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Research on Green Intelligent Building Design Strategy for small infrastructure project of Fujian Electric Power Company of State Grid

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Abstract. In order to realize the green and intelligent development of small infrastructure projects of State Grid Fujian Electric Power Company, and help the national strategic development goals of carbon peak and carbon neutrality, this paper analyzes and summarizes the green and intelligent design strategies suitable for small infrastructure projects of State Grid Fujian Electric Power Company, and help the green, low-carbon and intelligent transformation of State Grid Fujian Electric Power Company.

Keywords: Small infrastructure, green, low carbon, intelligent, design strategy

1. Research background

The "double carbon" goal sets out a clear timetable for the transformation of our energy structure, which will have profound influence on the economic life of the society in the future. As a large energy consumer, small infrastructure projects of State Grid Fujian Company are closely related to carbon emissions. With the rapid development of the Internet of Things, big data and artificial intelligence, intelligent buildings are of great significance for helping green and low-carbon, enterprise management and user experience. It is of great significance for State Grid Fujian Company to realize green, low-carbon and intelligent transformation that how to conduct analysis, research and overall consideration from the initial stage of construction and design, change traditional concepts and methods, and adopt appropriate green and intelligent design strategies and technologies.

2. Current situation investigation

Fujian Company has a large number of production and operation houses (about 200 in stock), diverse building types, and generally high building energy consumption. In 2021, the total comprehensive energy consumption of State Grid Fujian Electric Power Company is 14147983.72 kgce, with an average increase of 2.46% in recent three years. Per capita energy consumption is 736.26 kgce/p, and the average energy consumption per building area is 17.42 kgce/㎡ (Figure 1). The application of green and low-carbon technologies in buildings is not emphasized enough, and the application rate of renewable energy is low. The overall intelligent configuration level is low, and only basic intelligent modules are configured. The coverage of intelligent energy management system and environmental management system is low, and system integration and display are rarely used. Based on this, Fujian Company, together with Fujian Architectural Design and Research Institute Co., LTD., carried out research on the green intelligent design strategy of small infrastructure projects, compiled the green intelligent design guide suitable for small infrastructure

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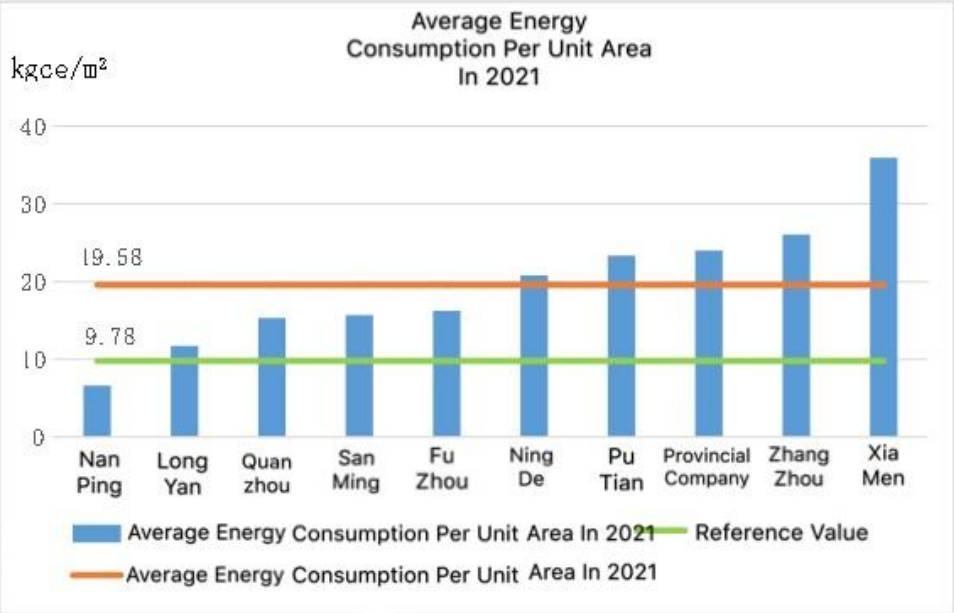
projects of Fujian Company, and accelerated the green low-carbon and intelligent transformation of Fujian Company.



