Analysis of Factors Influencing Clean Heating and Research on Sustainable Development Path

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Abstract. This paper summarizes the promotion of clean heating in the northern region in 2017-2018, analyzes the influencing factors of clean heating rate and the prominent problems restricting the sustainable development of clean heating according to the actual investigation and relevant basic data, and puts forward the targeted suggestions such as optimizing the technical route from multiple dimensions to ensure the sustainable development of clean heating.

Introduction

At the end of 2016, at the fourteenth meeting of the central financial and economic leadership group, general secretary Xi Jinping stressed that promoting clean heating in the northern region in winter is related to the warmth of the masses in the northern region for the winter, and whether the fog and haze can be reduced. This is an important part of the energy production and consumption revolution and the rural lifestyle revolution. As an important way to alleviate winter haze, clean heating has been raised to the national strategic height.

In view of the research on clean heating, literature [1] studies the advantages and challenges of renewable energy in clean heating in northern China. Literature [2] studies the existing problems and demands of the subsidy policies for clean heating environment in the northern region. Document [3] studies the impact of clean heating on haze. Systematic and comprehensive analysis of the influencing factors of clean heating is rare. Based on the mid-term assessment of clean heating planning organized by the National Energy Administration in 2019, this paper focuses on the study of influencing factors through field research and a large number of data analysis, and puts forward the path of sustainable development of clean heating.

Overall Promotion of Clean Heating

At the end of 2017, ten ministries and commissions including the Energy Bureau issued the notice on printing and distributing the winter clean heating plan in the northern region (2017-2021) [4]. In 2019, NEA organized the mid-term assessment of clean heating plan. By the end of 2018, the winter clean heating rate in the northern region has reached 50.7%, 0.7 percentage points higher than the planned value (50%), 12.5 percentage points higher than that in 2016. The clean heating rate of 2 + 26 cities has reached 72%, among which the clean heating rate in urban areas has reached 96%, that in county towns and urban-rural areas has reached 75%, and that in rural areas has reached 43%. In terms of the completion schedule, the completion schedule in rural areas is relatively low. According to the goal of 70% clean heating rate in 2021 in the plan, the follow-up overall task is more arduous, and the research on sustainable development is particularly important.

|                      | target 2019 of the plan | current | target 2021 of the plan |
|----------------------|-------------------------|---------|-------------------------|
| urban area           | 90%                     | 96%     | 100%                    |
| county and urban rural junction | 70%                     | 75%     | 80%                     |
| rural areas          | 40%                     | 43%     | 60%                     |
Along with a series of planning policies, financial subsidies have been issued. In 2017-2019, the Ministry of finance, the Ministry of housing and urban rural development, the Ministry of environmental protection, the national energy administration and other four ministries and commissions successively determined three batches of 43 pilot cities for winter clean heating in the northern region, with the central government's cumulative investment of 35.1 billion yuan. In response to the national policies, local governments have successively issued some local policies and regulations, mainly focusing on operation price subsidies, heating equipment subsidies, building energy-saving transformation subsidies, supporting grid construction subsidies, etc., but there is a large gap in the scope and strength of the subsidies issued by local governments.

From the perspective of heating mode, the area of clean coal-fired central heating increased the most in all kinds of modes, accounting for 49% of the total increase area of clean heating. Natural gas takes the second place among all kinds of new clean heating areas, accounting for 31% of the total increase in clean heating area. Electric heating occupies the third place among all kinds of new clean heating areas, accounting for 12% of the total increase area of clean heating. Replacing coal with electricity and coal with gas is still the focus of clean heating work in the future. Electric substitution mainly uses electric power, such as centralized heating facilities such as electric boiler or decentralized electric heating facilities such as air source heat pump and heat storage electric heater to heat users. The main alternative of natural gas (gas heating) is to use natural gas as fuel, and use the gas boiler and other centralized heating facilities after denitrification transformation, or wall mounted furnace and other decentralized heating facilities to heat users.

