased speed). The wheels are equipped with lift channels and the rear wheels are equipped with diffusion pipes, which can effectively improve the density of energy flow, overcome wind speed fluctuations, and improve the efficiency and reliability of wind power generation. Building reinforced wind power combined with wind and construction, the use of building to strengthen and concentrate the effect of wind energy, improve the efficiency of power generation. In recent years, researchers have systematically summarized the results of research on small buildings, from horizontal to vertical to improved wind. This paper introduces the research technology and the obstacles to the development of small and medium-sized wind power generation in buildings, analyzes the benefits of small wind power generation, and puts forward the development ideas of small wind power generation.

2. Issues to be considered in the design of wind energy utilization in the building environment

The application technology of wind energy utilization in the main environment of building mainly includes the three technical elements of using wind farm, building main structure and environmental wind power application system. Only these three key elements can work together to make effective use of building wind energy in large building environments. Because the new technology has been involved in construction, wind, mechanical and electrical, architecture, environment and other interdisciplinary research areas. Her main research results are of great universal significance. Since the European Commission introduced large-scale wind power to China's urban infrastructure sector in 2004, scientists at home and abroad have done a lot of research on this, but many problems remain. In order to effectively improve the comprehensive utilization rate of wind energy in high-rise buildings, the following problems need to be further studied and solved

2.1. Improve wind field simulation accuracy

The model location of wind turbulence generator will directly affect the efficiency of wind turbine, the site selection principle should improve the efficiency of wind turbine to the maximum extent possible, and the location should try to avoid being located in the vortex construction area, to minimize the impact of negative vortex structure force, which can require the use of wind field turbulence construction system simulation model high accuracy, turbulence construction model more accurate. Regardless of the integrated use of wind energy at the airport, the wind farm adjacent to the airport wind is more complex than other wind turbine generators, and the high-speed rotation of the turbine engine and wind blades has further changed the interconnected adjacent wind farm, undoubtedly greatly increasing the difficulty of building wind farm load simulation. It brings some difficulties to the simulation and analysis of air field aerodynamic load in the process of high-rise building design in China.

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2.2. Study on comfort in building air environment

In the study of wind energy utilization in the construction environment, most scholars simulate the air environment, mainly to strengthen and increase the wind energy in the building, while ignoring the comfort study. Because people have limited ability to perceive wind speed, wind speed acceleration and wind speed ratio, the study of the enhancement and accumulation of stroke energy in buildings must be based on the requirements of comfort.

2.3. Structural safety and reliability studies

Traditional buildings are designed to reduce the impact of wind power, but in buildings that use wind energy, wind speed is required to be as high as possible in order to improve the efficiency of wind energy utilization, which puts forward new requirements for headwind design. Wind shield construction, the distance between the two towers can reach tens of meters, a large span, support structure in addition to being able to withstand turbine weight, but also can withstand the vibration and vibration of turbine wind, load structure is more complex. In addition, the focus of the study is on the nodes that connect them to dual-component buildings, which are strong enough to minimize the impact of external loads on the building on the other. Wind turbine floors need vertical holes, hole size can reach more than a dozen meters or even dozens of meters, must also bear the load of the upper layer, and in the hole wellhead, air pressure is very large, the force is more complex. Further research is needed on the structure used.

2.4. Design a wind turbine that can be constructed

In high-rise buildings, the difference between wind power and traditional wind power, especially in the form of wind turbines, is not suitable for traditional wind turbines. Any small imbalance in the wind turbine blades is exacerbated by centrifugal forces, causing the turbines to fluctuate as the blades rotate. In addition, if the turbine rotates at the same harmonic resonance frequency as the surrounding components, such as load-bearing beams, the building itself may vibrate, increasing noise on the one hand and adversely affecting the structure and comfort of the building on the other. At present, turbines are designed to adapt to the wind in the building environment, improve power generation efficiency, reduce noise and reduce turbine vibration.

3. Conclusion

At present, wind power generation is the most mature research and use of the most extensive new energy technology, with great prospects for use. With the development of cities and the construction of urban residential buildings, the integration of wind and electric power buildings and other related methods have become a hot topic of research at home and abroad, in the city-specific conditions of effective use of wind power. Vertical axial wind turbine, due to the advantages of installation, maintenance convenience, etc., combined with wind power buildings, more and more widely used. With the development of wind energy and wind energy research, the use of urban wind energy is developing, but at the same time, the industry also faces great challenges, including public recognition and technical reliability. The use of policy incentives and technological innovation can promote the increased use of urban wind energy and the sustainable development of green buildings.

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