(Figure 1, average energy consumption per unit area of power supply companies and business support institutions in each city in 2021)

3. Design strategy research

3.1 Energy conservation

At present, the phenomenon of energy shortage is more and more prominent, resulting in the contradiction between supply and demand is more and more obvious. As an important guiding ideology to solve economic and energy problems, low-carbon concept takes energy saving as the core and goal of development, which is consistent with the original intention of green and low-carbon design. As an energy enterprise, State Grid should take the lead in demonstrating and setting an example in energy saving behavior. Small infrastructure projects of Fujian companies should adopt appropriate energy saving strategies according to the climate conditions of Fujian Province.

3.1.1 Energy saving of enclosure structure

Fujian Province spans two climate zones: hot in summer and warm in winter and hot in summer and cold in winter. In the annual energy consumption of public buildings such as small infrastructure of State Grid Fujian Company, about 20% of the energy consumption of air conditioning is consumed by the heat transfer of the external envelope. Therefore, the thermal performance of the envelope should not be ignored. The heat consumption caused by the indoor and outdoor temperature difference of the roof as the outer protection structure of the building is greater than the heat consumption of any external wall or the ground. The planting roof can be used to improve the ability to resist the outdoor heat effect of the roof in summer. In areas with hot summer and warm winter, solar radiation is strong in summer and sunshine duration is long. Building shading can effectively block direct sunlight into the room, reduce building energy consumption, and improve indoor thermal comfort. For different building functions and adverse orientation, small infrastructure projects give priority to the integrated design of building shading and set shading measures in combination with building facades. In addition, natural ventilation is also an economical and energy-saving appropriate technology. Ventilation corridors are set in combination with the overall layout, ventilation paths are combed in combination with the indoor plane, and hot

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pressure ventilation and other principles are used in appropriate seasons to reduce the use of air conditioning and reduce energy consumption.

3.1.2 Energy saving of the air conditioning system

Air conditioning energy consumption in summer is the main component of building energy consumption in small infrastructure projects, which is very important for energy saving. High energy efficiency air conditioning equipment can reduce the electricity consumption of air conditioning. Small infrastructure projects should adopt appropriate air conditioning system types and high energy efficiency air conditioning equipment according to the scale and function of each building, and adopt high energy efficiency air conditioning equipment for the energy consumption of each air conditioning system, and combine with intelligent control system to ensure accurate adjustment of stable indoor temperature and humidity requirements. For small infrastructure projects with large inner space, the air conditioning system should be reasonably divided based on factors such as the layout of building functional areas and the variation trend of air conditioning load, so as to meet the diversified needs of use. At the technical level, the application of energy saving and emission reduction technologies such as free fresh air cooling technology, heat recovery technology, pump frequency conversion transmission and distribution technology, and efficient refrigeration room technology should be encouraged. By adopting the partition control strategy at the end of air conditioning, more diversified control and hot and cold recovery means can be realized through reasonable internal and external and multifunctional partition scheme, which has great energy-saving effect on the thermal comfort adjustment of the room in different seasons and the annual energy consumption of the air conditioning system. In addition, in terms of technical energy saving, it is recommended to use the high efficiency refrigeration room first. In terms of operation management, it makes full use of the energy efficiency management monitoring and energy saving control system, and integrates the operation strategy of the high efficiency cooling and heat source equipment and the transmission and distribution system in the room, so as to make the air conditioning system in the high efficiency and the highest operating range, and consolidate the energy saving and emission reduction target of the air conditioning system. Realize energy-saving operation of the system; Secondly, frequency conversion transmission and distribution system should be adopted to solve the problem of low efficiency of water pump and realize energy saving of transmission and distribution system through intelligent frequency conversion control operation of water pump and distributed multi-stage pipe network configuration.

