# Research on Rural Building Heating Research and Improvement Strategy-- Taking Chengde County, Chengde City, Hebei Province as an example

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## Abstract

With the improvement and improvement of the economic level, farmers pay more attention to the aesthetics of the farmhouse, but they do not consider the function of the farmhouse and the efficiency of energy use. It can be seen that the energy saving situation of rural buildings is very serious. Improving the physical environment quality of rural houses and reducing energy consumption are imminent. Under this background, this study selected rural housing in Chengde County, Chengde City, Hebei Province, which has made great progress in rural residential energy conservation. Questionnaires were used in conjunction with interviews with farmers. Questionnaire set the building structure, building materials, construction costs issue, the winter heating mode, heating time, summer cooling and energy-saving measures in rural buildings facing the seven indicators. In order to find out the current situation and development problems in the development of rural civil buildings in Chengde County, Hebei Province. Based on the understanding of the current situation of rural housing in Chengde County, Hebei Province, it conducts multi-dimensional data analysis and evaluation. After investigation and analysis, it finds that it faces internal challenges and external challenges. External Challenges: High Energy Costs for Rural Residential Buildings The economic income of ordinary rural households cannot support their use of energy-efficient materials. Internal Challenges: First, from a technical perspective, rural residential energy-saving materials are less popular and lack technical support. Second, from the management perspective, there is a problem of insufficient planning depth and incomplete construction management system. Based on this, this study proposes a comprehensive development plan composed of macro and micro, which greatly enhances the propaganda and supervision of the macro, and subsidizes and assists the villagers who implement residential energy conservation, and focuses on the improvement of key links. The macro-micro optimization path together provides the driving force for the development of rural residential energy conservation.

## Keywords

Energy saving in rural houses; dilemma and challenge; path optimization.

## 1. Research Overview

### 1.1 Research background and issues raised

1. Rural housing energy saving space is broad

According to statistics, in 2017, the total construction area of rural areas in China is about 30 billion m2, of which more than 90% are residential buildings, accounting for 65% of the national building construction area, and the energy consumption of rural residential buildings accounts for 39.7% of

the total building energy consumption.[1] With the rapid development of the agricultural economy, the construction of new rural areas has been solidly promoted, the income level of farmers has increased, and farmers' awareness of the modern living environment has increased. Therefore, the implementation of new wall materials in the vast rural areas is not only an urgent requirement for transforming rural development methods and achieving sustainable development, but also an objective need to improve farmers' quality of life and build a harmonious society.

2. Rural residential energy conservation is valued

The Ministry of Housing and Urban-Rural Development issued the "13th Five-Year Plan for Building Energy Efficiency and Green Building Development", aiming at building an energy-efficient, low-carbon, green-eco, intensive and efficient building energy system and promoting supply-side structural reforms in the urban and rural construction sector. The overall goal is to achieve new breakthroughs in rural buildings, so that the overall energy intensity of China's buildings continues to decline.

### 1.2 Research objects, objectives, methods and ideas

(1) Research object

This study takes rural residential energy conservation as the main research direction, and selects rural housing in Chengde County, Chengde City, Hebei Province as the research object. In the past few years, Chengde City has made great progress in heating measurement and energy-saving renovation of residential buildings, which has had an important impact in Hebei Province and even the whole country. Analysis of the county's energy-saving situation is conducive to providing experience for rural residential energy-saving construction in other cold regions.

(2) Research objectives

Based on the current status of energy conservation in a rural residential building in Hebei Province, this study reveals the bottlenecks in current rural residential energy conservation. After investigation and analysis, it is found that rural residential energy conservation faces internal challenges and external challenges. In view of the constraints that hinder its development, this study proposes a comprehensive development plan consisting of macro, meso and micro, which further promotes the further improvement of fiscal and taxation policies. , Zhongguan established a multi-agent collaborative linkage mechanism, and micro-focus on the improvement of key links. By analyzing the residential energy-saving mode of Chengde County, Chengde City, Hebei Province, it finally rose to the entire rural residential energy-saving building system, and promoted the optimization and upgrading of rural residential energy-saving methods.

