

RESEARCH ON A NATURAL GAS DISTRIBUTION ENERGY COMPANY IN WUHAN, CHINA

Case company: Creative Capital New Energy Co. Ltd.

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Abstract

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Abstract <p>China is now seeking comprehensive transformation on energy structure. The traditional energy structure dominated by coal promotes China's rapid development, but also brings tremendous negative effects to Chinese society. Natural gas distributed energy is an advanced system helping China to build a clean, low-carbon, safe and efficient energy system. The aim of this thesis is to research the market of natural gas distributed energy and to gain understanding of its possibilities. The final target is to conclude a development plan for the case company to help them to better develop their market in southern China.</p> <p>The author proceeds deductively and uses both qualitative and quantitative research approaches. Secondary sources are collected from the internet and internal documents from the case company. Apart from secondary data, primary data is collected from a survey and an interview with the manager of the case company.</p> <p>In order to accomplish the final goal and conclude a development plan for the case company, SWOT analysis is used to gather information of the company and the market.</p> <p>Moreover, findings from the research indicate that establishing a natural gas distributed energy system is a great challenge for an enterprise. However, there are also many opportunities if disadvantageous aspects can be effectively circumvented. Carefully analyzing the merits and demerits from the internal and external environment will be beneficial for the case company.</p>		
Keywords Natural gas distribution energy, Marketing, Profitability, Development plan		

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1 INTRODUCTION

The chapter introduces the reader to the background of the thesis and explains the methods used to complete the research. The general idea of the objectives of the research and data collection methods are given and research questions are presented and explained.

1.1 Research background

The primary energy demand of the world has continuously increased since 2011 with an approximate annual rate of 1.8%, which, however, has an indication to slow down in the past few years. Renewable energy occupies an increasingly important position globally by constituting 19.3% of the overall energy consumption worldwide in 2015, the growth of which was largely accelerated by China, particularly in solar PV and wind power sectors. (REN21 2017, 29-30.)

In addition, the booming construction of renewable energy industry in China not only astonish Chinese people, but also arouse extensive attention. An incisive article with a title of "Forget China's red dragon, fear the green renewable one", published by an Australian media, straightforwardly criticizes US's and Australia's "blind" ideological adherence to traditional energy and points out China's future dominant position on new energy (Hull 2018). The fact is that most new capacity is being installed in developing countries, and primarily in China. Until 2017, China has been the single largest developer of renewable power and heat for the past eight years. (REN21 2017, 34.)

The diagram below shows renewable power capacities in world, BRICS, EU-28 and Top 6 Countries in 2016. What need to be notices is that hydropower is not included. Distinction is made because hydropower remains the largest single component by far of renewable power capacity, and thus can mask developments in other renewable energy technologies if included. The five BRICS countries are Brazil, the Russian Federation, India, China and South Africa. The survey was conducted by Renewables Global Status Report in 2017.

Figure 5. Renewable Power Capacities in World, BRICS, EU-28 and Top 6 Countries, 2016

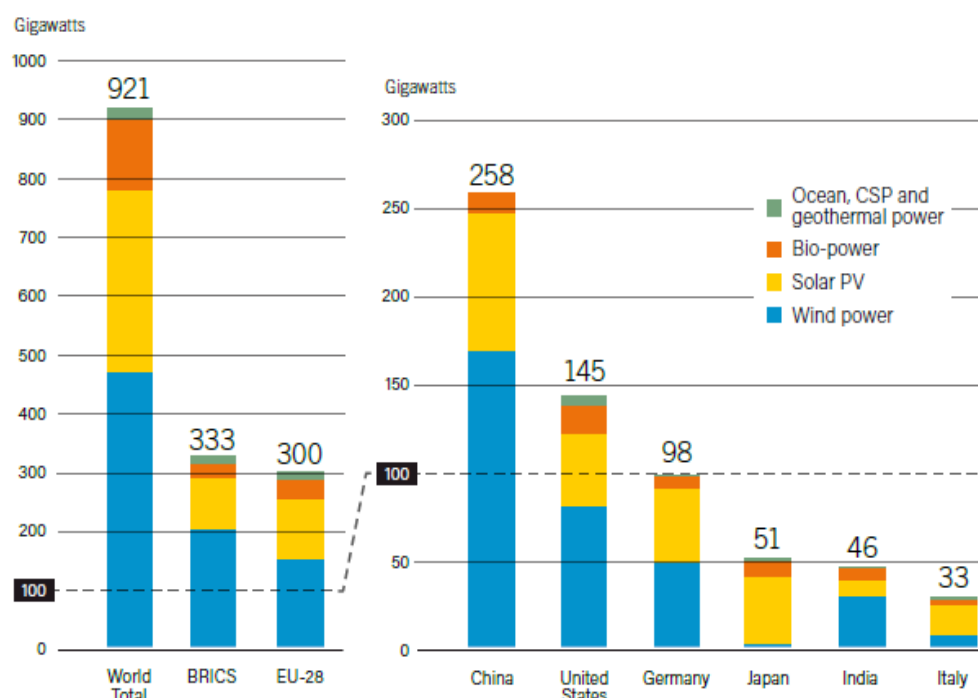


Figure 1. Renewable power capacities in world (REN21 2017, 34)

However, although China has the most installed capacity of renewable power, the structure of the whole industry, after a sudden outburst, is different from developed countries, which restrict industry's maximizing of the benefits. For example, heating capacity is one of the most typical short board of China's renewable structure. China is the world's leader of hydropower, wind power and solar PV and the largest consumer of heat. But only around 1.8% of the demand is generated by renewable power, whereas North America, the world's second largest renewable heat producer, supplies about 10% of its demand with renewable energy. And some countries have more mature district heating system such as Denmark, Finland and Sweden, which attracts attention in China. There are more than one-half of total world final energy consumption is related to use of heat, including water and space heating, cooking and industrial process. Therefore, there is still a long way for China to adjust its energy structure and improve its infrastructure. (REN21 2017, 37-38.)

In order to supplement centralized electricity system, achieve higher level of resource integration and improve the efficiency of energy usage, China is now transferring attention to distributed renewable energy (DRE) systems. DRE systems are power, cooking, heating and cooling systems that generate and distribute services independently of any centralized system, in both urban and rural areas of the developing world (REN21 2017,

97). And now natural gas, biomass, solar power, wind energy, ocean energy and other forms of energy are contained and utilized by DRE system.

Generally speaking, in China, DRE system is still an untapped market for entrepreneurs and investors, the potential of which, once unearthed, will be very promising. Therefore, after gaining an overview of Chinese renewable energy and DRE system markets, the goal is to conduct a development plan for a case company located in Wuhan, China, which is called Creative Capital New Energy (CCNE) Co. Ltd. The company aims to provide heating, cooling and electrical solutions for its customers with green energy which is, to be more specific, natural gas. Besides, CCNE is also the first group of pilot projects of natural gas distributed energy system supported by the national policy (Zhang 2018). As the saying goes, it is the first step that is troublesome. The company has encountered many obstacles since its establishment. Therefore, this thesis holds a mission to help CCNE monitor costs, reach more customers and enhance profitability. Simultaneous, future investors and entrepreneurs can acquire a comprehension of Chinese natural gas distributed energy market from this thesis.

1.2 Thesis objectives, research questions and limitations

The thesis aims to provide a deeper understanding of natural gas distributed energy market by analyzing case company's challenges and opportunities, advantages and disadvantages and its future direction. Eventually, the thesis is obliged to sum up a development plan for case company according to the viewpoint gained from market analysis. And the core objective is to offer suggestions to assist CWNE making up the deficits and getting surpluses, operating more profitably and effectively and gradually getting rid of national policy support. Besides, by comprehensively analyzing Natural gas distributed energy in China, this thesis wants to provide a reference for both domestic and foreign enterprises which want to enter this field in the future.

Obtaining a research question is one of the important steps in the research process. A research question is the fundamental core of the study project. An appropriate thesis question is the guidelines for research project, helping writers focus their research and construct logical argument. The research question should be a clear, focused question that summarizes the issue that the researcher will investigate (CIRT 2018). The purpose of a thesis question is to help the researcher stay on track and introduce the reader to the importance of the topic being studied (USCLibraries 2018). The research question in this research is:

- How should the case company improve their profitability in order to make up the deficits

and get surpluses?

Sub-questions are beneficial because a main research question can't be answered at once. Sub-questions will help us to draw the final conclusion step by step (Swane 2016). In this thesis, sub-questions are as follows:

- What is Natural Gas Distribution System?
- How can the case company reduce their costs?
- What methods should the company implement to reach more customers?
- How to expand business scope of case company?

Moreover, limitations and issues are always important aspects that need to be examined when conducting a research. In this research, the limitation is that it is only concerning Chinese customers and may not provide valid information concerning other nationalities. And to be more specific, only customers and market in city Wuhan, China will be researched. In addition, the customers of case company are not common users such as normal residents. The company's main target group are commercial premises and other large public organizations such schools, hospitals, government facilities and so on. Therefore, the outcome of this research may not suit for other industries whose target customers are in different segments. Besides, because this research only takes natural gas distribution industry as sample, other type of renewable energy generation systems such as solar power plant or wind energy are not taken into consideration. However, this research provides valid information for the case company and helps them in different ways, including internal and external aspects to better reduce costs and gain profit.

1.3 Theoretical framework

The aim of this thesis is to extricate case company from financial difficulties and help case company to operate profitably and individually without relying on support from government. The natural gas distributed energy in China is specifically analyzed through several aspects to make sure that the reader is familiar with the industry and its market condition

One of the most important mission of chapters 2,3 and 4 is to help readers to understand the overall background of natural gas energy market. Therefore, the analysis in later chapters can derive demonstrations such as advantages, disadvantages, risks and opportunities concerning this industry.

At the end of all actions a development plan for the case company is demonstrated. The information was gathered and analyzed with the help of SWOT- analysis, which was done

from the case company's point of view.

1.4 Research methodology and data collection

Choosing research approach is important for a research at initial stage. Normally there are two different options, which are namely deductive reasoning and inductive reasoning. Generally speaking, Deductive reasoning starts with a general aspect and finally reach a specific conclusion. And inductive reasoning is the opposite of deductive reasoning. Inductive reasoning develops a general theory from specific observations. (Bradford 2017.)

It is also important to choose data collection methodology which is supposed to be suitable for the research project. Research methods refers to the tools that one uses to do research. Qualitative and quantitative research methods are two most commonly used methods, which will also be our only study objects.

Qualitative research is used to gain an understanding of underlying reasons, opinions, and motivations. It helps researcher to make a judgment based on project's characteristics, features and regularities. It also provides insights into the problem or helps to develop ideas or hypotheses for potential quantitative research. (DeFranzo 2011.)

Quantitative research needs to quantify things such as attitudes, opinions, behaviors, and other defined variables and transform them into useful statistics. And quantitative research usually requires a large sample population to generate results. Quantitative research formulates facts and draws the conclusion based on data analysis. (DeFranzo 2011.)

In order to find out a best plan for case company's strategic development, in this research, both qualitative and quantitative methods will be utilized.

Further, it is time to start collecting the data. This research gathers two kinds of data, including primary data and secondary data. The primary data was collected by a questionnaire filled out by customers, which is aim to find out users' consumption habits and their attitudes towards renewable energy especially natural gas distribution industries. Carried out via online meeting and email, interviewing the manager of case company is another resource of primary data.

Therefore, in this research, research approach will be deductive and research methods are qualitative and quantitative methods. And data gathered from primary and secondary resources.

1.5 Thesis structure

The structure of this thesis will strictly follow its listed content above, including theoretical

part and empirical part. Theoretical part will introduce the concept of natural gas distribution system and its condition in China, the overall background information of energy service condition in southern China, natural gas market in Wuhan. Empirical part is going to demonstrate surveys and research outcome. Based on both theoretical and empirical part, the most important step is to broach a development plan for case company. And the function of the last chapter is to summarize the whole research done.

The introduction demonstrates the research background and presents the purpose of the thesis, research objectives, data collection methods and the overall structure.

The second chapter is leading the reader to the world of DRE and the author will explain the characteristics of DRE and its significance for China.

In chapter 4 and 5 the researcher gives an outlook of the situation of natural gas distributed energy in the southern China market and natural gas supply in Wuhan. These two chapter mainly explain the prospect and necessity of natural gas distributed energy.

The fifth chapter introduces the reader to the empirical research done for the thesis. The survey design is presented and the results of the research are displayed and analyzed. On the chapter 7 the development plan for the case company is concluded. And the last chapter of the thesis is summarizing the research done.

2 DISTRIBUTED RENEWABLE ENERGY IN CHINA

The aim of this chapter is to familiarize the reader with the concept of natural gas distribution system, its strategic importance to Chinese government and its situation in China. What needs explanation is that, because this is not an engineering scientific research, this thesis will not deeply introduce operating principles of distributed renewable energy (DRE) system.

2.1 Definition of DRE

At the international level, the definition of distributed renewable energy system is relatively a broad concept. First, as mentioned before, it has to have the capability to generate and distribute services independently, meaning that it is able to operate without any centralized system. Secondly, this system is supposed to be integrated. Hence, a distributed renewable energy (DRE) system usually can provide different services such as cooking, heating, cooling and so on. (REN21 2017, 97-98).

