Based on Analysis of Dest Simulation a Building Energy-Saving Retrofit Scheme

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Abstract

Aiming at the existence of our country has a large part of the building palisade structure heat preservation and heat insulation performance is poor, the problem of lower air conditioning heating equipment can effect comparing, resulting in energy waste is serious, serious restricts the sustainable development of society. For a certain office building energy-saving renovation project of Beijing project example, the diagnosis about the present situation of energy consumption, and in view of the retaining structure retrofit scheme is put forward. Energy consumption of different schemes are simulated by DeST software, according to the simulation results of retrofit scheme has carried on the comparison and analysis, put forward reform Suggestions, provide reference for both of office buildings. To a certain office building as an example, the DeST-e software combined with the hot summer and cold winter area residential building energy efficiency design standard "(JGJ134-2001) and the severe cold and cold area residential building energy efficiency design standard" (JGJ 26-2010) to simulate the different parts of the building room temperature difference.

Keywords

DeST；Retaining structure; Office buildings; Energy saving reconstruction.

1. Introduction

Building energy consumption in 1/3 per cent of total energy consumption in China, has resulted in energy and economic burden. In the total stock of buildings in China, a large number of existing buildings due to the construction of a long time, do not meet the existing energy efficiency standards, energy is bigger. In order to reduce building energy consumption, we must strengthen the energy-saving renovation of existing buildings. Envelope is the main building, is the basic building material is to maintain indoor comfort, barrier against outdoor climate change, energy efficiency of exterior-protected structure of energy-saving in buildings plays a very important role. This paper analysis in an office building in Beijing, for example.

Through computer analysis of energy consumption, accounting for whether to meet the State's energy requirements of the building. DeST-c was developed by Qing Hua University architecture environment and equipment Institute of analysis and calculation for civil building energy simulation software, the software has a powerful modeling capabilities and a large amount of data, considering factors such as ventilation, radiation effects, are one of the best energy analysis software. Using the software to model the existing buildings and energy analysis. Mainly for building envelope, and two aspects of energy saving reform of air conditioning system, survey the impact of various energy saving measures on building energy consumption.

2. General Situation of Engineering

For existing buildings to review cases of existing drawings, summarizing the whole of calculations in the Office building are as follows: the building was built in the 1980s, total construction area of 3493m^2, 3 floors, building height 12.45m, size coefficient of 0.18, ratio of window to wall 28%, the building is primarily used for teaching and research and office space.

