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## **RESEARCH ON THE DESIGN OF SUSTAINABLE BATH EQUIPMENT IN POOR RURAL AREAS OF HEBEI**

*HuHong*

Beijing University of Technology, Beijing, China, gysj2009@qq.com

*Li Heng*

Beijing University of Technology, Beijing, China, bjfulh@126.com

### **ABSTRACT**

The purpose of the research is to meliorate the situation of the rural residents who have difficulties in bathing and poor personal hygiene in the poverty-stricken areas of Hebei Province, improve the living standard of rural residents and reduce the environment pollution. We select the rural residents in a typical poverty-stricken village of Taihang Mountain Area in Hebei province as research objects. Through field investigation, questionnaires and detailed interviews, we learned the actual needs of the residents for bathing and finds that the main difficulty in bathing is that the residents cannot afford the independent bathing facilities because of poverty. After investigation, comparison and reference of the bathing methods and the various sustainable energy, we select the solar energy and biogas as a combined energy supply. Moreover, we bring out the design of a reasonable, sustainable and convenient service system. It can improve the sanitary condition of rural residents and provide a new solution to improve the quality of life of rural residents and reduce rural environmental pollution.

Key Words: sustainable, bathing, rural areas, low cost.

## 1. THE SIGNIFICANCE OF RURAL SHARED BATHING FACILITIES CONSTRUCTION

### 1.1. Bathing is important for people in China

Bath is an important way for human beings to keep clean, and it has become an important part of daily life for urban residents in China. However, in the rural areas of China, especially the Taihang in Mountain Area of Hebei Province, in the reasons of poverty, energy supply difficulties and other causes, urban residents have low bathing frequency, causing poor quality of life and other healthy and mental issues.

Bathing has a long history in China. As early as the Shang Dynasty, the words “mu” and “yu”, which means bathing appeared in the oracle bones. “Confucius bathed and swayed.” In the feudal society, regular bathing has always been the social etiquette and norms of behavior the upper ruling class. However, as the development of the agricultural society, bathing has rarely treated as necessities to the farmers, especially in winter season.

### 1.2. The problem of lack of bathroom is widespread in rural China

Agriculture is the foundation industry of the country. More than half of China's population lives in rural areas. According to the sixth census, in 2011, the population in China's rural areas was 67.415 million, accounting for 50.32% of the national population. The general peasants usually have poor living conditions. Compared with urban residents, the frequency of bathing is extremely low, and the sanitary conditions are poor all year round. In poor rural areas, more than 95% of villages do not have public baths, and more than 99% of households do not have bathrooms. The root cause is that economic costs are the most important problem. In some areas where extreme poverty is extreme, some residents have a few baths in their lifetime. Rural energy structure is unreasonable, relying heavily on coal to boil water. Each household has a slightly better economic condition to install the boiler. The poor one can only use the coal stove for heating, and there is no condition for intensive heating renovation in the short term. Causes serious air pollution in winter.

### 1.3. Construction of bathing facilities contributes to the construction of new countryside

The China government attaches importance to the development of the countryside. The Fifth Plenary Session of the 16th CPC Central Committee proposed to promote the construction of a new socialist countryside in accordance with the requirements of “production development, affluent life, rural civilization, clean villages, and democratic management.” The Central Rural Work Conference proposed to actively and steadily promote the construction of new countryside, speed up the improvement of the living environment, improve the quality of farmers, and promote the construction of “new rural areas” and “new rural areas”. To improve the living conditions of farmers, the vast rural areas need low-cost and easy-to-use bathing facilities to enhance the living environment.

## 2. DEMAND AND BACKGROUND RESEARCH ON SHARED BATHING FACILITIES IN RURAL CONSTRUCTION IN HEBEI

### 2.1. Choosing and introduce the research object

Select a village in one poverty-stricken county of Hebei Province as the research object. This county is the old revolutionary base areas, was identified as national key poverty-stricken counties in 2012, and is located in the south west of Hebei Province, northern of Shijiazhuang, on the edge of the North China Plain, the Taihang Mountains foothill light the mountainous area covers an area of 966 square kilometers. The terrain slopes from the northwest to the southeast. It administers 15 townships and 330 administrative villages with a population of 460,000.

The village is located 7 kilometers west of the county town, with a registered population of more than 1,300. In the whole village, about 90% of single-storey cottage housing construction. Most of the above do not have family bathing facilities, and less than 20% of the households use electric water heaters, solar water heaters and household bathing facilities. The bathroom is so simple that it cannot meet the requirements of the annual bath.