Analysis of the Influencing Factors of Clean Heating Rate

Through the analysis of field survey data, it is found that the main influencing factors of clean heating rate are as follows:

The rate of clean heating is most affected by the inclination of national policies. The clean heating rate of "2 + 26" key cities is significantly higher than that of non key cities, and the clean heating rate of the pilot cities included in the central financial support is higher than the average level. The state has given the largest support to Beijing's clean heating policy, which is far higher than that of other provinces. The goal of clean heating has been achieved in advance.

Environmental constraints have a great impact on clean heating. Areas with serious pollution are often at the forefront of accelerated progress in clean heating. For example, the cities where the annual average concentration of NO\textsubscript{x} exceeds the standard are mainly in Hebei, Henan, Tianjin, Shandong and other places. The cities with excessive annual SO\textsubscript{2} concentration are mainly in Henan, Hebei, Tianjin, Shandong and other places. Under the background of "double control of carbon intensity and total amount", these areas are willing to promote clean heating. Regions with high environmental overload rate tend to choose heating methods with good environmental protection performance, while regions with low environmental overload rate pay more attention to heating methods with outstanding economy. Heilongjiang, Liaoning and other regions with weak environmental protection constraints are relatively slow to promote.

The economic development of each region has a certain impact on the standard rate of clean heating. From the perspective of economic development, Beijing and Tianjin, with the highest per capita GDP, are in the top two places of clean heating rate. In the developed areas, the residents' economic endurance is relatively high, and the subsidy is timely and sufficient, so the promotion and application of clean heating is better. Some experts estimate that the utilization rate of clean heating has a strong correlation with the subsidy. To sum up, the clean heating rate is positively related to the economic development of the region.

Economy, equipment quality and after-sale are all the factors that influence the choice of clean heating mode. At present, the mainstream clean heating methods include coal-fired back pressure, coal-fired boiler, natural gas boiler, natural gas wall mounted boiler, centralized electric heating (heat storage electric boiler, heat pump central heating), household air source heat pump, geothermal
heating, biomass heating, industrial waste heat, etc. Due to the large differences in energy prices, infrastructure, resource endowment and other factors, the economic calculation results are quite different. Generally speaking, the economic order of the user side is as follows: centralized coal-fired heating > centralized natural gas heating > decentralized natural gas heating > heat pump > decentralized electric heating > thermal storage electric boiler. Experts in the industry summed up the principles of heating mode selection: one year for cost, three years for quality and five years for maintenance. This shows from the side that economy is not the only criterion to measure the advantages and disadvantages of heating methods. In the early stage, some equipment won the bid at a low price, which led to the manufacturer reducing the configuration or service specifications, and there was a large quality risk. Some areas have found that the equipment quality problem led to the case of user abandonment. At the same time, the follow-up operation and maintenance workload of clean heating is large, and after-sales problems increase, which will seriously affect the user heating. Reasonable operation mechanism can effectively improve the economy of clean heating.

Compared with the traditional heating mode, the cost of clean heating is still higher, which is difficult for some users to bear. Some places take various measures to improve the economy of clean heating. Zhangjiakou started to implement the "four party cooperation mechanism" jointly participated by "government + power grid + power generation enterprise + user side" in 2017, forming a new mode of "abandon wind and photovoltaic" as "low-cost economic power", promoting the large-scale consumption of clean power, while providing a low-cost power source of 0.15 yuan / kWh. Northeast and other provinces also provide low-cost electricity guarantee for electric heating through electric power trading mechanism, greatly improving the clean heating rate.

The application of information technology can effectively promote the clean heating work. Some provinces have implemented the "Internet plus heating" intelligent heating mode, which has achieved the goal of intelligent heating and precise heating. For example, Hebei heating company uses modern information technology to establish a heating information monitoring system for safety, emission, quality and energy consumption and storage in the whole province. In the heating area, a structure of "one heating network, multiple heat sources, supply and demand coordination, and market-oriented operation" is preliminarily formed, realizing "stable heating, balanced heating and comfortable heating", with remarkable results.