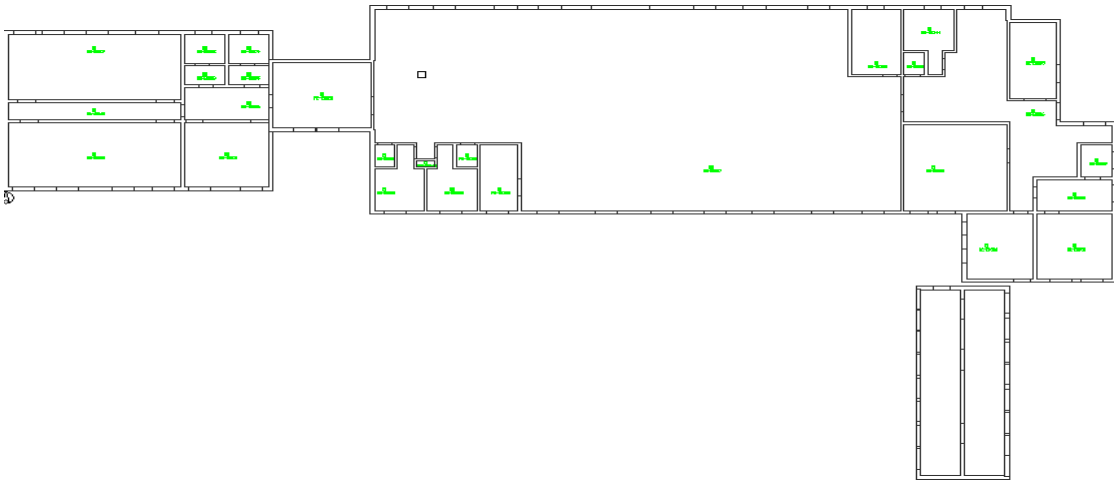

Figure 1. Office building floor plans

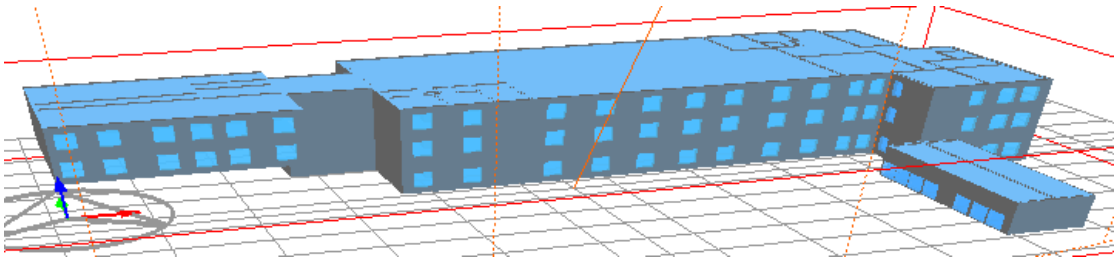

Figure 2. Office building three-dimensional stereogram

Table 1 Project basic information

	statistics	Conversion factor	Power consumption(kWh)
Air conditioning area(m2)	2763.62	**coal coefficient(kg)**	0.35
overall floorage(m2)	3493.74	**Fold the equivalent electric(kWh)**	1.00

Natural gas(Nm3)	Municipal water(kWh)	steam(t)	fuel(t)	coal (t)
1.33	0.12	83.09	1428.60	714.30
7.16	0.24	234.90	7840.00	2640.0

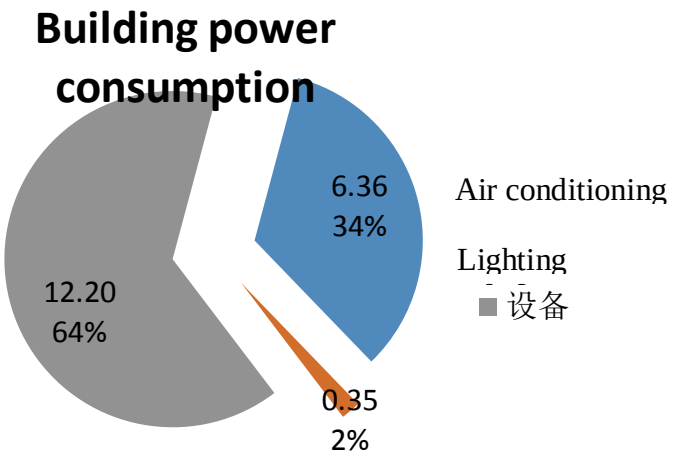

Figure 3. Energy consumption of building basic

The main content of the building energy-saving testing: building structures, building envelope thermal performance of Windows, air tightness, outdoor weather conditions, indoor thermal environment, energy consumption, etc. Test results are summarized below:

(1) Wall: the retaining structure with reinforced concrete frame structure, outside walls 200mm thick concrete, aerated concrete walls 240mm thick. Compressive strength of concrete structure with energy-saving renovation and strengthening of conditions.

(2) Windows: because of the long era of the construction of the Office building, building exterior Windows are common steel framed single glass Casement Windows. Part of insulating glass Windows adapted to film (film), most of the sliding window, casement window. Most of the 1~3 layers of the Windows has completed the transformation. Roof and 60 mm of polystyrene, all parts are up to standards after the transformation, transformed by the calculation of heat transfer coefficient for roof 0.54 W/(m^2 ·K), external wall heat transfer coefficients for 0.58 W/(m^2 ·K), /window heat transfer coefficient for 3.0W/(m^2 ·K).

3. Analysis on Energy-Saving Programs And Energy-Saving Potential

3.1 Optimization of the Retaining Structure

Building energy consumption affected by many factors, mainly environmental factors, building, structure, equipment and so on. Environmental factors as objective factors, mainly parts of the local climatic conditions, for example in summer hot and winter warm area, primary energy consumption for cooling in summer hot and winter cold area, heating and cooling account for a large proportion of energy consumption. Building envelope, including structural shapes and location selection, construction, building envelope materials ratio of window to wall, such as orientation, building shape coefficient, the thermal performance of building materials, etc.

