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# Research on the Low Energy Consumption Building Design Based on GUD

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In this paper, the author studies on the low energy consumption building design based on GUD. Low energy buildings to reduce the consumption of energy, promote the sustainable development of China's economy. Integrated design as an important approach to achieve low energy building, the method of comprehensive integration of various energy saving technology and architectural design, effectively improve the building energy consumption, to achieve good energy saving effect. Therefore, extensive use of integrated GUD system in low energy building design has the vital significance. Low energy consumption design of this article focuses on the integrated GUD system, a comprehensive exposition.

## 1. Introduction

Low energy building has an important significance in reducing energy consumption and achieving the target of reducing carbon emissions per unit of GDP for China. Integrated design is an important way in the design of low energy buildings. Through integrating the passive and active energy-saving technologies with architecture design reasonably, the balance between creating a thermal comfort environment and building energy saving can be achieved. GUD system is an energy saving technology that active ways highlighted. The underground cooling systems obtain the required adjustment hot and cold water to adjust the indoor thermal environment by pumping small amount of power; the floor air supply system achieve the proper temperature and wind speed with less energy by using the control method of local indoor thermal environment; the dynamic ventilation wall improves the indoor radiation temperature by using the active ventilation to isolate the impact of outdoor thermal environment on the indoor one (Yong and Yu, 2012; So et al., 2010). The combination of the three methods above improves the thermal environment comfort of indoor working space. The research is based on the study of the expansion projects of the College of Architecture and Urban Planning in the modern city, which is the demonstration construction of the application of renewable energy building ratified by the Ministry of Finance and the Ministry of Construction in China. It will carry out the research mainly from the following aspects: At first the author analysis the mechanism of three subsystems of the GUD system from related research and practical experience both domestic and international and gets clear the functional streamline of the system operation. The author takes a long-term measurement on the climatic characteristics of the site, the indoor thermal environment of the construction, the envelope surface temperature of the building, the energy consumption of the building and some other related aspects, and researches the characteristics by using comparative study method. During the simulation study, the author tests the computer models with measured data, optimizes the design of buildings integrated with GUD system using the CFD simulation method, and studies the impact on the indoor thermal environment with different ways of air supply, materials of walls and tectonic pattern of the system. Based on the experimental study and the simulation, the author takes a discussion on the design of low-power office buildings integrated with GUD system. In the aspect of system operation, the optimization of integrated system in building design are summarized, and several additional design ideas are suggested; while in the aspect of architecture design, the article probes into the impact of the integrated design on the Interior space of buildings and the tectonic design of retaining structures, and the design process of the low energy buildings integrated with GUD system are described (Jackson et al., 2011). This paper aims at laying a foundation for the promotion and application of the design

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patterns of low energy buildings Integrated with GUD System; and meanwhile, the concept of integrated design provides a new thought for low energy building design.

## 2. Low energy consumption building design

Building energy consumption refers to buildings under indoor environmental conditions required to meet the rational use of energy, constantly improve energy efficiency, and reduce energy consumption as much as possible. Since this paper is to study the design of the stadium construction in cold area, and thus mainly related to the climate and closely associated with building outdoor indoor thermal environment, building energy consumption light environment and wind environment issues. When the weather outside resources cannot meet the requirements of the user indoor thermal environment, light environment and wind environmental requirements, they will each take a human approach to complement its energy consumption corresponding to thermal energy, lighting and ventilation energy consumption. Wherein the indoor thermal environment is the most important part of the indoor environment, it corresponds to the thermal energy contained building heating and cooling energy consumption in two parts. In cold areas due to winter time is longer, so the heat energy used for heating the building only is far higher than the energy consumption for lighting and ventilation (Doo et al., 2015; Shi et al., 2015).

