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ANALYSING THE PROBLEMS OF BUILDING ENERGY EFFICIENCY IN CHINA, AND RESOLUTION METHOD EXPLORATION, EXPERIMENTATION

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Abstract: *Architecture is a huge sector of energy consumption. According to some relevant statistics, it consumes nearly 40% of total energies in all industries globally. In recent decades, the whole world is in the presence of a severe energy crisis, the conservation amount of fossil resources are decreasing continuously. Energy saving has been a compelling task for all human beings. Among all energies consumed by buildings, the buildings that have existed for a long term is a crucial section. Most of them were constructed in or before the middle of last century without the consideration of energy efficiency design. And new buildings have a replacement ratio of 1% to 3% annually. Reducing the total energy loads caused by buildings, the existing ones will be a key. It is extremely necessary to analyse the existing buildings to discover their weakness in energy efficiency for finding suitable measures to address the problems.*

Keywords: *Energy Efficiency Improvement, Building Energy Standards, Insulation, and Renovation*.

I.INTRODUCTION

Architectures consume a huge amount of energies among all industries. It is doubtless. According to some relevant statistics from the Europe, 40% of totally global energy consumption results from buildings [xi]. As to the decrease of worldwidely non-renewable resource storage, human beings are in the presence of serious energy crisis. Hence reducing energy loads has been a compelling task for the whole world. The United Nation and some single countries have enacted aims for energy saving in the next half a century. They have regulated that the whole world would reach zero-carbon emission five

decades later. In order to approach goals like this while resolving certain problems, some developed nations have enacted laws and standards for decreasing the amount of architectural energy consumption. Instantly, the UK has set a goal of reducing energy consumption needs by 20% in 2020 in comparison with 2007, while shrinking 80% of carbon dioxide release on the level of 1990 by 2050 [xxviii].

As the large proportion of energy consumption results from architectural field, descending energies consumed by buildings is a key of achieving the goal of universal energy saving. Based on the aim of energy load reduction, the UK has enacted Code for Sustainable Homes (CSH), regulating that new residential buildings must achieve Level 6 in this standard, that is zero-carbon emission [ii].

In present-day world, as the advancement of science and technologies, there are certain techniques integrated into building industry for improving the occupation quality. The advanced materials and installations are able to assist buildings to achieve higher levels of sustainability. New residential buildings based on CSH in the UK can achieve the energy efficiency standards. It sees that the prospect of architectural energy saving is optimistic. However, there are other problems relating to building energy load existing. A number of currently existed residential buildings were built before or during the middle of last century, they were erected more simply hence do not achieve present standards of energy performance, for no insulation placed. More seriously, there is only an annual replacement ratio of 1.0-3.0% for buildings in the Europe (in developed countries it would be below this figure) [xx]. Resultantly, if only depending on the low-energy effect of new buildings, there would be little possibility to reach the aim of whole decrease in global energy load. Thus it is essential to switch people's attention to existing buildings, especially those have existed for a long time without energy saving design. Exploring new ideas on renovating them to improve their energy efficiency for reaching the goal of total energy requirement reduction.

Architecturally, facility running is the main aspect of energy loads, it includes the requirements for heating, cooling, lighting, cooking, and other appliances). Renewable energy development and use is another factor in modern building design. The CSH involves all factors of them. Among the all sectors for energy demand, interior comfort maintaining (the running of heating or cooling equipment) is the key contributor (Fig. 1 [xxiv]). They are highly efficient in electricity consuming. In accordance with some appliance figures, heaters and coolers have the highest working efficiency and longest

working time, such as air conditioners. In very cold or hot weathers, for the interior temperature adjustment, there needs to be facilities working for keeping warm or cool, which causes temperature difference between indoor and outdoor areas. If the building envelopes are not well thermally insulated, so that heat exchange between indoor and outdoor spaces would happen frequently (this is called heat loss), the temperature conditioners have to work endlessly for maintaining the interior area comfortable. In fact this phenomenon is happening in the maintenace of most currently existing buildings. It is not hard to see that a high ratio of building-related energy is consumed for adjusting internal temperature, more exactly heat loss. If the architectural envelopes can be well insulated, heat transmission through building fabrics would be prevented, so that the mission time of conditioners could be reduced noticeably (Fig. 1 [xxvii]). Therefore, to renovate the existing buildings for better energy efficiency, enhancing the envelope insulation effect (pursuing lower U value) is a key.

