Study on Problems and Countermeasures of Clean Heating in Rural Areas of North China—a Case of Shandong Province

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Abstract. Clean heating is an important part of the transformation of new and old driving forces and the revitalization of rural areas. Speeding up the promotion of clean heating is an important measure to improve rural public service facilities, guarantee and improve people's livelihood. This paper introduces the development status of clean heating in rural areas of Shandong Province, and the target tasks to be completed in 2020 and 2022. Through household survey, a questionnaire survey was conducted among 910 clean heating users in rural areas of Shandong Province. Problems of clean heating in rural areas of Shandong Province are pointed out, and countermeasures and suggestions are put forward accordingly.

1. Introduction
Clean heating refers to the use of clean energy such as clean coal (ultra-low emission), natural gas, electricity, geothermal, biomass, solar energy, industrial waste heat, nuclear energy, etc. to achieve low emission and low energy consumption through an efficient energy utilization system, including the whole heating process aimed at reducing pollutant emissions and energy consumption. It covers clean heat sources, efficient transmission and distribution network (heat network), energy saving building (thermal user), etc. The implementation of clean heating in rural areas is very significant to improve the air quality and promote the revolution of rural life style in northern China. Speeding up the promotion of clean heating is an important measure to improve rural public service facilities, guarantee and improve people's livelihood, and also an effective way to implement the action plan of air pollution prevention and improvement of air environment quality. In December 2016, Xi Jinping who is the general secretary of China stressed at the 14th Meeting of Central Financial and Economic Leading Group that 6 issues including the promotion of clean heating in the northern China are major events, major livelihood projects and popular support projects. He pointed out that promoting clean heating in the northern region in winter can ensure warmth of people and the reduction of fog and haze in northern China. This is an important part of the energy production, consumption revolution and the rural lifestyle revolution.

Influenced by living habits, coal and firewood are the main heating materials for a long time in rural areas of China. By the end of 2016, the annual consumption of heating coal in northern China is about 400 million ton of standard coal equivalent (tce), in which the bulk coal in rural areas (including the coal for low efficiency small boilers) is nearly 200 million tce. The bulk coal heating is one of the important reasons for winter haze in northern China.
There are many problems such as large amount of building energy and low efficiency of energy utilization in rural areas of China. In recent years, the total amount of domestic energy consumption in rural areas of China has exceeded 300 million tce. The main energy consumption in rural areas is direct combustion of fuel with low combustion efficiency. Taking the bulk coal combustion heating in northern rural areas as an example, the annual consumption of heating energy is about 113 million tce with 30% - 40% of thermal efficiency, which is half less than that of large boilers. That means 56 million tce is wasted every year.

In order to thoroughly implement the spirit of the important instructions on clean heating of Xi Jinping at the 14th Meeting of Central Financial and Economic Leading Group, Plan for Prevention and Control of Air pollution in Beijing City, Tianjin City, Hebei Province and Surrounding areas in 2017 was worked out by Ministry of Environmental Protection and relevant air pollution prevention cooperation teams in Beijing City, Tianjin City and Hebei Province. 2+26 cities of north China were listed in the first scope of winter clean heating plan. In May 2017, the Ministry of Finance issued the Notice of Central Finance Supporting on Implementation of Pilot Work on Winter Clean Heating in north China, proposing a heating mode of enterprise oriented, government driven and affordable for residents should be formed as soon as possible. Overall requirements were promoted in Plan for Winter Clean Heating in North China (2017-2021) made by 10 ministries and commissions including National Development and Reform Commission in December 2017.

2. Current Situation of Clean Heating in Rural Areas of Shandong Province

On August 29th, 2018, Shandong Provincial Government issued Plan on Winter Clean Heating of Shandong Province (2018-2022). It is proposed that by 2020, the average clean heating rate of the whole province will be more than 70%. Clean heating in cities with a population of more than 200000 should be fully covered, and average clean heating rate in rural areas will be more than 55%. Clean heating rate of the whole province will be more than 80%. Whole coverage of clean heating is basically realized in counties, and the average clean heating rate in rural areas will reach 75% by 2022.

2.1 General Situation of Heating

By the end of 2017, the total construction area of Shandong Province is about 3270 million m², including 1.935 billion m² in urban area and 1.335 billion m² in rural area. The total heating area of urban and rural buildings in Shandong Province is about 2.886 billion m² with a heating rate of 88.3%. Among them, the heating area in city is 1.778 billion m² with a heating rate of 91.9%. The heating area in the rural area is 1.108 billion m², with a heating rate of 83.0%.

