Analysis on the difficulties and countermeasures of energy saving reconstruction of existing rural residential buildings

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Abstract. The energy-saving reconstruction of existing rural residential buildings can not only improve the living environment of rural residents, but also achieve energy conservation and emission reduction of the construction industry and sustainable development. At present, the energy-saving reconstruction of existing rural residential buildings has become a topic of global concern. Many countries begin to pay attention to the energy-saving reconstruction of existing rural residential buildings and begin to formulate relevant policies and regulations. Based on the analysis of the construction situation about the existing rural residential buildings, this study expounds the difficulties of the energy-saving reconstruction of existing rural residential buildings, and puts forward corresponding suggestions, so as to realize the development of the energy-saving construction of the residential buildings in the villages and towns.

1. Introduction

According to the statistical bulletin of urban and rural construction in 2016, by the end of 2016, the construction area of rural houses in China has reached 1.06 billion square meters, including 800 million square meters of residential buildings, 110 million square meters of public buildings and 150 million square meters of productive buildings. And the total floor space of rural houses in China was 38.30 billion square meters, including 32.32 billion square meters of residential buildings, 2.40 billion square meters of public buildings, and 3.58 billion square meters of productive buildings, accounting for 84.4 percent, 6.3 percent, and 9.3 percent, respectively [1]. Thus, it can be seen that rural residential buildings occupy a very large proportion. In addition, by the end of 2016, the per capita residential area in rural areas nationwide reached 33.75 square meters. However, most of existing rural residential buildings have not carried out thermal insulation treatment. Moreover, the thermal performance and air tightness of external doors and windows of the building is poor, heating equipment is simple and simple, thermal efficiency is low, indoor thermal environment is bad, which resulting in a large amount of energy waste. According to the research results of the building energy conservation research center of Tsinghua University, by 2012, the commercial energy consumption of rural residential buildings was 171 million tce, accounting for 24.8% of the total building energy consumption. Therefore, the energy conservation and emission reduction of rural residential buildings is imperative and should be placed in an important position of the new rural construction work in China. And with the development of social economy, the promotion of the concept of sustainable development and the implementation of the energy-saving building, the energy consumption level, use
function, thermal insulation of envelope structure and so on about the existing rural residential buildings have been unable to meet the needs of the construction of new rural development in China. So, it is necessary to carry out energy-saving reconstruction, improve living comfort and realize energy-saving and environmental protection.

2. Literature review
At present, there are few researches on the energy-saving transformation of existing rural residential buildings, and most of the research results focus on urban residential buildings and public buildings. The research scope mainly focuses on energy-saving renovation technology and energy-saving renovation benefit evaluation. In terms of energy-saving renovation technology, Zhang Ruifeng takes the envelope renovation of extant building in Tianjin as an example to introduce the envelope renovation technology of walls, roof, doors and windows, which of great significance to improve the thermal comfort and reduce energy consumption of buildings[2]. QIU Zheng and NI Wenhui analyzes the application of energy saving retrofitting technology of existing buildings in Wuxi,and find out problems with the corresponding suggestions[3]. YANG Dandan takes the retrofit project of the teaching building of Jiangnan university as an example,analyzes the technical decision-making of the retrofit, and puts forward technical suggestions for energy-saving renovation[4]. Lu Linghuan etc. analyze the appropriate energy efficiency retrofitting measures for the external wall, external windows and roofs of the existing buildings in this zone, including the increasing of insulation layer, thermal insulation coatings and three-dimensional greening in hot summer and warm winter zone[5]. ZHANG Zhishun etc. take the energy consumption structure of Jingtian Energy Investment Headquarters demonstrative project as an example to analyze its resource conditions and energy supply and demand and to introduce economic, reliable, low–carbon and effective technical schemes for energy–saving reconstruction of existing building[6]. In the evaluation of the efficiency of energy saving renovation, Wang Zhiwei etc. establish an index system and make comprehensively evaluation of quantified index for evaluating an actual case of residential building[7]. XuJian and Wang Zhiwei establish the evaluation system by taking into account of technical indicators, economic benefits and social benefits for existing residential buildings, and determine the weight of the three kinds of evaluation indexes by analytic hierarchy process[8]. WEI Xiaodong establishes a benefit comprehensive evaluation system of energy -saving transformation to existing residential building envelope. And also analyses and evaluates the comprehensive benefit of energy-saving transformation through AHM, and shows the value of this method in comprehensive benefit evaluation of building energy-saving transformation through an example[9].

