

## Research on energy-saving renovation of administrative office buildings in operation and maintenance stage in Wenzhou

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### Abstract

To strengthen the transformation of public building energy conservation is one of the important measures to implement the national "energy conservation and emission reduction". In order to implement the national spirit and build a resource-conserving and environment-friendly society, it is imperative to transform existing buildings into energy-saving ones. This paper focuses on the building materials, equipment, construction technology and methods of energy-saving reconstruction in the operation and maintenance stage of Wenzhou administrative office building, and studies from the aspects of envelop reconstruction, ventilation energy-saving technology, lamp and equipment renovation, and air-conditioning system renovation. It provides a theoretical basis for the administrative department of building energy conservation to accelerate the formulation or improvement of the design specifications of building energy conservation, improve people's understanding of building energy conservation, and promote the work of building energy conservation in Wenzhou.

### Keywords

Administrative office building, energy-saving transformation, operation and maintenance stage.

### 1. Investigation on energy consumption during operation and maintenance of administrative office buildings in Wenzhou

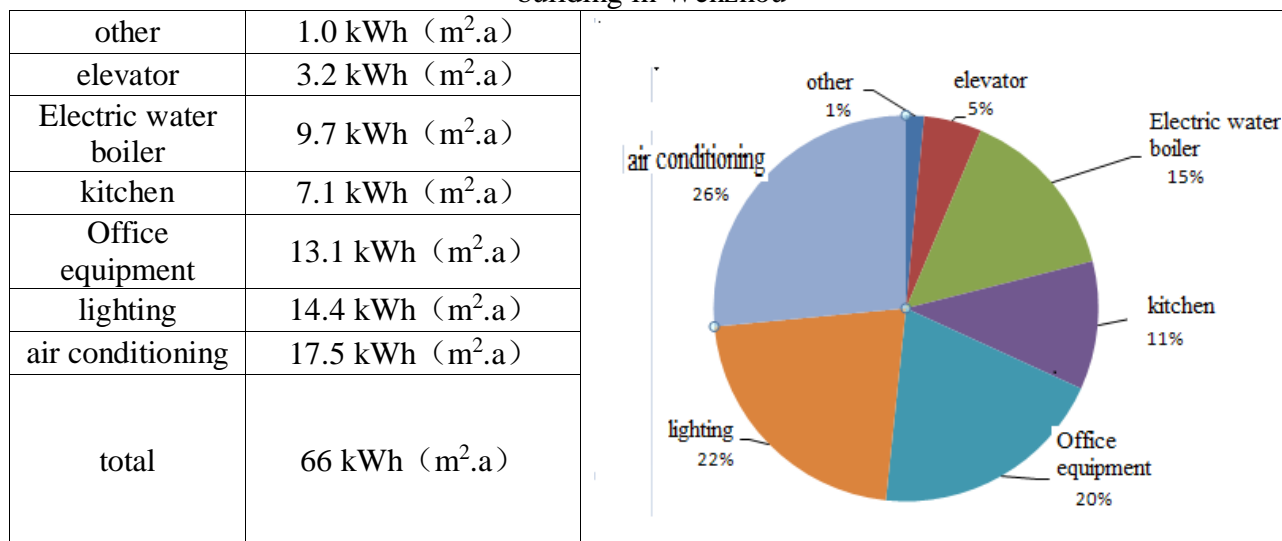
China's government has been focusing on industrial energy conservation while ignoring building energy conservation [1]. In China, the energy consumed directly in the construction and use of buildings accounts for about 30% of the total energy consumption of the whole society. In addition, the energy consumption generated in the production of phase produced building materials, the total energy consumption reaches about 45% [2]. According to relevant statistical data, energy saving buildings only account for 3% to 5% of the new buildings in China every year [3]. For the whole country, the total amount of large public buildings distributed in major cities like Beijing, Shanghai, Guangzhou and Shenzhen is about 500 million m<sup>2</sup>, which consumes more than 30% of the total electricity consumption of civil buildings [4]. In terms of building energy saving technology, the ultra-low energy consumption demonstration building of Tsinghua university brings together major new products, equipment and related technologies of building energy saving in the world today, representing the latest achievements in building energy saving and green building in China and the future direction of technology development [5]. Wenzhou as the typical characteristics of hot summer and cold winter region climate, long summer and winter, spring and autumn period is short, the climate is hot in summer, the summer of 75 days or so time is not comfortable, about 50% of time affect residents' life, high air conditioning usage, winter has 45 days or so indoor air temperature is below 10 °C. Winter did not consider heating, people often use air conditioning directly for heating, a huge energy consumption.