3.1.3 Water Saving

In terms of water saving, small infrastructure projects should adopt sanitary and water-saving appliances with high water efficiency. More than 50% sanitary appliances of a class of dispatching and production management rooms and operation and maintenance and repair production rooms should be selected products with water efficiency grade I, and the other types of buildings should reach Grade II. Spraying irrigation, micro-irrigation, low-pressure irrigation and other high-efficiency water-saving technologies should be adopted for greening irrigation of a class of dispatching production management buildings and operation maintenance and repair buildings. Indoor should use high energy efficiency energy-saving water heater, choose high electric heating conversion efficiency, good thermal insulation performance, energy saving water dispenser can be used with heat source.

3.1.4 Energy saving of electrical equipment

Among electrical equipment, lighting system is also a large power consumption in the operation process of small infrastructure buildings. Efficient lighting system should be selected for indoor space, and LED lamps are preferred as the main lighting equipment. In the areas with natural lighting, artificial lighting and zoning control should be rationally arranged. For the lighting of walkways, stairwells, underground garages and other places, zoning, timing induction and other

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energy-saving control measures should be adopted. The elevator should be equipped with energy-saving control measures such as car unmanned automatic lights off and drive sleep. For a class of small infrastructure projects should choose frequency control and "energy regeneration type" elevator.

3.2 Create green and healthy office space

With the rapid development of modern science and technology, under the influence of new ideas, new technologies and new materials, the connotation and extension of office activities have been expanded again, and the office environment has developed towards a healthier, comfortable and intelligent direction. In all types of buildings of the small infrastructure project of State Grid Fujian Company, except the material warehouse, most of the building types are mainly office space. Therefore, to create a green, healthy and comfortable office space is also the focus of small infrastructure project design.

3.2.1 Indoor air quality control

According to the report of the World Health Organization, people's air pollution exposure mainly comes from indoors. Indoor air quality is more important to people's health than outdoor air. Most people spend 1/3 of their time in the office every day. The deterioration of indoor air quality can be harmful to the health of employees. Among many air quality problems, indoor air pollution caused by decoration is the most eye-catching. According to environmental epidemiological studies, 1/3 of "sick building" diseases are caused by formaldehyde and volatile organic pollution released by decoration materials. Especially the modern office building decoration uses a lot of artificial composite materials, the space is closed, indoor pollutants are not easy to spread out, making the problem more severe. Small infrastructure projects should be controlled from the source. Green, environmentally friendly and safe interior decoration materials should be selected, and the limits of harmful substances such as formaldehyde, benzene, ammonia, radon and total volatile organic compounds in interior decoration materials and materials should be controlled. Optimize the building space and plane layout, improve the natural ventilation effect of the building, and strengthen the indoor natural ventilation by adding Windows to the building facade or setting ventilation devices. In the air handling unit of the main functional space such as office, conference and other effective air purification treatment measures are set up in the medium efficiency filter section, air purification device; Indoor air quality monitoring systems should be set up in command centers, dispatch centers, large meeting rooms and other areas with high personnel density and large changes over time. Data collection and analysis of indoor carbon dioxide concentration should be carried out and linked with the ventilation system. For projects with underground garages, carbon monoxide concentration monitoring devices linked with exhaust equipment should be set up. The exhaust design of toilet, restaurant, kitchen, garbage room, underground garage and other areas of the building should avoid the collusion of air and pollutants into other Spaces or outdoor activity places.