Multiple Challenges to Promote Clean Heating

In some areas, the cost of heating exceeds the affordability of residents, and the risk of coal return is high. The economy of clean-up heating is not outstanding, and the operating cost is widely higher than that of bulk coal. In the early stage, the promotion of clean heating relies on subsidies, which is relatively smooth, but subsidies are not a long-term solution. The financial pressure of governments at all levels increases, and the decline of subsidies is a high probability event. According to the median calculation of household income and fuel cost in 2012-2016, the reasonable fuel consumption accounts for about 5% - 6% of the median income. According to a survey, 32% of the "double substitution" residents who participated in the survey actually spent more than 2000 yuan after the government subsidies. About 43% of the users said that they would use coal in varying degrees without the government subsidies. Nearly 70% of the users said that they would use bulk coal instead of clean coal, and the recovery rate of bulk coal may be as high as 30%. According to incomplete statistics, the reburning rate of bulk coal in some areas has reached 8-10%.

At present, the accuracy of policy support is insufficient, and there is no long-term support mechanism in the long term. First, the government investment and subsidies in some regions do not fully consider the differences of user demand, subsidy objects and clean heating technology, resulting in inaccurate investment and subsidies and low efficiency. For example, in some areas, according to electricity subsidies, the larger the power consumption of large houses such as villas, the more subsidies they enjoy, the less subsidies they enjoy for economically poor users. Second, government policy support is insufficient. In addition to a few provinces such as Beijing, Tianjin and Shanxi, other
local governments lack clear and effective support policies in the aspects of residential renovation, heating equipment subsidies, supporting grid construction and renovation, electric heating operation subsidies, etc. Third, there is a lack of long-term policy support mechanism. The current subsidy policy has increased the financial pressure of the government. According to statistics, after completing all the transformation tasks of the three-year pilot project in 2019, if the current subsidy level is still used, the proportion of subsidy expenditure to the general public budget expenditure of the city is 0.11% - 4.72%. Some cities have implemented the policy of retrogression. In the future, if the long-term support mechanism is not established, it is difficult to achieve the sustainable development of clean heating projects, which will produce a large area of "coal return" phenomenon.

The imperfect operation mechanism of clean heating market restricts the healthy and sustainable development of clean heating. First, a mature business model suitable for wide promotion has not yet been formed. Due to the problems of difficult management, low heating charge and limited profit space, some clean heating modes are unable to attract social investment. At present, there is no business model. At the same time, some clean heating modes are affected by policies, energy endowment, technical characteristics and other factors. The replicability of the business model needs to be further demonstrated. Second, the market-oriented trading mechanism needs to be improved. For example, the lack of policies and Implementation Rules for some power saving and heating residents to participate in direct transactions is not conducive to reducing the heating cost of users and promoting the consumption of new energy such as wind power and photovoltaic.

In some areas, clean heating technology and promotion mode need to be further optimized. The regional characteristics are not fully considered in the promotion of heating in some provinces, and the promotion mode needs further scientific demonstration and optimization. There are many types of clean heating technology, but the application conditions and application fields of heating technology are quite different, which need scientific analysis. For example, some provinces, without scientific demonstration, do not consider the issue of resource capacity, blindly promote the "coal to gas" in the early stage, resulting in a large area of "gas shortage" and other prominent contradictions affecting people's livelihood.

The input-output rate of some clean heating methods is low. In the future, the difficulty of clean heating lies in rural areas. Because the cost of clean heating exceeds the bearing capacity of some residents, the utilization rate of clean heating in some areas is not high. Taking electric heating as an example, there is a large demand for supporting power grid transformation and a high idle rate of equipment. It is estimated that the average household capacity needs to reach more than 6 thousand VA to ensure the residents' demand for electric heating in winter. According to statistics, electric heating equipment is only used in winter heating period, with an average load rate of only 30%, resulting in waste of resources. In addition, there are a large number of "unused" and "basically unused" users in some areas where the coal to electricity transformation is completed, further reducing the use efficiency. In addition, the problem of house vacancy also leads to low utilization rate. The vacancy in Beijing, Tianjin and other places is mainly due to the rapid development of urbanization. In winter, most rural residents go to the buildings purchased for winter. The vacancy in Henan, Shandong and other places is mainly due to the fact that the main labor force in the household goes out to work, and the actual needs of the left behind elderly and children are significantly less than the installation needs.

