

## Research on Issues of Existing Residential Buildings Energy-Efficient Retrofitting during China's "Twelfth Five-Year" Period

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**Abstract**-In 2008, China launched existing residential buildings energy-saving retrofitting in northern heating areas and planned to retrofit 150 million square meters of existing residential buildings during 2008-2010, which has achieved good economic and social benefits. We have conducted in-depth research and investigation on buildings energy-saving retrofitting during 2008-2010 and made summarizing evaluation on the finished existing retrofitting work through questionnaires, field research and seminars and other forms. This paper analyzes several key issues about retrofitting of existing residential buildings in the questionnaire and puts forward opinions on such work during the "Twelfth Five-year" period.

**Key words:** Questionnaires, existing residential buildings, energy-saving retrofitting, "Twelfth Five-Year"

### I. INTRODUCTION

In 2008, China started energy-saving retrofitting on existing residential buildings in northern 15 provinces

(municipalities and autonomous regions) and planned to transform 150 million square meters of existing residential buildings in three years, with retrofitting tasks of various provinces (municipalities and autonomous regions) as shown in following table I[1]. Energy-saving retrofitting includes the following three elements: (1) retrofitting of indoor heating system measurement and temperature adjustment and control of buildings; (2) heating and pipe network heat balance retrofitting, including heat resources, thermal stations, pipe network installation metering devices and water balance, climate compensation, frequency and other adjustment and control devices; (3) energy-saving retrofitting of building surrounding retrofitting, including exterior walls, windows and doors, roof, floors and staircases, etc. The central government provides subsidies for energy-saving retrofitting of existing buildings in the form of award replacing subsidy with subsidy fund accounting for 20% of the retrofitting fund and other 80% fund will rely on local finance, enterprises and individuals.

TABLE I. 2008-2010 ENERGY-SAVING RETROFITTING PLAN TASKS ON EXISTING RESIDENTIAL BUILDINGS IN 15 PROVINCES IN NORTHERN CHINA[1]

Province (Unit: million square meters)	Beijing	Tianjin	Hebei	Shanxi	Inner Mongolia	Liaoning	Jilin	Heilongjiang
Retrofitting Area	2500	1300	1300	460	600	2400	1100	1500
Province (Unit: million square meters)	Shandong	Henan	Shaanxi	Gansu	Qinghai	Ningxia Hui Autonomous Region	Xinjiang Uygur Autonomous Region	Total
Retrofitting Area	1900	360	200	350	30	200	800	15000

As of the end of 2009, northern 15 provinces and municipalities have completed 110 million square meters of

energy-saving retrofitting. According to calculation of relevant departments, the transformed energy-saving projects

could form the capacity of saving 750000 tons of standard coal annually and reducing emission of 2 million tons of carbon dioxide. The left projects will be finished before the heating season of 2010. The retrofitting pilot projects have benefited residents in northern cold areas and residential housing insulation and heating situation have been fundamentally improved leading to remarkable improvement of living conditions.

After nearly three years of practice and exploration, the retrofitting model of guidance by government, support by policy, market-oriented operation, risks sharing of state, enterprise and individual and benefit sharing has been established in the energy-saving retrofitting on existing residential buildings in North China, which has laid solid foundation for further promotion of this work in the Twelfth Five-year Period.

## II. RESULTS EVALUATION OF ENERGY-SAVING RETROFITTING OF EXISTING RESIDENTIAL BUILDINGS IN NORTHERN CHINA DURING THE TWELFTH FIVE-YEAR PERIOD