3. Research methodology

3.1. Investigation and interview
The energy-saving reconstruction of existing rural residential buildings is a complex systematic project, which cannot be accomplished overnight. It is necessary to consider the climate characteristics, resource endowment, customs and so on. At the same time, it is need to grasp the building characteristics and energy consumption characteristics of existing rural residential buildings in each climate area when analyzing the difficulties and corresponding countermeasures of the energy-saving reconstruction of existing rural residential buildings. Moreover, in order to obtain the corresponding solutions, we will consult relevant experts according to the actual situation, such as designers, construction workers, supervisors, experts from scientific research institutions, etc. we cannot copy a certain design scheme, or adopt a certain mathematical method to simulate or evaluate, and we need to find out the deficiencies in the energy-saving reconstruction of existing rural residential buildings through on-the-spot investigation and interviews with the residents to know the residents' construction needs for the energy-saving reconstruction of existing rural residential buildings. Therefore, the main research method used in this study is investigation and interview.
3.2. Project design of investigation and interview
In order to better understand the construction status of existing rural residential buildings and the difficulties in energy saving renovation, the research team designed the research problems in the early stage. It mainly includes the following aspects: ① the construction characteristics of existing rural residential buildings; ② the planning and design of existing rural residential buildings; ③ the design standards for existing rural residential buildings; ④ the existing rural residential construction management organizations; ⑤ the use of energy-saving materials for existing rural residential buildings; ⑥ the transformation situation of existing rural residential buildings; ⑦ the will of the inhabitants to reform; ⑧ the existing support policies. However, we will randomly determine the number of survey samples according to the actual situation of survey visits, such as residents' knowledge level, participation of construction units and property management units, and support from developers.

4. Current situation of the existing rural residential buildings
At present, the stock of rural residential buildings is relatively large, but most of them have many problems such as backward construction technology, unreasonable design layout, insufficient ventilation and lighting, and poor thermal insulation performance.

4.1. Planning layout is unscientific, environmental damage is serious
For a long time, most rural residential buildings in China have been designed and built by rural residents themselves. In the construction process, the thermal insulation of the housing envelope is basically not taken into account, and the spatial pattern basically seeks to meet the needs of their own life and residence, usually lacking consideration of natural ventilation and lighting. Therefore, the residential energy consumption is high during the using and maintaining. At the same time, the existing rural residential buildings are all built in a decentralized way, and the commercialization rate of the houses is very low. The engineering quality, functional quality and environmental quality of the rural residential buildings are poor. And because of the lack of scientific and reasonable planning, the structure of the rural residential buildings is loose, and layout is messy. Moreover, due to abuse of cultivated land, poor infrastructure, traffic inconvenience, and pile up construction waste at will, arbitrary discharge waste water and gas make it not only can not adapt to the needs of agricultural modernization, but also not easy to organize production and life, and to save farmland, also make rural regional space difficult to form a modern system of towns and villages and the deterioration of ecological environment[10]. So the outstanding problems in the development of rural residential buildings have made rural construction become a difficult, key and weak link in China's modernization.

4.2. Serious resource consumption and high building energy consumption
Current, the building material that used in existing rural residential buildings is relatively backward, basically without regard to heat insulation, energy conservation and environmental protection problem. In the building materials of existing rural residential buildings, the wall materials occupy most of them, and about 70% of the wall materials are made of clay solid bricks. However, clay solid bricks are made of agriculture tillage soil, which will seriously damage the existing land resources. At the same time, the production of clay solid bricks needs to consume a lot of coal resources, and a lot of waste gas and dust pollution will be produced in the firing process. Moreover, door and window air tightness and insulation effect is poor, roof insulation layer is too thin and so on make the heat loss and heat insulation effect is poor in existing rural residential buildings. As a result, the air conditioning temperature needs to be lowered to cool down in summer and heating temperature needs to be increased in winter. However, it will increase energy consumption.

4.3. Simple construction technology and lack of scientific nature
Both the design and construction of existing rural residential buildings are designed, and constructed by the residents themselves according to the needs of life, without considering the building modulus,
design standards of the houses and the thermal insulation performance of the houses. In addition, due to the lack of relevant design specifications for rural residential buildings and the low attention paid by rural residents to energy conservation and environmental protection, most existing rural residential buildings have simple construction techniques and are not scientific enough [11]. Moreover, the thermal performance and moisture-proof and anticorrosive measures that meet the living requirements are not available, resulting in poor thermal insulation performance, low comfort level and large energy consumption in existing rural residential buildings.

5. Difficulties in energy-saving reconstruction of existing rural residential buildings
The current situation of the existing rural residential buildings construction make the energy-saving transformation become the key to the new rural construction. However, it is difficult in the actual implementation process, many factors are restricting the pace of energy-saving reconstruction of existing rural residential buildings.

5.1. Poor awareness of energy conservation and environmental protection
The energy-saving reconstruction of existing rural residential buildings can not only improve the living environment of rural residents and protect the surrounding environment, but also achieve energy conservation and emission reduction and promote the construction and development of new rural areas. However, as the concept of energy-saving building has not been accepted by rural residents, many residents even do not know "what is energy-saving building". For this reason, in the process of construction, rural residents are the first to pursue the decoration of the exterior and the spatial layout of the house, without any awareness of the use of energy-saving materials. In addition, in the process of energy-saving reconstruction of existing rural residential buildings, rural residents are often required to bear part of the economic burden, and will cause some interference to their daily life. Therefore, on the premise of comprehensive consideration of their own interests, rural residents do not care about the damage to the environment and the impact on their health of the existing living places.