The poor thermal performance, long heating and cooling time and low efficiency of the air conditioning system of the envelope of the administrative office building in Wenzhou have increased the pressure of building energy consumption on the energy supply in Wenzhou.

According to the results of energy consumption survey, the electricity consumption per unit area of an administrative office building in Wenzhou is between 40 and 150kWh (m<sup>2</sup>.a), which is quite

different from each other. Take one of the large office buildings [total power consumption 66 kWh (m<sup>2</sup>.a)] as an example to analyze the power consumption of its various electrical equipment. As shown in table 1 below, it can be seen that central air conditioning, lighting and office equipment are the three main power consumption links of the office building.

Table 1: power consumption and proportion of each equipment item of a government office building in Wenzhou



Therefore, every summer or winter season, Wenzhou power grid almost half of the electricity for building air-conditioning cooling, or heating, resulting in overburdened power supply, the phenomenon of frequent occurrence of the switch. The following survey shows the electricity consumption and cost of an administrative office building in Wenzhou from January to December 2018, as shown in figure 1.

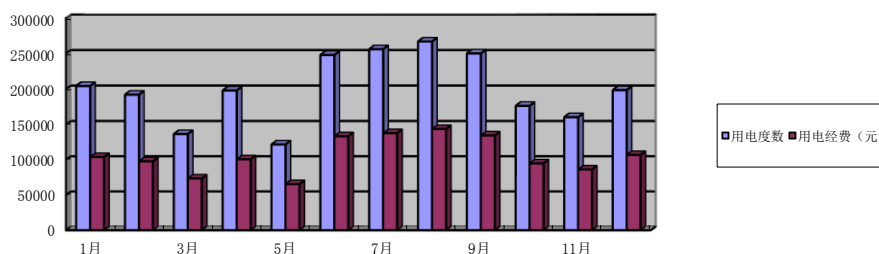


Figure 1: power consumption and cost of an administrative office building in Wenzhou from January to December 2018

As can be seen from the figure, June, July, August and September are the high temperature periods in midsummer, and the air-conditioning refrigeration energy consumption is large. The monthly electricity price is between 100,000 and 150,000 yuan, and the electricity consumption is mainly concentrated in December, January and February.

## 2. The reasons for the high energy consumption index of wenzhou administrative office buildings are analyzed

The energy consumption index of the administrative office building in wenzhou is on the high side. Problem of the unreasonable design of proportion is the largest, in the high energy consumption of public buildings, is quite a number of "congenitally deficient", is in the design of a series of hidden dangers, such as the area of high transmittance glass curtain wall, the unreasonable way of cooling and heat sources, selection of large refrigerator and water pumps, etc., and these problems are hard to use in built by adjusting or after simple modification to solve it.

There is another important reason: the construction process of all links seriously out of line. As shown in figure 2. The first disconnect is between the client's needs and the design. The second disconnect is between construction drawing expression and engineering construction unit determination and product procurement. The third one is a disconnect between the construction unit is selected at the bidding stage, basically undertake engineering section, the refrigerating machine, fan, water pump and other major energy-using equipment are the owner to purchase, to the requirement of the system is also in a way that is "working drawing clarificaiton" simple, guide to the construction unit because of some new products and the lack of relevant new technologies and installation errors. The fourth disconnect, perhaps the most serious of the present, is between engineering acceptance and building commissioning. The 4 sides of the project (owner, design unit, construction unit, prison unit) check and accept, still be heavy at present "install did not install", check equipment to be in place namely. The system related to building energy saving, especially the central air conditioning, is a dynamic process, which needs to be adjusted according to the different conditions of the four seasons of a year and the different needs of users. It should be evaluated after a year of trial operation.