As China's social and economic development, new service industries (such as banking, insurance, management, design, etc.) will have a greater future development, modern office requires a well-lit office space, and a variety of cable clouds widely used in floor and the computer, only electricity is based can be achieved. Additional office buildings will be new challenges for the supply of electrical energy (Jian et al., 2014). Not only the depth of the floor over the reach of natural light, and although you can use natural ventilation way to maintain air quality, but not in this way to disperse most of the office buildings used by the video display device generated heat. Artificial lighting is a major consumer of office buildings channel energy costs, 50% of the total electricity consumption. If the floor is very wide depth, we need to consume more energy than heating lighting. In addition, in summer, artificial lighting also need to consume extra energy to mechanical refrigeration. The use of natural light (by building a patio and into the deep narrow floor) instead of artificial lighting can save 40% -50% of energy consumption.

Static energy analysis method: The basic principle of static energy analysis method is to ten days each heating period or heating period, the heat consumption of each month is calculated according to the steady-state heat transfer theory, regardless of the regenerative effect of the various parts of the building envelope (Dong et al., 2014). The method of static energy analysis are: the effective heat transfer coefficient, degree days method, temperature and frequency method, load frequency table method and equivalent full load running time method.

(1) The effective heat transfer coefficient: the effective heat transfer coefficient of the main features of the method is to replace the original effective heat transfer coefficient of heat transfer coefficient of heat transfer coefficient generally refers to the unit temperature difference, heat transfer per unit area per unit time of . Here, the heat is only caused by the temperature difference between both sides. In fact, in the envelope, not only on both sides of the air temperature difference caused by the presence of heat consumption, but also by the presence of heat gain due to solar radiation and heat loss caused by radiation to the sky, these three parts is the algebraic sum of heat the net heat rate envelope structure. In the unit temperature difference, the net heat consumption per unit area per unit time, namely the effective heat transfer coefficient. "Energy conservation design standard (heating residential buildings)," the approach is effective heat transfer coefficient.

(2) The degree day’s method: live method is a simplified calculation method. It is based on two assumptions, that is, from a long-term average, while the average daily outdoor temperature is equal to a reference temperature, solar radiation and indoor heat gain can fully compensate for the heat loss of the building and the heating system does not need to run; in addition, heating power consumption is proportional to the difference between the reference temperature and the average temperature of the outdoor day. The United States will take the reference temperature is 18.3 ℃ Heating degree days is the difference between the average daily outdoor temperature difference between the reference temperature and the heating of the day, the sum of products (Yue et al., 2014).

## 3. Calculation and design analysis of low energy consumption building

At present, the scale of residential building construction is unprecedented in the histories of china and world. The building area has reached 16.5 billion in town by the end of 2005 and the total residential area of structure has reached 10.8 billion square meters, which accounting for 65.46070 (Anonymity). According to the statistic, although the different influence of climate, economic, and the life style, the energy consumption for cooling and heating accounts for 50%-60% of the country's total building energy consumption, energy efficiency for residential buildings has therefore becomes a hot issue of growing concern.

Hot summer and cold winter zone of China is also facing the residential energy consumption problems, where the mean temperature of the hottest month is between 25-30 0C and that of the coldest month is between 2-7 0C,the whole year relative humidity in most of the cities of this zone are 75%-80%. Date shows that heat gain through the external window accounts for 25-28% of the total heat gain, adding to the infiltration, it is up to 40% in hot summer and cold winter zone, so it is important to carry out the sustainable window system design with low energy consumption. Only a few researches have been conducted to study the effects of residential building window system on AC electric consumption, and GUD has only prescribed the heat-transfer coefficient of the glazing, the shading coefficient is not considered. So this paper used the eQUEST software to simulate the influence of window system including area ratio of window to wall and categories of glazing on energy consumption of AC, the limit values of glazing heat-transfer coefficient with different glazing shading coefficients and area ratios of window to wall in hot summer and cold winter zone in china are also studied. Results can be the reference of revising GUD and designing residential buildings.

The simulation software eQUEST is the upgrade program of DOE-2 that is the most widely recognized and respected building energy consumption analysis program in use today. It had calculated the yearly cooling and heating electric consumption of one building in a city of hot summer and cold winter zone in China, using DOE-2 and harmonic reaction analysis, respectively. Results showed that the yearly electric consumption of AC system calculated is the same by both DOE-2 and harmonic reaction analysis. The simulation engine within eQUEST is derived from the latest official version of DOE-2, but extends and expands DOE-2's capabilities in several important ways. This paper used eQUEST to simulate electric consumption of air conditioner and the cooling and heating load.