2.2 Development of Clean Heating

By the end of 2017, the area of clean heating in Shandong Province was about 1.775 billion m² with a clean heating rate of 54.3%, which is higher than 34% of that in northern China. Among them, urban clean heating area was 1.534 billion m² with a clean heating rate of 79.3%. Rural clean heating area was 241 million m² with a clean heating rate of 17.9%. The construction plan of clean heating in 2018 is shown in Table 1.

2.3 Plan of Clean Heating in Shandong Province in 2019

Shandong Provincial Plan of Clean Heating Work in 2019 was issued by Shandong Provincial Department of Housing and Urban Rural Development, Shandong Provincial Development and Reform Commission, and Shandong Provincial Energy Bureau. The goal of clean heating in 2019 is specified in the plan, which includes 73.2034 million m² of new clean heating area in cities (counties) and 885900 new clean heating households in rural areas. The plan requires that all cities in Shandong province should decompose and implement the annual construction plan, promote work orderly and complete work in time with high quality. Strictly implement the national and provincial requirements for clean heating work to ensure the implementation of the construction plan. At the same time, each city should make good use of the central and provincial funds for clean heating, adjust and improve the organizational leadership, strictly implement the division of responsibilities and fully promote the work of clean heating in combination with the reform of the organization at the same level.
Table 1. Clean heating construction schedule(2018)

| City  | City(Country) | Million square meters | Rural Areas / household |
|-------|---------------|-----------------------|-------------------------|
| Jinan |               | 900                   | 38600                   |
| Qingdao |             | 827                   | 46562                   |
| Zibo |               | 649                   | 102100                  |
| Zaozhuang |           | 220                   | 13662                   |
| Dongying |           | 428.46                | 36650                   |
| Yantai |               | 345.8                 | 31049                   |
| Weifang |              | 900                   | 11407                   |
| Jining |               | 400                   | 87297                   |
| Taian |               | 392                   | 9799                    |
| Weihai |               | 363.7                 | 8328                    |
| Rizhao |               | 367                   | 24216                   |
| Laiwu |               | 130                   | 17032                   |
| Linyi |               | 624.8                 | 32712                   |
| Dezhou |             | 563.3                 | 51000                   |
| Liaocheng |         | 507                   | 95704                   |
| Benzhou |             | 306                   | 40000                   |
| Heze |               | 500                   | 70000                   |
| Total |               | 8424.04               | 716118                  |

3. Investigation Process and Conclusions

3.1 Investigation Process
A questionnaire was made and a household survey on the users of clean heating in 16 cities of Shandong Province was conducted in order to know the current situation and problems of clean energy heating in rural areas of Shandong Province. 910 households were investigated including 471 gas replacing coal users, 170 electricity replacing coal users and 269 users who use biomass energy, industrial waste heat and central heating, etc.

3.2 Conclusions

3.2.1 Situation of house heat preservation. Heat preservation measures such as roof ceiling, door and window sealing, corridor sealing were basically taken to improve the heating effect in winter. Among the 910 samples, 710 users took simple roof ceiling measures, accounting for 78% of the total. 392took corridor insulation measures, accounting for 43% of the total.

3.2.2 Users’ satisfaction. Among the 910 samples, 492 users expressed totally accepted for clean heating renovation, accounting for 54%. 372 users expressed accepted, accounting for 41%. 46 users expressed rejected, accounting for 5%. The main reasons for dissatisfaction are as follows. Firstly the cost of heating by gas or electricity is relatively high. Secondly the relevant government subsidies cannot be paid to users.

3.2.3 Problems. 1) The installation of some clean heating renovation projects does not meet the requirements of technical specifications. It is found that the gas pipeline of some local users has not been blocked through the wall. Some users install the heating furnace in the bedroom and living room. In addition, most of users did not use alarm or installed the alarm in a non-standard way, which affects the use effect. There are second fire sources such as liquefied gas tank in the heating, which room, which is very dangerous.
2) Some users are lack of gas safety awareness. Users especially the elderly could not proficiently operate the gas furnace and other basic operation skills. At the same time, the rural people are lack of safety awareness, which leads to supervision difficulty. So training and publicity on gas safety is very necessary.

3) The protective measures for outdoor gas pipelines and pressure regulating facilities in some villages are not enough. Some outdoor gas pipelines in some villages are not treated with rust prevention and painted with yellow marking paint as required, and lack of necessary safety warning signs. The riser at the connection of some buried gas pipelines and overhead gas pipelines is not equipped with necessary protective facilities.

4) Warmth preservation measures are not in place. Restricted by economic foundation, the buildings in rural areas are bungalows made of earth, brick or concrete. Most of the external walls of bungalows are insulated, which leads to high energy consumption and low heating comfort. It was found in the household inspection that some rural houses did not take heat preservation and insulation measures such as roof ceiling, air tightness of doors and windows, and corridor closure, which affected the heating effect.