For the existing buildings, references to the code for thermal design of civil buildings (GB50176-93), heat transfer coefficient calculation related to the building envelope, as shown in table 1. However, in accordance with the design standard for energy efficiency of public buildings (GB50189-2005), external wall heat transfer coefficient $k \leq 1$, roof heat transmission coefficient $K_1 \leq 0.7$, and the window heat transfer coefficient $K_2 \leq 3.0$. In accordance with the requirements of the existing norms, the existing office buildings were substandard, high heat transfer coefficients leads to higher energy consumption, therefore does not meet the requirement of building energy conservation.

Table 2. Structural performance of building envelope parameters

Building components	Component materials	Heat transfer coefficient(W/m^2.K)
Exterior wall	Cement mortar 20mm+Reinforced concrete 200mm+Cement mortar 20mm	3.089
Interior wall	Cement mortar 20mm+Ceramsite concrete 180mm+ Cement mortar 21mm	1.515
Outside window	6mm ordinary single-glass	5.7
floor	Cement mortar 25mm+Reinforced concrete 100mm+ Cement mortar 20mm	2.944
roof	Mixed mortar 5mm+Lime sand lath and plaster 20mm+Ceramsite concrete 125mm+ Reinforced concrete 70mm+Lime sand lath and plaster 5mm	1.039

Therefore, combined with factors such as existing building envelope heat transfer coefficient, taking into account the building envelope can be, including external walls, roofs and Windows and other parts of the energy-saving, use heat transfer coefficient of material consideration window shading, and so on. Also, evaluate software based on DeST-e residential building, Tsinghua University, established the same as the reference architecture model for energy-efficient buildings, building

energy consumption compared both. For the reference architecture, DeST-e software in conjunction with the design standard for energy efficiency of residential buildings in hot summer and cold winter area (JGJ134-2001), outside the building's shape coefficient, wall, roof, old and out the window, wall, floor, floor, and choose empty floors, energy-saving door design assessments, determine whether the energy-saving requirements. Table 3 for building assessment standard for energy efficiency of the building envelope parameters.

Table 3. Energy saving performance of building surrounding structure parameters

Building components	Component materials	Heat transfer coefficient(W/m^2.K)
Exterior wall	Cement mortar 20mm+Reinforced concrete 200mm+Expanded perlite125mm+Cement mortar 20mm	0.501
Interior wall	Cement mortar 20mm+Ceramsite concrete 200mm+ Cement mortar 20mm	1.515
Outside window	Inert gas +Inner membrane insulating glass(double film)	2.01
floor	Cement mortar 25mm+Light insulation floor250mm+ Cement mortar 20mm	0.535
roof	Cement mortar 20mm+ Expanded perlite 200mm+ Reinforced concrete 120mm+ Cement mortar 15mm	0.32