(3) Research methods

This study uses qualitative and quantitative research methods combined with field research, supplemented by statistical surveys and literature studies.

Literature Research Method: This study extensively reviews domestic and foreign scholars' research literature on rural residential energy conservation, and carefully analyzes and analyzes it, which helps the research team to understand the development of rural residential energy conservation more comprehensively and profoundly. In addition, the research team will learn from the advanced experience of foreign countries to compare the status quo in China and have important value for research.

The investigation research method is combined with the field observation method. [2]The survey research method is divided into questionnaire method and structured interview method. Through questionnaire survey and structural interviews for farmers in a rural area in Hebei Province; questionnaires set up building structure, building materials, construction costs, winter heating methods, heating time, summer The problems faced by cooling measures and energy saving in rural buildings.

Data analysis method: Based on the survey data, statistical analysis, econometric method, and data analysis and processing software will be used to quantitatively analyze 186 valid questionnaires

collected in Hebei Province, especially the current situation description analysis and preliminary evaluation, and model evaluation. Relevant, regression and other analytical methods used in the process, thus laying the foundation for the conclusion.

## 2. Investigation and analysis of rural areas in Hebei

### 2.1 Overview of Chengde County Building in Chengde City

This project is based on the civil buildings in Chengde County, Chengde City, Hebei Province. Chengde is located in the northeast of Hebei Province, and the energy consumption of the building is mainly used for heating in winter. At present, the rural population of Chengde City accounts for 67.6% of the total population of the city. Chengde County is mostly composed of two-storey buildings, two bedrooms, two halls and two bathrooms. The building opens at 15.77 meters* and has a depth of 8.4 meters. It covers an area of 140.3 square meters and has a building height of 3.4 meters.

The rural construction houses are still dominated by clay solid bricks, destroying a large amount of land, consuming energy, destroying ecology and polluting the environment. Moreover, the building dissipates the heat through the enclosure structure, accounting for 70% of the energy loss of the entire building. The heat loss caused by the external wall and the window alone accounts for 50% of the total energy loss.

### 2.2 Building Structure and Structure of Chengde County, Chengde City

2.2.1 Building envelope structure

According to the results of the questionnaire survey, as shown in Figure 1, the brick-concrete structure wall, accounting for 85.2%; the frame infill wall accounted for 9.5%, the adobe wall accounted for 4.3%, and a small part of the movable board room form, accounting for 1 %. Therefore, by increasing the heat rejection coefficient of the enclosure structure, the heat transfer through the enclosure structure can be effectively reduced, thereby achieving energy saving effects and improving the comfort of the building.

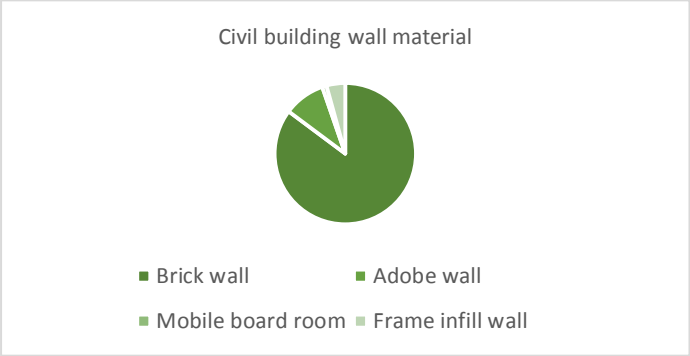


Figure 1 Civil building wall material

2.2.2 Roof structure

The roof of the building is exposed to the natural world and is directly in contact with the outside world. It is susceptible to changes in the natural environment, such as rain, snow and sunlight. Therefore, the building roof is also an important factor affecting the energy exchange inside the building. As shown in Figure 2, through survey and analysis, 64% of the residents used a concrete flat roof structure on the roof structure; 27% of the residents adopted a concrete slope roof structure; 7% residents adopted a tiled roof structure; only 2% of the residents Other forms of roof structures have been adopted.