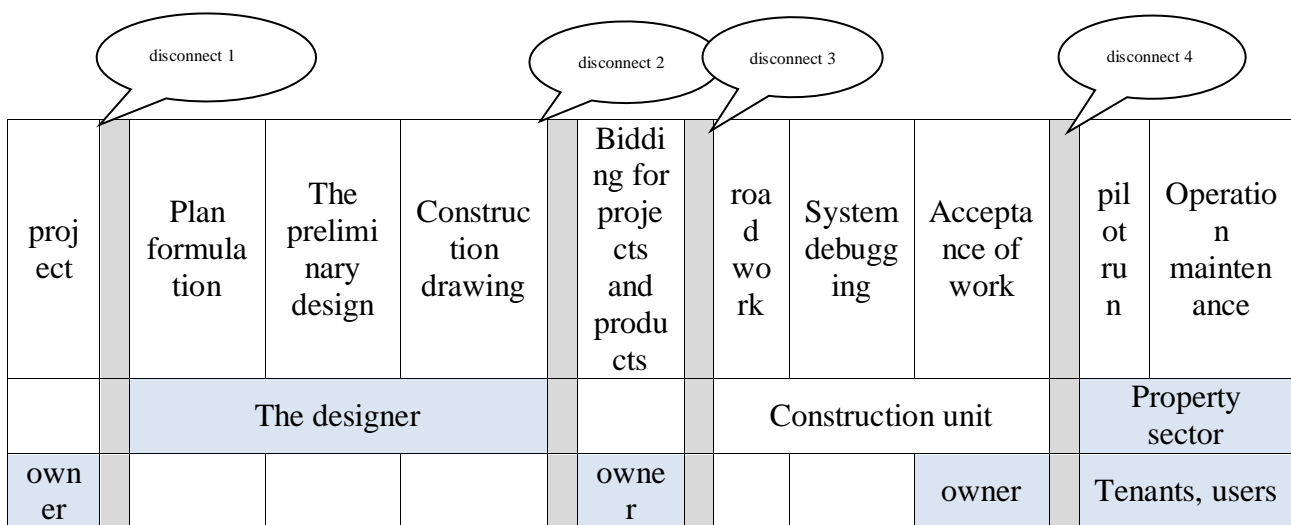


Figure 2: dislocations throughout the life cycle of a building

The quality of project implementation is rough. In addition to the defects in design, the traditional construction technology is still the leading method in the current construction process, which is far from the advanced installation technology abroad. In addition to the construction process, the construction quality is rough is currently a common phenomenon, such as freezing pump, cooling pump reverse, fan coil temperature controller leakage wiring, water pipe insulation cut corners and other problems in public buildings. However, these problems are often "hidden", and it is difficult to find them in the acceptance process. After delivery, a series of problems will occur, resulting in poor operation effect and serious energy waste.

Poor operational maintenance. The current situation is that the operation management personnel have low education level, lack of means and ability to adjust the whole building system, incomplete record data, almost no collation and analysis of the operation data, resulting in the loss of data resources; Refrigerator, fan pumps, transformers and other mechanical and electrical equipment is basically out of fault repair, lack of awareness of planned maintenance, equipment perennial inefficient operation. Many existing air conditioning water systems in buildings are seriously polluted, and the evaporator, condenser, water side dirt, corrosion and moss of the water unit of the chiller have a great impact on the refrigeration system, which is also an important reason for the high energy consumption of air conditioning. Dust, bacteria, oxygen and some harmful acidic gases in the air continuously enter the cooling water system from the cooling tower. Although the freezing system is relatively closed, the dissolved oxygen in water also has a corrosive effect on the frozen pipes. Over time, the air conditioning equipment will produce the biological sludge generated by dirt, rust, rust residue and

microbial reproduction, making the pipes blocked, cooling capacity decreased and electric energy wasted.