### A. Background of questionnaire

Since 2002, the Chinese Government has organized nationwide special inspection on building energy saving each year to conduct investigation, check, evaluation and summarization on implementation of energy-saving work in various provinces. However, the summarization of building energy saving special inspection is only limited within various provinces without systematic summarization on the nationwide energy-saving work implementation. In addition, the time period is only limited to the current year without continuous thinking on overall energy saving. 2009 is an important year for Chinese development as a connecting link between the preceding and the following. Therefore, in order to establish scientific development goal of energy-saving retrofitting in the next stage, it is necessary to conduct comprehensive and systematic summarization on the current situation and work achievements of energy-saving retrofitting and provide necessary basic support for the development plan of the Twelfth Five-year period. Under the support of the project of "China's Building Energy Efficiency Policy Review and Summary and Chinese Building Energy Saving Development Plan during Twelfth Five-year Period to Respond to Global Climate Changes" by Energy Foundation, we designed and distributed special questionnaire on building energy efficiency in the end of 2009.

The main contents of the questionnaire focus on evaluation of energy-saving retrofitting in recent three years, involving 30 questions on issues of building energy-saving retrofitting of existing residential buildings in Northern heating areas. The major respondents of questionnaire are corresponding government departments at various levels, including construction, development and reform and finance departments of provinces, cities and counties, and relevant bodies including financial institutions, energy service companies, and real estate developers, owners of public buildings, energy supply enterprises and residents.

Depending on different respondents, seven categories of questionnaires were designed and the total of 1547 valid questionnaires was recovered. Figure I and II shows the ratio of different respondents and composition of regions. Northern area in Figure I and II includes Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shandong Province, Henan, Shaanxi Province, Gansu Province, Qinghai Province, Ningxia Hui Autonomous Region and Xinjiang Uygur Autonomous Region. "Yangtze River region where it is hot in summer while cold in winter" includes parts of Shandong, Henan and Shaanxi where there is no heating and non-heating region includes Shanghai, Anhui, Jiangsu, Zhejiang, Jiangxi, Hunan, Hubei, Sichuan, Chongqing and parts of Fujian[2][3][4].

Figure 1. Composition of questionnaire respondents

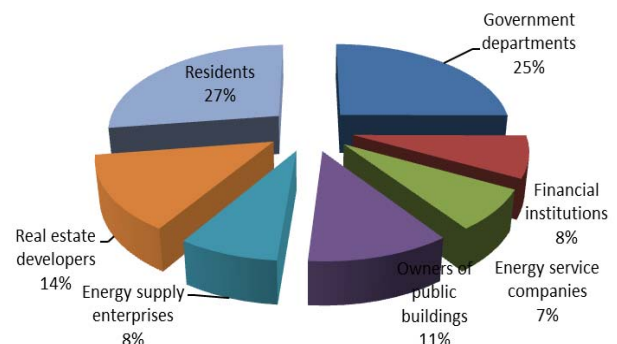
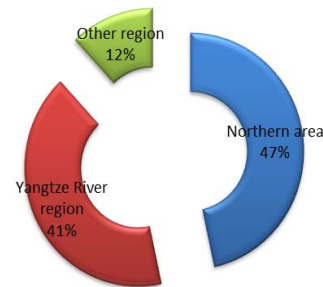


Figure 2. Region composition of questioner

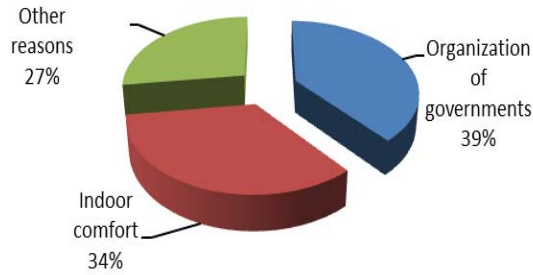


### B. Questionnaire results analysis

#### 1) Reasons for retrofitting of existing residential buildings energy efficiency

Existing residential building energy-saving retrofitting work is still in the initial stage in the "Eleventh Five-Year" period and lacks organization and implementation experience. Some residents were cautious on the retrofitting, mainly relying on promotion work of governments at various levels. As shown in the retrofitting reasons questionnaire on 424 households in northern region and region where it is hot in summer and cold in winter, 39% households have been transformed due to unified promotion and organization of governments and it is expected that such way could continue in the Twelfth Five-year Period, and 34% transformed households are out of the expectation to improve indoor comfort as shown in

