

Analysis of building energy efficiency in China

LI Deying¹, FAN Yun¹, HAO Bin²

¹Beijing Institute of Civil Engineering and Architecture, Beijing 100044, P.R. China

²Science & Technology Development Promoting Center, Ministry of Construction, Beijing 100835, P.R. China

Abstract: This paper analyzes the matter of building energy efficiency and heating system, and puts forward the measure of heating innovation, aiming at the improvement of Chinese building energy efficiency and heating innovation, which exceeds some possible advice for future development.

Keywords: building energy efficiency; energy-saving of heating system; heating reform

1. Introduction

There are two methods of building energy efficiency(BEE): One is reducing the heat-consumption of wall structure; the other is improving the thermal efficiency of heat-supplying system. These years, some researches have been done in order to improving the efficiency of heating (cooling) in civil buildings, but we have not achieved the expected effect.

Compared with many developed countries in the same latitude, it is colder in winter and hotter in summer. What is more, the atmosphere humidity in northern China is very high. But the heat preservation and heat insulation of Chinese buildings under such condition is much poorer than that in developed countries. Heat-transmitting of wall, roof, door and window per square is 1-4 times more than that in developed countries in the identical climate. Furthermore, no necessary measure of heat preservation and heat insulation has been done in many air-conditioned buildings. The waste of energy in our country is so astonishing that the energy-consumption of building amounts to nearly 1/4 of the total energy-consumption in China. Letting it go ahead, energy-production certainly can not match with energy requirement.

According to the estimate of Ministry of Construction (MOC), about 1.35 billion tons of standard coal is consumed in residential and commercial buildings in China every year, and most of the energy is wasted. Besides the heat loss of wall structure, the primary network heat loss lies in the unbalance and the unadjustment of thermal system, which forces consumers to taking the only measure of opening windows in order to solve the over-heated problem. More heat loss in heating system results from the poor management and maintenance under the condition of present heat charging.

The issue of Design Standard of residential Building Energy Efficiency indicated the beginning of the task

of Chinese BEE. China is a country with a vast territory, which covers an area of 9.6 million square kilometers and strides four climate districts : tropics, subtropics, variable zone and frigid zone. In order to popularize the application of energy efficiency design standard, we divided China into 3 parts: the area that is cold in north China, the area that is hot in summer and cold in winter and the area that is hot in summer and warm in winter. Different design standard of BEE have been established for these 3 parts. Not only key articles in building design standard have been brought into the forced items of engineering construction by MOC, but the 76th order of MOC —The Management Regulation of Residential Building Energy Efficiency has been issued in 1999, which required the owners, designers, constructors and inspectors should abide by the criterions of energy-saving , which put a good foundation for the implementation of BEE technique.

2. The major problem of BEE

2.1 BEE is just in the beginning

After the practicing of the design standard of BEE, we implied the standard as the compulsory one in 1999. However, this design standard of BEE is hard to spread out. Take the northern district for example, In 2000, MOC inspected the implement of standard of BEE in two directly under the jurisdiction of China, eight provinces, and 3 municipalities. It was found that the amount of buildings constructed according to the standard just accounts for 6.4%. By the end of 2000, the present building areas had been 7.66 billion square meters in city (residential building 4.41 billion square meters), 20.04 billion square meters in countryside (residential buildings accounts for 80%). Only 0.18 billion square meters buildings matched the standard, accounting for 0.6%.

The 27 billion square meters existing buildings have the problems of poor heat presentation and insulation,

airproofing and the low efficiency of heating. So those buildings would waste a large number of energy in the future if we do not carry out BEE reconstruction.

2.2 Lack of techniques, materials and products in BEE market and poor quality

According to the development of the work about BEE, the industry of BEE is becoming a new industry. With the applying of the standard, the demand of corresponding techniques, energy-saving materials of wall, energy-saving doors and windows, glasses, changing-flowed equipments of heating control, new ways of heat(cold)-supplying of energy-saving, thermal meters and temperature control equipments increased greatly. With the driving of the demands, there are all kinds of new techniques and products in the market, which partly meet the increasing demands. For example, the output of the new materials of wall is increasing and there are 100 billion bricks produced every year, the market of plastic doors and windows is developing and has the production of 149 million tons per year. However, the existing problems are:

2.2.1 Lack of wall materials with energy-saving function and heat preservation materials

Take heat preservation materials for example, the needs of material should be 0.5 billion square meters per year, if the new residential building in northern or transitional areas constructed according to the criterions. But the present production of 0.2 billion square meters doesn't match the demand of 0.5 billion square meters. Furthermore, type is few, such as polystyrene and asbestos.