There are various kinds of DRE systems using different primary energies. Primary energy is the energy that's harvested directly from natural resources. Sources of primary energy fall into two basic categories, fuels and flows. Typical examples for fuels include crude oil, coal and natural gas. Flow means power sources such as tidal power, wind power, and solar power, where energy moves from one place to another. (Energy Education 2018.)

2.1.1 Types of DRE

In China, there are three types of energies are most widely used in DRE systems, including natural gas, photovoltaic power and biomass. And developing natural gas distributed energy is the most critical mission for Chinese government. According to the Guidelines on the Development of Distributed Natural Gas Energy launched by National Development and Reform Commission, by 2020, the installed capacity will reach 50 million kilowatts. At present, for China, there is a long way from achieving the goal. (Guidelines 2011.)

2.1.2 Characteristics of DRE in China

Basically there are four characteristics concerning DRE in China, including functions, cyclic utilization, location and energy transmission and capacity.

Functions

In China, a DRE plant needs to at least accomplish three functions, including cooling, heat and electricity supply. And this kind of combined supply is also called triple generation, which is the core mission of a distributed energy company. (Zhang 2018.)

Cyclic utilization

In order to best maximize the use ratio, another important characteristic of DRE system is cyclic utilization of energy. Normally this cyclic system can collect obsolete energy such as gas, heat and pressure from previous production to regenerate electricity, cold or heat. (Zhang 2018.)

Location and energy transmission

Besides, compared to centralized power generation plants, a DRE plant is located closer to customers. Therefore, a DRE system is capable of providing services to its users directly. In this case, the energy transmission processes will be simplified and then reduce energy loss and costs during transmission. Meanwhile, due to the location advantage and simplified transmission system, a DRE plant can offer energy supply in a safer way. (Zhang 2018.)

Capacity

Because DRE focuses on local energy consumption, so it does not need large scale and long-distance energy output mode. Due to this fact, a DRE plant normally only requires medium or small-scale capacity. (Zhang 2018.)

2.2 Strategic Significance of DRE

Distributed energy plays an important role of China's energy strategic transformation. Deployed close to client side, DRE is an integrated energy utilization system that determines unit configuration and capacity size by optimizing resources, environment, and economic benefits. To some extent, DRE can be considered as the most advanced concept and technology representing the development trend of contemporary world (Zhang 2018).

As far as I am concerned, for some reasons, striving to develop DRE in China's market is a very convincing decision. And these reasons are justified as follow, which are environmental stress, transformation of energy structure, obvious growth on natural gas market, improvement on utilization efficiency, electrical power safety and energy security.

Environmental stress

China is still facing serious challenge after spending huge effort on environment governance. The end of 2016 marked four years in the implementation of the “Action Plan” (Action Plan of Air Pollution Prevention and Control) issued by the State Council in 2013. Overall air quality was improved but PM concentrations generally failed to comply with standards (China Air 2017, 7-8). And PM_{2.5}, as an important pollution source among PM penetrations, was mainly contributed to fired coal. Besides, because China is still a very coal-based country, other pollutions such as SO₂, NO₂, CO and other PM emitted by fired-coal industries are threatening China’s environmental security (Zhang 2018).

Transformation of energy structure

China relies heavily on coal as energy resource until today. However, nowadays China is seeking diversified development. And the traditional energy structure which heavily reliant on fossil fuels, as mentioned earlier, has exerted enormous pressure on environmental restoration. Therefore, changing energy structure is inevitable and urgent.

From National Bureau of Statistics of China, in 2011, the amount of raw coal occupies 67% of total energy production. But the consumption proportion of coal decreased continuously within 8 years, which turned into less than 60% in 2018 (National Bureau of Statistics of China 2018). The fact that, in China, the consumption proportion of coal never fallen below 60% since the establishment of country does necessarily imply the future prospect of energy structure.

Meanwhile, although the growth in energy demand has slowed, China will still account for about a quarter of global energy consumption until 2040 according to the prediction in BP Energy Outlook. And more importantly, in 2040, based on the collected statistics, coal’s share will decrease to 36%, signifying that other resources will partly take place of coal. At the same time, in 2040, the proportion of natural gas will double to 13% and other renewable energy will rise to 18% from 3% in 2016. (2018RSbook 2018, 7-8.)

Obvious growth on natural gas market

Compared to Oil and Coal, natural gas has apparent advantage on safety, efficiency and environmental protection (Zhang 2018). 2017 is a “bumper year” for natural gas, not only in China, but also all over the world. Global gas consumption increased by 3.0 percent and gas output increased by 4%. And China's surging demand for natural gas has become the most important factor driving the growth of global natural gas consumption.

More than 15% growth in domestic market contributed to 1/3 global consumption growth, which reached 31 billion cubic meters. (2018RSbook 2018, 7-8.)

This rapid growth is largely due to promulgation of “Action Plan” (Action Plan of Air Pollution Prevention and Control), which set targets for improving air quality over the next five years. Therefore, to fulfill the goal, a series of measures will be taken by Chinese government in the future to ensure the expansion of green energy and the transformation of energy structure.

Improvement on utilization efficiency

The average energy utilization efficiency is only 33% in China, which is 10 to 20 percent lower than developed countries. For example, normally a thermal power plant’s energy conversion is only 30% to 40%. However, a DRE plant can increase the efficiency to 80% to 90% or even higher (Zhang 2018). Hence, investing on DRE industries is a practical method to improve the overall efficiency of energy utilization. Moreover, because of DRE’s characteristics, it also minimizes the loss during transportation to maximize energy efficiency.

Electrical power safety

Extend DRE system is an effective measure for power grid peak-adjustment, which can not only remit power shortage, but also can significantly reduce the peak and valley difference of the power grid. In addition, by reducing power grid’s supply pressure, the probability of accidents will be decreased as well.

Besides, at present, the pattern of domestic power supply system is a centralized single power supply system characterized by large units, large power grid and high voltage. Under this pattern, any disturbance caused by a single fault in the power grid may have a great impact on the entire power grid. In severe cases, it may cause a large area of power failure or even the collapse of the entire network. But distributed energy can ensure the supply of local basic energy to a certain extent after serious accident so that it improves the reliability of energy supply and the security of the whole energy system. (Zhang 2018.)

Energy security

Ensuring energy security is a subject that needs to be taken into consideration seriously by any government. China is no exception. Based on the international and domestic markets, China is endeavor to establish a diversified and high-quality energy structure. It has become an important strategy to accelerate the development and import of natural

gas and develop distributed energy vigorously to replace petroleum products in several application fields. (Zhang 2018.)

3 NATURAL GAS DISTRIBUTION ENERGY IN SOUTHERN CHINA

Because the ultimate goal of this research is to present a development plan for a case company located in southern region of China, therefore, after introducing DRE, chapter 3 focuses on natural gas distribution energy system in southern China. So, the development condition, market, natural gas supply, policies and current situation will be covered.

Concerning energy service industries, China is country with significant south-south difference including energy resource, energy consumption structure, customer behaviors, climate as well as other regional characteristics. The southern region is characterized by the prominent contradiction between energy supply and demand in the relatively developed economy and the large seasonal difference in electricity load and natural gas demand, which determines that natural gas distributed energy in southern China has a broad development space and a unique development mode.

3.1 Development condition and characteristics

This segment introduces the most typical characteristics of natural gas distribution energy in southern china, including energy deficiency, various seasonal load and mature technology.

Energy deficiency

China's energy consumption is mainly composed of coal, hydropower, oil, natural gas, wind and other energy sources. As mentioned before, coal has absolute dominant position in energy structure until today. However, more than 90% of coal resources are mainly distributed in regions which are north of Qinling Mountains-Huaihe River Line (the boundary of south and north of China). Other energy resources have more dispersive distribution, which, however, are still mainly concentrated in the north areas. Wind energy resources are mainly distributed in China's north, northeast regions and southeast coast and nearby islands. More than 80% of Natural gas resources are distributed in the west, northwest land and east sea areas (National Bureau of Statistics of China 2018).

Therefore, looked from the overall condition, energy resources are scarce in the south. On the other hand, the economic development of the southern region is rapid, with the level and total amount of economic development leading the country, which, furthermore reflects the contradiction between energy consumption and supply. It is urgent for southern regions to expand the energy supply model and optimize the energy structure.

The pictures below demonstrate the distribution of coal, wind and natural gas distribution respectively in China.

Picture below shows coal distribution. The annotation is in Chinese. Blues, black, yellow and red colors represent coal-producing areas, the outputs of which account for 60%, 26%, 7% and 5% respectively. The survey was conducted by China Mining Association.

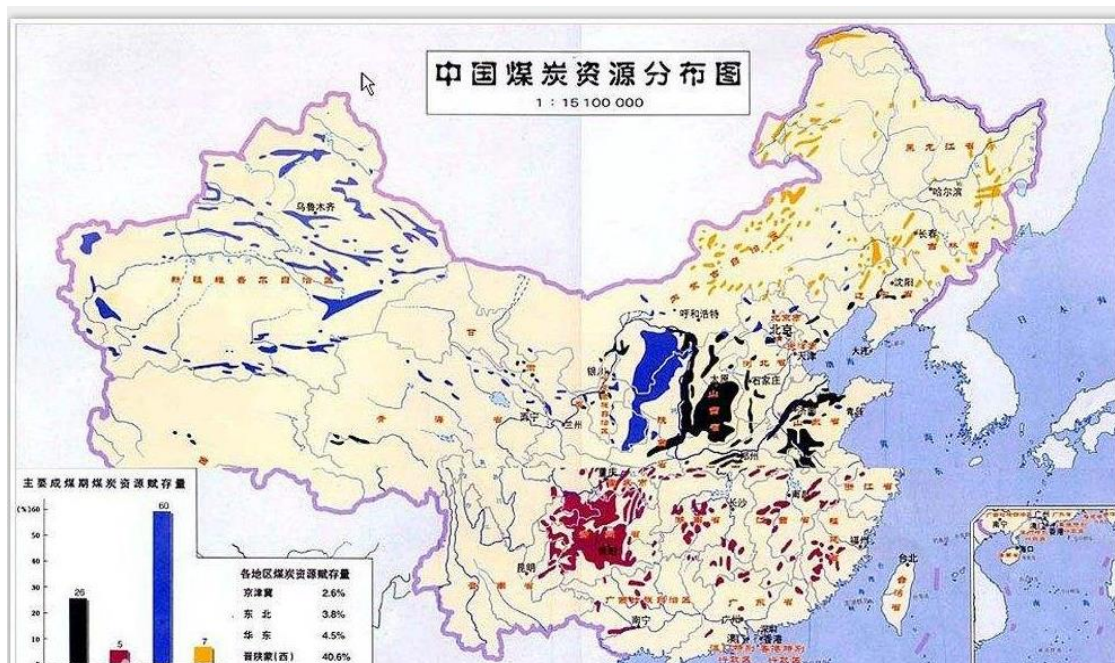


Figure 2. Distribution of Coal Resources in China (China Mining Association 2016)

Picture below shows wind energy distribution. Green zones represent the richest wind energy resources. The survey was conducted by Chinese Wind Association.

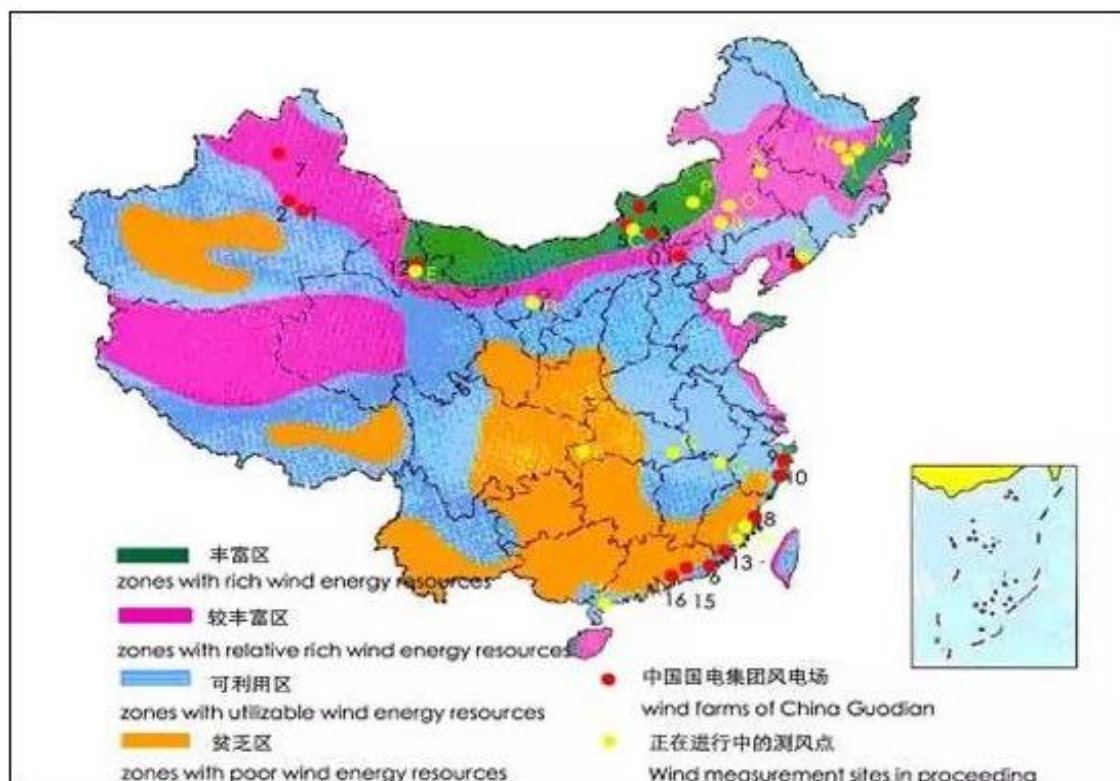


Figure 3. Wind energy distribution (Chinese Wind Association 2018)

Picture below shows oil and natural gas distribution. The oil well signs with blank inside represent gas fields. The survey was conducted by China Center for Energy and Development of Peking University.