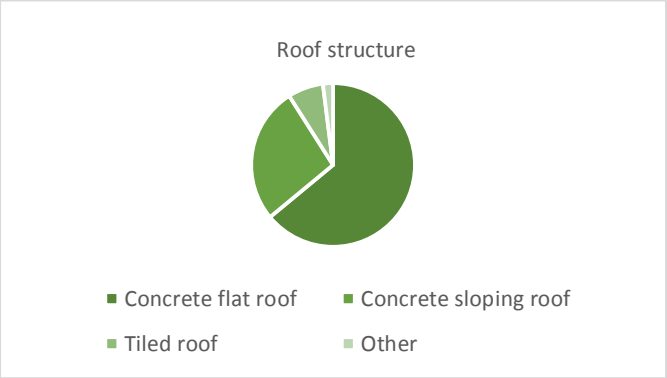


Figure 2 roof structure

2.1.3 Building materials

The building materials have a close relationship with the energy loss of the building. The distribution of the wall materials is shown in Figure 3. According to the survey results, the common forms of external wall insulation in Chengde County are: thicker walls and porous bricks on the walls. Install insulation boards on the outer wall. Among them, 50% of the users who use the thicker wall method for the external wall insulation; 29% use the method of installing the porous brick; and 19% use the method of installing the insulation board as the thermal insulation measure; Other forms of users have 2%. According to the data, in terms of thermal insulation effect, the way of installing the thermal insulation board on the surface of the wall is the best, followed by the method of using the porous brick in the wall, and the worst effect is to directly adopt the thick wall.

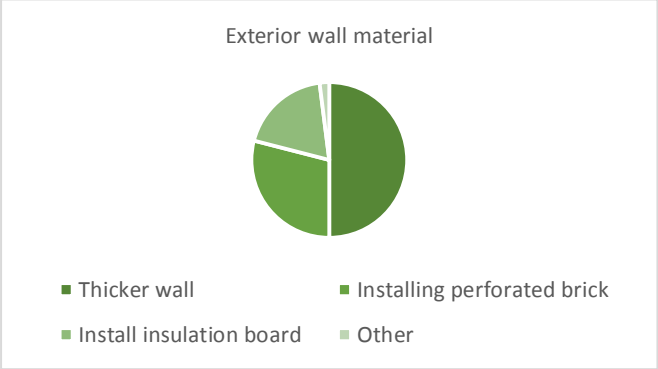


Figure 3 exterior wall material

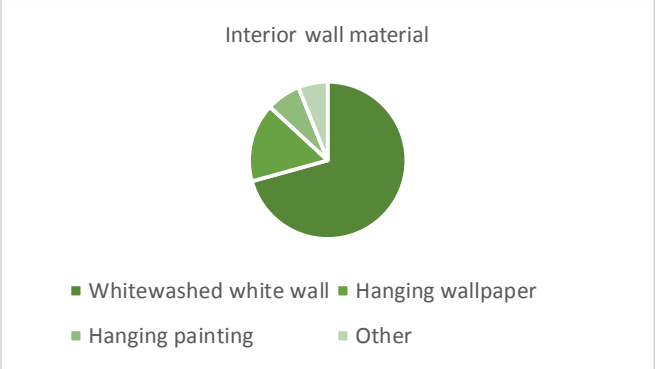


Figure 4 interior wall material

In the two insulation forms of the wall, the internal wall insulation is an important form, which plays a vital role, often the internal wall insulation effect is better than the external wall insulation. effect. As shown in Figure 4, in the interior wall decoration of civil buildings in Chengde County, 70% of users use the form of whitewashed walls for interior wall insulation; 16% of users and 7% of users

use wallpaper and hanging pictures respectively. Decorate, improve daylighting and improve thermal insulation; 6% households use other methods to decorate.

