Research on Supply Chain Cooperation Optimization Model of Electric Heating Market Replacing Traditional Coal Power Generation

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Objectives: The rapid development of central heating service in China mostly uses fossil fuels such as coal for production. The market competitiveness of new energy such as wind and solar energy to replace coal to produce heat energy for heating is relatively poor. Under the multiple requirements of energy security, ambient air quality and low carbon, electric heating is practicable because of its flexible use, adapts to the differential demand of consumers for heat, which energy supply can improve efficiency with the progress of power generation technology and so on. On the basis of case study data and results of residential users, companies and public buildings adopting electric heating technology, the analysis of consumer demand, supply chain structure and market relationship in China's electric heating market, this paper discusses the supply chain cooperation model by using revenue sharing contract mode. The results show that the performance of the benefit sharing ratio in the data simulation is acceptable when the revenue sharing contract is used in the supply chain. This model can promote the spontaneous and effective operation of the market, and help the local government in China to get rid of the embarrassment of the continuous subsidy.

Key words: sharing contract mode; electric heating; demand curve; coal power generation
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INTRODUCTION

Since the 1950s, China has implemented the construction of heat sources and pipe networks for central heating in the cold seasons in Northeast, Northwest China, where the latitude is above 33N degrees. By 2017, the area of central heating has reached 9.77 billion square meters, with an annual investment of more than 50 billion yuan[1], and more than 65% of the heat sources are coal. Coal-fired heating has accelerated the energy waste and air pollution in China, which is harmful to the health of residents[2, 3]. In order to ensure the safety of energy supply, improve the quality of ambient air and promote low-carbon emissions, China has put forward the "Coal to gas" and "Coal to electricity" plans, and the government has implemented measures such as extensive publicity, equipment and contract subsidies, extended valley period preferential electricity price and open scale electricity trading market[4], and the key development

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of Beijing, Tianjin and Hebei region has completed 3.4141 million "coal to electricity" projects[5]. The electric heating mode has attracted the attention of the society and the market, but whether the subsidy policy can be implemented continuously has been a unique dilemma and problem that perplexes the development of the electric heating market in China.

Nordic countries, South Korea, Japan and other countries have adopted decentralized heating for more than 50 years[6], and the application experience is relatively successful[7]. Research on the application of new cleaner and more efficient technologies such as photo-voltaic power generation technology in electric heating has also been carried out[8], including technology[9], strategy, economic feasibility analysis and post occupancy behavior analysis[10]. The research on the application of electric heating power generation[11] and equipment technology[12], economic feasibility analysis[13], air quality[14] and the benefit of low-carbon environmental protection[15-17] are mostly based on the background of China.

In 2004, Morrimer created a sharing contract model in the study of DVD rental market in the United States. The model used linear regression method to study the impact of revenue sharing on the profits of renters. The results show that the revenue sharing contract between DV producers and renters spontaneously formed in the industry market can improve the total system performance by about 7%[18]. Such contracts are rarely seen in developing countries because of the inactive market conditions. In addition to theoretical discussion, Chinese researchers have tried to make practical application in the fields of agricultural products such as corn, coal, new energy vehicles and other industries[19-22], but so far, no large-scale industry or field application has been formed. This paper investigates the operation and equipment cost of electric heating technology application in residential buildings, public buildings and non-energy saving buildings in Northeast China, understands and analyzes the problems and resistance in the development of electric heating market, and puts forward a solution to the problem based on revenue sharing contract mode to promote the cooperation of suppliers. By analyzing the game mode of the behavior and model simulation of the supplier in the electric heating market under the general situation and revenue sharing contract, the feasibility of the implementation of the project is discussed. The application of this mode can promote the spontaneous and effective operation of the market, provide supplementary countermeasures for reducing the financial pressure of government subsidies, help the local governments in Northeast China to get rid of the embarrassment of the discontinuous subsidies, and then promote the development of clean energy market.

INVESTIGATION AND EVALUATION

According to the current equipment and technical characteristics of electric heating market in Northeast China, its operation mode can be divided into centralized heating mode and decentralized heating mode for independent users. As shown in Figure 1, the system composition of centralized heating mode is similar to traditional heating mode, except that the heat generating equipment is replaced by electric boiler or heat pump. In order to achieve the purpose of using the electricity in the valley period of the power grid as much as possible to save the cost, the regenerative electric boiler is often used, so it is also called the regenerative electric heating system. The decentralized electric heating mode is that users purchase direct heating electric heater (wall mounted electric heater and electric heater), low-temperature radiation electric heating film, electric heating cable, electric heating floor and other equipment, who can adjust the temperature and switch the electric heating equipment by themselves, that is, the so-called direct heating system.