Figure 4. Natural gas resource distribution (Shi, Ma & Li 2012)

Various seasonal load

Moreover, due to the difference of land and sea thermal properties and subtropical high pressure in southern China, high temperature and heavy load of electricity are common in summer. In winter, although the temperature is not low and the total amount of energy used for heating is moderate, unlike common central-heating network supported by the government in northern China, most thermal power plants in southern China only purely generate electricity. In this case, electric heating has become the main way for residents to keep warm, leading to situation in which electricity is usually in short supply. But within a year, in the spring and autumn, the load of electricity is very low, signifying that the seasonal difference of annual load of electricity is substantial. (Zhang 2018.)

In order to ensure the safety of peak electricity consumption in some regions, the increase in installed thermal power capacity caused a large number of thermal power units to shut down during low-load season, resulting in serious waste of installed power and reduced operating efficiency of enterprises.

This climate and load characteristics present a good opportunity for the development of distributed natural gas energy. If there are additional gas power generation, the power plant can start and stop and regulate peak more conveniently and economically, concerning that the time, costs and damage of start-stop in thermal power generating unit are longer, higher and bigger.

Mature technology

In addition, until 2018, cogeneration technology (CCHP) of natural gas has been mature. Compared to centralized generation with remote electricity transmission, CCHP can significantly improve the efficiency and reduce energy loss during transmission. Simultaneously, CCHP is much more environmental-friendly than an air conditioner using freon as a refrigerant. And the refrigeration system and waste heat recovery unit has been constantly facilitated, which has laid a solid foundation for future development. (Zhang 2018.)

3.2 Market layout

Natural gas distributed energy is one of the main ways of natural gas utilization and will be an important direction of energy consumption structure adjustment in China in the invisible future, which has appreciable effect of energy saving and emission reduction. Therefore, the market expansion of natural gas distributed energy needs to be tentatively taken into account. Different types of natural gas distributed energy projects are adapted to different functional zones. The project has to proceed orderly based on the characteristics of the southern region. The following aspects are paid attention to when determining the development ideas and countermeasures, which consist of measuring supply, industrial park and new built constructions.

Measuring supply

The precondition of natural gas distributed energy station construction is to have reliable gas source. Now the natural gas supply capacity of many southern regions is still unpromising, which can only basically meet the needs of residents. Most towns and villages are still unconnected to the gas transportation network.

At this time, it is not scientific to construct large-scale distributed natural gas energy system generally. But with the development of the west-east natural gas transmission project and vigorous exploitation of local natural gas resources. Therefore, gas supply capacity in the south areas is increasingly strengthening. Overall, the planned plants of

natural gas distributed energy will be coordinated with the main network construction and dedicated gas supply lines in the planning to meet the demand. (Zhang 2018.)

Industrial park preferred

The development of distributed energy system centralized cooling and heating in industrial parks, as an important competitive infrastructure for attracting enterprises, can greatly save the cost and operation cost of equipment systems such as self-built boilers, and bring considerable economic benefits to enterprises. The construction of thermal power plants with cogeneration function is an unusual case in southern regions, meaning that only other high-efficiency and low-pollution centralized cooling and heating modes can be sought. Enterprises in industrial parks are centralized, the extension radius of pipeline network, cost of pipeline construction and energy transport loss are small. (Zhang 2018.)

Newly built constructions preferred

Furthermore, technically, small-scale distributed energy projects can be encouraged to be promoted when new buildings are constructed or existing building systems are renovated. Stations can also be built in individual and small-scale commercial buildings, public buildings and residential areas. Because of the higher temperature in winter (the coldest monthly average temperature is between 0 ~15 C) than in the north, the proportion of central heating and cooling in most buildings in the south is not high, most of which even have no central heating system at all. Some walls of old buildings have poor thermal insulation effect. It is difficult to reconstruct the natural gas distributed energy system which may cost too much. So, it is not suitable to consider these buildings as recent promotions. (Zhang 2018.)

Therefore, at the present stage, the natural gas distributed energy system of CCHP are normally demonstrated and popularized in new large-scale public buildings, new large residential areas and so on by considering the climate, architectural features and residents' heating habits in the South.

3.3 Natural gas supply

With the development of economy and the increase of energy demand, the existing energy structure restricts China's sustainable development a certain extent. The large-scale utilization of natural gas is a plan worth looking forward to. This segment will give a brief introduction on distribution of natural gas resources in China. Firstly the advantages of natural gas are introduced and afterwards the researcher aims to help readers get familiar with West-to-East Natural Gas Transmission Project.

Advantage of natural gas

Compared to traditional energy such as coal, natural gas has a plenty of merits, which are classified into four categories including safe, economical, environmental-friendly and convenient.

Safe

Gas density of natural gas is one-half of air density, lighter than air, easily volatilized, and not easy to explode. And the methane, ethane and propane contained in natural gas are non-toxic. Hence, Large-scale construction of natural gas pipelines in cities is safe.

(Zhang 2018.)

Economical

Economic benefits are one of the advantages of natural gas and one of the reasons why pipeline natural gas has been rapidly popularized throughout the country. Under the same consumption (calorific value), the monthly cost savings of using natural gas compared with using bottled liquefied petroleum gas are at least 25%-35%. (CNGIA 2018.)

Environmental-friendly

98% of natural gas is methane, which produces only a small amount of carbon dioxide and water vapor during combustion without residue, pollution and sulfide production. As a kind of green energy with high quality, cleanliness and high efficiency, natural gas is the energy for the promotion and popularization of national energy policy. (CNGIA 2018.)

Convenient

Moreover, Natural gas directly enters millions of households in the city through natural gas pipelines. There are endless sources of pipeline transportation. There is no trouble of breaking off gas and replacing cylinders. It does not need to be stored or added on the spot. Because of its convenience, it is called "tap gas" by the masses. For industrial users, natural gas equipment is simpler, easier to operate and easier to maintain than those burning coal and other fossil fuels, and there is no need to deal with solid waste or ash after combustion. (CNGIA 2018.)

West-to-East Natural Gas Transmission Project

The western region of China is rich in natural gas resources, especially in the Tarim Basin of Xinjiang, where natural gas resources account for 22% of the total natural gas resources in China. (But in the west, this kind of resource demand is not enough to be transformed into economic advantage only by the strength of the western region. In

contrast, the eastern and southeastern regions are the main gas-using areas in China, but the energy resources in this area are quite short. 85% of the energy in the Yangtze River Delta region should be transferred from other places. The serious imbalance between supply and demand shows the necessity of cross-regional allocation of natural gas resources in China. (Chinapipe 2019.)

Therefore, the first meeting of the State Council in February 2000 approved the launching of the "West-to-East Gas Transmission Project", which is not only the largest energy project invested in the past decade, but also the largest infrastructure project invested. A lot of provinces in southern China are benefited from the project, including Hubei, Jiangxi, Hunan, Guangdong, Guangxi, Zhejiang, Shanghai, Jiangsu and Hong Kong. And it benefits more than 400 million people as well. The West-to-East Gas Transmission Project provides an important natural gas source for the South and guarantee a basis for the popularization and development of distributed natural gas energy sources. (Chinapipe 2019.)

The picture below briefly shows the network of West-to-East Gas Transmission Project. The survey was conducted by Chinapipe.

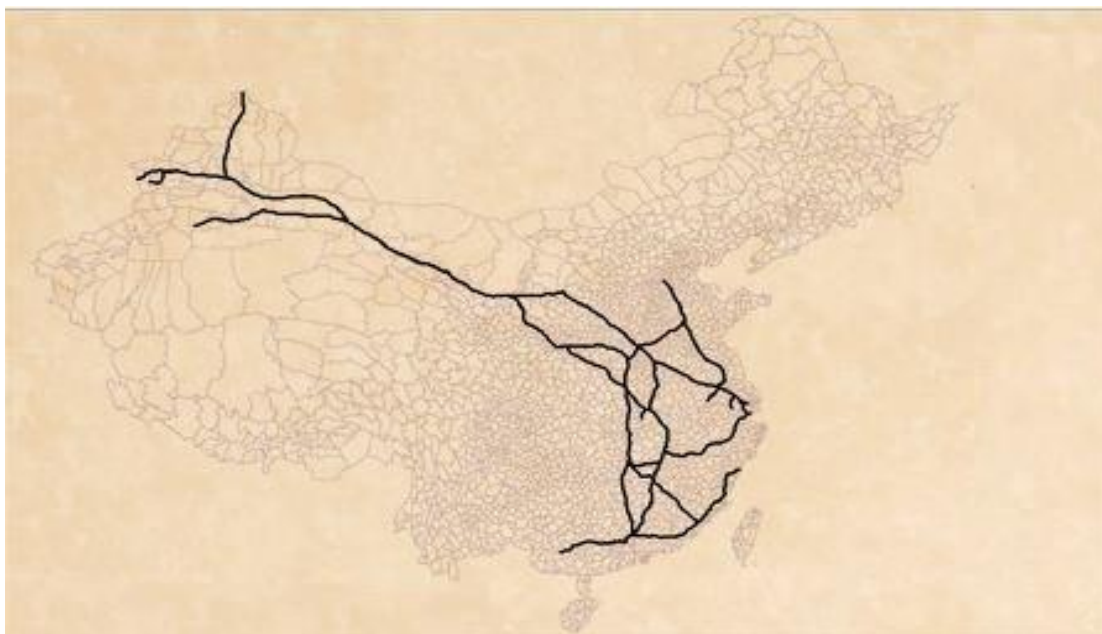


Figure 5. West-to-East Gas Transmission (Chinapipe 2016)

3.4 Policies

This segment introduces efforts made by Chinese government to promote the application of natural gas, especially relevant policies.

Accelerating natural gas utilization

As mentioned before, improving the proportion of natural gas in primary energy consumption structure is an important mission for Chinese government. Suggestions on Accelerating the Utilization of Natural Gas have been formulated and issued by National Development and Reform Commission in 2017. There are two clear concepts were mentioned in Suggestions.

The first guiding opinion is that the local government needs to fully understand the significance of accelerating the utilization of natural gas. The second opinion claimed that it is essential to strengthen the implement responsibility. All in all, provinces including districts and municipalities should conscientiously assume the responsibility of speeding up the utilization of natural gas, formulate and promulgate opinions on in their respective regions, establish a coordinated mechanism in their departments, decompose the main objectives, implement key annual tasks, clarify the division of responsibilities and improve supporting policies. (Suggestions 2017.) Although only two concise guidelines were released in this document, it delivers a signal that the development of natural gas has been deeply rooted in local governments.

Natural gas distributed energy policies

In fact, China began to pay attention to the distributed energy of natural gas very early, which can be traced back to eight years ago. The State Council issued Guidance on the Development of Natural Gas Distributed Energy as early as 2011. According to the file, during the Twelfth Five-Year Plan period, about 1000 natural gas distributed energy projects and about 10 typical distributed energy demonstration areas will be constructed. And the target is that, by 2020, distributed energy systems will be widely used in main cities. The installed capacity will reach 50 million kilowatts, and the industrialization of distributed energy equipment will be preliminarily realized. (Guidance 2011.)

Until 2017, thirteen documents related to distributed natural gas energy have been approved by the State Council, State Grid and National Development and Reform Commission, signifying that China attaches great importance to the distributed energy of natural gas.

3.5 Capacity and situation

By the end of 2014, the installed capacity of China's natural gas distributed energy projects has reached 3.8 GW, of which 22 have been completed and 53 are planned.

Compared with the national total installed capacity of 1360.2 GW, the proportion is only 0.28%, which is much lower than the level of 5% - 10% in developed countries. (Zhiyan Organization 2016.)

But that is why there is a huge market space for natural gas distributed energy. With the promulgation of the reform of gas price mechanism, the implementation of subsidies and the technical solution to the problems in the process of grid-connected, China's natural gas distributed energy is in the ascending channel of obvious improvement. And the future development of the industry is promising.

4 NATURAL GAS MARKET IN WUHAN 5 SECOND CHAPTER

The ultimate objective of this research is to develop a practical plan for a case company located at a weighty city in Hubei province of China called Wuhan. Hence, this chapter introduces a general study of the natural gas market in Wuhan and its relationship with natural gas distributed energy. And two parts are covered, which are namely overall energy consumption condition and construction of natural gas market.