3.2 Programme Energy Consumption Simulation and Energy Saving Potential Analysis

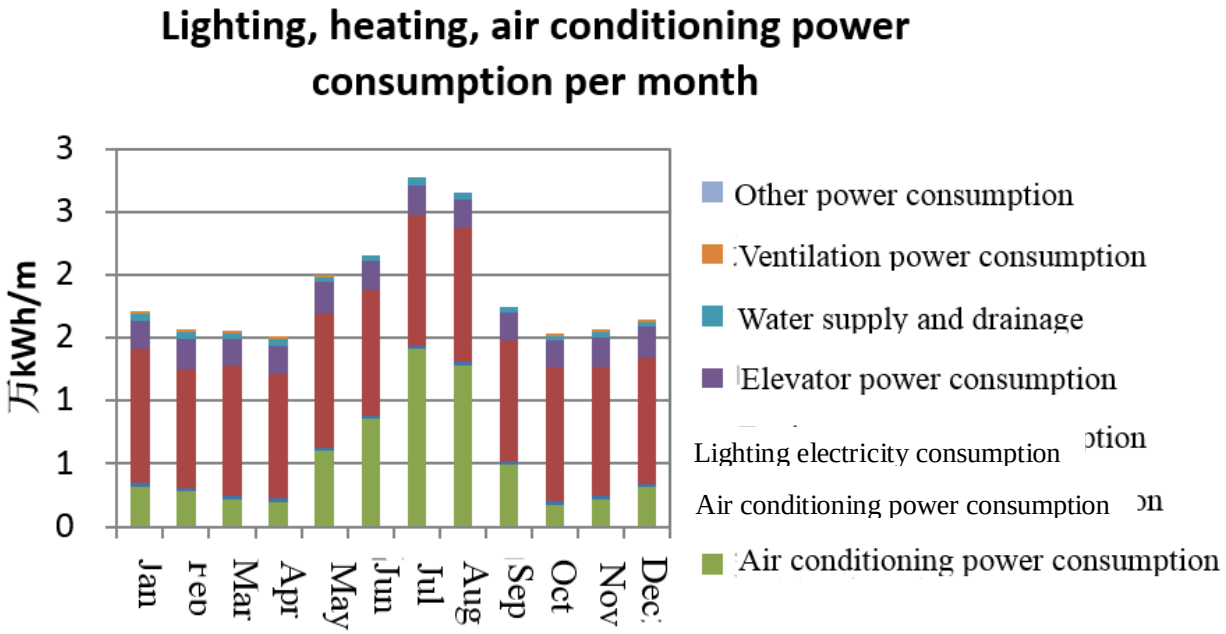

Figure 4. Engineering status quo lighting, heating, air conditioning power consumption per month

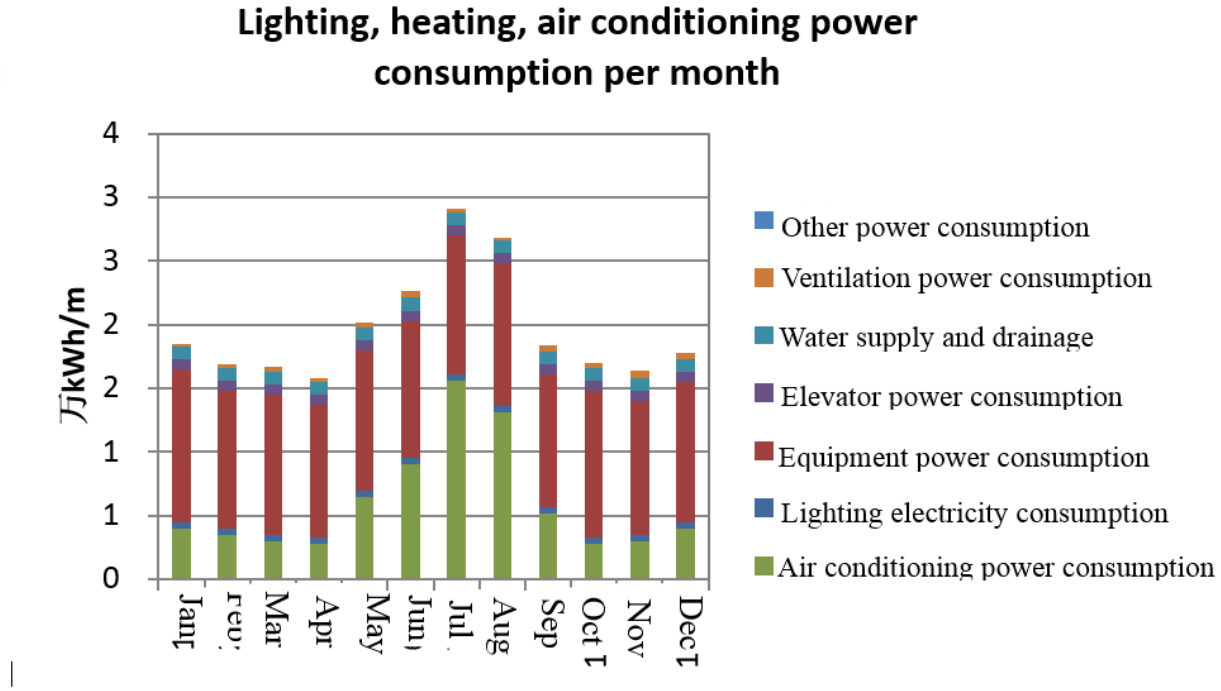

Figure 5. Engineering construction energy conservation transformation after lighting, heating, air conditioning power consumption per month

Table 4. Simulation results and analysis in different scenarios

Program description	Cumulative load index	Maximum load index	Energy consumption ratio
Present situation	53.74	89.12	—
Transformation scheme	34.61	73.54	17.48%