Operation Cost Survey Results

As of the end of the heating season in 2015, entrusted by the energy management department of the local government, a series of investigations have been carried out involving the common residential users and public buildings adopting centralized and decentralized heating. A total of 10 valid reports were obtained, including a case of basic operation

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parameters of early non occupied houses. As the market share of electric heating mode is very low and the locations of each case are relatively scattered, the investigation time should be as far as possible for a complete heating season. The investigation cases whose investigation time is inconsistent with the local central heating time are converted according to the local central heating parameter data of that year to standardize the energy consumption data of each case.

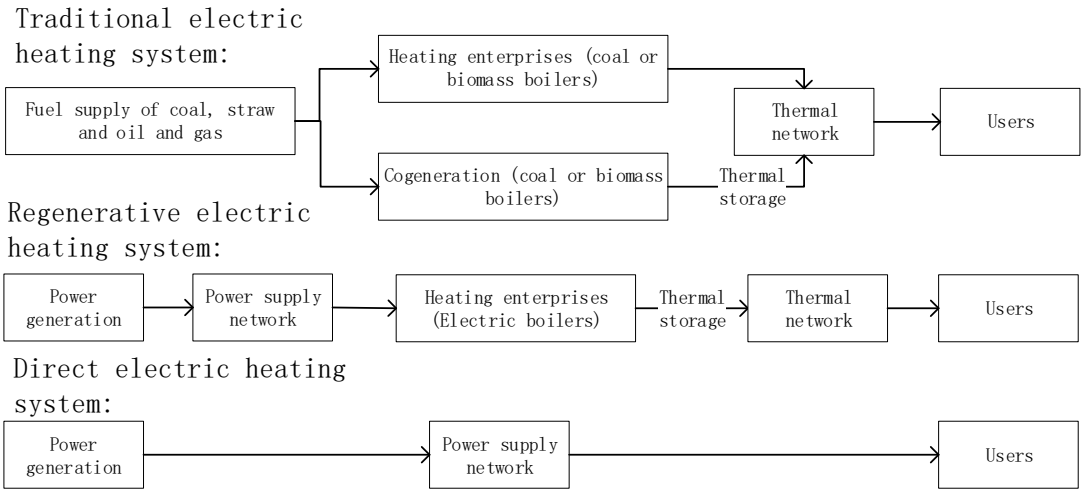

Figure 1
Heating System Structure Sketch Map

Figure 2
Comparison of Case Operation Costs

Figure 2 shows the overall trend of comparison with the local central heating cost, which shows that in 8 of 10 cases (x axis), the operation cost of electric heating (y axis) is lower than the local central heating charges for this type of users. Non-residential buildings are mostly used for education, training, office, residential and entertainment services, which activity time is relatively fixed daily, and is basically closed in the coldest months of winter. The flexible application advantage of keeping low temperature operation in inactive period has been brought into full play, and the

energy saving effect has exceeded 50% (case 6, 7, 9 and 10). The operation cost of residential buildings is also low (case 2, 3 and 4). The user's actual control temperature in case 2 and 3 with higher measured cost is higher than that of central heating by 3-5 degrees, and the user gets higher comfort.

Case 8 is a company's administrative office building with high requirements for heating. The regenerative electric boiler in case 5 is used for heating service, and the flexible advantages of electric heating are lost. case 1 is the basic operation parameters of the uninhabited house, which shows that the cost is relatively high in the natural situation without any adjustment, and the heat is considered to be excessively consumed in the heat transfer of dry walls, empty balconies and adjacent empty rooms.

Equipment Installation Cost

In the regenerative electric heating system, the heating medium transmission system and the user heating system are the same as the traditional central heating mode, but the construction cost of the regenerative electric boiler room is higher than the coal-fired boiler room, meanwhile the cost of the power transformation device and the distribution line part also needs to be increased; The power supply system of low-temperature radiant heating in direct heating power supply system is generally laid separately from the main line of building lighting power supply system, which initial installation cost is: the installation cost of indoor heating cable or electric heating film and line, the increase cost of indoor electric heating distribution main line, the increase cost of outdoor electric heating transformer and distribution line. In 2015, Jilin Electric Power Co., Ltd. investigated the investment of thermal storage boiler, direct heat type electric heating film and heating cable equipment as well as grid supporting system in the electric heating market of Jilin Province. The survey results in Table 1 show that the average investment of electric heating for various types of equipment is higher than that of central heating in Jilin Province by 200 yuan/m^2, with an increase of 30-234 yuan/m^2, the increase rate was 15.0% - 117%. Among them, the investment cost of direct heating equipment is the lowest in residential buildings, while that of regenerative electric boiler is the highest.

