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HVAC system green retrofit survey and analysis of public institutions building in cold region

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Abstract

Public institution building energy consumption is an important part of building energy consumption. With the rapid spread of HVAC systems, the status of building energy consumption is increasingly prominent. Taking 16 typical public institution buildings of Shenyang in the cold region for example, this paper presents current problems of Shenyang public institution existing buildings HVAC system green retrofitting. Through the HVAC system green transformation of existing buildings, energy-saving effects demonstrate the effectiveness of the green retrofitting.

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Keywords: Public institutions; HVAC system; Green retrofit; Energy saving rate

1. Introduction

In 2012, total national energy consumption of public institutions 199 million tons of standard coal, accounting for 5.8% of total energy consumption of the whole society. With the rapid spread of HVAC systems, the status of building energy consumption is increasingly prominent. The methods of questionnaire and site visits are adopted to elaborate the development of HVAC system green retrofitting of public institutions in cold region. Data shows that air conditioning and lighting energy consumption of modern office buildings account for 60% to 70% of the total building energy consumption. With the growing demand for energy consumption, the goal of public institutions to achieve energy efficiency is becoming more and more difficult. For this reason, to carry out the research of HVAC system green retrofitting provides strong technical support to public institution in the cold region.

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2. Factors affecting energy consumption situation of public institution building HVAC system in cold region

In Shenyang, for example, the area of existing buildings types is about 202 million square meters, including residential building about 112 million square meters, and public institution building about 090 million square meters. 95% of these public institution buildings are not energy saving buildings.The impact of building energy consumption of public institutions are complex, and the main factors are the building envelope and HVAC systems.

2.1. Building envelop

The high energy consumption phenomenon of HVAC systems is exacerbated by the large external structure heat transfer coefficient. In summer, even air conditionings are extensively used, the effect is still poor. In winter, although electric heating is increased indoor, the temperature is still low.

2.2. HVAC system

The survey found that some building air conditioning system is not well quantitatively to be allocated fresh air, resulting in some room air volume, and some room air flow. And because air distribution is unreasonable, some space could not feed fresh air.

The water system is mostly constant flow water volume system, the prevalence problem is large flow of small temperature difference. So to achieve the design load, it will waste a lot of energy by increasing flow method. Therefore, engineering practice will eliminate the phenomenon of "big flow of small temperature difference", and gradually introduce design method of "small flow of large temperature difference". Of course, increasing the cold water supply and return water temperature difference need change equipment operation parameters, so to determine after comparing technical and economic analysis.

The choice of cold and heat source is single, because China's electricity and gas load exists imbalance. In summer, power is short, and gas resources are not fully utilized. In the winter on the contrary, "peak-valley difference" is formed.

Many buildings do not consider heat recovery air conditioning system. In fact, since the introduction of new wind, the air-conditioned environment is bound to drain part of the indoor air. Relative atmospheric temperature of the exhaust gas temperature has a certain temperature, and will bring energy loss. Switching equipment makes use of heat recovery fresh air before being treated first with exhaust heat exchange, new air temperature will be reduced, thus reducing the load of new wind generating units, reducing the energy consumption.

3. Case analysis of public institution building energy consumption in cold region

3.1. Basic building information

For the comprehensive analysis of cold region public institution building green retrofitting in cold region, 16 representative institutions building in Shenyang is selected to be researched and done field testing. Specific information is as follows.

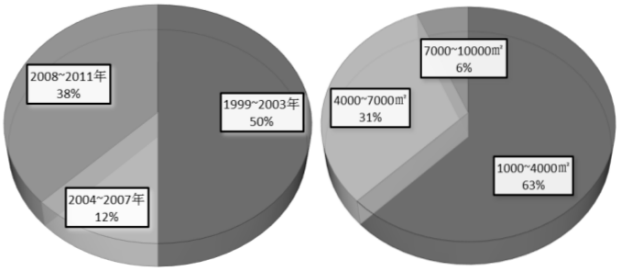

Fig. 1. Cases of public institution building basic information (build time and build area).

Research buildings include government buildings, educational institutions and health institutions, etc., generally smaller building area, and construction time span is not great.

3.2. Building Energy Analysis

(1) Case of building energy consumption statistics

Through the analysis of the survey data collation, building energy consumption of public institution chart is shown in Figure 2.

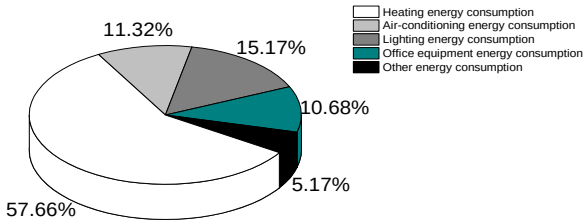

Fig. 2. The percentage of public institution building energy consumption statistics.