Located in the central part of China, Wuhan is a mega-city in the middle reaches of the Yangtze River and the capital of Hubei Province. It is an important industrial, scientific and educational base and comprehensive transportation hub in China. With the land area of 8494 square kilometers and the population of 12 million, Wuhan is one of China's seven cities with a population of over ten million. Besides, Wuhan is the only sub-provincial city in Central China. Although in the middle, it is geographically classified as a southern city. (Walk into Wuhan 2019.) Due to its unique geographical location, Wuhan is one of the most important transportation as well as West-East Gas Transmission hub in Central China.

4.1 Overall Energy Consumption Condition

This segment introduces the energy consumption condition of natural gas in Wuhan. All in all, there are 3 characteristics, including positive relation between GDP and energy consumption, steady growth of energy consumption and optimization of energy consumption structure.

Positive relation between GDP and energy consumption

With the rapid development of Wuhan's economy, the overall ascending trend of energy consumption is obvious. And there is an obvious positive proportional relationship between GDP of the whole city and total energy consumption. (National Bureau of Statistics 2007.)

Steady Growth of Energy Consumption

In addition, the total energy consumption of the whole city in 2015 was 48.58 million tons of standard coal, which increased 34.45% compared to 2010. And what need to be noticed is that, because of the successful implementation and completion of the 12th Five-Year Plan, the consumption of natural gas has ballooned. With an increase of 138.75%, the consumption of natural reached 1.910 billion cubic meters in 2015.

Optimization of energy consumption structure

Moreover, during the 12th Five-Year Plan period, Wuhan strictly controlled the total coal consumption and vigorously developed clean energy such as natural gas. The proportion of raw coal and natural gas in total energy consumption was adjusted from 53.81% and 2.69% in 2010 to 50.03% and 4.77% respectively.

And according to the following 13th Five-year Plan launched by National Development and Reform Commission, by 2020, the total energy consumption in Wuhan will be 56.4 million tons of standard coal with an average annual increase of 3%. Coal consumption will decrease by 15.1% compared with 2015. On the contrary, natural gas consumption will increase to 4.8 billion cubic meters, the growth rate of which will be 151.31% over 2015. Thus, the total percentage of natural gas will rise from 4.77% in 2015 to 10.23% until 2020. (13th Five-year Plan 2017.)

4.2 Construction of natural gas market

To achieve low carbon and environmental protection requirements, laboriously promote the development of natural gas and new energy industry is one of the three development priorities in 13th Five-year Plan concerning energy structure. And four aspects are taken into account, consisting of the construction of pipelines, residential gas utilization, the start of a batch of distributed energy projects and popularity rate.

For natural gas, the first mission is to enhance natural gas pipeline network. There three main important pipelines are under the construction. After the accomplishment of the pipeline, multi-source supply and gas carrying capacity will be guaranteed and facilitated. The construction of natural gas dispatching ability is promoted as well. By 2020, 696.6 kilometers of high-pressure pipelines, 3187 kilometers of medium-pressure trunk pipelines and 265 natural gas stations will be built in the city, which will form an integrated and efficient gas supply pattern.

In addition, the local government is going to start the construction of 100 million cubic meters (gaseous) large-scale liquefied natural gas reserve base. Striving to build and put into operation at the end of the 13th Five-Year Plan period, the city's liquefied natural gas storage capacity can reach 112 million cubic meters, which can meet the needs of citizens for gas source in emergency situations for more than 30 days. After that, Wuhan will become the city with the highest degree of emergency protection of natural gas in the central region of the country. In this case, the city's status as the national liquefied natural gas distribution center will be established. However, if the degree of completion is

insufficient, integrated reception and dispatch of natural gas will be hindered and the contradiction between supply and demand will not be effectively alleviated.

Besides, LNG vehicle or shipping mode is also an important supplementary way to ensure natural gas supply.

The government will continue to steadily promote the development of residential gas consumption and, on the basis of guaranteeing full coverage of new commercial residential places, intensify the transformation of old communities. Through price concessions and the integration of some subsidies for environmental protection, enterprises will be guided and supported to use natural gas.

In the central urban area, we should focus on the development of distributed energy projects with commercial public services as the main part, including Wuchang District dominated by universities and government agencies, Hanyang District dominated by business exhibitions, and Hankou District dominated by business, commerce and finance. To become a national demonstration city of natural gas distributed energy, During the 13th Five-Year Plan period, 15-20 distributed energy projects were planned and constructed, with an installed capacity of 150,000 kilowatts.

The goal of 2020 is that the popularity rate of natural gas for residents in urban development areas will exceed 75% and the gasification population in the whole city will exceed 7.77 million people.

5 EMPIRICAL RESEARCH AND DATA ANALYSIS

This chapter mainly introduces the empirical research done for the thesis. The analysis of the research is also synchronized. Research methods and survey design are introduced primarily and afterwards the results are demonstrated and analyzed.

The empirical part consists of an interview of the manager called Xianzhe Zhang working in the case company and a survey conducted among workers of business premises in Creative Capital Park. Results gained from the interview of the manager will be used as a source of information and no distinct analysis will be done. Questions and answers of the interview will be found from the appendix. After the interview, the researcher investigated company's development condition and analysis will be found from this chapter. And the next part is a survey for the workers of Creative Capital, the results of which are also shown and analyzed in this chapter.

5.1 Design and formulation of the empirical research

Empirical research is based on observed and measured phenomena and derives knowledge from actual experience rather than from theory or belief. It is an efficient method of testing a hypothesis of the research and finding out how people behave. (PennState University Libraries 2018.)

Two possible research methods mentioned in earlier chapters are used in this thesis, including both qualitative and quantitative research, to accomplish the interview done with the manager and the survey done among staff working in Creative Capital.

The first part of the empirical research was done by interviewing the manager of the case company. The interview was processed via face-to-face conversation. Questions of interview are mainly about the current market layout, financial condition, resistance encountered and future plan. The aim was to gain a deeper understanding about the current situation of the company and to learn about their future potential. Researcher found out that the company has been facing serious losses since its establishment, which was caused by many reasons. The company has a burning desire to make a profit instead of suffering a loss and needed help with that. After the interview the researcher familiarized himself into natural gas distributed energy, market condition and profitability of the case company.

Afterwards, the second part of this research is a conducted survey which was the main primary data. The aim of the survey was to find out the energy consumption, consumer

behaviors, and attitude towards renewable energy of the target group, including both premises and individuals.

Because the researcher wanted to explore the relationship between age and consumption habits, the investigated subjects ranged in age from 18 to 50. The survey was done among the working staff in Creative Capital. And because the case company is located in Wuhan China, only Chinese citizens were selected to be part of the survey. Paper Questionnaire were sent to 43 premises including 120 workers to gain the database. The language of the survey was Chinese.

The survey included totally 9 questions and the form of survey with all questions can be found from the appendix. The first seven topics are single-choice questions and the last two are multiple questions.

5.2 Data collection

This chapter is going to introduce the processes of the data collection phase of the thesis.

The writing process of the thesis started in May 2018. The first step was collecting already existing data about energy consumption condition, natural gas supply and natural gas distributed energy market. After the collection of data, it was time to prepare an interview for the person working in the case company. The researcher visited the case company during the summer of year 2018, meaning that reaching a potential employee for a face-to-face interview was effortless. The interview was conducted via online meeting in November 2018. Answers gained from interview are used as one source of information in the research.

Afterwards the paper questionnaire for possible customers was prepared. With the help of case company's personnel, papers were sent to premises and work staff in Creative Capital Park.

In order to acquire enough samples to analyze the results, 120 responses were finally gathered. The next chapter introduces and analyses the primary data collected via survey.

5.3 Data analysis

In this chapter, before the analysis, it is necessary to introduce the background condition of case company firstly to help the reader better understand the following results.

Information was gathered from official website of Creative Capital and feasibility study report as well as other internal documents of Hubei Huadian Creative Capital New Energy

(CCNE) Co. Ltd. The second part of data analysis is showing the results of the survey and analyzing the findings.

5.3.1 Background of the case company

The case company is located at Hongshan District, Wuhan, China, providing electricity power, cold and heat supply, at present, for users in Creative Capital industrial park. The plant started to be constructed in April 2014 and was put into operation on September, 2015. In fact, CCNE is a product of the energy structure reformation and the development of natural gas distributed energy driven by the country. It was one of the first four demonstration projects of natural gas distributed energy approved by National Development and Reform Commission of China (Circular of demonstration projects 2012). The case company was built inside the Creative Capital Park. Because of some reasons, the industrial park can not provide independent ground power station site. Currently, the power station that can be built is located in the basement of a building, which is about 4370 square meters (Feasibility Study Report 2011).

In addition, Creative Capital Park is an agglomeration zone for creative industries established by Honshan District, covering an area of nearly 200000m² and building area of 31 hm². It is the largest newly built theme Industrial Park in China with creative industry as its main service. (Park Planning 2018.) Therefore, the energy consumption potential of the park is promising.

However, the occupancy rate of the park is low, leading to low consumption and limited cold and heat sales. The planned energy supply area of this project was 310,000 square meters, and the annual energy supply was 180,000GJ. Until July 31, 2017, the contracted energy supply area was about 172353 square meters, accounting for 55.6% of the total energy supply area planned for the park, and the actual energy consumption area was about 148 346 square meters, accounting for 47.9% of the total energy supply area. And only 24137GJ of energy was consumed by users until 2017. Although the energy consumption area reached nearly half of the goal, there was a big gap between the actual energy consumption and planned consumption. All in all, the case company has been suffering from serious financial deficits since the establishment in 2015. Net profits of CCNE were about -4.9 million, -8.9 million and -10.4 million yuan respectively. (Material Report 2017.)

All in all, if the future development of the company will be hampered if the situation can not be changed in time.

5.3.2 Data analysis of the survey

The first two questions in a survey were concerning the basic background of the respondents. The first question was about the age of the target group. As shown in the diagram, respondents of 18 to 30 years constituted the biggest group, following by respondents of 30 to 40 years old and 40 to 50 years old. Only 4 persons were over 50 years old. So most of respondents in the samples were under 40 years old, which was a relatively young group.

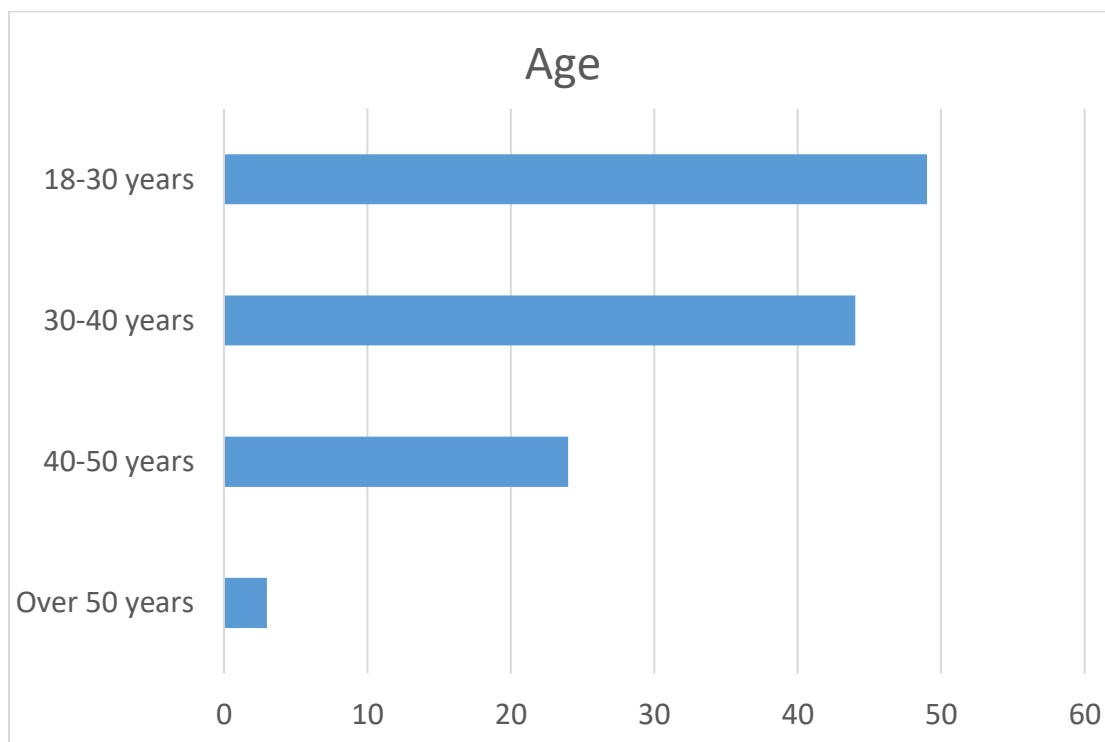


Figure 6. Age distribution of respondents

The second question was to get information about the income of respondents. The most concentrated interval is in the salary of ¥ 5000- ¥ 10000. And the second biggest group was people with ¥ 3000- ¥ 5000. And the amount of people who earn less than 3,000 yuan and more than 2,0000 yuan were both small.