Figure 3. Reasons analysis on existing residential buildings energy efficiency retrofiting

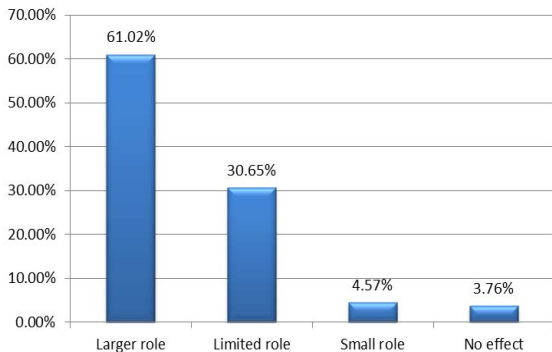


2) Fund for the retrofiting of existing residential building energy efficiency

a) Investigation made by government departments at all levels

Since the retrofiting work has been organized and implemented by government departments at all levels during the Eleventh Five-year Period, investigation has been made mainly on the fund for existing residential buildings energy-efficient retrofiting of governments at various levels. Most respondents hold that economic incentive policy has played a significant role in the energy-saving retrofiting in northern heating area, which has also promoted smooth retrofiting. As shown in Figure 4.

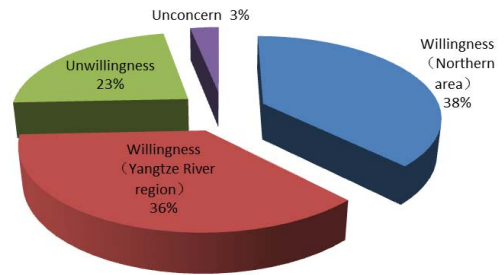
Figure 4. Evaluation of government departments on current economic incentive policies



b) Survey on residents willingness to provide fund

Asked whether they are willing to conduct energy efficiency retrofiting if the current economic incentive policies continue in the Twelfth Five-year Period, among 424 residents who live in northern area and region where it is hot in summer and cold in winter, 74% residents are willing to conduct retrofiting among which residents in region where it is hot in summer and cold in winter have expressed strong willingness for energy-saving retrofiting; 26% residents expressed their unwillingness or indifference, who are mainly living in region where it is hot in summer and cold in winter. The results are closely linked with the great economic benefits and social interests shown by the existing retrofiting work. As shown in Figure 5.

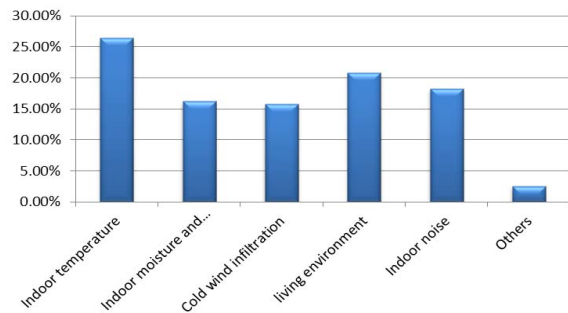
Figure 5. Analysis of residents to provide fund for existing residential building energy-saving retrofiting



3) Results of existing residential building energy-saving retrofiting

Survey has also been carried out on the results of existing residential building energy-saving retrofiting in the northern region. The implementation of existing residential building energy-saving retrofiting has resulted in effective improvement of residents living environment, particularly the improvement of indoor temperature. Moreover, the phenomenon of indoor moisture and condensation has also been improved and the issue of cold wind infiltration and indoor noise has also been relieved. As shown in Figure 6.

