Research on Energy-Saving Reconstruction Technology of Hospital Buildings Based on Measured Data

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Abstract. In order to effectively reduce the carbon emission in the process of building operation, the energy consumption per unit area and energy consumption system of hospital buildings were analyzed and studied. The practical application shows that the energy-saving transformation of hospital buildings in hot summer and warm winter area can effectively reduce its energy consumption, it also saves at least 654 tons of carbon dioxide annually.

1.Introduction

According to 《the 2022 China building energy consumption and carbon emissions research report》 2.27 billion tce was consumed in 2020, accounting for 45.5 percent of China's total energy consumption. Carbon emissions from buildings during operation amounted to 2.16 billion TCO_2, accounting for 21.7 percent of China's total carbon emissions[1]. Compared with the developed countries, our country is still in the development stage, with the continuous urbanization process and economic development, the total amount and proportion of carbon emissions from building operation in our country has a greater promotion power [2].With the progress of medical technology, the development of diagnosis and treatment equipment, the expansion of hospital scale, the improvement of environmental control standards, and the importance of patients and medical staff to the degree of medical environment comfort, the level of hospital energy consumption is increasing year by year [3] .

Unlike other public buildings, a hospital is usually a complex of buildings containing many types and functions, for example, the energy intensity and energy consumption system of different buildings are different, such as the inpatient building, the outpatient and emergency building, the medical and technical building, the administrative building, the logistics building, the scientific research building, the canteen, the dormitory and so on[3], it is necessary to investigate the energy consumption of every building in the hospital, and to analyze the operation of the centralized energy supply system of the whole hospital, so as to master the energy consumption characteristics of the hospital buildings, to understand the problems and energy-saving potential of hospital building energy use is the premise to carry out the energy-saving transformation of hospital effectively[4].

Taking a hospital project as an example, through the analysis and study of the energy consumption value per unit area of a hospital building and the energy-using system, the paper puts forward the application of energy-saving technical measures for air-conditioning and hot water systems, the project energy saving effect is analyzed by the measured data. To explore the energy-saving retrofit technology for hospital buildings [5] , and to provide an effective way for hospital buildings to reduce carbon emissions.

2.Energy use status and analysis

2.1. Energy systems

The hospital has independent energy system, including power distribution station, air conditioning system, boiler system, water supply and drainage system. The main energy consumption of hospitals includes electricity, natural gas and water. Electricity consumption is used in refrigeration plant rooms, air-cooled heat pump air conditioning units, split air conditioning, lighting, water pumps, fans, electrical steam generator and medical, laboratory, office and other equipment; Natural gas is mainly used for steam boiler, steam is responsible for the supply of hospital domestic hot water, heating, clean air-conditioning, supply room, kitchen, laundry (the end of 2014 laundry discontinued) , medical building, etc. Water for air conditioning water supply, domestic hot water, wards and kitchens.

2.2. energy consumption analysis

Before the transformation, the total energy consumption of the hospital was about 21.53 million yuan, electricity consumption was about 17.52 million kWh, natural gas consumption was 1.27 million m3, and tap water consumption was 289,000 tons. Total standard coal 6912

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tons, See Table 1. The distribution of energy consumption before modification is shown in Figure 1 The hospital has a total floor area of about 110,000 m 2 and a total of 10 buildings. Before the renovation, the energy consumption per Gross leasable area was 62.8 KGCE (m 2 * a) .

Table 1 Energy used in the project before transformation

Project	Electricity (kWh)	Natural gas (m3)	Water (T)	Total
Dosage	17524015	1273319	289136	/
Standard coal (tce)	5257	1654		6911

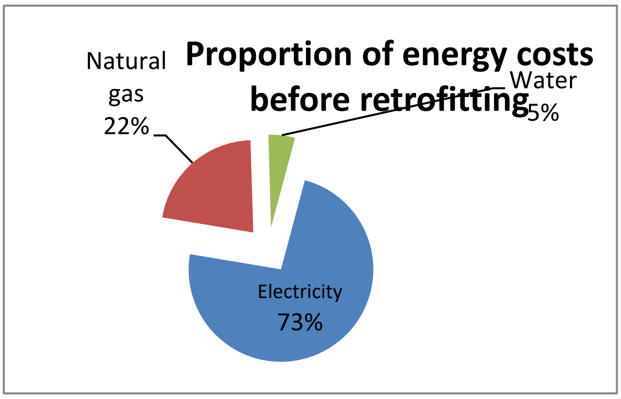

Fig. 1 energy ratio before modification

The proportion of electricity and natural gas in standard coal was about 73% and 22% respectively in the year before reform.