Table 4 lists has software simulation of calculation results, which status of cumulative load index for 53.74kW • h/m, transformation programme 1 of simulation results displayed cumulative load index for 34.61kW • h/m, visible due to enclosure structure hot workers parameter beyond energy-saving standard limited value requirements, led to existing of building consumption heat than energy-saving standard Xia of enclosure structure energy increased near 61%; Thus, improved enclosure structure of performance, has is big of energy-saving potential, especially in reduced winter heating energy Shang is highlight. From table 4, the programmatic transformation can also be seen in the situation after reducing the proportion of, renovation of exterior Windows to reduce building energy consumption plays a major role, transforming effect will be far higher than the exterior walls and the roof, therefore, priority should be given in the energy-saving renovation of exterior Windows.

4. Different Parts of the Building Temperature Difference

4.1 Cold and Cold Area City

Urban are residential buildings in severe cold and cold areas in China a total of 5.12 billion m^2, the scale is enormous, and the number of annual new home construction is still considerable. Located in residential buildings in severe cold and cold areas, is the main body of building energy consumption in heating energy consumption, although some cities also have air conditioning in the summer cooling demand in cold areas, but for three or four months of continuous heating demand, still is the dominant energy. Therefore, the support structure based on the thermal performance of the main insulation into account.

Heat transfer of building envelopes are mainly caused by the temperature difference between indoor and outdoor, but also influenced by solar radiation, sky radiation and the effect of ground reflection radiation and other buildings, the influence of solar radiation. Sky radiation, surface reflect radiation

and other buildings in this not be taken into account. Measure the extent of a local cold can use different indicators, starting from the subjective feeling, and the average temperature of the coldest month of the year more directly reflects the level of cold, before other relevant criteria are basically the temperature indicator. Severe cold and cold region in winter indoor and outdoor temperature, the open stairwells, corridors if will definitely increase stair, corridor outside the walls and doors of heat dissipation, resulting in unnecessary energy consumption, therefore closed. Cold, cold year-round (4~6) month heating season, long time heating energy consumption occupies high proportion. In recent years due to the increased proportion of electricity for heating, resulting in some provinces and cities in winter peak demand has also increased rapidly, power difficulties appeared power-hungry winter. Blind promotion no electric boiler heat storage configuration, direct electric heating, further deterioration of power load characteristics, influence people's daily electricity consumption. Therefore, should be strictly limited use of direct electric heating for central heating mode. Severe cold and cold areas of the thesis, analysis Beijing as an example, the results in Figure 6. as shown in Figure 8.

4.2 In Hot Summer and Cold Winter Area

Summer hot winter cold area is refers to Yangtze River middle and lower reaches of and around area, the area of range roughly for Longhai line South, nanling North of, Sichuan basin East of, including Shanghai, and Chongqing two municipalities, Hubei, and Hunan, and Jiangxi, and Anhui, and Zhejiang five province all, Sichuan, and Gui Zhou two province East half Department, Jiangsu, and Henan two province South half Department, Fujian province north half Department, Shaanxi, and Gansu two province South end, Guangdong, and Guangxi two provinces north end, involved 16 a province, and city, and autonomous regions. The region has hot summers and cold winters.

Residential buildings in hot summer and cold winter area, in spring and autumn, and cool summer sessions, organized indoor and outdoor natural ventilation, not just to improve indoor thermal comfort levels, and can reduce air conditioning running time, reducing the actual energy consumption of the building. In the complex when the General layout and design of buildings, taking into account the natural ventilation is necessary. Solar heat gain great influence on building energy consumption, solar heat gain in summer cooling loads, solar heat gain in winter reduce the heating load. Due to the altitude and azimuth of the Sun changes, South, North orientated architecture can reduce solar heat gain in summer, and can increase the solar heat gain in winter, is the most favorable orientation. In hot summer and cold winter area during winter and summer heating and air conditioner is a resident individual is basically some time, some space heating and air conditioning, so to reduce the heat transfer between the rooms and public spaces in the building, reduce the heat transfer between residential. Incoming solar radiation through Windows, constitutes the main load of air conditioner in summer, can reduce the heating load in winter and in summer hot and winter warm area set the movable visor is the most reasonable.