5.2. Insufficient government support
It is a complex systematic project about the energy-saving reconstruction of existing rural residential buildings, which involving multiple participants, each of whom has different interest demands. Therefore, among the many participants, the government becomes the coordinating and leading body. However, it is difficult to show the government's supervision and leadership in the energy-saving reconstruction of existing rural residential buildings. The reason is that the geographical location of existing rural residential buildings is scattered, the construction time and specifications are inconsistent, and it is difficult to formulate a unified supervision standard. Although the government has been advocating public participation in environmental protection and ecological construction in recent years, due to the lack of targeted policy support, the energy-saving reconstruction of existing rural residential buildings is not obvious.

5.3. Externality of energy conservation market
No matter for rural residents, governments or energy-saving service companies, they all pursue the maximization of their own interests in the energy-saving reconstruction of existing rural residential buildings. Although carrying on the energy-saving reconstruction to the existing rural residential buildings has obvious positive externality that marginal private income is less than marginal social income. However, all participants tend to only consider the direct benefits or costs related to their own interests, while the additional benefits or costs will be ignored [12]. In the process of energy-saving reconstruction of existing rural residential buildings, it can not only improve the comfort level and residential environment, but also reduce the energy consumption and air pollution of the houses, and bring good influence to the surrounding residents and the whole society. However, in the process of reconstruction, rural residents will choose to give up the reconstruction in the face of the direct cost and disturbance to daily life.
5.4. Market failure of energy-saving products

Energy saving products are indispensable for the reconstruction of existing rural residential buildings, however, because of the lack of related knowledge and testing ability to conserve energy, the rural residents do not have the ability to identify energy-saving products. Therefore, in the face of a wide range of energy-saving products, rural residents often seem at a loss. But for energy-saving service companies, they have complete information on energy-saving products. So when the reconstruction of existing rural residential buildings, rural residents who are at information disadvantage will regard as that all energy-saving products are not very different when they think about their own economic strength. In this case, low-priced energy-saving products will be selected, leading to the elimination of high-quality energy-saving products from the market and the phenomenon of "defective products driving out good products" [13].

6. Countermeasures for energy-saving reconstruction of existing rural residential buildings

6.1. Strengthen government supervision and management

As the main participant in the energy-saving reconstruction of existing rural residential buildings, the government plays a leading role in supervision. At present, the energy-saving reconstruction of existing rural residential buildings market is not perfect, and the relevant policies, laws and regulations are not perfect, making the energy-saving reconstruction of existing rural residential buildings cannot be complied with. In the process of transformation, as an energy-saving service company, it needs to provide appropriate energy-saving products. However, due to market failure, high-quality energy-saving products will be eliminated from the market. In order to avoid market failure, the government needs to increase tax incentives and financial subsidies for energy-saving service companies to effectively reduce the market price of energy-saving products, so as to make rural residents can accept them. In addition, a large amount of capital investment is required for the reconstruction of existing rural residential buildings, but most rural residents cannot bear the corresponding reconstruction costs alone. Therefore, as a government, it is necessary to guide rural residents to actively participate in the energy-saving reconstruction of existing rural residential buildings, and at the same time, introduce relevant economic incentive policies to stimulate the spontaneous participation of rural residents.

6.2. Enhance the publicity of residential energy conservation and emission reduction

Many rural residents believe that energy conservation and emission reduction should be the responsibility of heavy industry. It is not clear that building energy consumption has accounted for a large part of China's total disposable energy consumption. In order to make rural residents aware of the importance of energy conservation and emission reduction, and to pay attention to the energy-saving reconstruction of existing rural residential buildings, the concept of energy conservation needs to be deeply rooted in people's hearts. Therefore, as the government needs to publicize the importance of ecological civilization construction, it should allocate special funds for energy-saving reconstruction of existing rural residential buildings, so that rural residents can truly realize the benefits brought by energy-saving reconstruction of existing rural residential buildings, and stimulate the initiative of rural residents to participate in energy conservation reconstruction.

6.3. Standardize the existing residential energy conservation renovation market

The weak consciousness of energy conservation and emission reduction makes rural residents tend to choose energy-saving products with low prices. Energy conservation service companies will also pay attention to the purchasing behavior of rural residents. In order to maximize their own interests, they will sell unqualified construction products with relatively low prices to rural residents. Therefore, in order to effectively avoid the phenomenon of "defective products driving out good products", it is necessary to standardize the market of energy-saving products, improve the market operation mechanism, and improve the access system of building materials.
7. Conclusions

Energy-saving reconstruction of existing rural residential buildings is a heavy task and a long way to go. It requires joint efforts of all participants, and it needs to improve relevant policies, laws and regulations, standardize the market operation system of energy-saving products, and improve the initiative of rural residents to participate in energy-saving reconstruction. Based on the analysis of the current situation of energy-saving reconstruction of existing rural residential buildings, this study discusses the difficulties of energy-saving reconstruction of existing rural residential buildings and puts forward relevant Suggestions. And, in the future research, we will further discuss the appropriate technology and the effect evaluation of the energy-saving reconstruction of existing rural residential buildings.

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