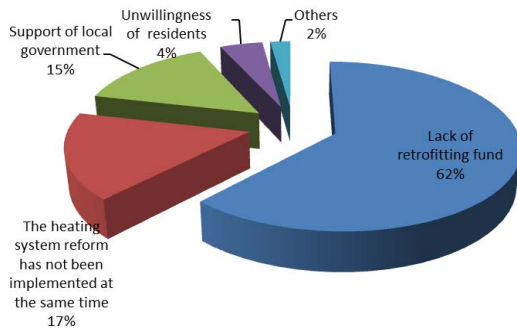
Figure 6. Survey on results of existing residential energy-saving retrofiting in northern area



4) Major problems in the process of promoting existing residential building energy-saving retrofiting

The questionnaire results show that government departments at various levels are mainly promoter for the existing residential building energy-saving retrofiting and the major problem during the retrofiting process is lack of retrofiting fund. Because the heating system reform has not been implemented at the same time, the heating usage volume could not be accurately calculated after retrofiting. Charge according to heating usage volume is also another major problem for the existing residential building energy-saving retrofiting. Support of local government has also played a role in overall coordination work and the unwillingness to cooperate by residents in the initial stage only accounts for 4%. In addition, some respondents also hold that lack of professional management personnel, lack of retrofiting policies directly targeted on residents and lack of clear retrofiting technology plans are also elements to hinder the smooth retrofiting.

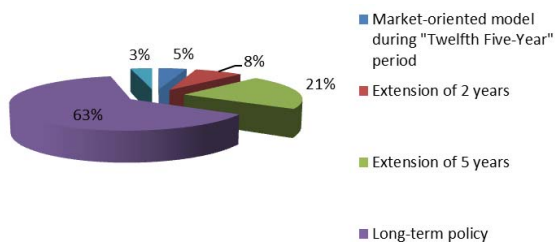
Figure 7. Analysis of major problems during the process of existing residential building energy-saving retrofitting



### 5) Survey on continuity of economic incentive policies on existing residential building energy-saving retrofitting in future

The survey on current economic incentive policy continuity shows that 63% respondents hope this policy could continue for a long run and 29% residents hope appropriate extension of 2 – 5 five years of existing residential building energy-saving retrofitting. Therefore, according to current survey, most respondents hold that existing residential building energy-saving retrofitting is closely related to fundamental interests of residents and is of public welfare nature, involving several main bodies. Current economic incentive policy shall be the long-term mechanism of Chinese government. As shown in Figure 8.

Figure 8. Analysis on continuity of economic incentive policy on existing residential building energy-saving retrofitting



### III. CONCLUSION

By the end of 2010, the energy-saving retrofitting tasks on exiting residential buildings in northern heating area shall be completed during the Eleventh Five-year period and government departments at various levels have played an important role in existing residential building energy-saving retrofitting work in current stage, having ensured retrofitting results. The existing residential building energy-saving retrofitting significantly improved indoor temperature during heating seasons and indoor comfort. Charge according to heat usage volume has also been implemented with some retrofitting projects, leading to reduction of heating expenses of residents and initially forming mass basis conducive to retrofitting. Strong investment from central government and local governments also guaranteed smooth implementation.

On the basis of summarizing results of existing residential building energy-saving retrofitting during the

Eleventh Five-year Period and the questionnaire, the paper puts forward several suggestions on residential energy-saving retrofitting:

(1) Establish long-term work mechanism of existing residential building energy-saving retrofitting.

(2) Further expand financing channels and gradually establish the financing mechanism with heating suppliers, energy service enterprises and financial institutions as main financing channels and governmental financing and residential fund as support.

(3) Fully implement the system of charge according to heating usage volume to fully demonstrate retrofitting effect and realize the situation of whoever invest will benefit.

(4) Establish emission reduction calculation system with carbon dioxide emission compulsory index in early days.

(5) Actively guide local governments to closely link existing residential building energy-saving retrofitting work with city construction and city appearance improvement and improve the enthusiasm of local governments to participate in retrofitting.

(6) Launch existing residential building energy-saving retrofitting demonstration work in the transitional region and explore the model and accumulate experience of carrying out such work in transitional region and southern region.

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