3.2.2 Green building materials

In order to achieve comprehensive practice of green building, the application of new, green and environmentally friendly building materials is also an extremely important link. The use of green building materials can reduce environmental pollution and energy consumption. The design of small infrastructure projects must choose green building materials that can achieve a virtuous cycle, such as grass wallpaper, plastic and metal composite pipes, solar lighting, biological latex paint, etc. This kind of material has obvious advantages in meeting building quality requirements, saving energy and reducing consumption, controlling pollution, improving resource utilization rate and improving project economic benefits. Therefore, products certified as green building materials should be preferred in the project (FIG. 2). The application ratio of green building materials

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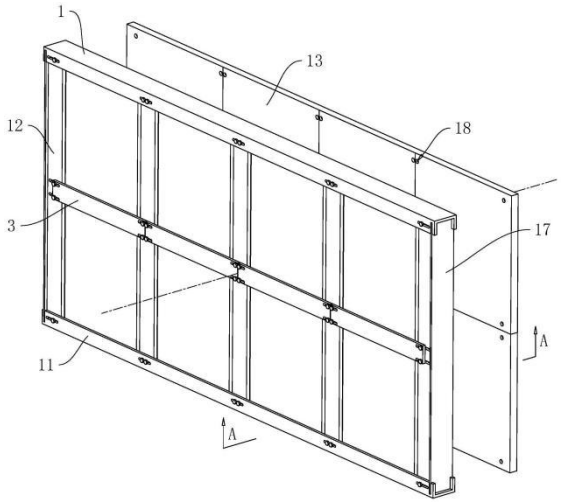
certification should not be less than 50% for category 1 projects, and not less than 30% for category 2 projects.

(FIG. 2 Green Building Materials Certification Mark)

3.2.3 Adaptability of indoor space

The interior space design of all kinds of small infrastructure projects is designed in accordance with the current corresponding construction standards and use requirements, in order to meet the existing demand conditions as the design foothold, and the future development of the space is not too much consideration. The result of such design is often the inflexibility and lack of adaptability of the space, which cannot meet the needs of future functional changes and development. In today's society, the industrial age is stepping into the information age. The acceleration of the pace of life and work makes adjustment, development and change become the characteristics of The Times. The static and limited office mode no longer meets the requirements of social development. Open office has brought about a series of positive effects, such as flexibility, communication and cooperation and innovation, but the disadvantages of open space in the face of epidemic prevention are obvious. We emphasize the use of flexible spatial design mode in office space, the building plane is based on modular design, and the partition mode of light partition wall is adopted between various functional Spaces (FIG. 3). In order to meet the current functional requirements, privacy and epidemic protection requirements of the indoor space, the layout of the space has greater changes and freedom of combination.



506/5000 (FIG. 3 Light steel keel partition wall)

3.3 Promote the use of renewable energy

Improving the application of renewable energy in green buildings can effectively reduce the carbon emissions of buildings, reduce the emission of pollutants and protect the ecological environment. As an energy enterprise, State Grid should first set an example in the utilization of low-carbon renewable energy and increase the application proportion of renewable energy in small infrastructure projects. According to the actual situation of small infrastructure projects, Choose suitable renewable energy utilization strategy according to local conditions.

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3.3.1 Solar photovoltaic technology

Compared with other forms of energy, solar power generation has the advantages of no pollution, no emissions of greenhouse gases, no fuel consumption, no noise, so solar energy is widely used as a free, efficient, clean renewable "green" energy. From the perspective of world energy supply security and clean utilization, countries around the world are taking the commercial development and utilization of solar energy as an important development trend. In the small infrastructure project of Fujian Company, the outdoor area that meets the sunshine hours of more than 3 hours all day on the winter solstice should adopt the green tram space integrated with light storage and charging. Materials warehouses with large roofing areas and a large number of township power supply offices should be equipped with solar photovoltaic panels on the roof. Other small infrastructure projects should be equipped with solar photovoltaic panels according to the conditions of the roof (FIG. 4). If conditions allow, buildings should adopt integrated building photovoltaic curtain walls (FIG. 5) or photovoltaic sunshades combined with the building facades. In the design of photovoltaic system, the type of photovoltaic system should be determined according to the building function, power grid conditions, load nature and system operation and other factors, and should be equipped with anti-countercurrent, anti-island effect protection measures.