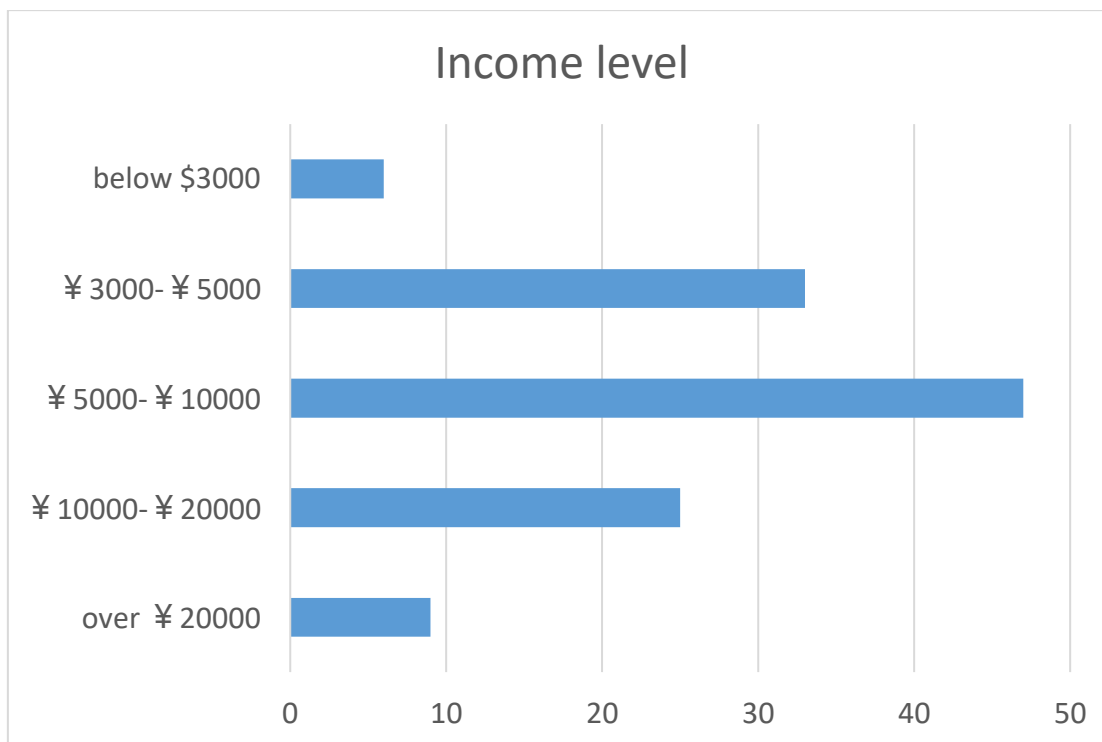


Figure 7. Income level

After the first two questions concerning background information, the next question was about impact of energy consumption on consumers. Only two persons thought the cost brought serious impact to their lives. At the same time, 9 respondents held the view that cost of energy consumption is not worth mentioning. The majority of respondents thought that this expenditure more or less affected them.

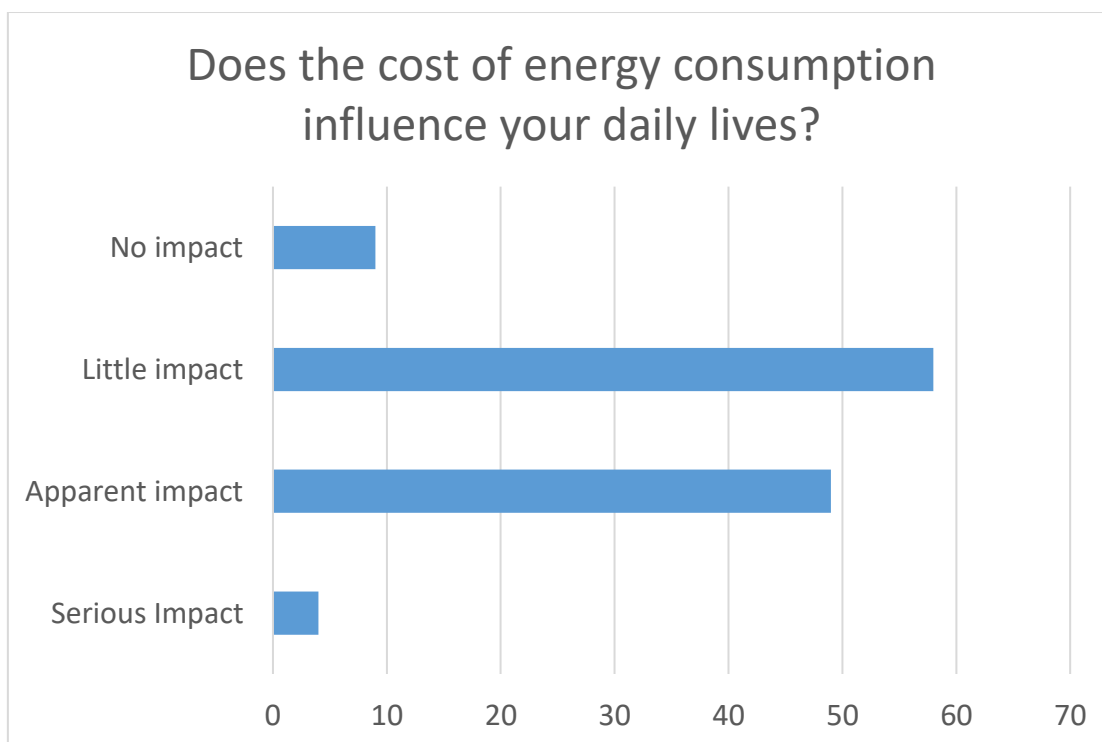


Figure 8. Impact of energy consumption on consumers

The fourth question was concerning dissemination work of new energy. The government is vigorously promoting the expansion of new energy such as natural gas distributed system. But efforts made only by enterprises and government are apparently not enough. The development of new energy needs the active participation of ordinary people. And figures below reflect that relevant enterprises and government still have a great space to improve the propaganda work of new energy industry. Most of people responded that they rarely see dissemination of new energy. But the good news was that, for quite a few respondents, advertisements about new energy were familiar to them. 42 people and 15 people have occasionally and frequently seen dissemination of new energy respectively.

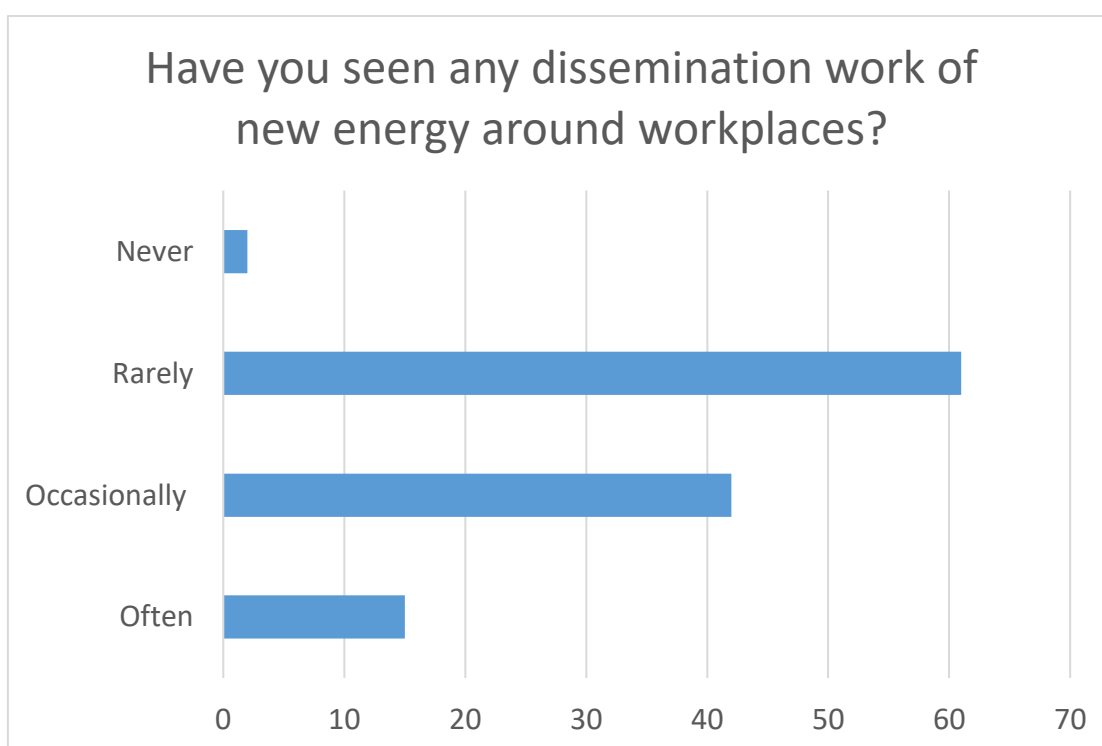


Figure 9. Frequency of encountering dissemination work

And then the fifth question asked about respondents' willingness to renovate household appliances. The diagram shows that most of respondents were willing to upgrade their equipment. But a small group of people chose to keep the traditional situation and refused to make changes which may bring unnecessary trouble for them. More than a quarter of respondents thought that they could not make decision immediately and deeper understanding of services provided by the company were needed. In general, the results show that Chinese citizens have great intention on accepting new energy for their daily lives. But at the same time, some people are not ready for the changes yet. The rest of people have no clear idea on renovating heating and cooling appliances.

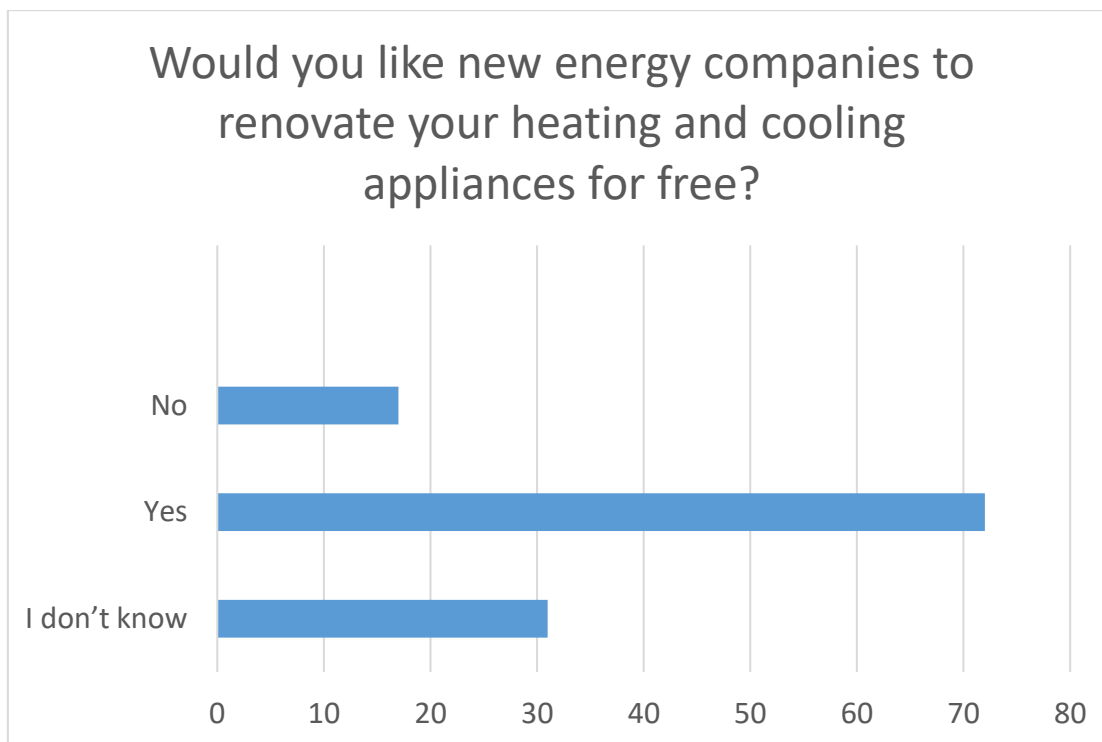


Figure 10. Respondents' willingness to renovate household appliances

After gaining information about respondents' willingness to renovate household appliances, the next question investigated how price affects respondents' energy consumption choices. The data in the chart clearly reveals a fact to the reader that price indeed has obvious impact on customer's choice. Less than a third of respondents chose to continue using natural gas. The amount of people saying no had the absolute advantage. This condition also means that, on the other hand, as a result of price increases, the company might lose a lot of customers.