### 2.2. The demand of bathing for people in the village

In some areas, summer bathing can be done by the river or outdoors. At present, the water quality in Hebei cannot meet such requirements. Some rural residents have opened bathing rooms in their own homes, but they are often very simple. The picture shows poor farmers who are bathing in large pots, unable to use showers or go to the bathhouse. Children in the rural bathroom. However, even the bathrooms with such simple conditions are not distributed in every village. Most of the bathrooms are only distributed in the more affluent villages where the township government is located. The coal is burned every day, the cost is high and the profit is difficult, and the pollution is serious.

Through visiting villagers and old village cadres, we can understand the bathing conditions and energy use of residents. In the past 40 years, the village stoves have been demolished in large numbers; quite a few residents with better economic conditions have begun to use coal-fired boilers; the number of residents using new energy sources such as solar energy is small.

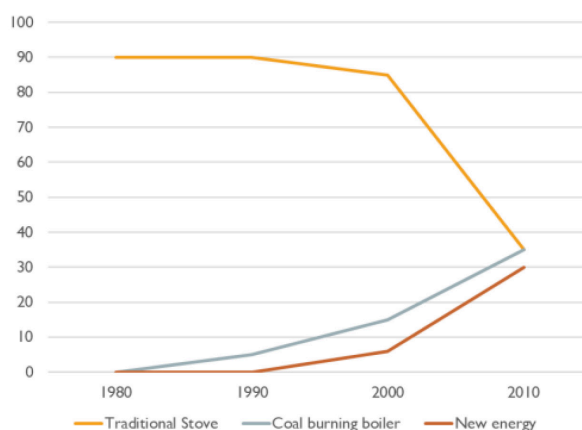
Most of the villagers with better economic conditions moved to the buildings in the county, and the problem

of bathing in poor families in winter still has not been solved. Residents need to go to the bathhouse in the town to bathe; families using solar energy or water heaters have obvious frequency of bathing in winter.



[Figure 1]The village and one of the self-built bathroom

The village is in the future for a long period, the family does not have the amenities of rural residential houses will remain the majority. How to solve the problem of bathing for the majority of farmers has become the most pressing issue in the future. It is necessary to build a public bath in the village by using economical solar energy, ground source heat pump, building insulation, waste heat recovery and bathing wastewater treatment technology.



[Figure 2] Changes of the amount of different ways to heating the water

### 3. THE EXISTING RURAL BATHING FACILITIES SURVEY

Needle current situation in rural areas lack the amenities, from the current solutions, in 2007 Shandong Guoqiang Group proposed “convenience solar bath room” design; this “Environmental protection, energy-saving convenience bath room”, covers an area of over 50 square meters male and female rooms each one. 2 m<sup>3</sup> tank capacity, which can accommodate 8--10 personal bath while continuously bathing 100. Renewable clean solar energy source is the main heat source, supplemented by biogas source. The cost of the program is about 80,000 yuan. It uses a combination of new energy sources, adopts the hardware facilities provided by the bank loan, and the mode of contracting the villagers to reduce the price and propose a better solution for the utilization of rural bathing facilities.

Ming Solar Co., Ltd. is located in Zhangjiakou City, Hebei Province, which in 2010 launched the product, “Yuan Hao brand overall bath room” with 15 solar tubes, bucket capacity of 140 liters of water daily for 10 people to take a bath. The wall of the bath room is made of thermal insulation board; the part that absorbs light energy adopts hollow sunlight lighting board: high heat absorption efficiency, slow heat dissipation, good light transmission effect, and equipped with Yuba. It has many functions such as start clock display, water temperature, water level prompt, water shortage prompt, automatic water supply and so on. Stainless steel floor, the overall bath life can reach 15-20 years. Equipped with hair dryer, thermometer, ventilation fan, clothes box, beauty mirror and other facilities, it is convenient to use.

In the rural areas, in the cold and cold regions, in the winter, the heating will be done by burning and burning the stove throughout the day. After the fuel is fully burned, most of the residual heat is discharged outside the flue gas, causing waste of energy. The packaging device applied to the fire wall designed in this paper incorporates a phase change thermal storage material. According to the phase change of the phase change thermal storage material at a specific temperature and accompanied by energy storage and energy release, the

smoke can be absorbed and stored in the daytime. Gas residual heat. After the indoor heating is stopped at night, the packaging device can release the energy stored in the phase change material to ensure the comfort of the indoor environment at night.