(FIG. 4 Building roof PV system source: Goode Design Network) (FIG. 5 Building PV integration source: Goode Design Network)

3.3.2 Air source Heat pump

The air energy heat pump water heater is mainly composed of a heat pump host similar to an air conditioner outdoor unit and a large capacity pressure insulated water tank. The specifications range from 0·7kW to 100kW, and installation is not subject to building or floor restrictions. Use is not subject to climatic conditions. With high efficiency, energy saving, safety and environmental protection, all-weather operation, easy to use and many other advantages. Its thermal efficiency is 4 times that of electric water heater and 4 ~ 6 times that of gas water heater. On the premise of guaranteed use. It's also more efficient than solar water heaters. Air energy heat pump water heater due to the use of heat pump technology, can be a large number of low-grade heat energy (heat in the air) through the compressor and refrigerant, into high grade heat energy, energy efficiency ratio above 3.0, that is, the compressor of air energy heat pump water heater consumes 1kWh electricity, can produce electric heating consumption of 3kWh electricity generated hot water, greatly saving energy. For buildings with stable hot water demand for small infrastructure projects, priority should be given to using air source heat pump system to provide hot water.

3.3.3 Utilization of waste heat and waste heat

Due to the considerable energy contained in the air conditioning area (or room) exhaust wind, when the technical and economic analysis is reasonable, concentrated recycling can achieve good energy saving and environmental benefits. Exhaust energy recovery should meet the following requirements: For small infrastructure projects with centralized air conditioning systems, exhaust air

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should be used for preheating (pre-cooling) treatment of fresh air to reduce the fresh air load, and the rated heat recovery efficiency of exhaust heat recovery device (total heat and sensible heat) should not be less than 60%; Adopt two-way ventilation device of fresh air and exhaust air with heat recovery, and the rated heat recovery efficiency of two-way ventilation device is not less than 55%; When small infrastructure projects adopt fresh air units with independent electric cooling source, indoor low temperature exhaust air is used to cool the condenser in summer, and indoor high temperature exhaust air is used to heat the evaporator in winter, so as to make full use of the cold/heat in the exhaust air and improve the energy efficiency ratio of the fresh air unit.

3.3.4 Water source Heat pump technology

Water source heat pump (WSHP) technology is a technology that uses shallow surface water as an energy source and realizes energy conversion in the process of transmission. The shallow water and soil on the earth's surface are like a large heat collector, in which the heat energy mainly comes from the sun. The temperature of shallow surface water used by WSHP is constant, no matter what the season is. The water temperature is always about 10~2530℃. In winter, the water source temperature is higher than the ambient temperature, and in summer, the water source temperature is lower than the ambient temperature, so it is a very good heating and cooling energy. There are abundant surface water resources in Fujian, which can be fully utilized as the cold and heat source of surface water source heat pump units. The water source heat pump air conditioning technology can be used in Class I or Class II small infrastructure projects where conditions permit.

3.4 Intelligent Multi-Scenario Configuration

3.4.1 Intelligent Energy Consumption management system

How to do energy-saving work of Fujian Company's small infrastructure projects in a large range is inseparable from the data analysis of building energy consumption equipment. Fujian Company should gradually set up online monitoring and itemized metering devices for building energy consumption of new and existing small infrastructure projects, and automatically carry out statistics, calculation, diagnosis, evaluation and analysis of energy consumption monitoring data to optimize the operation control strategy. Besides, it is equipped with monitoring system of distribution power station and floor distribution monitoring system, and adopts centralized monitoring, statistics and control for small infrastructure projects that adopt photovoltaic energy storage power generation technology.

3.4.2 Intelligent Device Management System

Intelligent control of the equipment system of small infrastructure projects, to create a healthy and comfortable intelligent space, such as the indoor and outdoor lighting system to adopt intelligent lighting control, according to the needs of the region, time segment automatic control, for class II and above small infrastructure projects, to create the intelligent lighting management system of each floor office area, to achieve no automatic lights out, lighting analysis lighting. And through the illuminance control system, to achieve the building each floor office area lighting illuminance and color temperature automatic control. Intelligent control is carried out for the HVAC system, and differentiated temperature and mode control is implemented. The fresh air system of the building is equipped with environmental monitoring sensors, and the ventilation system is automatically controlled according to the indoor pollutant index.