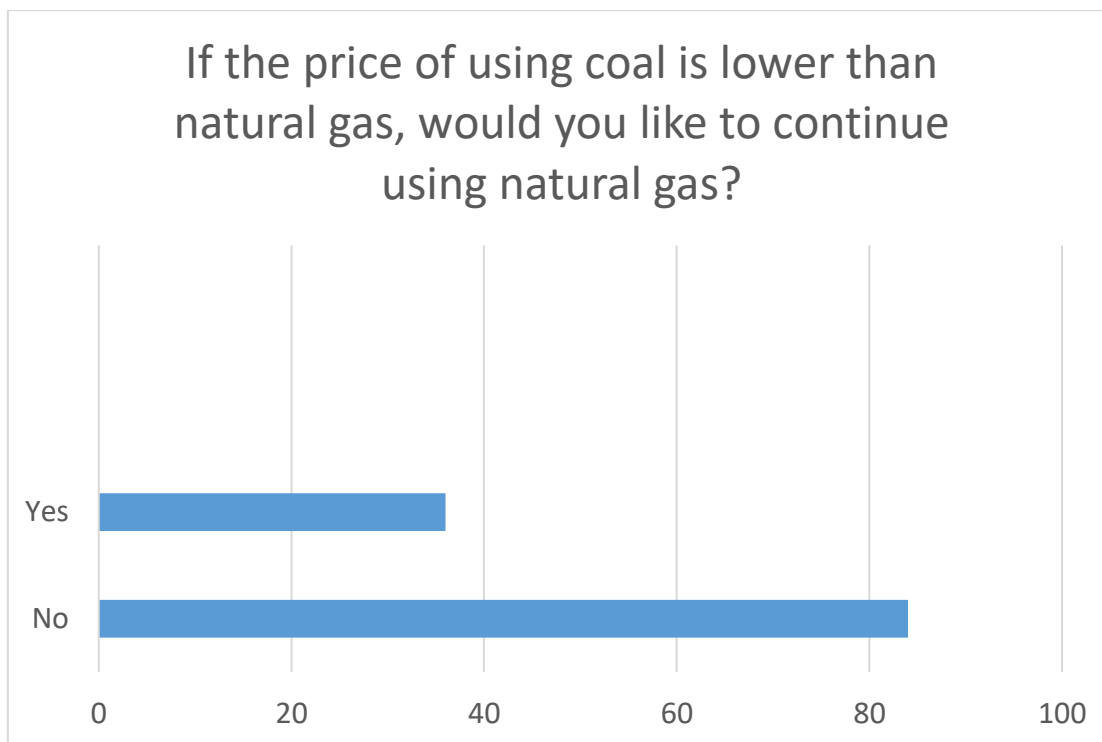


Figure 11. How price affects respondents' energy consumption choices

As mentioned before, there is no large-scale central heating services in southern China. Therefore, the researcher wants to know attitudes of southern residents to centralized heating. The following question asked whether respondents were eager to have central heating in winter. The majority of respondents held the views that central heating is a good way for them to live through the cold winter. The conclusion is clear that respondents were strongly hope to have central heating services as in northern China. And this will be a huge market potential for the case company.

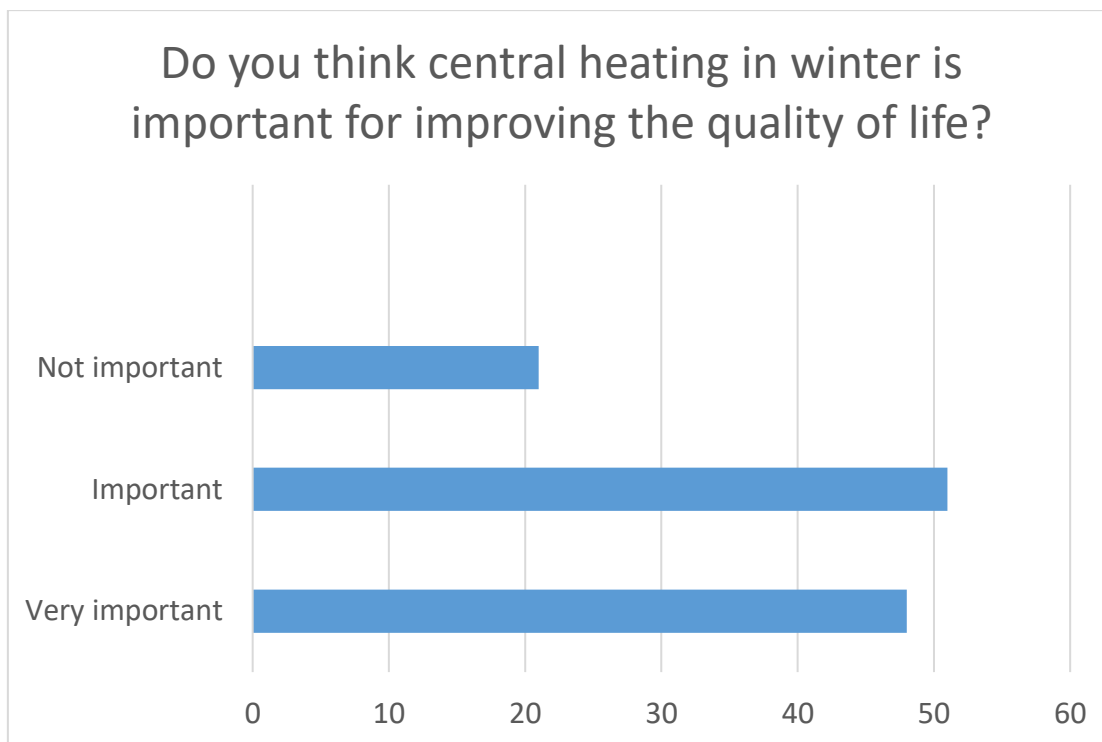


Figure 12. Central heating

Now the research comes to the final two multiple-choice questions. The eighth question wanted to figure out which was the most important fact that will encourage more customers to choose the case company's products and services. Four options were provided including lower price, after-sales service, clean energy and better quality. The number corresponding to each option is very high. All these selections will help CCNE attracts more customers. And among these factors, quality and prices were most concerned about by users.

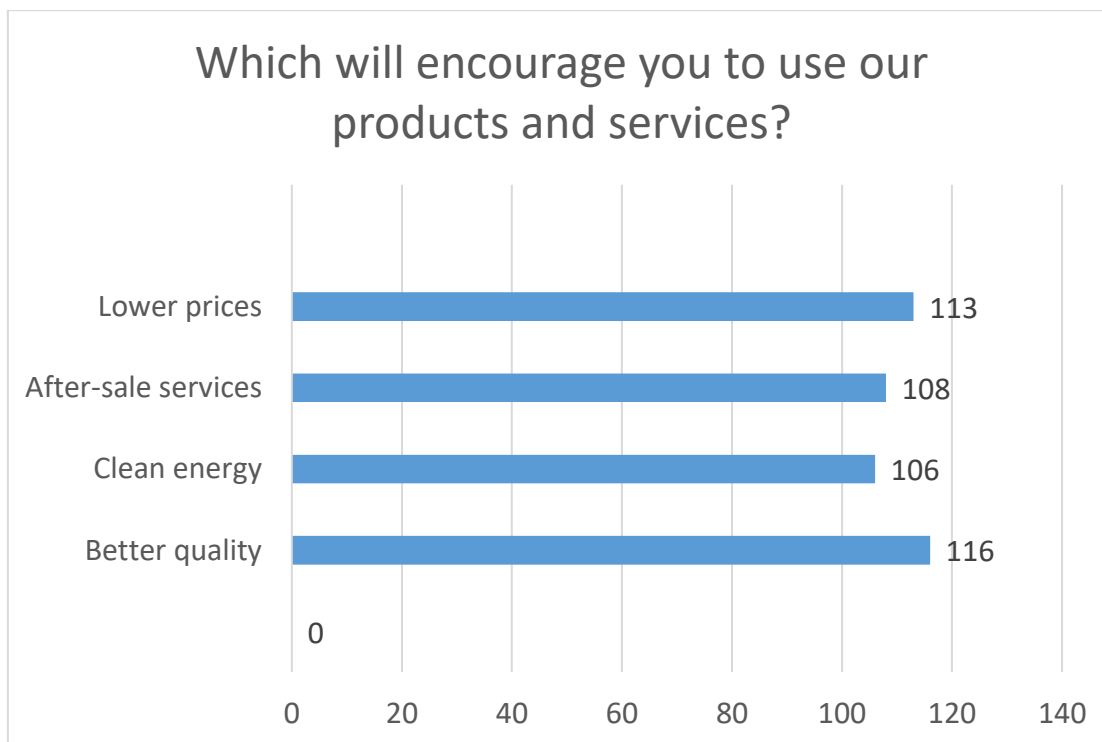


Figure 13. Factors attracting more customers

The last multiple-choice question asked respondents about their favorite payment methods. Nowadays, Alipay and Wechat are the most common mobile payment methods in China. Because of the great success of Alipay and Wechat, currently mobile payment methods have deeply penetrated into Chinese residents' daily lives. Due to high popularity rate, Wechat and Alipay, unsurprisingly, were preferred by most of respondents, which have overwhelming advantage. Paper invoices were also generally accepted, which was still reliable way for more than half of respondents. Only 5 and 23 out of 120 people chose e-mail as payment methods. So, both of these two methods are not recommended.

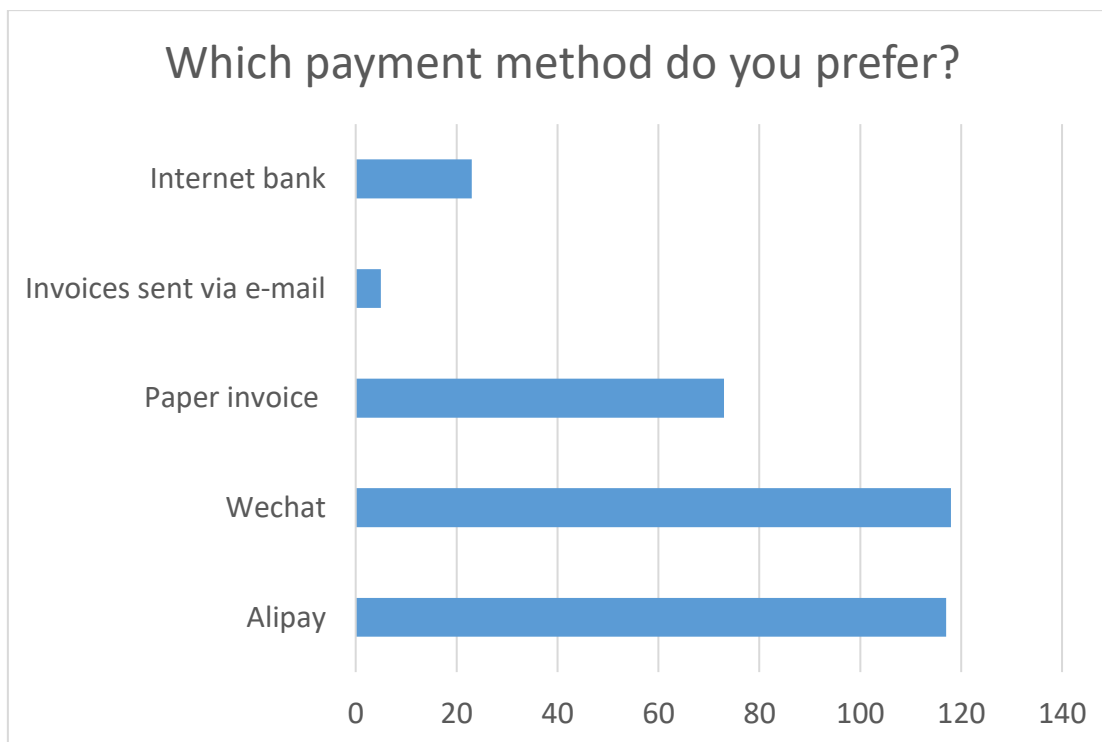


Figure 14. Payment methods

The results of the survey revealed the relationship between natural gas distributed energy and target group from various perspectives.

Firstly, there are some relationships between the background of respondents and energy consumption. By comparing different samples, the researcher found out that older respondents and respondents who have higher income usually undervalue the influence of the cost of energy consumption. So, the age and income of customers will have an effect on usage frequency of household appliances. Therefore, the case company needs to consider background of consumers carefully when expanding or building new plants.

The second conclusion from the results is that price is one of the most important reasons shaping people's consuming habits. This phenomenon is more evident for low-income people. And no matter existing or potential customers may be lost if the price rises. Therefore, controlling the selling price or even keep the number below the normal market price will help the company transfer more benefits to customers to increase the competitiveness.

In addition, although some outcomes have been achieved, the dissemination work of new energy made sources by government and enterprises is not enough. Many people still do not understand the significance of new energy to society and individuals. Better and stronger guidance is required to help residents to know that they are in the mainstream

trend of vigorous development of new energy, which is an important period of china's energy transformation.

Providing multiple payment methods will also help the case company to reach its customers. The company needs to integrate mobile payment into our system as soon as possible. This will not only bring convenience for users, but also improve their cost recovery rate.

At the same time of controlling the price, CCNE needs to ensure the quality of heating and cooling and after-sales services, making sure the temperature of cooling and heating will reach the standard.

6 DEVELOPMENT PLAN

Now when the researcher has studied about natural gas distributed system and is familiar with its overall development condition in China and factors influencing its expansion, it is time to conduct a development plan for the case company after the results gained from empirical research. Firstly, this chapter is analyzing the strengths, weaknesses, opportunities and threats based on SWOT analysis. By using SWOT analysis, the researcher obtains an in-depth understanding of the case company's internal and external situation. And after SWOT analysis the researcher will conduct a final development plan for the company.