3.Technical Measures for energy-saving transformation

3.1. Intelligent control of refrigerating machine room

Before the reform, there is a set of control system provided by Kaili factory, which can not realize the intelligent control according to the feedback of staff In addition, due to the dehumidification requirement of the clean air-conditioning in the operating room, the water temperature setting is lower, and the refrigeration efficiency is lower, resulting in the waste of energy consumption.

Transformation Plan:

1. single group of Equipment Control (Open Program, close program) : when there is a cooling machine loading needs, first open the cooling tower valve, cooling water valve, cooling water valve, cooling tower valve and cooling water valve feedback open more than 90% , open the cooling water pump; cold water valve open more than 90% , open the freezing water pump. When the cold machine receives the signal of the switch of the chilled water and cooling water flow, it sends out the start order of the cold machine. The closing procedure is opposite, and the water flow switch, valve position feedback and the time interval of starting and stopping of each equipment are set.

2. rotation procedures: every morning sort, according to the cold machine operating time, pump operating time sort, priority to open the shorter operating time of the cold machine and pump; if received a fault signal equipment, the device will jump out of rotation sort, to be manually reset, to join the sort program.

3. Add/subtract machine program/according to the working condition of the hospital, when the system is turned on, first open a cold machine (large machine) , according to the current percentage, if the current percentage is maintained above 90% for 20 minutes (adjustable) , add a cooler (load from the small unit) ; if the current percentage of two units is less than 45% to 20 min (adjustable) , reduce one unit.

4. Outlet Temperature: according to the outdoor temperature, the outlet temperature should be increased and decreased accordingly. Determine every half hour and set the upper and lower limits/

5. System shutdown procedure: at least keep a small machine to supply the operating room, judge the return water temperature and outdoor temperature at night under certain conditions, shut down the refrigerator for 1 ~ 2 hours, once the return water temperature rises to a certain value, immediately open the corresponding unit.

6. pump frequency control: according to the temperature difference between supply and return water frequency control, according to the return water temperature control frequency minimum.

7. cooling tower temperature control: cooling tower pipe connected, according to the back water temperature of cooling water main, load or load cooling tower number and frequency conversion.

8. the original cooling tower by Schneider PLC control and water temperature control, consider pulling into the BA system control.

9. and the site implementation process found in the energy-saving adjustment measures.

3.2. 4 # building hot water system retrofit

The present situation before reformation:

the steam boiler used for hot water heating in 4 # building before Reformation has the disadvantages of pipeline loss, condensation water heat loss and possible steam leakage, etc.

Transformation Plan:

1. Heating the basement water tank with the original screw water heat pump of the hospital

2. Adding an air source heat pump system when the water heat pump is not used in winter and the transition season, making hot water needed by 4 # Building

3. Auxiliary water-water heat pump of air-source heat pump system in summer to make system structure and operation control of hot water:

System structure and Operation Control:

1. In summer, when the water-type screw unit has refrigeration start-up needs, the water-water heat pump condensation heat recovery, heating the basement water tank.

2. Design a set of direct-heating unit in 5f to supply hot water for 5F water tank. The hot water in 5F water tank reaches a certain level, 20F of hot water from the basement tank, through the original pump, the original pipe, supplemented to 20F three hot water tanks.

3.5F and 20F water tanks are raised and kept at constant temperature by circulating heating air source heat pump unit. Four 75kW cooling water pumps in the sub-item of ECM02 are equipped with two ABB frequency converters, the transducer is installed in an existing control cabinet, and one transducer drives two pumps.

4, for the 4# building hot water system transformation (ECM07) new equipment configuration power supply, the new equipment installed in the 4# building 5F and 20F equipment room: the total capacity of the 5F new equipment is 120kW, the power supply from the B1F distribution room 5D5 distribution cabinet WP04 circuit, along the original cable bridge to the 5F equipment floor new distribution cabinet, laying cable signals: Double spell 2*(YJV-3x70 2*35).

5. The total capacity of the new equipment in 20F is 47kW, and the power supply is drawn from the air circuit of the original heat pump unit of the 20AP09 distribution box in the 20F distribution room. The cable signal is YJV-3x35 2*16 along the original cable bridge to the new distribution cabinet on the 20F equipment layer.

3.3.Analysis of energy saving effect

According to the comparison of sub-items before and after the transformation, the energy saving of the intelligent control of the refrigeration plant room and the transformation of the hot water system in building 4 is as follows Tables 2 and 3.