2.2.2 Low ability of innovation, research of new techniques and new product is behind others

Most of techniques used now are brought from abroad. Only a few corporations have their own independent property rights of knowledge and their product can not meet the increasing demand of energy-saving building market.

2.2.3 Industry of plastic doors and windows is out of order.

Many corporations produce blindly which lead to the malignant competition. Techniques and products covered a lot, from the best to the worst. Some corporations even made fake propaganda and fake products.

These problems interfere with the development of the BEE industry and market, impact the quality of project and make the energy-saving building can not achieve the goal of energy-saving, environment protection and heating comfort.

2.3 Low quality of construction

The energy-saving work can not be carried out without decision-makers, policy-makers, managers, designers and constructors and the instruction of BEE standard, especially the attending of large numbers of people and without . However, our construction quality of energy-saving is terrible. The problems existed are as follows:

2.3.1 Standard system has not formed

The energy-saving criterion of southern areas , public buildings and industrial buildings has not formed. Majority of new techniques and new products are still short of corresponding criterion.

2.3.2 People are not aware of BEE

As for this phenomenon, people are not aware of both the importance of BEE and the popularization of corresponding knowledge. What is more, people from decision-maker to normal man have not the consciousness of BEE and they lack enough training, so it is very hard to insure the total quality of BEE in construction.

2.4 Poor management of heating and poor quality facilities

2.4.1 No metering facility in heating system

The heating system is short of gross controlling and metering, the single pipes heating mode makes consumers such an integer that heat measuring individually is out of the question, which not only does harm to some consumers but also help some consumers use heat at the cost of naught.

2.4.2 Low efficiency of central heating system and poor management of dispersed boiler houses

In the programming and management of heating, we followed the precedent of branch division and dispersed management. For example, it is very common to build a dwelling house and then build a boiler house or set up a heating corporation with terrible organizational system and poor management, which runs for a short period of time.

2.4.3 Low efficiency of heating and great pollution

To some extent, some improvements have been achieved, yet the construction of thermal source has been in a state of lacking united programming and management for a long time .A large number of dispersed boiler house could be seen here and there. The energy consumption of dispersed small boiler under 10 tons is very much, which like that a small horse pulling a big vehicle. Atmosphere pollution in winter in China's three north areas mostly results from

the poor management of heat-supplying and low thermal efficiency.

2.4.4 Poor heating quality

Local governments take the task of ensuring the quality of civil heat-supplying as an important work in winter, in some cities, even some corresponding laws has been formulated in order to fulfill the task. Although these laws took effect to some extent, heat-supplying systems in some civilian's house were still out of order, which resulted from the design, the enlargement and rebuilding, the tubing waterpower maladjustment and the poor management of heat-supplying system.

2.5 Finds of Demonstration Project

Many demonstration projects of BEE in China have achieved their goal of demonstration. For example, in Tianjin, Harbin, Changchun, Beijing and so on, tests and evaluations have been taken in collocation of heat-measuring devices and pipeline, and the technique of heat-metering has been introduced to many cities. Because of the obstacle of the system, it is difficult to charge based on heat-consumption. Heating corporations usually play the role of technique participants rather than business entity. Considering the pressure of short-term finance and the difficulty of management and system transformation, heat-supplying corporations considered it more difficult to measure heat and charge based on heat-consumption.

After several years' demonstrations and researches, experts and policy makers generally considered that newly built houses and old buildings should be dealt with separately. In new buildings, the inner pipelines must be adapted to individual thermal-meter, but this is only one of the possible methods of measuring. As to old buildings, further discussion should be taken in collocation of inner pipelines and the method of heat-metering. Changing the plane pipelines requires a great deal of money will disturb dwellers, which may result in the elevation of charging.

At the same time, these demonstration project reflected the other problems: remarkable difference in society, economy and system has not been considered at the time of introducing heat-measuring and charging in term of heat-consumption. It is thought that cost of heat-consumption would reduce and energy would be saved when heat-measuring and charging in term of heat-consumption was put into practice. In the long term, it is true; but in the short term, policy made biased on it will only lead to unpractical expectation.

3. Measures implementing BEE

3.1 Design energy-saving building

Heating system control and reform of billing is a crucial measurement to improve BEE, the other measurement is to improve the function of the material structure. Besides changing the heating (cooling), the chief way to improve BEE is reduce the heat-consumption of the material structure. In building designs, especially great commerce buildings, it is very important to make full use of natural conditions (solar energy, wind direction and so on), optimize the inner flow structure and comfort and take advantage of effective heat (cool), such as permutation ventilation.