(2) Case of each building's total energy consumption and HVAC system energy consumption statistics

Data processing analysis results of each building's total energy consumption and HVAC system energy consumption, as shown in Figure 3.As can be seen from Figure 3, public institution building per unit area of energy consumption is a big gap up to 8.28kgce / (m · a), the minimum 4.62kgce / (m · a). The heating energy consumption levels remain the same, at 3.22 ~ 3.49kgce / between (m · a). Air conditioning energy consumption levels is between 0.6 and 1.3kgce / (m · a).

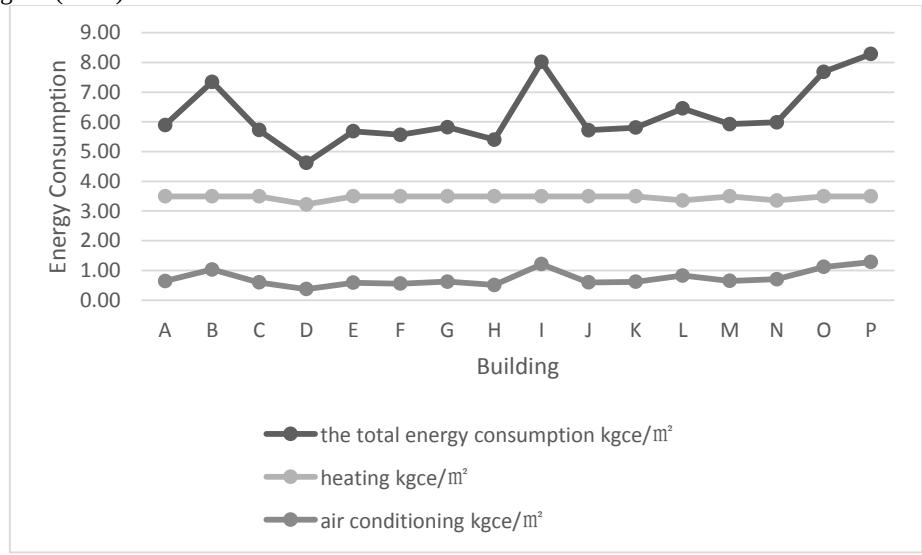

Fig. 3. The total energy consumption of each building and energy consumption of HVAC system.

3.3. Case analysis of building energy consumption

Figure 1, Figure 2 and figure 3 show that the per unit area energy consumption of public institutions is 6.17kgce / (m · a), including air conditioning and heating per unit area energy consumption 0.72kgce / (m · a) and 3.47kgce / (m · a), respectively accounting for 57.66% and 11.32% of the total energy consumption of public institution building. HVAC system energy consumption about accounts for 70% of the building energy consumption in public institutions, so air conditioning and heating system energy consumption is a key factor affecting the total energy consumption of public institution building.

4. Public institution building HVAC system green retrofitting in cold region

Found through research, public institution building HVAC system green retrofitting in this region mainly include envelope, heating system, air conditioning system and heating and cooling source.

4.1. Envelope green retrofitting of public institution building

Table 1. Exterior wall retrofitting.

Building	Content	Form
AL	40mm waterborne polyurethane foam	Internal insulation
EK	40mm Polyurethane Internal insulation	Internal insulation
DGNH	100mm EPS insulation board	External insulation
BMPIJ	50mm Insulation benzene plate	External insulation
CFO	50mm Polyurethane Internal insulation	External insulation

Table 2. Exterior window retrofitting.

Building	Before	After
ACGJOP	Push-pull window	Flat open plastic steel window
DFHLM	Aluminum alloy windows	FRP energy-saving window
BEIKM	Plastic steel window	Glass steel window

Table 3. Roof retrofitting.

Building	Content
ACGJP	Plate type thermal insulation materials
BHILNO	120mm polystyrene board
DEFKM	150mm rock wool board and 120mm flame retardant extruded polystyrene board

16 buildings of this investigation were carried out envelope retrofitting effectively. Heat transfer coefficient of envelope is directly related to the level of energy consumption of HVAC system.

4.2. HVAC systems green retrofitting of public institution building

Table 4. The form retrofitting of HVAC systems.

Building	Before	After
AFJM	Radiator system	Fan coil plus fresh air system
BGHNO	Split air conditioning system	Fan coil plus fresh air system
CD	Split air conditioning system	Online system
EIKLP	Radiator system	Radiator system

Table 5. The retrofitting of cold and heat source transformation.

Building	Before	After
ACFJ	Boiler room	water-source heat-pump system
BHIKMOP	Municipal pipe network	No retrofitting
DEGLN	Boiler room	No retrofitting

Through the investigation on the collation of information, we can find some public institution buildings change heating system into water-source heat-pump heating in winter. The use of water source heat pump is not only more environmentally friendly, no pollution, which belongs to the use of renewable energy and reduce operating costs, and promotes the development of building energy saving and environmental protection. At the same time, we can also see that the public buildings and cold will form the original split air conditioning system into the existing central air conditioning system in summer. Some online central air conditioning system is not only more efficient operation, and the ODP (ozone damage index) coefficient is zero, and environmental characteristics also make it widely concerned by public institutions green retrofitting.