### 3. Measures shall be taken for energy conservation and renovation of buildings

With the idea of "green, ecological and sustainable building" [6], a series of new technologies and materials are adopted to make the building meet users' requirements for environmental comfort and achieve good energy saving effect. China's building energy conservation work started in the 1980s, in the building energy conservation transformation of conventional technology, and foreign countries are not much different, but there are still many gaps in the new technology. At present, there are three main directions of building energy saving technology in China. Second, energy saving technology of construction equipment engineering; Third, the application of clean energy technology. The energy saving of building envelope includes the energy saving of wall, roof and exterior window. Among them, the energy consumption of air-conditioning caused by external wall and roof heat transfer accounts for about 50%. Therefore, the energy conservation of building envelope is often put in the first place in the design of building energy conservation. At present, the energy-saving materials used in the building envelope are mainly resistive thermal insulation materials. The energy-saving measures adopted include external thermal insulation, self-thermal insulation and internal thermal insulation. Due to the defects in material, design and use of the internal insulation of external walls and masonry self-insulation, there are many buildings using external insulation of external walls at present.

Wenzhou administrative office buildings, a large number of energy-saving building proportion is very small, energy consumption is large, the existing buildings to be urgently needed energy-saving transformation. At the same time, the source distribution of air-conditioning load in administrative office buildings is more uniform, so we should not only pay attention to one or several aspects, but also pay attention to comprehensive and coordinated transformation. At present, through the careful comparison and analysis above, as far as the economic development and energy-saving technology level in wenzhou are concerned, the more suitable energy-saving transformation methods are as follows:

#### (1) External wall renovation

External insulation system should be adopted for common external walls, and cost-effective insulation wall materials, such as EPS board, should be adopted. In consideration of safety, other energy-saving wall materials such as XPS with smaller K value can be used in high-rise buildings to reduce the thickness. For multi-storey buildings, if the facade is not a high-grade building such as curtain wall and the facade shielding does not affect the normal work of the building, it is particularly recommended to use climbing plants such as ivy or deciduous trees to green the building. Not only save the cost of transformation, but also bring comfortable ecological environment.

#### (2) External window reconstruction

In wenzhou area, the radiation is strong in summer and the daily light rate is low in winter. In addition to reducing the solar thermal radiation in summer, winter should try to obtain sunshine. At the same time wenzhou temperature on the building air conditioning load is also large, the heat transfer coefficient of the window should also pay attention to. Therefore, generally speaking, low e glass with strong east-west and south radiation, which can penetrate more visible light and block a large amount of thermal radiation, is the optimal choice in terms of applicability and economy. Northward use hollow glass to wait cost performance is higher.

#### (3) Use natural energy

The use of natural energy in building energy saving can play a good role in energy saving no matter it is summer night or morning natural ventilation. This kind of low cost that is often ignored or even zero cost energy saving method will bring great surprise to people.

#### (4) Air conditioning system renovation

Air conditioning system directly deals with heat and humidity load, and its modification is very important, which directly determines the energy consumption of air conditioning. At present, various energy-saving split air conditioning and energy-saving heat pump technologies, frequency conversion technology, energy storage technology, automatic control technology, pipe network optimization and matching technology are becoming increasingly perfect, which is bound to provide great help to improve the overall performance of air conditioning. Large central air conditioning renovation should be based on their own situation, in the financial conditions, the choice of energy-saving equipment and systems; At the same time, try to improve the professional quality of equipment operation and maintenance personnel, improve the efficiency of energy saving operation.

