Exploration and practice of zero-carbon intra-park in the context of Carbon peaking and Carbon neutrality Goals： A case study on an intra-park

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Abstract. Aiming at the planning of zero carbon park under the background of double carbon, this paper takes an industrial park as an example, and analyzes and evaluates the industrial planning situation, energy resources situation and energy planning situation of the park based on the concept of "passive priority, active optimization". Taking the project as the blueprint, integrating the building energy-saving measures and the advanced nature and carbon reduction ability of the integrated smart energy technology, starting from the overall optimization layout of the park, covering the industrial structure, buildings, transportation, energy and other key areas of the park, the comprehensive application of low-carbon technology forms such as building micro-environment, ultra-low energy consumption building system, efficient integrated energy system and renewable energy. Total carbon emissions as the core goal, to achieve the goal zero carbon zone. This study for the project and project time zero carbon building and future zero carbon park planning to provide the reference of the same kind of park.

1 Introduction

As the basic unit of a city, the park gathers various resource elements such as industry, function, innovation and human resources [1], and is the national and regional engines of economic growth [2], as well as highly aggregated units of social production and life [3]. The zero-carbon upgrading of the park determines the effectiveness and speed of the implementation of the "double carbon" strategy [4]. The current study focused on measuring the sources of carbon emissions in industrial parks, with direct and indirect emissions. Electricity consumption and renewable energy offsets were all taken into account [5]. From an energy use point of view, energy saving and emissions reduction are mainly from the energy, production, transportation, building, and living aspects of parks [6]. Therefore, adjusting the industrial structure, optimizing the energy structure, improving the overall energy efficiency and accelerating the construction of zero carbon parks will become the focus of implementing precise emission reduction and achieving carbon peak and carbon neutrality. Literature [7] the analysis of typical low carbon development both at home and abroad as well as domestic and international low-carbon city development zone model of development, from the policy, the park low-carbon industry circulation loop, low carbon cycle economy and low carbon propaganda Angle are summarized, but applies only to the national development industrial park and other large industrial park, concrete measures and rough granularity. Literature [8] analyzes the typical forms of the integrated energy system of the future industrial park, and discusses the characteristics and connotation of the integrated energy system of the park. Literature [9] summarizes the low-carbon development model of national pilot industrial parks, puts forward the low-carbon development focus of different types of industrial parks, and points out the focus point of low-carbon development of industrial parks. Literature [10] summarizes the research progress of low-carbon park and the key problems to be solved in the future by combing relevant research literature.

At present, there have been a considerable amount of research and practice on how to build low-carbon parks in China. Based on a industrial park as an example, this paper based on the concept of "passive priority, active optimization" to carry out the zero carbon park planning and construction, from the industrial layout, construction and a single building energy saving, comprehensive low carbon energy system, production system and ecological landscape optimization for further work, from the Angle of the park carbon emissions aspects has carried on the quantitative analysis, To provide the reference and help for the zero carbon construction.

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2 Project overview

The project is located in shandong province, the industrial park covers an area of 114700 m2, planning a total construction area of 130000 m2, including the floor area of 120000 m2, underground is about 10000 m2. The park contains about 90000 m2, passive digital processing center residential experiment and demonstration base of about 10000 m2, research and development office center of 15000 m2.

Adhering to the "passive priority to reduce demand, active optimization efficiency" concept, from the layout optimization, construction monomer design, low carbon energy system coordination, to low carbon production technology introduced. Overall layout, carry out the top-level design of zero carbon park, consider the direct or indirect carbon emissions of enterprise production, buildings, park transportation and other aspects in an overall way, and comprehensively promote the transformation of zero carbon production, zero carbon buildings, zero carbon transportation and other application scenarios.

3 Technical route

Zero carbon park refers to the systematic integration of the concept of carbon neutrality in the planning, construction, management and operation of the park. Relying on the zero carbon operating system, carbon neutrality measures such as energy saving, emission reduction, carbon sequestration and carbon sink are integrated by digital means, and low-carbon industrial development, green energy transformation, facility agglomeration and sharing, and resource recycling utilization are realized by intelligent management. Park internal carbon emission and absorption balance itself, production ecological life depth integration of new industrial park.

When creating zero carbon park, need to consider the factors including the energy structure, energy efficiency and unit energy consumption intensity, carbon emissions and carbon intensity, the influence of these factors mainly came from the park building, can use in the field of industrial and traffic demand. Therefore, the construction of zero exploration park mainly starts from energy, construction and transportation, and digitalization runs through the whole process.