A Typical hot summer and floors typical building, building typical kinds of external walls winter city is 3143 m2 building selected, the model (Figure l) is 10 shape coefficient is 0.28, Select six five typical kinds of roofs as research objects, specific parameters are adjusted; the glazing is normal 3mm glazing with a shading coefficient of 1.0. The interior wall is 190mm air brick with plaster on both sides and its heat transfer coefficient is 2.0 W/m2K, the floor is 120mm concrete which is covered with an 10 mm polystyrene heat insulation layer, its heat transfer coefficient is 2.0 W/m2K.

Indoor design temperature for summer air conditioning is set 26 0C, and for winter heating is 18 0C,the air change coefficient is 1-1h. Suppose the lighting load to be 0.0141kWh/(m2·day), mean value of other indoor heat gain intensity to be 4.3W/m2. Adopt the intermittent household air source heat pump air conditioner for heating and cooling, the rated air conditioning and heating energy efficiency ratios are 2.3 and 1.9 respectively in GUD.

Typical meteorological year (TMY) which obtained from China standard weather data for analysing building thermal conditions is used in this paper, on the basis of measured weather data of year 19712003 from 270 countrywide ground observatories provided by China Meteorological Bureau-Climate Information Centre-Climate Data Office and Tsinghua University Department of Building Science and Technology.

Experimental researches indicated that the highest daily indoor temperature tmax and highest daily outdoor temperature twmax and lowest daily outdoor temperature twmin summer have a relation to max=0.44 twmax +0.56w min when intermittent ventilation, and areas where percentage of possible sunshine in winter is below 30070, the indoor healthy condition can be satisfied when the mean daily outdoor temperature is higher than 12 0C Huang DG 2006 .Accordingly, set tmax =26 0C in summer, the mean outdoor temperature in the city is about 26 0C, percentage of possible sunshine in winter is 270C and the critical temperature is 120C for the heating season. So, its cooling season is from June 1st to September 15th, while heating season is from December 1st to April 1st according to the whole year outdoor temperature.

Most residential buildings are strip buildings in hot summer and cold winter zone in China. The study object is an extant six floors strip residential building in Changsha which we call it BASECASE model. The building area is 2616 m2, and shape confident is 0.29 and the height of per floor is 3m, building ichnography is shown in figure 2. The whole building except bath rooms and corridors are conditioned. The calculation parameters are as follows.

1 .External wall: 240mm clay solid brick wall;

2. Building roof: 30mm cement sand bed and polystyrene, the U-value is 1.5 W/m2K the U-value is 2.0 W/m2K.

3. Sand 120mm reinforced concrete with 10mm solar absorb of external wall and roof: 0.6.

4. External windows: 3mm clear glazing with aluminium frame, the U-value is 6.4 W/m2K.

5. The area ratio of window to wall: _5007o for the south, west, north and east windows.

6. HVAC systems: room air conditioner with EER of 2.2 for cooling, electric radiator with the EER of 1.0 for heating

7. Air changes per hour: 1.5

8. Indoor temperature set point: 26 0C in summer and 18 0C in winter.
9. Air conditioning time: June 1st to September 30th for cooling and December 1st to March 31st for heating;
10. Interior loads: 0.5382W/m2 for lighting systems, 4.3w/m2 for others.