Due to summer hot winter cold area of climate characteristics, indoor outside temperature compared small, day within temperature fluctuations on enclosure structure heat transfer of effect compared big, especially summer, day outdoor temperatures is high, and has is strong of sun radiation, heat through enclosure structure from outdoor incoming indoor; night outdoor temperature than indoor temperature declined fast, heat has may through enclosure structure from indoor biography to outdoor. In order to more accurately calculate the heating and air conditioning loads, dynamic calculation methods is needed. In hot summer and cold winter zone Chengdu city as an example, this paper analyses, the results in Figure 7, as shown in Figure 9.

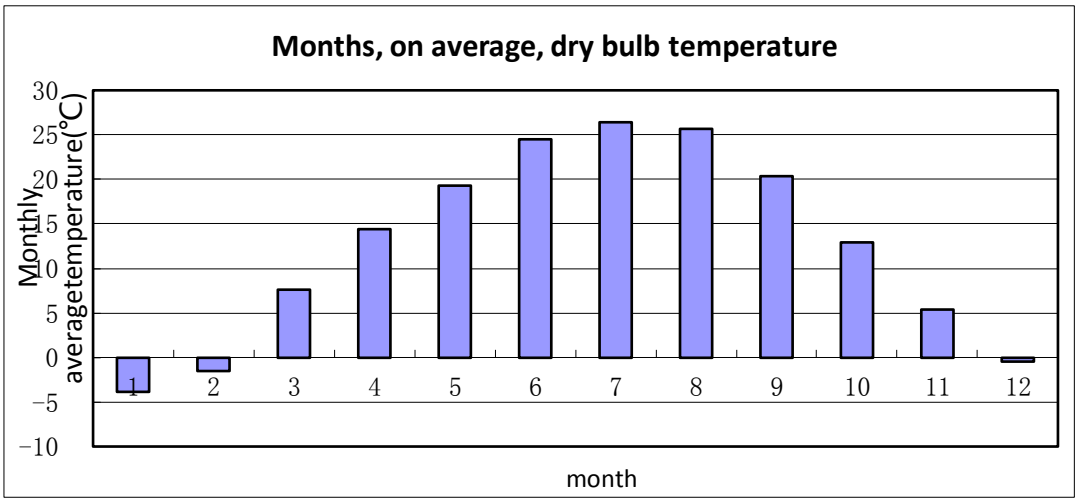

Figure6. Average of months and dry bulb temperature of Beijing

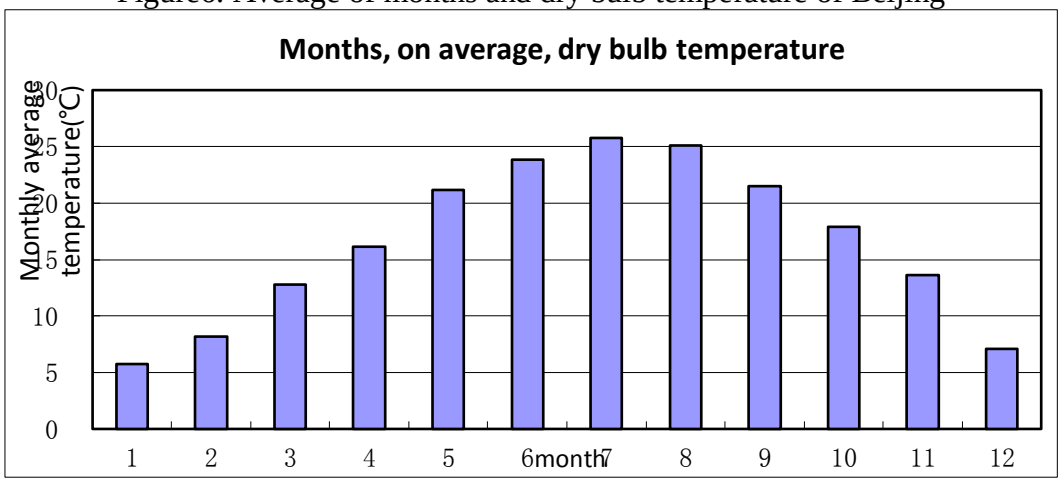

Figure7. Average of months and dry bulb temperature of Chengdu

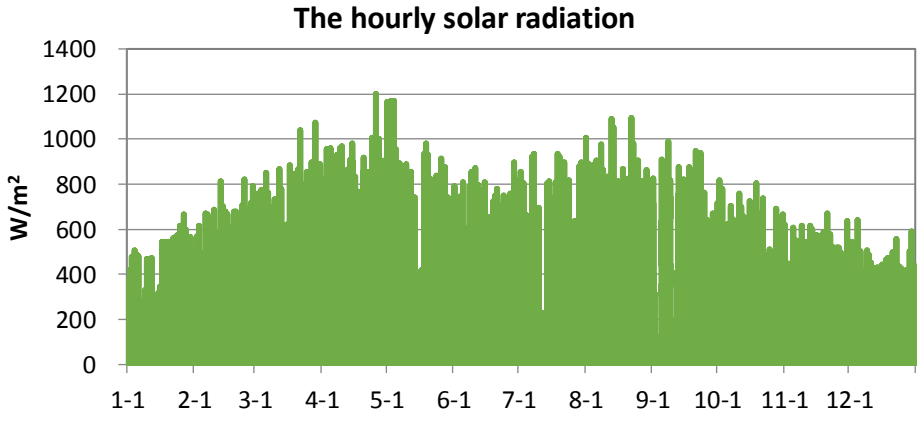

Figure8. The hourly solar radiation of Beijing

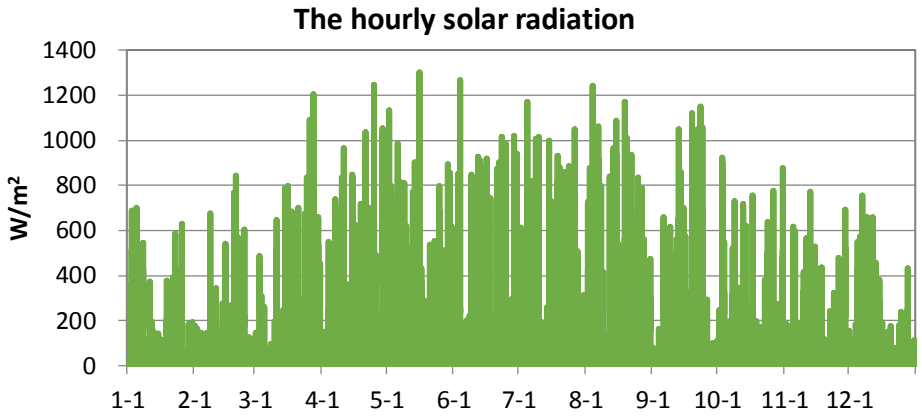

Figure 9. The hourly solar radiation of Chengdu

5. Conclusion

(1)Energy-saving diagnosis results displayed, the Office building enclosure structure hot workers performance poor, exists obviously of hot workers defects, cannot meet indoor hot environment of need, should its for transformation, while from energy simulation analysis results in the found enclosure structure on building energy effect is big, transformation enclosure structure on building energy-saving meaning major; energy-saving benefits analysis results also displayed has: through transformation outside window by save of energy and the produced of benefits far above outside wall and roof of transformation, building of energy-saving transformation must attention outside window of transformation.