The zero-carbon smart park is achieved through the smart energy system of demand-side energy saving + supply-side efficient utilization, supply-side renewable energy use + supply-demand matching.

4 Technical solution

4.1 Layout design optimization

Based on the climatic environment characteristics of Shandong, where the project is located, combined with the actual function of the building and the innovative living concept, the computer physical environment simulation technology is used to simulate and analyze the sunshine, wind environment, lighting system and daylighting and shading, so as to form the overall layout in line with the evaluation requirements of the green park.

(1) The layout of the building group is dense, and the height of the building is considered to be low in the south and high in the north, so as to facilitate ventilation in summer and shelter northwest or northeast wind in winter. The group layout of the building has a great impact on the microclimate environment of the plot and the quality of the public space, so the group layout of the building should be tested and simulated. Through deduction, the daylighting and ventilation in the building should be ensured, the wind speed and wind pressure of the site meet the requirements, and the power consumption of the building due to daylighting and ventilation should be reduced.

(2) to the north and south direction is as a benchmark, monomer building toward the east and by west Angle should not exceed 30 °. Maximize the effective use of sunlight throughout the year, while avoiding cold winter invasion, increase indoor lighting and ventilation, improve indoor comfort.

(3) the reasonable development and utilization of underground space, in the case of guarantee rate and meet the local natural lighting and ventilation of underground car park.

4.2 Single building design optimization

The project plant in accordance with the green factory, smart factory, happiness factory and tourism factory as the goal. According to the "Green Industrial Building Evaluation Standard" GB/T58378-2013, the application of green technology, construction of three-star green industrial building, clean production, to achieve sustainable development.

The research and development office center and the passive residential experimental demonstration base are planned to build near-zero energy consumption buildings. The scheme comprehensively considers the use of optimized building scheme, window-to-wall ratio, fresh air heat recovery, natural ventilation, high-performance building envelope, high-performance doors and Windows, external shading design, high air tightness and intelligent lighting to minimize the demand for cooling and heating of the building. At the same time, the use of efficient cold and heat sources and other renewable energy sources to improve the building's comprehensive energy saving rate and renewable energy utilization rate. The following is explained by taking the R&D office center as an example.

4.2.1 Envelope

(1) High-performance envelope structure is one of the key basic technologies for building energy saving. To realize building energy conservation and emissions reduction, USES the high performance of retaining structure is indispensable, through efficient thermal

insulation technology can avoid building palisade structure heat bridge, reduce construction cold heat loss, protect the main body structure, reduce the temperature stress, increase the life of structure. The difference between the near-zero energy consumption building with high energy saving level and the general building is that not only the external wall and roof are insulated, but also the parapet, partition wall, floor, underground foundation and floor are required to carry out thermal insulation design according to higher standards.

(2) High-performance Windows and doors, enhance thermal insulation and air tightness, reduce the heat transfer load and fresh air load of the building, and minimize the heat gain from radiation in summer by setting adjustable external shading; This project increase hovel in complex building hall design, reduce the cold winter. At the same time, the project uses high-performance exterior Windows and exterior doors.

(3) There are many factors for building heat gain in summer, among which solar radiation is an important factor affecting the cooling demand of buildings in summer, and solar illumination will bring large building heat gain in summer.

(4) In the design of high-performance buildings, the generation of thermal Bridges is more strictly controlled, and the non-thermal Bridges are designed for the outer protective structure of the building to reduce the local heat loss of the building, lower than the indoor dew point temperature, and avoid the damage of building mildew and condensation caused by moisture intrusion. During the design and construction, it should be ensured that there is no thermal bridge on the roof, exterior wall, ground and exterior Windows of each building.

(5) In order to reduce indoor seepage load, need to take a series of technical measures of dealing with the envelope connection nodes, gas-tight can meet specified requirements. Such as the connection between doors and Windows and external walls; Sealing treatment of pipe through wall; Install the seal of the switch socket hole and so on.

4.2.2 Efficient heat recovery system

The complex building of this project is an office building with dense personnel and large demand for fresh air. This plan requires the building to set up fresh air heat recovery. In the system plan, heat recovery technology is used to utilize the surplus cold and surplus heat of exhaust air.