5. Results

The energy-saving rate of green retrofit:

$$\zeta = \frac{E - E'}{E} \times 100\% \tag{1}$$

where ζ is the energy-saving rate of green retrofit, E is the former energy consumption, and E' is the latter energy consumption.

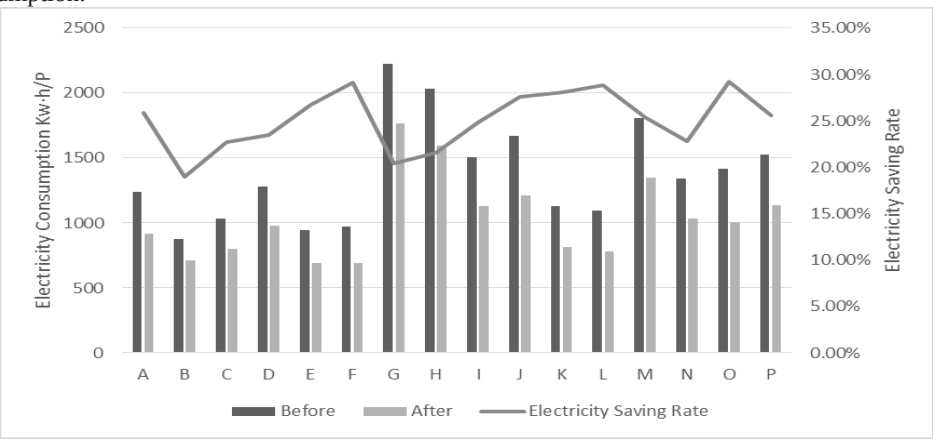

Fig. 1. Per capita electricity consumption and electricity saving effect (kW · h / P).

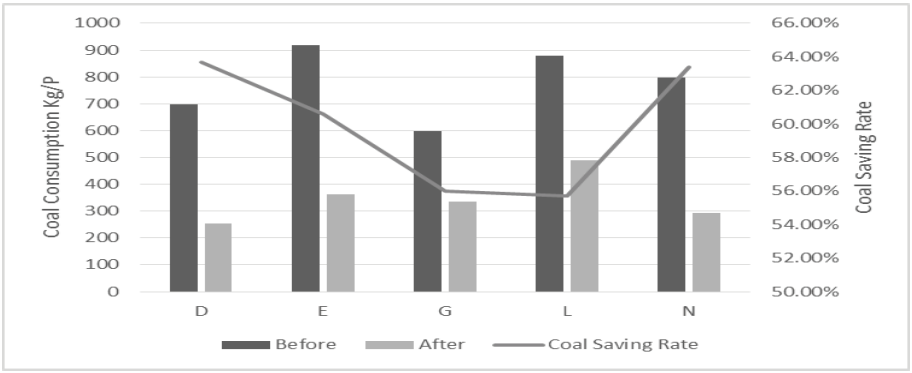

Fig. 2. Per capita coal consumption and coal saving effect (Kg/P).

Based on the research data, the energy saving rates are figured out to test the validity of the existing public institution building HVAC system green retrofitting. From the effect of energy saving, coal saving effect of building A, B, C is the most obvious, and the coal saving rate is between 61.3~64.1%. However, energy-saving effect of five buildings are not very obvious, and the saving rate is lower than 30%, between 21.1~29.2%. The main reasons causing the energy saving effect is not obvious are office equipment renewal and large increase.

6. Discussion

The limitation of area selection may make the research results have certain errors, which have influence on analysis of public institution buildings HVAC systems green retrofitting.At present, our country still has not established a set of existing public building green retrofitting methods and standards of judgment. Therefore, in the retrofitting process, most of the building is based on the past experience of retrofitting. Currently, the green retrofitting of public institution buildings mainly includes envelope and equipment retrofitting. Therefore, we should pay more attention to solve the building environment and public facilities t as soon as possible.

7. Conclusions

There are some main problems of HVAC system of public institution buildings in the region from the research. Aiming at the existing problems, public institutions in the region mainly has carried on envelope and HVAC systems retrofitting, as well as cold and heat source. Of public institutions in the region the main structure of the transformation, the transformation of HVAC envelope system and cold heat transformation. The energy saving effects are obvious, especially coal saving effect, and coal saving rate is as high as 64.1%. Electricity saving effect is not obvious, however, and the electricity saving rate is between 21.1~29.2%. The green retrofitting of public institution buildings HVAC systems need further implement, due to lack of the use of renewable energy and other green building technology.

Acknowledgements

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