As shown in Figure 5, 50% of rural residential buildings in Chengde County use aluminum alloy doors and windows, 25% of households use plastic steel doors and windows, 21% use wooden doors and windows, and 4% of households use other forms of doors and windows, glass. A single layer of glass is used.

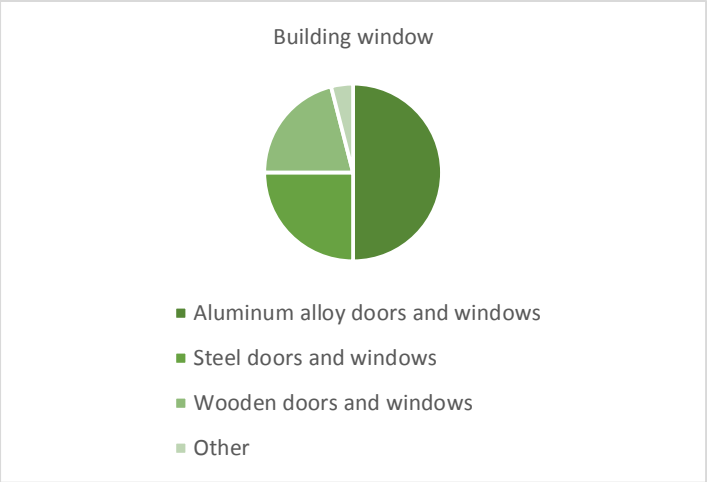


Figure 5 building window

2.1.4 Construction costs

According to the survey, 87% of the construction costs of self-built houses are relatively moderate expenses, that is, between 30,000 and 200,000 yuan, and 77% of them use the price in the middle. The expenses are between 100,000 yuan and 200,000 yuan; 10% of the farmers have invested more than 200,000 yuan in the construction process. At the same time, 13% of the farmers invested no more than 30,000 yuan in the construction process.

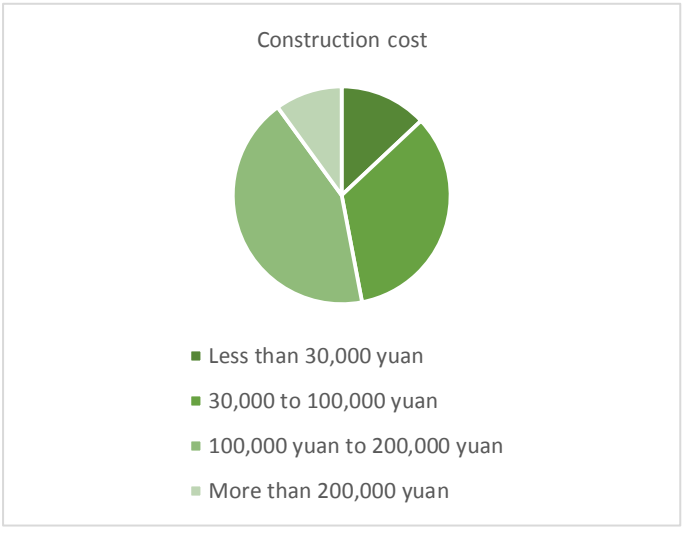


Figure 6 construction costs

2.1.5 Heating costs

In terms of heating costs, after investigation and analysis, people who spend between 1,000 yuan and 1,500 yuan and between 1,500 yuan and 2,000 yuan have a large proportion, accounting for 67%. The proportion of people who paid more than 2,000 yuan was 18%, which was in the middle. The proportion of residents who spend less than 1,000 yuan is 13%, and 2% of them have a heating expenditure of less than 500 yuan, which is at the lowest position. It can be seen that the residents of Chengde County are more in line with the current situation when investing in winter heating.