3.4.3 Intelligent Security Management System

Build a one-card management system for small infrastructure based on the epidemic situation, so that internal staff can pass without feeling, check attendance, and external staff can make an appointment to manage the passage and check the passage of epidemic prevention. Access permission management is carried out for the designated areas by levels, time segments and regions,

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and non-perception face recognition can be realized in specific office Spaces to improve the security and convenience of personnel management in small infrastructure projects.

3.5 Build the smart platform of the State Grid

In the case of intelligent multi-scenario configuration, the small infrastructure project of Fujian Company should improve the integration of intelligent system, get through the data of all subsystems, rely on the Internet of things technology to gather all kinds of operating data, and build the comprehensive service intelligent platform of Fujian Company. On the smart platform, historical data can be calculated and compared to learn and adapt to the individual needs of building users according to their daily artificial Settings and usage habits. Finally, the intelligent adjustment of the small infrastructure project system and the information sharing between the systems can be realized to improve the efficiency of intelligent management, so as to save energy, reduce labor costs and improve maintenance efficiency.

4. Green intelligent hierarchical modular configuration

Small infrastructure projects have various types and different construction standards, so different design objectives should be formulated according to different types and levels. For example, a small infrastructure project is designed against the two-star green building design standards and intelligent to meet the design requirements of the intelligent level. A second small infrastructure project is designed against the one-star green building design standards and intelligent to meet the design requirements of upgrading. Other small infrastructure projects are designed according to the basic green building design standards and intelligent to meet the basic design requirements. For different design objectives, different green and intelligent design strategies are adopted, and each green and intelligent design measure is modular and hierarchical configuration (Table 1, Table 2), and menu-style management is convenient to guide engineering practice.

Green building design module				Dispatch production management room				Operation and maintenance of production rooms			Marketing service room		Township power supply office	Warehouse of supplies	
Major in Design	Category	Green Building Initiatives	The numerical	A class	The second	Three types of	Transform	A class	The second	Three types of	The second	Three types of	A,B,C	A class	The second
General graphic design	Site safety	Set up anti-fall object buffer zone, isolation zone		●	●	○	○	●	●	○	●	○	○	○	○
		Anti-skid measures are installed on		●	●	○	○	●	●	○	●	○	○	○	○

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		the outdoor ground or pavement													
	Site planning and outdoor environment	Choose native plants and multi-layer greening		●	●	○	○	●	●	○	●	○	○		
		Take reasonable measures to enhance natural ventilation in summer and transition seasons to avoid cold air in winter		●	●	●		●	●	●	●	●	●		
		People and vehicles in the construction site		●	●	○		●	●	○	●	○			
		It is reasonable to use the site space to set up green rainwater infrastructure such as		●	●	○	○	●	●	○	●	○	○	○	○

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		permeable paving, concave green space and rain garden													
	Site resource utilization	Improve the utilization rate of the site space, reasonable development and utilization of underground space		●	●	○		●	●	○	●	○			
		Mechanical parking facilities, underground parking garages or ground parking buildings are adopted reasonably according to the site conditions		●	●	○		●	●	○	●	○			
		Charging parking Spaces should be set up for		●	●	●	○	●	●	●	●	●	○	○	○

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		ground parking Spaces, and green tram Spaces integrated with light storage and charging should be used in areas with full sunshine hours of more than 3h on the winter solstice													
Architectural design	Space layout	The location of noise sources such as equipment should be fully considered in the building plane and spatial layout to avoid noise interference		●	●	●	○	●	●	●	●	●	○	○	○
		Indoor public areas, outdoor public activity		●	●	○		●	●	○	●	○	○		