4.2.3 Efficient cooling and heat sources

Based on renewable energy and energy efficiency project system, the engineering complex building adopts high efficient heat recovery fresh air units and fan coil air conditioning system, cold source using ultra-low temperature air-cooled heat pump units + water storage; The heat source adopts ultra-low temperature air-cooled heat pump + water heat storage, which fully improves the energy utilization rate of the building and reduces the operating cost.

4.2.4 Energy efficient lighting

The energy consumption of lighting system generally accounts for 20%-40% of building energy consumption. For buildings with stable personnel and lighting equipment such as office buildings, the energy saving potential is great. The project lighting system adopts LED lighting, and the project will use intelligent lighting control technology to control the lighting system according to personnel activities and outdoor sunlight.

4.3 Smart low-carbon energy design

Smart low carbon energy system includes cold and heat source system, domestic hot water system, solar photovoltaic system, smart micro grid system and smart low carbon control system.

(1) Based on the project is nearly zero energy consumption target and demonstration benefits, fully considering the project basic conditions and the owner, the cold and heat source system configuration scheme of the project. According to the project energy resources conditions and load characteristics, priority is given to the selection of air source heat pump and energy storage system and other energy-saving technologies.

In research and development office center, for example, at the end of project adopt fan-coil unit plus fresh air system, heat pump units in summer a separate design for the return water temperature on 7/12 ℃, cool storage system to participate in the design for the return water temperature on 7/15 ℃, winter design for 45/40 ℃ by monitoring the return water temperature.

Heat pump heating, decrease the design conditions of water temperature not only can improve the COP value of heat pump units, reduce the operation cost, and meet with the project of energy conservation and environmental protection concept. According to load conditions during operation, to set heat pump units out of the water temperature in stages. At the beginning and end of the heating season, set a lower water supply temperature; At the beginning and end of the cooling supply, set a higher water supply temperature to improve system efficiency and reduce system operating costs.

This project is preferred by end of the heat pump system for building foundation of cold and hot load, peak period of electricity during the day can release.

(2) using solar energy light heat as living hot water heat source, solar thermal system is the efficient use of solar energy is a renewable energy, concentrated solar thermal system has the advantages of high integration, stability of water supply, and beautiful. The roof of the project is set up with a full glass vacuum tube collector to form a solar heat collection system. The full glass vacuum tube solar collector is used, and the collector is set in series and parallel.

(3) This project adopts the solar photovoltaic (pv) + battery as regional renewable energy power generation of local power supply. The PV modules of this power station project are installed on the roof of the joint workshop, using BAPV installation with slope, the

azimuth Angle of the module installation is 14°, and the total installed capacity is 2391.12kW.

(4) This project is based on the park energy system to establish a smart micro-grid system as the energy basis for the application of smart energy in near-zero energy consumption buildings. By setting up photovoltaic power generation, power storage system, flexible load absorption equipment, energy equipment close to the demand side, make full use of new energy and renewable energy power generation, realize the miniaturization system of local power generation and demand matching, which has the characteristics of clean and environmental protection, high flexibility and high efficiency. When controlled reasonably, it can significantly improve the reliability of energy consumption and reduce the investment in transmission and distribution network.

(5)The project is equipped with a composite energy system composed of air source heat pump, water storage, solar hot water and solar photovoltaic. At the same time, the building adopts high-performance active sunshade, intelligent lighting and other equipment, and combines the actual use function and building energy monitoring needs to set up relevant energy management platform. Energy system informatization, automation, digital features is an important support of intelligent energy, the project is based on the actual use requirements to build high intelligent and strong demonstration, the wisdom of the energy management cloud platform. The multi-energy complementary system in smart energy involves massive data, and there are requirements for data processing and calculation, real-time data analysis and data sharing. The application of big data and cloud computing technology in smart energy is to solve the complexity problem of data type, computing theory and system architecture. Cloud computing is an intelligent foundation based on big data, data computing technology as the means, and cloud platform as the infrastructure. Big data and cloud computing technology Through the establishment of cloud computing platform, the massive dynamic data in the intelligent energy processing analysis and intelligent application, so as to realize the scheduling decision.

4.4 Optimization of landscape ecological programs

The project design and implement "people-oriented" the guiding ideology, through elaborate design, the environment design in the factory the factory and dormitory, complex well reflect integrity and practicability of reasonable division, on the design of the scenic spot the pursuit of nature and harmony. Based on the characteristics of large factory floor area, high comprehensive runoff system, large net rainwater flow, small green roof space, low green land rate and less pavement area, the technology library of sponge city in the park is constructed based on the principles of economic feasibility and technical rationality, and the guidance of function strength and suitability is put forward.

