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Heating Energy Consumption Questionnaire and Statistical Analysis of Rural Buildings in China

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Abstract

The heating energy consumption in rural residential buildings is increasing in recent years. In order to analyze the rural heating energy consumption, energy consumption questionnaire which covers main factors related to rural building energy consumption is designed. The information collected in questionnaire which covers 181 questions mainly includes five parts: family basic information, rural residential building features, building envelope information, indoor air quality in winter and building heating energy consumption. Two hundred questionnaires were collected in three northeastern provinces in China. Different frequency distributions can be obtained from the statistical analysis. Three ratios which included the ratio of annual household heating energy consumption to total energy consumption, that of annual household heating commodity energy consumption to total heating energy consumption and that of annual household heating non-commodity energy consumption to total heating energy consumption were calculated and analyzed. The questionnaire and statistical analyses present a reliable, valid, and economical instrument for in-depth rural energy saving research.

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Keywords: Heating energy consumption, Rural building, Energy consumption questionnaire, Statistical analysis

1. Introduction

In China the building energy consumption accounts for about 30% of the total social energy consumption and it gradually increasing to nearly 40% [1]. The rural population constitutes over 60% of the total population. The rural living area accounts for 60% of Chinese total living area. The rural building energy consumption is about 37% of total

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building energy consumption [2]. The heating energy consumption of northern rural building accounts for over 60% of the total building energy consumption. The high heating energy consumption of northern rural building is mainly due to the cold winter and long heating period.

There exists different structures, dimensions, types, envelope materials in rural buildings. Rural building energy consumption covers heating, cooking, hot water, lighting, ventilation and household appliances. There are commodity energy such as coal and non-commodity energy such as straw. Occupants' behaviors of rural buildings have big differences in energy consuming. So the rural energy consumption is complicated and uncertain. Few comprehensive rural building energy consumption investigations and analyses had been reported.

The aim of the present study was to investigate the current status of rural buildings in China, especially heating energy consumption characteristics and its relevant factors. An informative questionnaire including five sections 181 questions was designed to conduct amounts of statistical research for rural buildings in detail. The questionnaire includes whole information which related to rural heating energy and provides basic data for in-depth heating energy statistical analysis.

2. Methods

Based on the preliminary work, many factors which affect rural building energy consumption were collected and grouped. The information collected in the questionnaire which covers 181 questions mainly includes five parts: family basic information, rural residential building features, building envelope information, indoor air quality in winter and building heating energy consumption. Two hundred questionnaires were collected in three northeast provinces in China.

The family basic information includes the following: family address, family population, with or without older or younger residents and economic income level. The rural residential building feature covers building type, building storey, roof type, construction date, floor area, heating area, building orientation and shape coefficient.

Building envelope information mainly includes window material, glass layer number of window, glass type, infiltration in winter, with or without covers on the external windows, the window to wall ratios of different orientations, layer of exterior door, door material, with or without roof insulation, wall thickness and its material, building ground material.

Indoor air quality in winter consists of average indoor temperature, indoor air circulation and indoor thermal comfort.

Building heating energy consumption information includes the following: heating and cooking combined type, heating energy type, heating duration, daily time spent at home in winter, with or without renewable energy, cooking appliance, with or without energy-saving stove, winter heating instrument, with or without new-type high-efficiency heating equipment, total heating energy (perhaps including cooking energy) and annual heating expense.

The frequency analysis of descriptive statistics is presented based on these questionnaires with SPSS [3]. Furthermore the ratio of annual household heating energy consumption to total energy consumption, that of annual household heating commodity energy consumption to total heating energy consumption and that of annual household heating non-commodity energy consumption to total heating energy consumption were calculated and analyzed with statistical method.

Because the rural residents usually used stove for cooking and heating at the same time, the cooking energy and heating energy can't be separated clearly and the annual heating energy includes some cooking energy. The heating energy consumption should be corrected by mixed frequency of cooking and heating. Based on the tested data [4], the