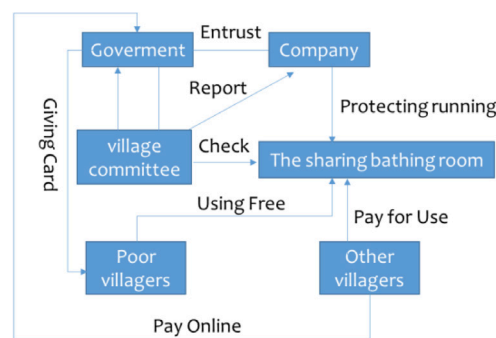
#### 4. SUSTAINABLE SHARING LOW-COST BATHING DESIGN

##### 4.1. Service mode and management mode design

The government, the village committee, highlights the service model and the villagers assist in maintenance; the county government and the village committee evaluate and evaluate the scale of the village bathroom, and purchase, entrust the company to produce and install the bathing facilities. Poor villagers can use it free of charge, and other villagers pay for it. The county government identifies the poor villagers. The village committee is responsible for the supervision, maintenance and repair of the bathing facilities. The company is responsible for the commissioning and overhaul of the bathing facilities.

In the rural areas where the bathing in the poverty-stricken counties is difficult, the village government and the village committee set up the village public bath. The scale of the bathroom is determined according to the size of the resident population and the sex ratio, and the company is entrusted by the national poverty alleviation fund. in production. After the bathing facilities are manufactured, the company is responsible for installation and commissioning. After the county government and the village committee accept the inspection, the card issuance work is initiated. For poor villagers who meet the state regulations, they cause the social security card to swipe their cards. Other villagers can use the pre-existing amount in the social security card for paid use.

The village committee is responsible for managing the daily opening hours of the bathroom to maintain the daily cleaning of the bathroom. For the faults and use problems, the village committee will report to the company for repairs. The company is responsible for timely maintenance and regular maintenance. The county government pays the relevant fees.



[Figure 3]Service and management mode

##### 4.2. Design of product composition and energy supply mode

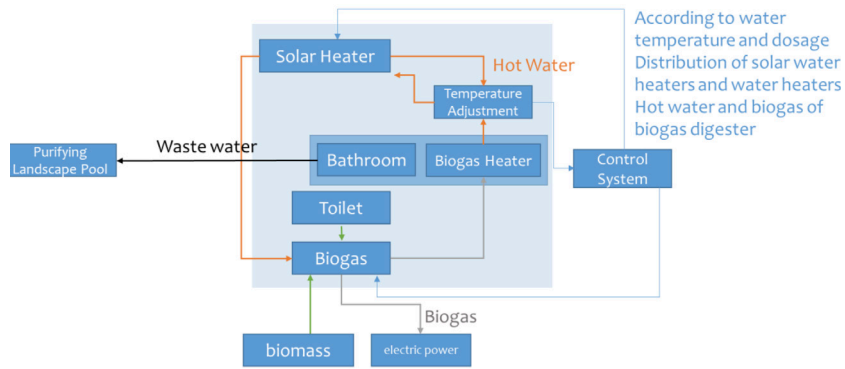
The bathing facility consists of a power supply part, a bathing part and a sewage treatment part.

The bathing part is a plurality of independent bathing rooms, and the number of opening can be adjusted according to the number of bathing persons to avoid waste of large bathhouse formation.

The energy supply method is mainly based on solar energy heating, supplemented by biogas heating. The normal temperature water passes through the control system and adjusts the distribution of the control water according to the water temperature and room temperature information fed back by the sensor. The hot water generated by solar energy during the winter can be used to replenish the biogas. The biogas produced in the summer can be used to generate electricity, supplementing the shortage of electricity generated by the summer electricity peak.

The sewage enters the purification landscape pool and is purified by multi-layer sedimentation, so that the discharged sewage is purified through layers and flows into the farmland of the village for irrigation.

4 square meters solar-based solar hot water bath system under daylight conditions county, 40 may be supplied per day 5 tons of hot water . The system may be employed a temperature cycle heating mode, to ensure all-weather use. Using a temperature sensor for water temperature automatic intelligent control, without staff on duty. Constant temperature water to prevent the elderly and children from scalding due to misuse. Compared with gas water heaters and electric water heaters, solar water heaters have an investment recovery time of 2-4 years, but the service life is greater than 15-20. Years, not only energy security, and easy to use non-polluting, is an ideal green energy product.



[Figure 4]Energy supply mode of the bath

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