Table 1
Investigation Results of Electric Heating System Investment

Product category	Customer type	Building category	Configuration capacity (W/m^2)	Equipment investment (yuan/ m^2)	Supporting investment of power grid (yuan/ m^2)	Total investment (yuan/ m^2)	Increased investment in electric heating (yuan/ m^2)	Static payback period (year)
Regenerative electric boiler	Residential district with central heating	-	120	194	240	434	234	-
	Non-residential buildings	-	135	169	200	369	169	2.53
Electric heating film	Residential buildings	Energy efficient building	60	110	120	230	30	4.75
		Non energy saving building	110	160	220	380	180	-
	Non-residential buildings and public buildings	Energy efficient building	80	110	160	270	70	5.38
		Non energy saving building	130	140	260	400	200	-
Heating cable	Residential buildings	Energy efficient building	63	115	126	241	41	7.52
		Non energy saving building	110	135	220	355	155	-

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	Non-residential buildings and public buildings	Energy efficient building	85	125	170	295	95	8.22
		Non energy saving building	130	140	260	400	200	-

Note.
Energy-saving buildings refer to buildings that comply with the People's Republic of China industry standard "Energy Conservation Testing Standards for Public Buildings" (JGJ/T177-2009) and "Energy Testing Standards for Residential Buildings" (JGJ/T132-2009)

Based on the overall analysis, the electric heating with high economic feasibility, can meet the individual needs of residents, which is more suitable for public buildings and non-residential buildings with flexible time demand. The high cost of initial installation is one of the main obstacles. The initial investment cost of the equipment system is relatively high, but the static investment payback period of the high investment part of the equipment is generally less than 10 years, and the most optimistic estimate is less than 3 years.

SIMULATION AND DISCUSSION

Electric Heating Market Operation Model

In the previous survey results, companies and enterprises choose electric heating methods are complete market behaviors, which are selected by enterprises and regulated by the market. Therefore, this paper focuses on the decentralized electric heating system that can replace the district central heating, that is, the operation mode and economic model of the direct electric heating system.

Market Composition

As shown in Figure 3, compared with the regenerative electric heating mode, since the thermal production and the construction of the heating pipe network are not required, the industrial chain system of the decentralized heating mode only includes three components: the production and supply of energy and electric power, the supply of the electric heating equipment and users, the supplier can be simplified to a two-tier supply chain system of equipment suppliers (hereinafter referred to as SG) and power suppliers (hereinafter referred to as DG).

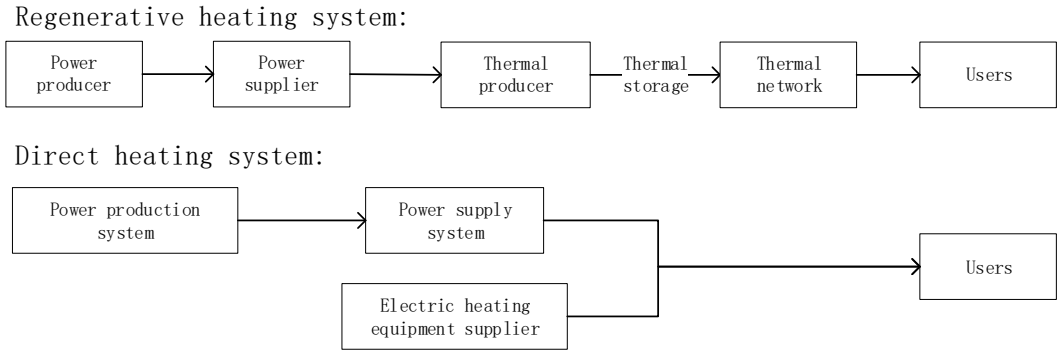

Figure 3
System Structure Diagram of Electric Heating Industry Chain

Consumer Demand Assumption

Now assume that a new community with Q households, each household with the same structure and residents can freely choose traditional central heating or electric heating, ignoring other influencing factors, the demand for direct electric heating is only related to the total cost of heating method, and set it to the linear relationship, the demand curve is:

$$C_{DR} = a * I + b \quad (1)$$

In the formula, C_{DR} is the total cost of each household heating system, and I is the usage rate of the community electric heating system, $0 \leq I \leq 1$. a, b is a coefficient, when the total cost increases, the usage rate decreases, so $a \leq 0$. From this, it can be inferred that $b \leq C_{DR} \leq b+a$. The consumer demand curve is shown in Figure 4.