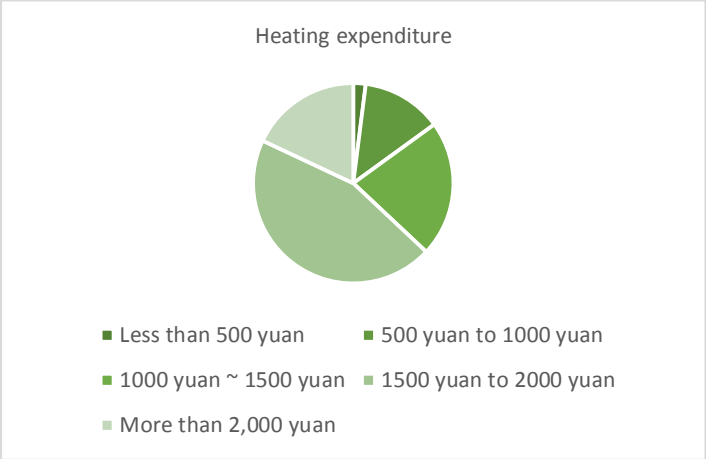


Figure 7 Heating expenditure

2.1.6 Obstacles faced by rural building energy conservation

The problem of building energy efficiency in rural areas is that farmers do not know how to carry out building energy conservation, and do not understand what is building energy conservation. Environmentally friendly materials are expensive, farmers have a shallow understanding of energy-efficient buildings and other unknown factors. It can be seen from Figure 8 that the price of environmentally friendly materials and the economic income are the main obstacles affecting the promotion of energy efficiency in rural buildings.


Figure 8 faces obstacles

## 3. Local problems

### 3.1 External challenges

Most of Chengde County in Hebei Province uses earthworms and earthen coal stoves for heating. Many families still do not have heating equipment. They only rely on burning firewood to drive off the cold. Excessive felling has aggravated soil erosion. Residential construction takes up a lot of good land and changes the natural environment to artificial. The environment, human destruction and intervention exceed the regulation capacity of the ecosystem, leading to deterioration of the ecological

environment. Moreover, the relative dispersion density of rural houses is low, and it is not appropriate to adopt a centralized heating mode with large investment and high maintenance level.

### 3.2 Internal challenges

3.2.1 Technical level

Less popularization of rural residential energy-saving materials

In the survey, it was found that the building structure of a rural area in Hebei Province was mostly brick and tile reinforced concrete buildings. The second floor of these buildings was almost empty and there was no living. Due to the relatively large space of houses, the comfort of rural residential houses is better. Most of the building materials of these houses are traditional solid bricks. Hollow bricks have not been widely used. In recent years, reinforced concrete has been slowly used, and it has gradually become a trend of building houses.

Rural areas are not combined with local conditions

Most of the houses are facing south, making full use of the sun, increasing the brightness of the house, and improving the lighting rate of the room. However, the biggest disadvantage of building houses in rural areas is that the cost is too high. These houses neither use the local geological environment. Conditions, and almost no structural strength calculations, and the use of building materials in large quantities, so that housing prices climbed.

Lack of technical support for rural housing

Because rural housing construction is seriously lacking in technical support, the masses have not yet realized the importance of technical support, and do not pay much attention to design work. A large number of projects are undocumented design and undocumented construction. Even with the certificate design, for various reasons, it has not been able to really follow the relevant standards. Therefore, the quality of the building is generally poor. Moreover, most of these houses do not have external wall insulation, and the temperature difference in the room is particularly large in winter and summer. When the weather is cold in winter, the warmth of the house is poor.

3.2.2 Management level

The planning depth is not enough, and the planning layout is monotonous or unreasonable. In rural planning, only the overall planning and land use analysis is done, and detailed analysis planning is not done. The management department only manages the homestead, but regardless of the housing problem, it does not matter the number of layers. Some are built according to the plan, but they are disorganized.

It is a standard residential design drawing, which is difficult for the people to accept and lead to their own affairs.

It is difficult for designers to carefully study norms, procedures, and regulations, and lack management measures for approval and supervision.

The rural construction management organization is not perfect, lacks the proper management, and is scattered and built everywhere. Due to the lack of management institutions, the service facilities are not perfect, there is no maintenance team, and the environment is lack of maintenance, resulting in the construction of new houses and the new houses. Room, green space becomes a pile of dead grass.