II. PROBLEMS AND SCOPE

Globally, there are several key high-density building regions, the Europe, America, and China. Among them, China is a typical area that has huge potential for building energy reduction. Initially, China is the most important construction producer universally. In accordance with the statistics in recent years, half of the globally fresh construction areas (㎡) take place in China [viii]. Moreover, energy wasting is an obvious issue in China nowadays. As being weak in scientific field, domestic facilities for Chinese families are low ratio in energy transferring. The poor-efficiency products are popular in China for their low cost in manufacture and installation. Meanwhile, its building envelopes are not strong in heat conservation. Insulation idea was introduced into and implemented in China very late. Chinese constructions were designed in insulation after 2000. Yet the most severely, for being technically weak, the insulated buildings in this region do not achieve high standards. The U-values of most insulted buildings are three times higher than the European degrees. For example, the thickness of insulation in buildings of China are only 1/3 of that in the Europe. Finally, sustainable development has not been implemented in China. The running of industrial production and daily life are supported by burning fossil fuels. While emitting waste gas, it wastes lots of mine resources. Resultantly, China has been a key energy consumer internationally. For getting the international target of energy requirement descent, improving energy efficiency of buildings in China is crucial.

The latest four decades were are key period of building development in China. After beginning to implement the Policy of Opening and Revolution in 1978, for the cultural exchange and import, some advanced techniques were also introduced into China, such as the technology for envelope insulation.The technologies of external wall insulation were original from the Europe by 1940s, more exactly in Germany and Sweden for repairing the envelope leaks caused by the World War II. Users of this discovered that the repair materials were not only thermally and soundly insulated, but also water proofed, which improves the interior comfort degrees for occupants. [iv and v]

A rapid development of this technology took place in the 1970s. For the effect of global energy crisis, many countries have been aware in the necessity of energy saving. The technology of exterior wall insulation was introduced into China during the 1980s. It was initially used in the northern regions that are severe cold at the interior sides of walls. Through practical implementation, its shortages were exhibited obviously. For the considerable temperature difference between the two sides of exteriors walls, some cold water formed on the surface of walls, leading to the material erosion. [xxiii]

To combat problems like this, investigators started to research and develop more suitable measures toward the climate and building features. Through a period of nearly one decade for studying and importing advanced technologies from developed countries (from 1980 to 1990), there is a wholy theoretical norm developed. Issuing laws and standards for reducing building energy needs started in 1995. In that year the government enacted the <Design Standards of Energy Efficiency for Buildings (Residential)> (DSEEBR), regulating to approach the aim of saving half of energy. In 1998, <The Law for Energy Saving of the PRC> was formally released and implemented. Yet in 2002, the working office of construction continuously issued several specifications, they are the <Exterior Wall Formulation of Buildings I (02J121 (2002-9-1))>, <Standards for Building Energy Saving Design in Hot-Summer and Cold-Winter Regions>. Since 2004, some big cities, Bei jing and Tian Jin, began to implement the standards that save energy by 65%. After that, each area started to release their regionally sole standards for energy efficiency. A timeline for the process of the energy saving standards is being exhibited in the following table. [xvii]

China is a big area that stretches across several climate zones. From the south to the north, in the same season, the air temperatures change considerably. For the considerable climate differences in various regions, there

should be suitable standards of architectural insulation levels to adapt to the regionally characteristic climates. Hence the standards divide the whole nation into several climate regions, each of them has their special energy relating regulation. Although there are regional standards, the constructions in different areas are not considerably various. They are developed based on a central standard, the DSEEPB. In 2005, <Design Standard for Energy Efficiency of Public Buildings> was formally issued on 4 April, while being formally implemented since 1 July 2005. [xxxiii]

Despite being titled as 'Public', it is available in all kinds of buildings. This standard is used continuously till now. During the period from 2005 to present, many provinces have enacted their regional laws or standards for improving architectural energy efficiency within one's management scope. In design tasks, designers could select to follow their local specification or the national one for building energy saving design. Meanwhile, as the distinctive climate features of various locations of China, the whole region is divided into several parts for following regionally various standards. They are Severe Cold Region (Containing A and B), Cold Region, Hot-Summer and Cold-Winter Region, Mild Region, Hot-Summer and Warm-Winter Region. The chosen precedents for study would be in different climate regions, to show their differences in insulation. Their difference in energy saving design will be illustrated in the words and tables in the section of each case study.