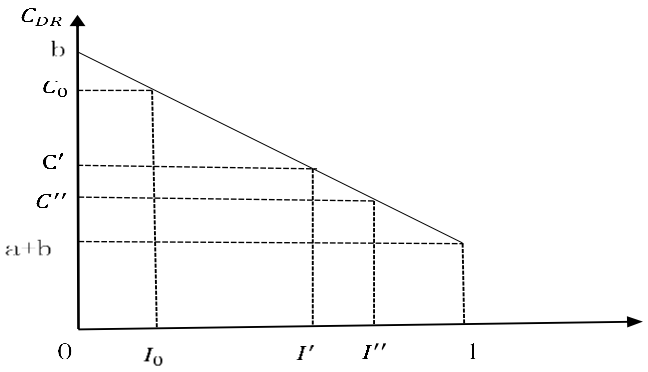

Figure 4
Consumer Demand Curve in the Electric Heating Market

When the service life is n years and the discount rate is I_s, the calculation equation of C_{DR} is:

$$C_{DR} = V_S + V_{D1} + V_{D2}(1+I_S)^{-1} + V_{D3}(1+I_S)^{-2} + \cdots + V_{Dn}(1+I_S)^{-(n-1)} \quad (2)$$

In the formula, C_{DR} consists of two parts: the initial installation fee and the operating cost. V_S is the cost per household equipment and pipe network installation, the charge is obtained by SG, $V_{D1} + V_{D2}(1+I_S)^{-1} + V_{D3}(1+I_S)^{-2} + \cdots + V_{Dn}(1+I_S)^{-(n-1)}$ is the operating cost per household per year during the operation of the equipment, which is electricity fee and obtained by DG. Since the operating cost of the heating system is related to temperature, consumer usage, residential structure, and neighboring house temperature, the annual operating cost is not a fixed value. To simplify the model, take the average value as the fixed annual operation cost, formula (2) is simplified to:

$$C_{DR} = V_S + V_D * \sum_{k=1}^{n}(1+I_S)^{-(k-1)} \quad (3)$$

Then the utilization rate of community electric heating system is:

$$I = (C_{DR} - b)/a \quad (4)$$

It can be seen from equation (4) that when C_{DR} decreases, (C_{DR}-b) also decreases, but since the numerator denominator is negative, I increases. That is shown in Figure 4, when $C'' \le C' \le C_0$, $I'' \ge I' \ge I_0$.

It should also be considered that since the central heating market has a certain natural monopoly, no matter what kind of electric heating system is used, when the usage rate exceeds a certain value in the community, the remaining users may only choose to access the same system under monopoly conditions.

Supply Side Market Behavior Analysis

Both SG and DG can directly sell their own products to the consumers who choose direct electric heating, and the revenue is directly proportional to the community usage rate, so the total revenue of SG and DG is

$$V_{SG} = V_S * Q * I_{DR} \quad (5)$$

$$V_{DG} = V_D * \sum_{k=1}^{n}(1+I_S)^{-(k-1)} * Q * I_{DR} \quad (6)$$

Further assume that the profit is fixed, and the total increased profit is also proportional to the total income, which means the total increased profit can only be achieved by increasing the utilization rate of electric heating in the community. The electric heating usage rate is affected by the total cost under the assumption, the indicator will increase only if the user usage fee is reduced.

Obviously, it is one of the feasible countermeasures to reduce the cost from the equipment subsidies and electricity tariffs concession by the government's fiscal policy, but it is impossible to implement it for a long time. The electricity tariff concession is to reduce the income of DG to improve the utility of consumers. Even a Pareto improvement is at the expense of the loss of one party. At the same time, consumers will doubt the continued long-term implementation of this policy. The deep subsidy policy may also involve social equity issues for users who do not use electric heating and those who cannot receive subsidies from the financial sector in the later period. In reality, it is more common because of the shortage of financial funds. Early users may make hasty decisions for subsidies. If the best products are not selected at this time and the experience is poorly, it will be detrimental to the development of the market.

Therefore, it is imperative to find a mechanism to enable the market to operate on its own.