6.1 SWOT analysis

SWOT Analysis is a tool that a company can use when a company is making a strategic plan or trying to manage the company more effectively. With help of SWOT analysis, a company can improve its organizational structure and enhance its overall competitiveness. In SWOT analysis, two aspects that affect the company, one being in itself and the other being outside. Analyzing two dimensions of internal and external environments is necessary for a company's strategic management practices. This process of examining the organization and its environment is termed SWOT Analysis. The process of SWOT includes four factors in these two dimensions, which are namely 'Strengths', 'weaknesses', 'opportunities', 'threats'. Strengths and weaknesses are internal factors that have impact on organization, opportunities and threats are external factors that have impact on external environment. In this sense SWOT Analysis is a strategic planning tool used to evaluate the strengths, weaknesses, opportunities and threats of an organization. (Emet GÜREL 2017, 995.) The following chart illustrates those two dimensions and four factors.

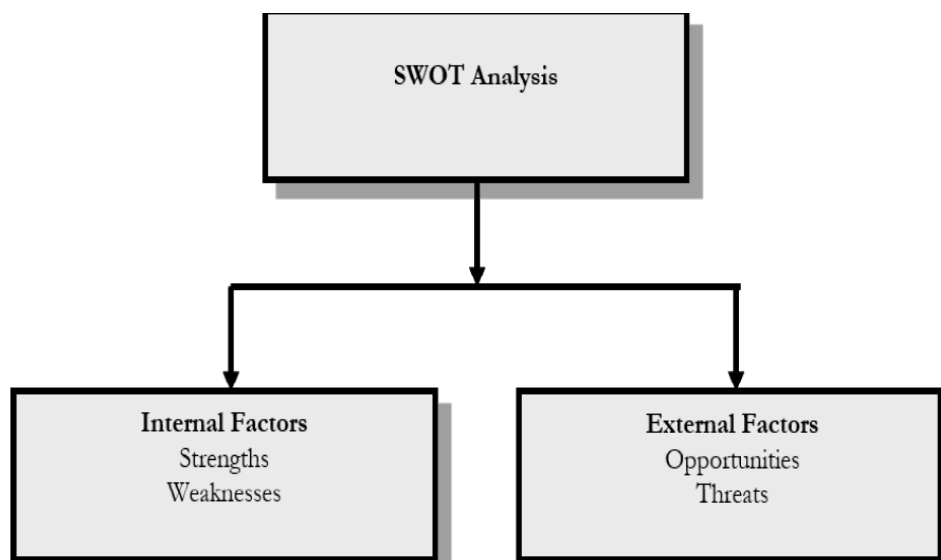


Figure 15. Internal factors and external factors of SWOT (GÜREL 2017, 995)

Strengths are elements adding value to a company in various aspects. In other words, organizational strength defines the characteristics and situations in which an organization is more effective and efficient compared to their competitors.

Weakness means that in some conditions the current existence and ability capacities of an organization are weaker compared to other organizations and competitor organizations. In other words, weakness can lead to a result that an organization will be less effective and efficient in some functional parts compared to its competitors. These aspects negatively affect the organizational performance and weakens the organization.

Opportunities are factors that the company could take a full advantage on in order to improve their performances and these factors would yield positive results for the entire organization.

Threats mean disadvantageous situations or elements encountered by an organization. Threats can make it difficult or impossible for a company to reach its organization goals. And afterwards a company will lose its superiority in competition. Furthermore, some immediate threats may prevent the organization from maintaining its existence.

The table below summarizes the components of SWOT analysis.

Table 1. The components of SWOT analysis (GÜREL 2017, 996)

Organizational Strengths	Characteristics that give advantage over others in the industry.
Organizational Weaknesses	Characteristics that place at a disadvantage relative to others.
Environmental Opportunities	External elements in the environment that give benefits for the organizations.
Environmental Threats	External elements in the environment that could cause trouble for the organizations.

This SWOT analysis is gaining the information about the strengths, weaknesses, opportunities and threats associated with the case company's marketing. Some internal unpublished files will be used for SWOT analysis, especially when evaluating the internal organization of the company. The interview done for the manager of the company has also been part of the analysis. Results of the SWOT analysis can be seen in a table below. And detailed information will be explained afterwards.



Figure 16. SWOT analysis of case company

Strengths

The comprehensive utilization rate of energy in NNCE is about 90.00%, which is much higher than national standards (Zhang 2018). Therefore, NNCE is a great example saving energies and responding to the national requirements to change energy structure. And saving energy will also help the company itself to reduce the import volume of natural gas and then reduce the cost.

And the case company has huge advantages to protect the environment compared to thermal power plant, which is supposed to be advocated and supported by government and local residents.

Afterwards, due to the smaller scale and independent network, the existence of NNCE will provide more reliable energy supply for customers in this region.

Moreover, the premises of the plant is great as well. As mentioned in earlier chapters, Creative Capital is the biggest comprehensive industrial park in China. Because the power plant was built inside the park, the transmission distance is short and energy loss is small. And because of the location, the company can have a face-to-face contact with their customers and consult with Creative Capital Park at the first time. Besides, there are subway hub station and large-scale residential areas near to the park. So, in general, the potential customers and market are huge.

The plant is highly automated, meaning that the number of company personnel and relevant labor cost can be largely reduced. The number of permanent employees in the company does not exceed 30.

Weakness

The total investment of the project reached 231.63 million yuan (about \$35 million), unit cost of which is higher than thermal power plant and previous feasibility study report (Zhang 2018). And this huge investment lead to two results. On the one hand, the payback period is quite long. On the other hand, the depreciation costs are high. For the case company, the annual depreciation costs are as high as 7.5 million yuan (about \$1.1 million).

Another major expense is due to the maintenance of equipment. All gas turbines are imported from GE Power, a foreign company. Firstly, the total investment increased because of these imported devices. And in subsequent routine operations, the company found out that maintenance costs are too high, further reducing marginal profits from power generation. According to NNCE's internal calculation, the expenditure on maintenance materials for every 10 million kilowatt-hour power generation will reach 1-1.3 million yuan (Material Report 2017). In addition, for example, if the relation between exporting and importing countries becomes uncertain, the company may face a supply cut-off. So, heavy dependence on imports will be detrimental to enterprise's long-term development.

Besides, previous chapter has mentioned that the case company was the first group of pilot projects of natural gas distributed energy. The advantage is that the government will pay more attention on these projects because of their great reference significance. However, on the other hand, neither the employees nor the top managers have any operational experience. For example, the company met great obstacles during grid connection processes.

Opportunities

The third chapter has mentioned that, until 2017, thirteen documents related to distributed natural gas energy have been approved by the national organizations. More relevant policies will be issued later on and local government will also respond positively, which is supposed to support the development of case company. Actually, the case company already gained some subsidies from government and is still striving for future support. To illustrate, in 2014, CCNE got altogether 18 subsidies in two policy categories, amounting to 1.4 million yuan (Zhang 2018).

The construction of natural gas pipeline as well as other facilities around Wuhan city are also constantly being processed, which will provide more stable natural gas prices. These infrastructures will assist the company to control their cost.

As a state-owned company, the case company was founded in May 2013 by Huadian Fuxin Energy Co., Ltd. and Wuhan Natural Gas Co., Ltd. with a share ratio of 80% to 20% respectively. The parent company can provide help when necessary. And this indeed brought advantages for the case company, for example, In the process of financing and application for loan.

Threats

The occupancy rate of Creative Capital Park is low and the number of users is unsatisfactory, leading to low consumption and limited cold and heat sales. Actual energy supply area is far below the planned data. Unfortunately, Creative Capital Park, at present, is the most important and only recipient accepting the case company's energy supply. Another point is that due to the impact of the overall economic environment concerning the real economy and inconvenience of transportation in this region, many shops have been gradually closed after opening. And it was noticed previously that Creative Capital is also a newly established park. There are many start-up enterprises in the park, the energy usage of which failed to reach expected amount.

Although China is striving to explore and exploit domestic natural gas resource, it still heavily relies on import. Domestic feeding is not keeping pace with the growth of demand. In recent years, the external dependence of China's natural gas market has gradually increased, which reached 34% in 2016 (Jiang 2018). In this case, domestic prices are deeply influenced by international gas prices, causing more uncertainties to the profits of enterprises.

For an enterprise that depends on national policy, it is more likely to be determined by external factors. Until now it seems that policies are advantages for the case company.

But policy can sometimes turn into obstacles for CCNE's future development if the trend of policy changes its direction into an unfavorable way.

6.2 Action plan for the case company

In this stage, the researcher is about to implement a development plan for case company's future action, which focuses on both internal environment and external market. And the goal of the action plan is to maximize company's profitability and minimize the loss. Suggestions of the action plan are based on former completed theoretical research and empirical research. SWOT analysis is used as one of the tools to optimize the implementation plan as well. Just like SWOT analysis, the following content is divided into two parts including external and internal elements. External part is to improve the external environment and strengthen market expansion. And the main content of internal part is about how to strengthen internal management of the organization. It is worth mentioning that the researcher believes that external factors are more important.

6.2.1 Strengthening external environment

To strengthen external environment, the company should find and create opportunities from outside the company that may be helpful to the company's development and maximize the benefits of the following elements, including increasing power generation, expanding heating and cooling market, hot water supply, striving for preferential national policies and dissemination work.

Increasing power generation

In fact, electricity generation is not the main factor restricting the profitability of a company, which is not limited by the area of the park and the number of users. Because the excess electricity produced can be connected to the power grid. Hence, as long as the company can actively coordinate with the power grid company to ensure the level of grid price, the profits from power generation can be guaranteed.

When the machines run for 317 days of actual operation amounting to 7608 hours of total power generation with full load, calculated by the company's grid price in 2017, the power generation can contribute to 3.7 million yuan to the company (Zhang 201). But the above calculation is only an ideal model, and a large number of other production costs are not taken into account. Even so, the contribution of income from increasing generation to profits is limited in the current situation. Even if the case company tries to gain more profits by increasing power generation, they must confront intensified maintenance costs.

But every chance is deserved to chase. The company should make efforts to increase the benefit of electricity by strengthening management, ensuring equipment reliability, and ensuring the completion of the annual electricity plan.

Expanding heating and cooling market

Furthermore, because of the reasons listed above, we put the increase of electricity aside and focus on the cooling and heating market. CCNE needs to take various measures simultaneously to open up the hot and cold usage market, and then increase the sales revenue, production as well as efficiency. Energy consumption patterns in southern and northern China are quite different. This is largely due to different energy consumption concepts and habits. In previous survey, the results showed that 99 out of 120 respondents considered central heating in winter as an important factor influencing their lives. People in southern areas are generally eager for better services. Therefore, it is a good opportunity for the company to cultivate consumption concept and change consumption habits. Following content are demonstrated to help the case company to achieve that goal.

Firstly, the company should analyze the types of customers to find out customers with the most consumption potential, develop various marketing schemes for different users and formulate customized energy charging packages. For example, according the previous survey in last chapter, for Individuals and businesses with higher wages and profitability, the company can make preferential packages such as discounts when energy consumption reaches a certain amount. At the same time, we can provide additional services and other conveniences for heavy consumers. And this pattern, in my perspective, will be suitable for families with a lot of members and businesses with many employees. Afterwards, lower-income individuals and businesses with poor profitability can not be ignored either. For this group, on the one hand, the company may appropriately postpone the time of fees collection. On the other hand, NNCE can encourage group purchase. If a user can encourage and attract more users to use the company's heating and cooling devices and increase the utilization amount, the company should give favorable treatment to this individual and group.

Simultaneously, the company can make efforts on charging patterns. For example, two patterns can be offered for users. The first one is charging by areas. And another pattern is to install measuring instrument and according the measured amount to collect fees. But in this condition, a minimum monthly fee is required.

Thirdly, cooperating with companies producing cooling and heating appliances may be a viable option, especially when CCNE is going to explore new customers such as factories or other kinds of enterprises nearby.

The next step is to cultivate new customers outside the park. The primary target is the nearby subway station as well as other large public facilities, the energy consumption of which is high and stable. But the company has to consult with the metro department and control the renovation cost. Another goal is to extend network to concentrated residential areas and provide timely heating and cooling services for them.

Hot water supply

Moreover, increasing revenue by supplying hot water may be a viable option. The company's cooling and heating load has obvious seasonal variation, causing higher maintenance costs and lower benefits. The refrigeration time of air conditioning in Wuhan is generally from the first ten days of May to the middle of October, and the heating time is generally from the middle of November to the middle of March. In this case, the company confront great heating pressure in summer and cooling pressure in winter. Therefore, in spring and autumn, when energy consumption is low, the company's economic situation is often confronted with difficulties. So, adding hot water services can help companies alleviate this problem because the demand of Hot water is more stable compared to hot and cooling. CCNE can study and learn from domestic successful cases such as natural gas distributed energy project in Guangzhou Higher Education Mega Center (HEMC). Anyway, the company should strengthen market research and make a serious study of the feasibility and economy before implementing real actions.

The figures below show the change of cooling load and heating load of the company in different seasons. The research was implemented by the case company's internal technical staff.