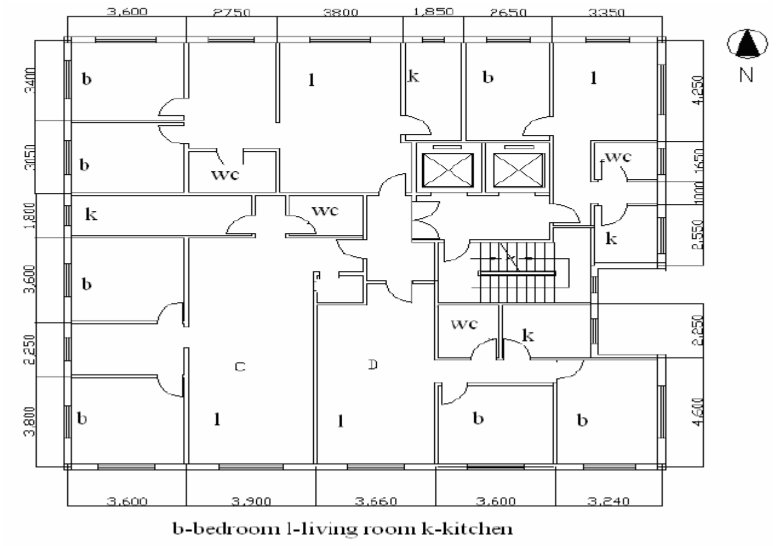


*Figure 1: The basic place chart of the case*

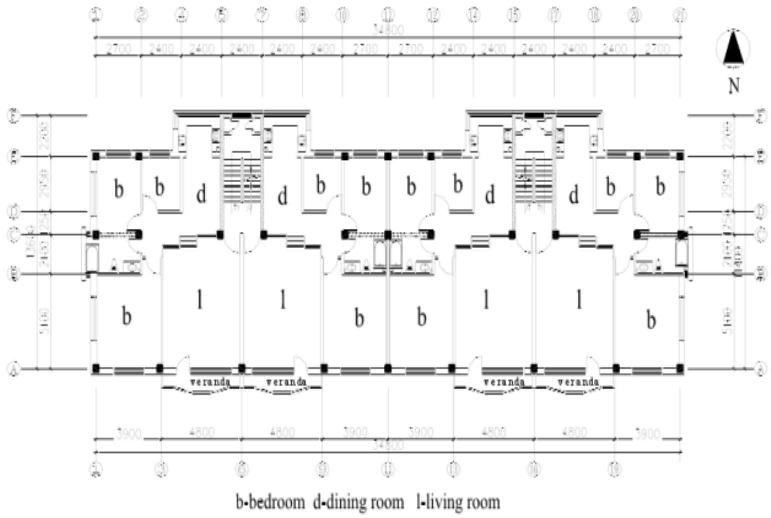


*Figure 2: The device display chart of the case*

## 4. Results and discussion

Comparing with the traditional air conditioning system, the hybrid system has great advantages in energy consumption as flows.
(1) In the hybrid system, GSHP are attractive alternative to conventional heating and cooling systems owing to their higher energy utilizations efficiencies. In general, when inputting electric energy of 1kw, it gains cooling or heating output of 4.5kw~6.0kw, even more.
The statistical data in America in the last decade showed that the operating cost of GHSP systems was lower 22%~25% than air conditioning system driven by electrical, and lower 40%~60% than boilers. Figure 3 shows the effect of the wall on the cooling energy consumption.
(2) In the hybrid system, the temperature and moisture are conditioned and controlled respectively. The system does not need to supply water of 7 0C since it adopts LDAU.

Thereby, the temperature of chilled water yielded by the GSHP could be raised to 18 0C and could be used to radiant cooling directly. Thus, the COP of GSHP could be improved 40% or so. While if it utilizes natural cool source directly, better economy would be achieved. In winter, it works similarly.
(3) In the LDAU, the COP can reach 6.0 or so when electronic-motive type adopted, even in the unit driven by heat water of 70 0C,the COP can reach 1.1. Furthermore, it will develop to an efficient mode for energy storage. Research indicated the amount of energy storage can attain 1000MJ per cubic meter. It would be an effective way to solve the deficiency of intermittence for utilization of solar energy and has great significance to utilize low-grade heat energy and shift the peak load to the valley of power systems in summer.
(4) During the radiant cooling process, people would feel cooler than actual since the exterior-protected construction surface cool down. Therefore on the premise of the same sense of temperature, the design temperature can be raised at 1~2 0C which leads to the reduction of cooling load 10%~20% or so. The radiant heating acts similarly. The radiant cooling & heating system make it applicable of natural energy and low-grade energy, because of the lower temperature of heating source or higher temperature of cooling source. It used meteorological parameters of all around U.S.A to calculate the energy consumption of commercial buildings, then made conclusion that the radiant cooling could save energy of 30% comparing with the all-air system, and the peak load of electricity consumption was just 27%~37% of all-air system, when both Goofing systems were driven by electricity. Figure 4 shows the effect of the wall on the heating energy consumption.
(5) Comparing with mixing ventilation, to maintain the same temperature in the human activity area, the average temperature of the whole room is higher. Therefore, the cooling load is smaller and helpful for energy saving, especially for rooms with higher space. Figure 5 shows the decease of AC electric consumption of per unit area glazing.