Building energy saving has not been paid enough attention. The rural construction area accounts for 40% of the total urban and rural construction area in northern China. More than 80% of buildings in rural areas have not taken energy-saving measures. According to the survey, most of the rural houses are built by farmers themselves, with poor heat preservation and insulation performance. There are problems such as large building energy consumption and low energy efficiency in rural houses. If the indoor comfort temperature of agricultural buildings is up to the standard, the heating load per unit building area is 2-3 times of that of urban energy-saving buildings. Taking Huaien Town, Shanghe County, Jinan City, Shandong Province as an example, the single household investment of energy-saving renovation of rural houses is about 4000-10000 yuan, and the comprehensive energy
efficiency can be improved by more than 30%. At present, rural winter building heating has become the first building energy consumption, but the cost of building ENERGY-saving transformation is large and the construction cycle is long. Without effective subsidies, farmers are not willing to accept transformation.

The promotion of rural clean heating lags behind. The heating building area in rural areas accounts for 36% of the total heating area in the north. In 2018, the clean heating rate in rural areas is 24%. The clean heating path in rural areas is mainly natural gas heating and electric heating. There are three main reasons for the lag of clean heating in rural areas. First, due to cost constraints, farmers’ willingness to use is low, and the financial burden of large-scale subsidies from local governments is heavy, which is difficult to sustain. Second, the conditions of gas pipeline network in rural areas are generally poor, and the grid structure of distribution network is still weak, which can not guarantee the safe and stable use of electricity for electric heating facilities. Third, the structure of rural houses is generally simple, and the insulation effect is poor. Only 20% of them have taken certain energy-saving measures, and the building energy efficiency is low.

There are uncertainties in energy security and energy market prices. China's energy production, supply, storage and marketing system is gradually improving, and there are still some problems. At the same time, with the continuous promotion of the market-oriented reform of the energy industry, energy prices move to the market. For example, in recent years, the domestic demand for natural gas has grown rapidly, but the growth of natural gas production still lags behind the growth of demand. At present, about 40% of China's natural gas consumption is imported, and its dependence on foreign countries exceeds 45%. The price rising trend of natural gas has always existed. Although the letter of the national development and Reform Commission on ensuring the supply and price of natural gas has temporarily restrained the price rising trend, there are still unstable factors in the price of natural gas. In 2017, there was a tense situation that natural gas supply was in short supply, which attracted wide attention from all walks of life. The National Energy Administration issued the notice on doing a good job of clean heating in heating season 2018-2019, which requires that local "coal to gas" should be changed according to the gas, first implement the gas source and then implement the transformation.

Suggestions on Promoting the Sustainable Development of Clean Heating

Clean heating is a systematic project, which needs constant scientific optimization and improvement. In the next three years, clean heating projects need to be vigorously promoted in rural areas and non-key areas, which is more difficult. Sustainable development in many regions is facing challenges. The next step is to consolidate the achievements, solve the problems and difficulties in the process of promotion, and ensure the completion of the planning objectives and tasks in accordance with the principles of "electricity, gas, coal, heat and transformation". First, urban planning and urbanization should be coordinated with the layout of clean heating. Second, optimize the technical route of clean heating according to local conditions. Third, further optimize the subsidy policy. Fourth, do a good job in ensuring energy supply. Fifth, the enterprises jointly carry out building energy-saving transformation. Sixth, establish a sound assessment system for clean heating. Seventh, innovate business model and realize sustainable development.
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