#### (5) Office and power equipment

All the time, the administrative office building USES the energy expense to repay the actual expenses, the permanent bright light, the summer is too low, the winter excessively high air conditioning sets the temperature and so on the phenomenon to see repeatedly does not show, the non-energy conservation elevator, the electric light and the office equipment everywhere. Too strong light, indoor and outdoor temperature difference, not only is not conducive to vision and physical health, but also brought a huge waste of energy. Therefore, this paper emphasizes the huge benefits brought by energy-saving habits in energy saving. With the appropriate energy-saving transformation technology, we must also combine with the standard energy-saving supervision system. Each building has its own characteristics, and the installation of monitoring instruments, the scientific record and statistics of building energy consumption, and the analysis of its characteristics, can finally be targeted for the transformation, and truly achieve the optimization of economic, ecological and social benefits.

## 4. Conclusion

At present, the energy conservation of public buildings in wenzhou's operation and maintenance stage has not reached the expected goal. Every square meter of existing buildings' energy conservation renovation can bring more than 200 yuan of market opportunities. Building energy conservation is conducive to promoting scientific and technological progress, stimulating domestic demand, and driving the development of industrialization. Through the implementation and demonstration of the building energy conservation project, it will also promote the development of the whole set of new technology, new equipment and new materials industries for high efficiency and energy conservation, and promote the renewal and transformation of traditional industries in the construction industry. All in all, the market outlook is very good.

According to the experts' preliminary estimation, the direct energy saving (converted into electric energy) of wenzhou administrative office building is 10 million kWh/a through the implementation of the reform of ventilation, envelope, lamps and equipment, air conditioning system, behavioral energy saving and other energy-saving measures. Calculated according to the average electricity price of 0.63 yuan /kw·h in wenzhou, it can save more than 6 million yuan of electricity fee every year, which correspondingly can save more than 2,000 tons of standard coal, reduce more than 5,000 tons of carbon dioxide emissions, reduce more than 20 tons of sulfur dioxide emissions, and reduce more than 60 tons of nitrogen oxide emissions. In a word, there are both good economic benefits and good ecological and environmental benefits.

It is necessary to actively promote the transformation of the administrative office building in the operation and maintenance stage, and to study the energy-saving transformation technology. Building energy conservation transformation is a noble cause that benefits the people and society, and it is also the only way to build a harmonious and comfortable living environment. It has the following significance:

(1) To understand the current situation of energy consumption in the operation and maintenance stage of the administrative office building in wenzhou, find the loopholes in the energy conservation work of the administrative office building in wenzhou according to the difference between the current



situation and the goal, point out the deficiencies in the energy conservation work of the building in wenzhou, and make improvements.

(2) To provide theoretical basis for the administrative department of building energy conservation to accelerate the formulation or improvement of design specifications for building energy conservation, strengthen the theoretical research and publicity of building energy conservation, improve people's understanding of building energy conservation, accelerate the training of design and construction management personnel for building energy conservation, and promote the work of building energy conservation in wenzhou.

(3) By analyzing the energy consumption characteristics of the administrative office buildings in wenzhou, the paper points out the key points in the energy conservation field of the administrative office buildings in wenzhou. The energy-saving transformation of the administrative office buildings can not only set a good example, but also help improve the efficiency of building energy conservation in wenzhou.

(4) Promote the application of new energy-saving technologies in wenzhou. The energy saving of building envelope includes the energy saving of wall, roof and exterior window. Among them, the energy consumption of air-conditioning caused by external wall and roof heat transfer accounts for about 50%. Therefore, the energy conservation of building envelope is often put in the first place in the design of building energy conservation. At present, the energy-saving materials used in the building envelope are mainly resistive thermal insulation materials. The energy-saving measures adopted include external thermal insulation, self-thermal insulation and internal thermal insulation. Due to the defects in material, design and use of the internal insulation of external walls and masonry self-insulation, there are many buildings using external insulation of external walls at present.

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