## 4. Jinzhou straw power plant development path optimization

### 4.1 Macro level

In summary, the energy-saving effect of rural buildings in Hebei Province is generally poor due to many reasons. The government should play a role in supervision, publicity, and implementation of relevant national laws and regulations in rural building energy conservation in Hebei Province.

Strengthening the publicity of rural civil buildings

Publicity should be carried out through various channels, such as using the media network for online promotion, using newspapers and other channels for offline promotion, or organizing special presentations on a regular basis so that rural residents can learn about building energy-saving knowledge in a timely manner and improve energy efficiency in buildings. The understanding of low carbon, environmental protection, etc., truly achieve the goal of reducing living energy expenditure and environmental protection and mutual benefit.

Increase supervision and ensure the effective implementation of regulations and standards

After the 21st century, China has successively introduced or revised a series of standards such as "Energy Conservation Design Standards for Residential Buildings in Summer and Warm Winter Warm Areas", "Energy Testing Standards for Residential Buildings", and "Design Standards for Energy Efficiency of Civil Buildings", which provide a strong force for building energy conservation in China. Guarantee, but because the local government has not carried out strong supervision, and the relevant local laws and regulations have not kept pace with the times, the old content has no guiding significance. Leading to the random selection of rural buildings, the building energy consumption is serious. Therefore, the government should play a macro-control role in rural construction in the future work. First, it is forbidden to build illegal construction. The construction of the building will be supervised from the site selection design to ensure the implementation of the country in terms of site selection, construction and construction. Item standard.

Provide relevant subsidies and assistance

Looking at the current situation of rural buildings in Hebei Province, one of the reasons why it is not possible to popularize energy-saving construction in large areas and large areas for a long time is that residents feel that the price of building energy-saving construction or renovation is slightly expensive and they are not willing to adopt them. The subsidy of energy-saving materials or related equipment can effectively promote the implementation of energy conservation in rural buildings.

Combine rural renewable energy with the status quo of rural building energy conservation

Hebei Province is a large agricultural province with a large amount of renewable energy resources in rural areas. In addition to industrial production of these renewable energy sources, it can effectively solve the living needs of rural self-generated heating anecdotes; taking crop straw resources as an example, the annual total straw output is about 61.76 million tons. In 2013, the province's straw utilization was 51.3 million tons, and the comprehensive utilization rate was 83%. Among them, energy utilization accounted for 4.6% of utilization and consumed 240,460 tons of straw. It is obvious that a considerable part of the platy codon resources are not fully utilized. Promoting the use of renewable energy in rural buildings under the coordination of local governments, such as promoting the construction of household biogas digesters and household solar power systems, can effectively reduce the energy consumption of rural buildings.

### 4.2 Micro level

At the micro level, it can be optimized when the user's residents carry out building construction or renovation. According to the survey, due to the lack of reasonable planning and design in the initial stage of construction, most of the rural houses in Hebei Province consume a lot of energy. Therefore, the location planning, interior layout design and construction, and promotion of energy-saving technologies from newly built or renovated houses. With the use of other aspects, the problem of large energy consumption in rural buildings in Hebei can be improved.

1. Location planning

The lack of planning construction of residential buildings in most rural areas of Hebei makes it not only the energy consumption of individual buildings, but also the energy saving effect of buildings. Therefore, reasonable planning should be made at the initial stage of construction to improve the overall energy saving effect of rural houses. Full consideration of the natural lighting, heating and ventilation of the house. This requires the rational use of natural conditions such as sunlight. Plan and design should be based on local conditions to avoid direct exposure to direct sunlight and winter frost in summer. And determine the orientation of the building according to the actual lighting conditions;

reasonably plan the layout and spacing of the high-rise building and the low-rise building with natural factors such as the local solar incident angle and the winter wind direction, to ensure that the building as a whole has good ventilation conditions and lighting effects.

2. Layout design and construction

Use reasonable interior layout design and adopt building energy saving measures.