4.5 Low carbon production technology

(1) On the basis of product production logistics, determine the workshop process layout, so that the workshop logistics and factory logistics are fully integrated, so that the workpiece logistics is smooth, convenient and orderly, and unnecessary parts are reduced: create conditions for lean production, economic batch distribution, on-time processing and distribution, and improve the production efficiency of workpiece processing and distribution.

(2) Adopt the production organization mode combining process specialization and productization, set up the cutting section, welding processing section and painting section, and improve the processing and production efficiency.

(3) New automatic welding production equipment to reduce labor intensity and improve production efficiency.

(4) The sorting area is set to reduce the cutting production time occupied by the material picking after cutting. The cleaning and sorting storage area of the cutting plate is set at the back end of the cutting machine to realize the fixed-point material picking

5 Calculation of carbon emissions

Through the application of the overall low-carbon technology in the park, the comprehensive energy consumption per unit building area of HVAC system, lighting, domestic hot water and elevator of the complex building is 92.25kWh/(m2.a), and the annual carbon emission is about 425 tons, under the condition of air tight measures and without considering the external photovoltaic access of the building. The comprehensive energy consumption of rental housing unit building area is 67.52 kWh/ (m2.a), and the annual carbon emission is about 205 tons. Park plant construction is carried out in accordance with the green building three star, without considering the production under the condition of energy consumption, the HVAC, lighting, living hot water in carbon emissions about 1200 tons. Joint workshop roof adopts BAPV with slope to install pv single crystal components, with a total installed capacity of 2391.12 kW, an annual capacity of 2.377 million kWh, 1862 tons of carbon dioxide.

This project aims at zero/low carbon park. Through the efficient utilization of renewable energy, near zero energy buildings, and the application of smart low carbon energy related technologies, the total annual carbon emission of buildings in the park is about 1822 tons of HVAC, lighting, domestic hot water and elevator system. The carbon emission reduction of photovoltaic renewable energy generation in this project can meet its carbon emission. Achieve the goal of zero carbon building and energy field.

6 Conclusion

The project in a park as the goal, zero carbon/low carbon energy investment and energy technologies by integrating park, based on passive and active optimization design principles, from the source to reduce carbon emissions in the industrial park. The top-level layout design park layout, construction, transportation, production and other aspects, build give priority to with renewable energy of zero carbon energy system, and supporting infrastructure, such as intelligent control platform effectively integrated comprehensive energy planning. Through the application of near-zero energy buildings, smart low-carbon energy and other related technologies to reduce the basic carbon emissions of the park, the carbon reduction of photovoltaic renewable energy power generation can meet its carbon emissions. From the park, construction level to the indoor outdoor green, low carbon design, through the establishment of low carbon environment and improve living behavior.

(1) the complex building of office and apartments rental housing 2 buildings designed and built according to nearly zero energy consumption building standards. Among them, the comprehensive energy saving rate of the complex building is 60.56%, the energy saving rate of the building body is 48.71%, and the utilization rate of renewable energy is 30%. The overall energy saving rate of rental housing is 61.13%, the energy saving rate of the building itself is 53.17%, and the utilization rate of renewable energy is 30%.

(2) Based on the low level of energy consumption in the zero-carbon park, the concept of smart energy is innovatively penetrated and demonstrated, the construction and control of smart energy system is combined with zero-carbon technology, and a micro-grid and intelligent management platform are planned to be built in the future. This project intends to use the smart energy management system of the park to establish the first smart energy demonstration with zero carbon characteristics in Shandong Province through the informatization of energy systems, the intelligence of operation links, and the synergy and complementarity of multiple energy sources.

(3) Through the planning and design of zero carbon park, the annual carbon emission of the near-zero energy consumption building complex is about 425 tons; The annual carbon emissions of rental housing are about 205 tons. The plant in the park is constructed according to the three-star green building. Without considering the production energy consumption, the annual carbon emission of HVAC, lighting and domestic hot water is about 1200 tons. The roof of the joint factory adopts BAPV to install photovoltaic single crystal modules along the slope, which can reduce carbon dioxide by 1,862 tons per year, and the carbon emission of the park reaches the standard of approaching zero.

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