Supply Side Market Game Countermeasures

In order to increase consumer usage, both the supply DG and the SG can reduce the total cost of the consumer by reducing their respective income. At this time, the strategies that can be adopted by both parties for independent decision-making are both price reduction and no price reduction. If the same total cost reduction C′ is triggered, the consumer usage rate will also rise from I to I′, then the income matrix is as shown in the Table 2. In Table 2, after the SG side adopts the price reduction strategy, the income of each household is V_S', and the DG side is V_D'. When both parties adopt the price reduction strategy, since the total cost C′′ of the electric heating consumer is lower than C′, the usage rate becomes I′′, with I′′>I′, refer to Figure 4.

Table 2
Supply Side Strategy Income Statement

DG / *SG*	Price reduction	No price reduction
Price reduction	$V_S'' * Q * I'', V_D'' * \sum_{k=1}^{n} (1+I_S)^{-(k-1)} * Q * I''$	$V_S' * Q * I', V_D * \sum_{k=1}^{n} (1+I_S)^{-(k-1)} * Q * I'$
No price reduction	$V_S * Q * I', V_D' * \sum_{k=1}^{n} (1+I_S)^{-(k-1)} * Q * I'$	$V_S * Q * I, V_D * \sum_{k=1}^{n} (1+I_S)^{-(k-1)} * Q * I$

In the proceeds under the combination of strategies shown in Table 2, the total revenue of the supply system is the sum of the returns of SG and DG. In the price reduction strategy of SG and DG, it is a very obvious boundary condition that the income after the price reduction exceeds the original income, that is,

$$V_S' * Q * I' > V_S * Q * I$$

and

$$V_D' * \sum_{k=1}^{n} (1+I_S)^{-(k-1)} * Q * I' \quad (7)$$
$$>$$
$$V_D * \sum_{k=1}^{n} (1+I_S)^{-(k-1)} * Q * I \quad (8)$$

after simplification to get:

$$V_S' * I' > V_S * I$$

and

$$V_D' * I' > V_D * I \quad (9)$$

Obviously, the price reduction of both parties is the optimal combination of strategies. At this time, the cooperation strategy will increase further than the two companies' separate price reduction strategies. But the price reduction strategy is risky, depending on the demand elasticity. In the heating market of northeastern China, there is no relatively active market in operation, so the specific parameters of the strategy are difficult to determine for the supplier. In the investigation case of this paper, except for the large-scale entertainment enterprises that operate in the off-season in winter are the active choice, the majority of other electric heating methods are determined by the real estate agent or the collective legal person of the housing enterprise, and the market share is relatively low. Under this circumstance, the supplier, especially the SG, can only determine the price reduction parameters through trial and error, which will undoubtedly further increase the equipment cost. Instead of actively changing the price strategy, they can enjoy the rising benefit of the free rider when the other party's suppliers adopt the price reduction strategy, which is the most favorable strategy when the market data information is not clear. When both SG and DG adopt a non-price reduction strategy, the market maintains the status in quo, and the equilibrium strategy of the prisoner's dilemma is relatively stable.

ANALYSIS OF REVENUE SHARING MECHANISM

Shared Contract Mode

The shared contract usually refers to the agreement of cost sharing and revenue sharing. It is the contract between the members of the supply chain system to

share the cost and share the benefits. In particular, the revenue sharing contract part plays a unique role and important role in the coordinates and development of the supply chain of non-identical legal person.

The heating market in Northeast China may be more suitable for this model than other areas. First of all, the heating time is longer, most areas are more than half a year, and the heating area continues to grow at a high speed, the heating market continues to expand. Second, the cogeneration mode accounts for more than 90%. Under the people's livelihood requirements for winter heating, only it is possible to prioritize the consumption of electricity generated by cogeneration, and increase the unequal competition factors in the power supply. At the same time, local governments are under pressure to reduce the total consumption of coal in traditional industries and promote the transformation of the energy industry. In recent years, the joint production has occupied the market for new energy development. The proportion of wind power abandoned and the power generation of Jilin Province where the author is located are in the forefront of China,[23] which is extremely unfavorable to the development of the relatively clean energy market; In recent years, the economic development rate in the Northeast has been lagging behind, and the local government has been in a tight financial situation. The financial subsidy policy is often difficult to implement. Many of the subsidy policy implementations have the basis of special subsidies from the central government. Therefore, the feasibility of promoting the electric heating market by relatively long-term subsidy fiscal policy is very low. In summary, it is very urgent to promote the market to start and operate well.