The interior layout is reasonable. Places where residents' activities are frequent, such as living rooms, kitchens, and bedrooms, are placed on the south side of the house where lighting and heating conditions are better, while toilets and utility rooms with less staff flow are placed on the north side of the building. According to the local dominant wind direction, arrange the places that need good ventilation conditions, such as the warehouse, in the upwind direction; make full use of natural resources.

Take building energy conservation measures.

In the design stage of the building, the design side shall design and develop according to the national "Design Standards for Energy Efficiency of Civil Buildings" and relevant energy conservation regulations in the region. Adopt advanced and mature energy-saving technology and energy-saving products to ensure the quality of energy-saving design. During construction, the construction must be organized in accordance with the building energy-saving design standards. The construction drawing review agency should consider the building energy-saving design as the mandatory content for the construction drawing review when reviewing the construction project, and the project that violates the building energy-saving design standard shall not be reviewed and approved. The supervision unit shall supervise the project in accordance with energy conservation standards and energy conservation design;

In the aspect of wall construction, solid clay bricks shall not be used. Wall materials of other clay products shall be gradually banned, and new wall materials such as gas concrete walls shall be applied. The use of water stone finish or 20mm expanded polystyrene board for exterior wall construction provides excellent insulation. If certain water and soil conditions are met, green walls such as climbing walls and dwarf shrubs can be planted on the external wall to improve the thermal insulation effect of the outer wall; improve the insulation performance of the outer part of the building and avoid the thermal bridge structure;

Improve the door and window design, on the one hand, control the window area as much as possible within a reasonable range. On the other hand, the frame structure of the door and window is effectively treated, and the high-efficiency energy-saving glass is used to strengthen the seal and reduce the heat transfer coefficient. It is also possible to use a heat-dissipating aluminum alloy and a double-layer vacuum glass, which has good thermal insulation, sound insulation and high quality performance, and effectively reduces heat loss. In buildings where a basement is required, the outer wall is covered with a protective layer of foam glass insulation, as economic conditions permit.

Use of energy-saving technology

The use of energy-saving technologies in rural areas is an important measure for energy conservation in rural buildings.[3]

Use the fuel-saving coal-fired stove, which saves 1/3 to 1/2 of the firewood compared to the old-fashioned firewood stove, saving 1/4 to 1/3 of the time.

Use energy saving 炕. Compared with the old-fashioned bandits, each year can save more than 900 kilograms of firewood.

Use energy-saving furnace, which increases thermal efficiency by 20% compared with traditional coal stoves. The fuel combustion chamber is built under the indoor floor, filled with straw, sawdust, etc., water is added appropriately, ignited and ignited, and heat is radiated through the ground for heating in winter.

Make full use of all kinds of renewable energy.

## 5. Conclusion

The coordinated development of energy and the environment is the goal of realizing rural modernization in China. With the continuous deepening of the work of building a new socialist countryside, the energy-saving construction of rural housing will become one of the hot spots in China. The energy-saving housing in rural concentrated residential areas is very important for China's overall building energy conservation work. Rural building energy conservation faces severe challenges, and there is still a long way to go in the future.

Rural residential energy-saving materials face external challenges when they are popularized with villagers. There are also internal challenges in both the technical and management aspects of rural residential energy-saving entities. In response to the internal and external challenges of straw power plants, this study proposes a comprehensive development plan consisting of macro and micro. Among them, the macro has increased publicity and supervision, and subsidized and assisted villagers who implement residential energy conservation, and micro-focus on the improvement of key links. The macro-micro optimization path together provides the driving force for the development of rural residential energy conservation.

In rural areas of northern China, most rural buildings have failed to use energy-saving design due to economic constraints. This requires the state and local governments to provide policy and economic support, develop cheap and energy-efficient building materials and energy utilization equipment in rural areas, establish a sustainable development concept, and establish a rural building planning management system. At the same time, vigorously promote energy-efficient buildings in rural areas to create a healthy and comfortable living environment for the majority of farmers.

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