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		venues and roads should meet the barrier-free design requirements, and buildings should be designed with barrier-free elevators that can accommodate stretchers													
		Setting up fitness venues and Spaces		●	●	○		●	○	○	○	○			
		The building space ADAPTS to the change, the use of universal, flexible space design		●	●	○		●	●	○	●	○			

(Table 1, Excerpt from Green Building Modular Configuration Table)

Intelligent design module				Dispatch production management room				Operation, maintenance and repair of production rooms			Marketing Services room		Township power supply	Supplies warehouse	
Category	Subitems	Level	Intelligent	Acl	The sec	Three	Transform	Acl	The sec	Three	The sec	Three	A,B,C	Acl	The sec

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			measure	ass	ond	types of		ass	ond	types of	ond	types of		ass	ond
Intelligent Energy Management system	Energy management	Basic level	Building energy consumption online monitoring and itemized metering devices should be set up	●	●	○	○	●	●	○	●	○	○	○	○
		To upgrade	Building energy consumption monitoring data application, should be able to achieve automatic data statistics, calculation, diagnosis and evaluation of the analysis function, can optimize the operation control strategy based	●	○			●	○		○				

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			on energy consumption data analysis												
	Power Supply and Distribution System Management	Basic level	It can monitor the power parameters of the main equipment in the building floor in real time, configure the power quality monitoring equipment, configure the safety monitoring equipment, can collect and sense the electricity consumption of the building in real time	●	●	●	○	●	●	○	●	○	○	○	○
		To upgrade	Equipped with power station detecti	●	○	○		●	○	○	○				

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			on system and floor distribution detection system, intelligent analysis of electricity consumption is carried out, electricity consumption report is formed, and electricity alarm is given to abnormal areas with excessively high electricity consumption, so as to achieve timely investigation and management of safe electricity												

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			consumption												
		Level of wisdom	While meeting the requirements of basic level and upgrading, renewable energy can be utilized. Photovoltaic power generation can be installed on the roof or corridor roof to store energy and play the role of peak elimination and valley filling	●	○			○							
Intelligent Device Management System	The lighting system	Basic level	Indoor lighting system, outdoor lighting system	●	●	●	○	●	●	○	●	○	○	○	○
		To upgrade	Indoor lighting system, outdoo	●	●	○		●	○	○	○				

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			r lightin g system												
		Lev el of wis dom	Indoor lightin g system (illumi nance control system), outdoo r lightin g system	●	○			○							
	Hvac system	Basi c leve l	Central air conditi oning, multi - line air conditi oning system, split air conditi oning system	●	●	○	○	●	●	○	●	○	○	○	○
		To upg rade	Central air conditi oning, multi - line air conditi oning system, split air conditi oning system	●	○	○		●	○	○	○				
	Water supply and draina ge (includ ing fire fightin g) system	Basi c leve l	Intellig ent water supply system, intellig ent drainag e system	●	●	○	○	●	●	○	●	○	○	○	○
		To upg	Intellig ent	●	○	○		●	○	○	○				

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		rade	water supply system, intelligent drainage system												
Intelligent security management system	Smart elevator system	Basic level	Elevator monitoring system	●	●	●	○	●	●	○	●	○	○	○	○
		To upgrade	Voice call ladder	○	○	○		○	○	○					
	Video Ann	Basic level	Video security monitoring	●	●	●	○	●	●	●	●	○	○	○	○

(Table 2, excerpt from Intelligent Modular Configuration table)

5. Conclusion

All kinds of small infrastructure projects of State Grid Fujian Company should adopt appropriate green and intelligent design strategies according to the actual situation of the projects. On the basis of reducing building energy consumption, emphasis should be placed on promoting the utilization of renewable energy, focusing on the integrated design of buildings and green and low-carbon technologies, promoting the application of intelligent buildings, energy consumption monitoring and other technologies to create smart buildings. Orderly promote the company's production and operation sites energy conservation and emission reduction, to create a green and healthy office space. To facilitate the green, low-carbon and intelligent transformation of State Grid Fujian.

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