5) The use frequency of heating equipment is low. The cost of clean heating is 2-3 times of that of coal-fired heating. Affected by local economic conditions, residents' income level, natural gas and electricity costs, the use frequency of heating equipment is low. Even some of them do not use the heating equipment at all.

4. Suggestions

4.1 Make Emission Reduction as the Core Index of Clean Heating Standard and Evaluation System.
As long as low energy consumption and low emission can realized, it does not matter what clean energy or efficient energy system is used. We aim at reducing heating energy consumption and pollutant emission. Therefore, no matter what kind of fuel the user uses, what process and technical path the product adopts, as long as on the basis of ensuring the normal heating quality, achieving the pollutant standard or ultra-low emission, and the energy consumption index of the heat user and production link is lower than the national or industrial standards, it should be defined as clean heating.

4.2 Priority Should be Given to Local Resources and Technical Path Should be Made which Meets the Local Economic and Social Development Level.
We should take people as the center and adjust measures to local conditions on rural area clean heating. The principle of reasonable, effective, safe, economic and sustainable and appropriate should be abided by. Appropriate energy used in the right place in the right time is more appropriate.

4.3 Improve the Safety Operation Management System.
Firstly, implement the territorial management responsibility of the government. Each district (city) government is responsible for the safe production of clean heating within its jurisdiction. It is necessary to establish and improve various rules and regulations such as safe management, safety inspection, quality supervision, maintenance and repair of clean heating. Task objectives should be refined and decomposed to each level, and implement the task should be practically guaranteed. Secondly, the main responsibility of safe production of clean heating enterprises should be guaranteed. Enterprises are required to set up safe production management organizations in accordance with laws and regulations, improve safe production management system, and strengthen standardized construction and risk management of safe production. Thirdly, strengthen the safety supervision responsibility of the industry authorities. The industry authorities at all levels should conscientiously perform their duties, implement the supervision responsibility, innovate the supervision methods, practically do a good job in the supervision and inspection of clean heating safety production, timely find problems, guide and urge the enterprises to do a good job in rectification. Fourthly, strengthen the safety management at the basic level, further improve the system of full-time safety officers at the village level and focus on safety training.
4.4 Strengthen Emergency Capacity Building.
Authority at all levels should study and formulate the emergency plan for rural clean heating in combination with the actual situation of the local countryside to deal with all kinds of sudden failures and emergencies as soon as possible. Clean heating enterprise should increase capital investment, strengthen the construction of emergency rescue team and emergency materials reserve in the rural clean heating area under its jurisdiction, strengthen the training of personnel business ability, establish and improve the rural clean heating emergency rescue system with unified command, rapid response, excellent equipment and well-trained. At the same time, clean heating enterprise should formulate internal emergency plan, organize and carry out emergency drill regularly, and practically improve the emergency handling capacity. The emergency plan of each clean heating enterprise should be smoothly connected with the plan of the government and relevant departments. Strengthen the safety education and skill training of relevant employees, set up special technical personnel in different areas, strengthen the daily maintenance and repair of safety, and form a long-term guarantee mechanism to ensure the safe heating of people.

4.5 Intensify Publicity and Education.
Authority at all levels and clean heating enterprises should make full use of multimedia platforms such as TV, radio, Internet, newspapers and magazines to organize and carry out various forms of rural clean heating safety publicity and education activities in rural areas and communities. By distributing cards and brochures to popularize knowledge about the safe use of gas and electricity, enhance the awareness of the safety and improve the ability of safety prevention.

4.6 Focus on Improving the Energy-saving Level Buildings.
Encourage building construction according to the energy conservation standards or transformation of energy conservation in rural areas, improvement of the heat preservation performance of the enclosure structure to reduce the heating energy consumption and improve the heating effect. New rural communities are suggested to adopt energy-saving design and construction to improve the energy-saving and thermal insulation effect of buildings in winter. Newly constructed and reconstructed farm house is suggested to enhance thermal insulation function through adding external wall, roof insulation, insulated bridge broken hollow glass doors and windows, etc. For the existing rural houses, measures such as exterior wall insulation, roof transformation, building sealing and rear window transformation are suggested to be taken to reduce the heat consumption of buildings and improve the effect of energy conservation.

4.7 Make Full Use of Industry Association and Promote The Integrated Innovation of the Whole System of Rural Clean Heating.
The healthy and sustainable development of clean heating needs the support of science, technology, and supporting industrial system. Industry association platform should be fully used to promote the integrated innovation of rural clean heating system. Promote the overall technical progress of the industry and the upgrading of heating system by gradually improving technical standards. Accelerate the establishment of monitoring and evaluation system for clean heating, and introduce a third-party evaluation mechanism to implement supervision and management are very important as well.

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