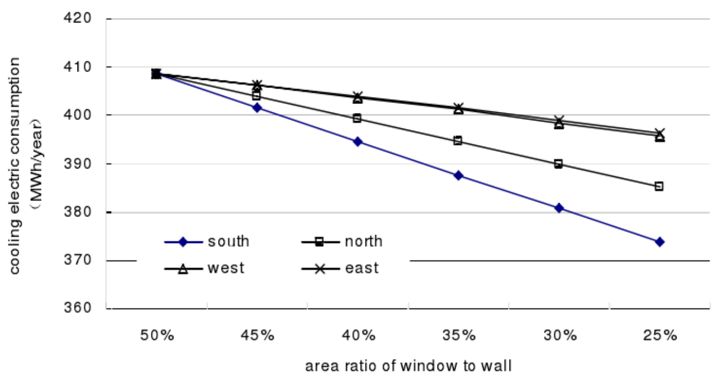


*Figure 3: The effect of the wall on the cooling energy consumption*

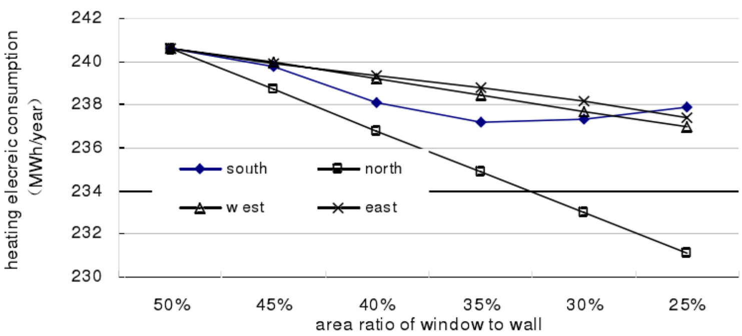


*Figure 4: The effect of the wall on the heating energy consumption*

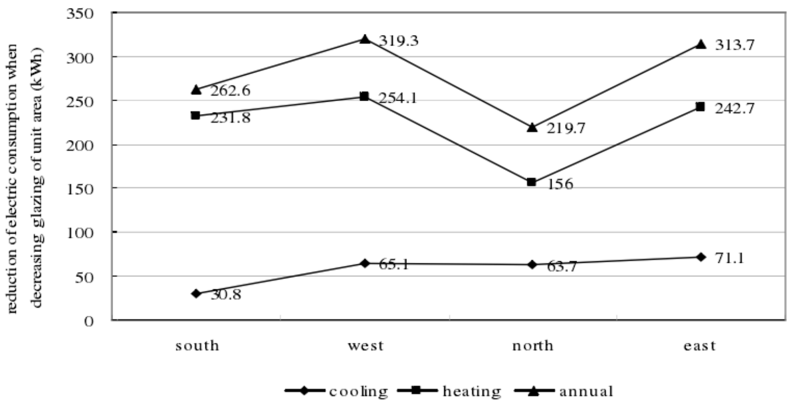


*Figure 5: The decease of AC electric consumption of per unit area glazing*

## 5. Conclusion

In this paper, the author studies on the low energy consumption building design based on GUD. Low energy buildings to reduce the consumption of energy, promote the sustainable development of China's economy. Integrated design as an important approach to achieve low energy building, the method of comprehensive integration of various energy saving technology and architectural design, effectively improve the building energy consumption, to achieve good energy saving effect.

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