Table 2 Group Control Power saving of refrigerating station

Time	Power saving rate	Power consumption before modificationkWh	Energy saving kWh
August	13.27%	730,024	96,874
September	13.27%	593,379	78,741
October	25.22%	371,285	93,638
November	25.22%	202,639	51,106
December			
January			
February			
March			
April	25.22%	351,765	88,715
May	25.22%	640,217	161,463
June	13.27%	749,106	99,406
July	13.27%	791,544	105,038
Total	/	4,429,959	774,981

Tested, the power saving rate of the freezing station was 13.27% in the high temperature season (June-september) and 25.22% in the transition season (April, May, October and November) , because there is no annual data after the reconstruction, the current data of the monthly power consumption of the refrigeration station before the reconstruction are compared and inferred: the power consumption of the refrigeration station before the reconstruction is = σ, the power consumption before the reconstruction × the power saving rate of each month is = 774,981 kwh

Table 3 energy saving data summary of hot water system in 4 # building of hospital

Time	Heat production (kWh)	Electricity consumption (kWh)
August	75,858	18,004
September	64,588	15,309
October	81,202	21,125
November	116,012	31,100
December	171,495	39,131
January	220,062	39,809
February	157,468	36,633
March	123,778	33,833
April	111,818	30,569
May	88,883	21,162
June	79,351	19,539
July	74,560	18,591
Total	1,365,075	324,805

The unit heat consumption of hot water system is 0.1809 m3/kWh before retrofit, so the solar term quantity is: annual solar term quantity = annual heat production quantity × unit heat consumption before retrofit =

1365075 × 0.1809 = 246942 m3 annual electricity consumption = 324805 kWh.

A summary of the energy efficiency of each sub-item of the project is shown in Table 4:

Table 4 The energy saving situation of each sub-item is summarized

System	Contains child items	Energy savingkWh	Solar termsm³	Water saving m³	Save standard coaltce
Freezing station system	Intelligent control of refrigerating machine room	774,981			95
Hot water system optimization	4 # building hot water system transformation	-324,805	246,942		259
Summary		450,176	275,530	7,306	354

Energy consumption before and after retrofit is shown in Figure 2:

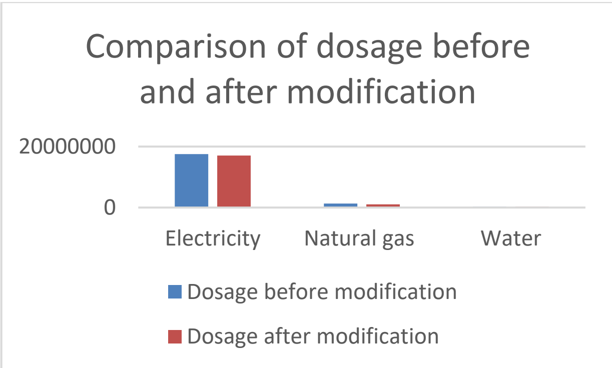

Fig. 2 comparison of energy before and after Reconstruction

The energy consumption per Gross leasable area was 58.6 kgce (m 2 * a) , which could reduce the energy consumption per unit area.

4.Conclusion

At present, the global greenhouse effect is becoming more and more serious, and people continue to pay attention to this issue as a basic means to improve the greenhouse effect, many countries and people around the world for the development of"Low-carbon economy" more and more recognition and support attitude[4], vigorously promote low-carbon development and actively advocate energy conservation and emission reduction, it is imperative. Under this background, after the hospital project transformation, the hospital saves about 354 TCE of standard coal annually, and at the same time saves at least 654 tons of carbon dioxide emissions annually, The energy consumption per Gross leasable area was reduced from 62.8 kgce (m2 * a) to 58.6 kgce (m2 * a).realizing the hospital's commitment to energy saving and emission reduction, for the community to make a positive contribution to energy conservation and emission reduction, green development of the social environment to promote.

Acknowledgments

This work was financially supported by the National Key Research and Development Program of China (no. 2019YFE100300)

References

1. 《the 2022 China building energy consumption and carbon emissions research report》[R]2022
2. Wang W，Wang D，Ni W，et al． The impact of carbon emissionstrading on the directed technical change in China［J］． Journal ofcleaner production，2020，272: 122891
3. Liu Ye; Min Yun .case analysis of comprehensive energy-saving reconstruction in Shanghai large and medium-sized hospitals ,[J] Shanghai energy-saving 2022(5)
4. Yuan Yuan; Zhu Weifengn. Energy-saving diagnosis and reconstruction of a general hospital building.[J] HVAC, 2020
5. Ko YuDe.Analysis of Shanghai Hospital comprehensive energy-saving transformation. [J]HVAC, 2016