(2)The energy-saving renovation of the Office building is economically feasible, energy-saving investment cost can be recycled through energy savings, energy-saving will not only save energy, but also for China's environmental protection and sustainable development is of great significance

(3)Energy saving renovation of existing buildings to be considered comprehensive, integrated energy-saving effect of factors such as affordability, building life, party, tried to reduce costs. Meanwhile, State and local governments are not yet fully bear the costs of reconstruction required owners to bear part of the costs, so on the premise of guaranteed energy saving effect, should try to reduce costs, to lighten the load, improve energy-saving initiative.

Through the building each model of simulation analysis, the conclusions are the following:

(1)On energy-saving reconstruction of existing building envelopes and air conditioning system and energy-saving construction standards, significantly reduce building energy consumption, meet the requirements of energy-saving 50% Ministry of construction;

(2)Building energy-saving measures should take into account regional characteristics, does not affect the normal use of the housing as far as possible, should also take into account its economy;

(3)Aiming at building envelope and analysis of energy-saving of central air conditioning system, but for the interior lighting of buildings, other equipment, such as improvement of evaluation needs further study;

(4)In this paper, an office building in Chengdu as an example, analysis of existing buildings energy consumption, energy-saving effect of the remaining area evaluation and selection of energy-saving measures, needs to be further expanded.

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