In the SG and DG supply chain of electric heating system, the profit of DG side comes from the use of electric heating equipment installed by consumers, which is stable and long-term due to the natural local monopoly of heating market. Therefore, the DG side is more willing to improve consumer usage. At this point, the cooperation mode of the supply chain two-tier suppliers to implement the revenue sharing mechanism is very promising. In the optimal strategy of Table 2, the most ideal situation is the excess return of the DG side after both parties adopt the price reduction strategy, the revenue part of (10) serves as the basis for the benefit sharing of both parties. Or in DG's unilateral price reduction strategy, SG's higher return part (11) can be used as the basis of benefit sharing.

$$V_D'' * \sum_{k=1}^{n}(1+I_S)^{-(k-1)} * Q * I'' - V_D' * \sum_{k=1}^{n}(1+I_S)^{-(k-1)} * Q * I' > 0 \quad (10)$$

$$V_D' * \sum_{k=1}^{n}(1+I_S)^{-(k-1)} * Q * I' - V_D * \sum_{k=1}^{n}(1+I_S)^{-(k-1)} * Q * I > 0 \quad (11)$$

Feasibility Analysis of Revenue Sharing Ratio

At present, most of the community electricity heating market is basically blank. According to the data in the investigation case, we can preliminary estimate the benefits that can be shared by electricity suppliers in an initial market. This ratio is the key indicator for the two sides of the supply chain to achieve the best strategy.

Firstly, the price reduction strategy of SG is Z yuan/m^2, and the heating cost of a heating season is simplified to a constant C yuan/m^2. When the user with S m^2 in the community chooses electric heating, the proportion of sharing benefits set by DG for SG is X% (hereinafter referred to as sharing ratio), then:

$$Z * S \geq C * S * \frac{X}{100} * \sum_{k=1}^{n}(1+I_S)^{-(k-1)} \quad (12)$$

Which can be deduced that:

$$X\% \leq \frac{Z}{C*\sum_{k=1}^{n}(1+I_S)^{-(k-1)}} \quad (13)$$

It can be known from formula (13) that the main factors affecting the sharing ratio are the SG's price reduction strategy Z, the electricity running cost C, the discount rate I_s, and the time n when the two parties can share the benefits. Among them, the influence of

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Z on the sharing ratio is positive, while the influence of other variables is reverse.

According to the investigation case, to establish a market that can compete with the cost of the traditional central heating market, the value range of Z can be selected from 30-234 yuan, and the value range of C is 13-41 yuan. When I_s = 5%, and the time of sharing benefits is 5 years, there is a possibility of benefit sharing in the decentralized heating mode of ordinary residential houses using electric heating film equipment. When the time for sharing benefits is adjusted to 10 years, there is a possibility of benefit sharing for all electric heating methods, as shown in Figure 5.