3.2 Reconstruction of old buildings

The cost of reconstruction of old buildings is much (that is to say reclamation after 10 years), because the basic design has already been done, so the cost of alteration is much. But if consumers were active in reducing heat expenditure, controlling heating and saving energy, such as reducing the penetration of cold wind, the effect of energy-saving would be remarkable. At the same time, Chinese families have gained house property right, so if owners are aware of energy-saving and are access to better and cheaper equipment, and take measurements of doing wall heat preservation or using doors and windows that save energy, then we can achieve our goal of saving energy, and owners will be glad to do so.

3.3 Carry out the standard of BEE, promote energy-saving of newly buildings

Under the present condition, the item that municipal government is popularizing should include some elements as following: (1) Carrying out the regulation of newly buildings, including inner pipeline criterion and charging criterion doing good to owners; (2) Carry out the heat-charging innovation on newly buildings firstly, and do it on present buildings; (3) Evaluating item of energy-saving material and other energy-saving product may promote the product that saving energy with high quality, depending on market mechanism. Many years' experience indicated that it is impossible to reduce the heat cost by taking promoting measurements. Only band individuals' interest of economy and comfort and additional society benefit together, and carry out more persuasive cost benefit measurements, could BEE develop in continuance.

4 The following step implementing BEE

4.1 The work in policy

The municipal government plays a crucial role of being successful on building energy efficiency. To rebuild heating system and improve the thermal efficiency of building needs the collaboration of many organizations and institutions. Only gain the government's support, break the conventional limit and systemize the corresponding departments of energy-saving, could Chinese BEE develop greatly.

4.2 Heating reform in heating areas

The reform of heat-metering system and applying the BEE standard efficiently need the support of the government. The municipal government should do many things, such as directing the orientation of innovation, ratifying basic plans, organizing the application of innovation. The important policy work include basic plans of heat-measuring ratified by relevant department, carrying out the BEE criterions, organizing necessary investment and financing to support the innovation. The government plays an important part in heating innovation.

4.3 Special investment and program support

With the encouragement of criterions and policy adjustment, the majority of investments on BEE should be solved by both corporations and consumers. Commercial credit is the best way to get money. Common finance (from government or international sponsors) should be used to promote the implying of the energy-saving criterions and the modification and drawing of the policy is important to establish effective market.

4.4 Specific technical measures of BEE

- 1) Draw design criterion of household heat-metering system
- 2) Evaluate the demonstration project of heat-metering buildings
- 3) Evaluate the present BEE
- 4) Do research on the cost benefit of all kinds of energy-saving measurements
- 5) Do research on the price of heating (cooling)
- 6) Analyze the different areas' heating methods and make relevant plans
- 7) Establish and apply the projects the government participate in
- 8) Do research on the effect and the cost benefit of energy-saving measurement

4.5 Strengthen heating operation, put quantified control into practice

After the establishment of BEE, the key measurements are the relevant facilities, managements and the heat metering and billing innovation. In other words, to implement BEE, heating system is the basic thing, i.e. designing, construction and management should be considered completely in heat source, network and customers. It is because the management doesn't match with it, so the building can not save energy.

In the running process, the important thing is controlling and how to supply and distribute meeting customers' demands. Not only customers but heat sources also need metering in the heating system. Using the measuring equipment to inspect, adjust and control, so that we can take quantified management according to the running problems (thermal load, circling water, total heat, temperature of supplying and return water, temperature of outdoors and indoors...). It is necessary to charge individually for those buildings equipped with heat-meters.

In order to popularize heat-metering, we still need a lot of supports of techniques and policy systems, such as the development of service medium, the construction of equipment testing and adjusting institutions. In the early stage, the stage of learning, the government policies should be made corresponding with different kinds of heat meters which can be chosen by customers, corporations and markets.

5. Conclusion

In a word, to implement BEE and heat-metering in China, we should make heat to be commodity and ask consumers to save energy. In the long run, our target is to apply heat-metering in all central heating systems. In order to reach the goal, the government plays an important role in the process i.e. effective institution should be set up to assure continuous development of BEE.

References

- 1 WU Yong, Thoughts on the government management efforts in implementing building energy efficiency, 2003.4.3
- 2 Chinese Demonstration Projects and International Experiences. Heat Metering and Billing: Technical Options, Policies and Regulations, 2002.11
- 3 YANG Xiwei, LI Ping, Thoughts on promoting building energy efficiency, Construction Science and Technology, 2003.8