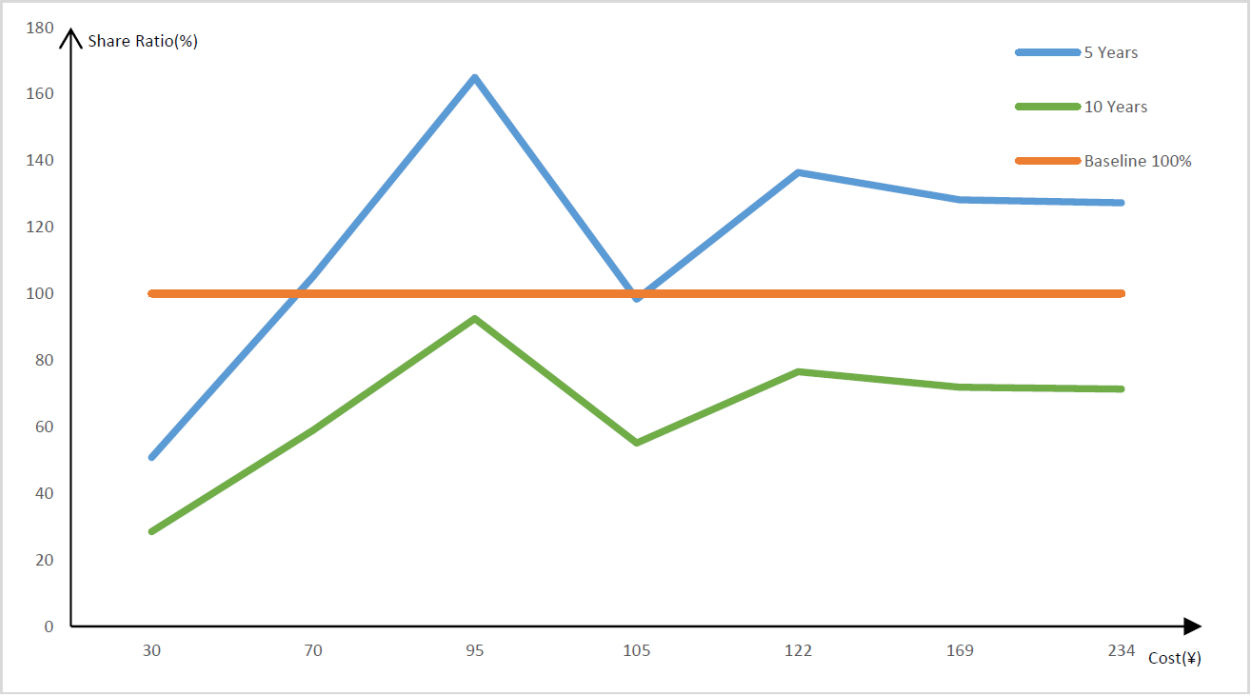

Figure 5
The Proportion of Share Benefits

The impact of the discount rate, operating costs and sharing benefits time (y axis) to sharing ratio (x axis) is shown in Figure 6. When other conditions remain unchanged, only when the discount rate level rises, the sharing ratio increases in the same scenario, while the actual operating costs and cooperation time fluctuate in opposite directions, and the sharing ratio decreases as the actual operating costs and cooperation time increase.

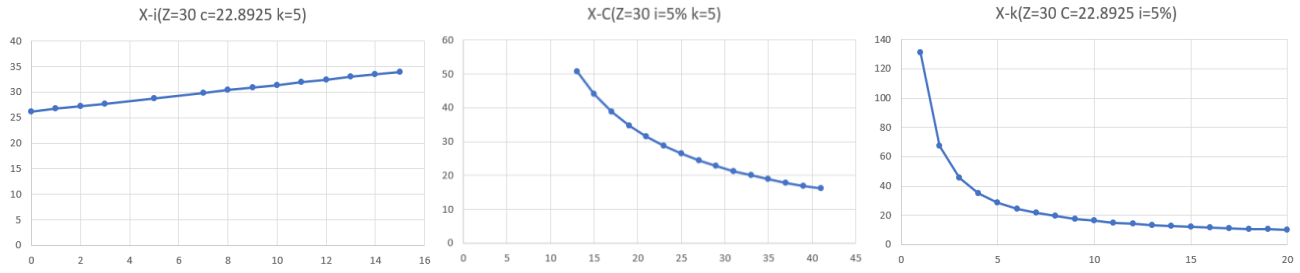

Figure 6
Impact of the Time Changes in Discount Rate, Operating Costs, and Sharing Benefits

In addition, according to the current market operation in China, electricity and concentrated heat supply involving people's livelihood are operating under the government-rated price system, which is relatively stable (Economically, the price is sticky). Referring to the current peak and valley

electricity price and other preferential electricity price pricing levels in Jilin Province, when measuring the benefit sharing ratio of SG is 40-60%, the fluctuation range of DG's price reduction strategy is 15-73 and 21-110 yuan/m^2 respectively.

RESULTS

Conclusions

The advantages of the electric heating system in the centralized heating market are worth promoting because of its flexible use, adapting to the consumer's demand for different heat, and the energy supply can be improved with the advancement of power generation technology. Comparing with other heating methods that use coal, oil, gas and straw as power generation resources, electric heating does not emit pollutants when producing heat, and the total emission control of pollutants is entirely borne by electric power producers. Although electricity is a secondary energy source, the scale of power generation enterprises is large and the number is small. Under the stricter environmental protection requirements, the equipment and process upgrades are relatively under strict control. The pollution degree and scope are controllable. At the same time, the electric heating system usually meets the low electricity consumption time in a large part of the electricity consumption time. In particular, the regenerative electric boiler can completely adopt the low valley electric heat storage, which can play a good role in reducing the peak-to-valley difference of the power supply, cutting the peaks and filling the valley, and optimizing the operation structure of the power system. Users are also benefiting from enjoying the low price of electricity, which is a win-win situation. Therefore, even in the current electricity production status which coal is the main fuel, the electric heating method is still favored by managers.

The electric heating market has considerable cost savings in many scenarios, such as ordinary residents, businesses, schools and public service facilities, and the main reason for hindering its market development is higher equipment and pipe network installation costs.

In the two-tier supply chain of equipment suppliers and power suppliers, they often fall into the prisoner's dilemma when they operate independently and cannot obtain more revenue.

It is feasible to operate in the supply chain using the contract mode of revenue sharing, and the performance of the benefit sharing ratio in the data simulation calculation is acceptable. When electricity suppliers share the annual operating income of electric heating with equipment suppliers, they can increase the enthusiasm of equipment suppliers to reduce equipment price strategies. At the same time, in order to successfully achieve the benefits of sharing, equipment suppliers will improve the quality of after-sales service to enable users to obtain a better consumer experience, which will promote the healthy development of the market.

Risk Assessment and Policy Recommendations

Among the suppliers of electric heating market, the equipment supplier SG bears more operational risks. When SG adopts a price reduction strategy to reduce one-time gains, the main risk comes from the expectation of rising market share and the subsequent acquisition of shared income during the operation period. In the simulation calculation, the annual operating cost is designed as a constant, but the flexible use of electric heating, weather conditions and other factors all determine that this figure will be a variable. In case 4, with the increase usage of residential equipment and the degree of technical proficiency, each household has concluded a suitable operating plan, and operating costs have decreased year by year. However, due to the further improvement of building insulation performance, the high temperature in winter or the reduction of the utilization rate of equipment due to personal reasons, the annual operation cost will be reduced, and the risk of SG will be further increased under the fixed sharing ratio. Therefore, SG should consider the dynamic benefit sharing scheme to avoid the risk as much as possible. But for the SG, this risk is affordable. The DG side only provides services after the equipment is operated, and the operating expenses after the benefit sharing period are exclusive to the DG, especially

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with the expansion of the market scale, the future income of the DG is hard to estimate, so the DG is more willing to see it and fulfills the benefit-sharing contract.

The increase in electricity bills is expected to have a significant adverse impact on the market. At present, the residential electricity price billing method that has been widely implemented in various parts of China may become one of the unfavorable factors for consumers to choose electric heating. Taking Jilin Province as an example, the current price of ladder electricity is divided into three grades. The ladder price is set to the three-level electricity price with the annual electricity consumption of 2040 and 3120 degrees. The user with annual electricity consumption exceeding 3121 degrees will pay according to the highest price. In case 1 to 3 of with electric heating, the power consumption is more than 50 degrees/m^2. Users are faced with the risk of the highest price pricing mode, and the annual operation cost will increase by more than 60%, which will eliminate the advantages of the operation cost of electric heating mode. Of course, the price management department immediately issued a special charging regulation on the price of electric heating electricity. In this regulation, in order to encourage the promotion of the relatively clean electric heating energy utilization mode, the electricity price for the electric heating part is basically charged at the lowest level and gives a 40% discount on the electricity price of the valley period (11 hours in a day is considered to be the valley period).

In addition, there are challenges from other heating mode. The flexibility of time and temperature adjustment compared to the traditional heating mode of fossil energy for fuel may no longer be advantageous with the advancement of precision heat metering technology. But for a long time, this will not affect. The cost of equipment retrofitting and upgrading involved in the popularization of traditional central heating is not low, and operators enjoy regional monopoly status in the non-differential heating mode, and the monopoly income is relatively high. For example, even if some residents do not use heating services for personal reasons, as long as they access the pipe network, they must pay 20% of the household heating fee as the equipment maintenance fee, which is called the basic operating annual fee. Other new energy heating modes are difficult to match the universality of electric heating due to the limitations of regional natural environmental resources, industrial development status, market size, and economic development speed.

The heating market and the electricity supply market usually have natural monopoly characteristics. The production and supply of electricity suppliers DG involves energy security, and has always been a strict regulatory department of the Chinese government. Under this scenario, Chinese local governments can provide more effective conditions for promotion under the multiple control objectives of people's livelihood, environmental protection, and economic restructuring. With reference to the successful experience of the Chinese government in guiding and implementing policies in the past, the government can start from the new clean energy sources such as wind power and solar power, and provide managers with relevant measures and basic economic management knowledge training, incentive the supply side such as equipment and power supplier to establish profit motives for the market. At the same time, appropriate new communities will be selected as pilot or demonstration communities, and operational experience will be promoted to further increase the market share of electric heating methods.

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Conflicts of Interest Disclosure Statement

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All the authors declare no conflict of interest. The authors declare no sponsored financial sources by any organization related to tobacco production for the undertaken study.

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