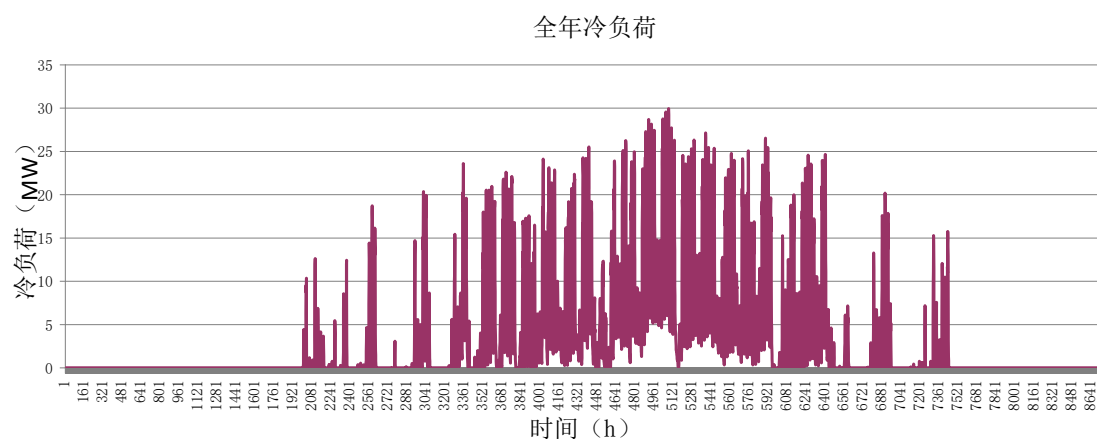


Figure 17. Annual cooling load of CCNE (Material Report 2018)

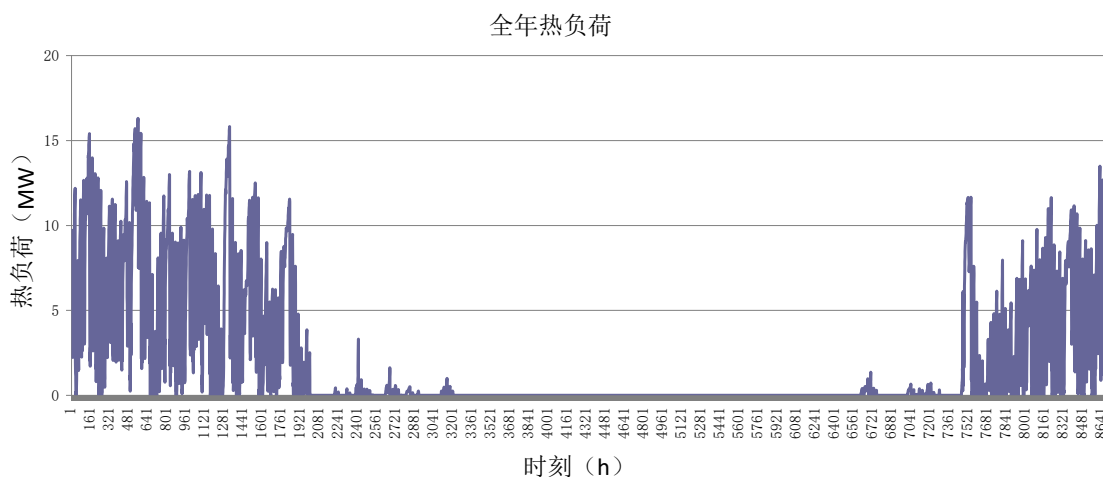


Figure 18. Annual heating load of CCNE (Material Report 2018)

Striving for preferential national policies and prices

Actions for utilizing policies can be divided into three parts, including direct financial subsidies, lower gas prices and higher grid-connected tariffs.

As mentioned in the previous section, the company has already gained some financial subsidies, which, to some extent, helped to reduce the company's financial pressure. Companies should always actively focus on national clean energy policies and strive for policy subsidies in accordance with the actual environment.

In order to decrease gas prices, NNCE is supposed to actively fight for favorable gas price and seek the possibility of multiple gas sources. And in previous SWOT analysis the researcher noticed that the case company has powerful parent company. So, they should take advantages of it to negotiate with natural gas suppliers. To illustrate, in 2016, the company has won a price discount of 0.095 yuan per cubic meter. But the unit price of the case company was still higher Hubei Huadian Wuchang Thermal Power Company Ltd., which has same parent company as CCNE and is a huge customer for almost every natural gas supplier (Zhang 2018). Due to its massive scale, it can always enjoy the most advantageous price. If the parent company can take the lead in price bundling between the company and these large thermal power plants, it will be beneficial to the company's development. And according to the survey in chapter 5, price is the most significant factor shaping consumer behavior. Therefore, reducing the price of natural gas is the most effective way for companies to offer more preferential treatment to customers.

Moreover, the earlier chapter mentioned that the instability of natural gas supply and price is threatening the company's profitability. Therefore, short-term price advantages still bring

potential risks to the company, signifying that a long-term dialogue mechanism with relevant departments is strongly needed to obtain a relatively stable price.

The next factor can only bring a slight impact to the case company, but every aspect should not be neglected. The company should reinforce the communication and coordination with provincial price departments, finding out policy information in time, and cooperating with project cost accounting and supervision. However, due to the government's regulation on the price of electricity on the grid, which can not exceed 0.35 yuan/KW.h of the local benchmark price of coal-fired power generation, profits made by this approach are limited.

Dissemination work

Last but not the least, proper dissemination work should be positively processed by alliance of local propaganda departments and the case company. From the questionnaire, the results reflected that people's awareness of using clean energy is not mighty yet, which is largely due to the lack of guidance from government. The researcher holds the opinion that improving the guidance to the public will certainly reduce the resistance to the development of natural gas distributed energy market.

6.2.2 Improving internal efficiency

After strengthening external environment, the case company should now manage their internal affairs more effectively. This segment has two parts to assist the company, including solutions concerning devices maintenance, procurement and inventory management, personnel performance examination, reasonable control of employment, cost of recovery work and quality and after-sale service.

Reducing maintenance fees

First of all, CCNE needs to fortify the control of maintenance fees. The company should actively discuss how to reinforce the management of unit maintenance cost on the basis of ensuring the safety and reliability of unit equipment so as to meet the requirements of regulations and reduce overhaul cost.

Procurement and inventory management

Afterwards, reducing the cost of material purchasing is another important approach. The company can improve the construction of material management system and mechanism. For instance, by better utilizing the advantages of e-commerce platform of Group Company, the company can simplify purchasing processes, make comparative

procurement and reduce the overall costs. The company also is able to strictly control the approval of material purchasing plan. The effectiveness of reusable spare parts need to be maximized, which should not be replaced frequently as well. Components that can be repaired by technical personnel should not be switched as far as possible.

In addition, the company can make efforts on more elaborate management work concerning each procurement segment. For example, strict warehousing and acquisition procedures need to be executed to eliminate waste of materials. Personnel related to materials management will be regularly assessed.

Furthermore, inventory management will also be taken into account. The company should refine the inventory quota according to the actual situation. For example, delivery in different batches can be used to minimize inventory and capital overhead.

Personnel performance examination and reasonable control of employment

Besides, more detailed performance examination should be issued to improving staff efficiency, which can cover aspects such as work discipline, work plan, cost control and safe production. The results of the assessment will be used as the basis of rewards and penalties for the company's monthly performance appraisal.

Besides, CCNE ought to manage the employment plan reasonably to avoid redundant workers and strictly control the expenditure on labor force.

Cost recovery work

In addition, cost recovery work should be done properly and timely. Researching on customer's payment habits to create convenience for customers will help the company to better collect fees. According to the survey, the majority of customers prefer Alipay and Wechat as their payment methods. So, the company should integrate these payment methods into your system in time. In addition, CCNE should constantly communicate with the property company in the park and keep abreast of the users' business situation in time in case of company's profits are damaged by the user's inability to pay the fee due to poor operation.

Ensuring quality and after-sale service

Providing products with better quality will surely help the company to win more customers. And in data analysis part the researcher concluded that quality is one the most important factors to attract customers. For CCNE, their mission is to make sure that the temperature of heating and cooling reach the standard. If they fail at quality control, a large number of

users are bound to lose. Ensuring after-sale services means that the technical personnel are supposed to arrive at the scene quickly if a user's equipment fails to work properly.

7 CONCLUSION

This part is an integration of all the previous information and conclusions. The first part of this chapter is about the answers of research, which are listed as follows. The second part of the chapter is focusing on the reliability and validity of this study, followed by a suggestion for further research.

7.1 Answers for Research Questions

The research focused on natural gas distributed energy market in southern China, especially in Wuhan. The case company has been facing serious losses since its establishment and that is why the main research question was: **How should the case company improve their profitability in order to make up the deficits and get surpluses?**

In the previous section, this question has actually been discussed. The ultimate goal of development plan is to solve this problem. Therefore, concrete solutions can be implemented by two dimensions, which are namely inter organization and outside environment.

Concerning the internal factors, the case company should focus on reducing operational costs and enhancing the initiative of employees. For external factors, the most important solutions are striving for preferential policies to reduce the cost and expand cooling and heating market in various ways. Among all these methods, the solution of expanding cooling and heating market to increase energy supply will be the most promising way to change the case company's current situation.

What is Natural Gas Distribution System?

Natural gas distribution system is one type of DRE systems utilizing natural gas as its energy source, one of the most common distributed energy systems in China. It must provide heating, cooling and electricity supply for a certain customer. The station can be independent of large power grids and operate by itself to constantly providing energy for users. But at the same time, it is also a good supplement to the power grid. Natural gas distribution system is of great significance to China's energy transformation.

How can the case company reduce their costs?

From the internal perspective of the company, they should reduce maintenance fees to improve procurement and inventory management. In external environment, the case

company need to explore multiple supply sources and actively negotiate with existing suppliers to cut down the price of natural gas.

What methods should the company implement to reach more customers?

There are two methods to increase the number of customers. The first one is to implement preferential treatment for users such as discount on heating and cooling fees. Another way is to actively establish cooperative relations with large enterprises or residential areas outside the park.

How to expand business scope of case company?

At present, the most feasible solution is to develop hot water supply service. But this also can bring extra operational and renovation costs for the company. Therefore, CCNE has to make a comprehensive feasibility and economy study report before they try to explore a new service.

7.2 Validity and Reliability

Finding out answers for all research questions is the main purpose of this research. In this research, the objectives were reached when the answers to research questions were found. The information for the research was gathered both from secondary and primary sources. Secondary sources were made up by internet sources. The primary data was collected from an interview with the manager of the case company and from a survey, when the aim was to find out general condition of case company's market development. Totally 120 respondents participated in the survey, the number of which is enough to draw conclusions and makes the research reliable. According to these facts, the research is valid and reliable.

7.3 Suggestions on Further Research

As mentioned in the Limitation part of the research, only Chinese customers were considered. In order to gain more comprehensive results, further research on natural gas distribution energy marketing covering also other nationalities is suggested. A more data-driven study would be interesting and offer more viable solutions for the case company.

8 SUMMARY

The thesis aims to provide a deeper understanding of natural gas distributed energy market in southern China. The final goal was to implement a development plan for the case company and to answer the research question of How should the case company improve their profitability in order to make up the deficits and get surpluses?

At the beginning of the study, basic concepts of DRE and natural gas distribution energy were introduced by the researcher. Because China is a huge country and the researched case company is located in southern China, natural gas distribution energy market in southern China was emphasized.

The researcher wanted to find out users' consumption habits and their attitudes towards renewable energy especially natural gas distribution industries and for that reason, an empirical survey was conducted on the target group of the case company.

A development plan was summed up for the case company to increase their overall profitability, reduce costs and expand their market. The development plan was conducted by using theoretical data collected from internet sources, empirical data gathered from the survey and internal documents from the case company.

The findings of the study stated that considering both external and internal factors is the key to promoting the company's development. And among all factors, expanding the market of heating and cooling is the most important task for the current company. The company also needs to coordinate with every objective including users, Creative Capital Park, local government, parent company and suppliers.

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APPENDICES

APPENDIX 1. Survey

1.您的年龄处在哪个区间? *

- 18-30
- 30-40
- 40-50
- 50以上

2.你的工资水平处于那个阶段? *

- 3000元以下
- 3000-5000元
- 5000-10000元
- 10000-20000元
- 20000以上

3.您认为日常用电, 制冷和取暖费用对您个人生活造成影响了吗? *

- 完全没有影响
- 影响较小
- 影响较大
- 影响严重

4.您有看到关于清洁能源的相关宣传吗? *

- 完全没有
- 有但很少
- 偶尔
- 经常

5.如果免费, 您愿意让新能源公司对您的供暖供冷设备进行改造吗? *

- 不愿意
- 愿意

6.如果使用煤炭价格低于天然气，你还愿意继续使用天然气吗？ *

不愿意

愿意

7.您认为冬天集中供暖对生活品质重要吗？ *

不重要

一般

很重要

8.哪一项会促使您使用我公司的产品和服务？ [多选题] *

价格优惠

新能源

售后服务

更好的质量

9.您更偏向于哪一种收费方式？ [多选题] *

支付宝

微信

纸质发票

电子邮件

网上银行

APPENDIX 2. Interview with the manager of the case company

How is the company doing at present?

1. What are the advantages and disadvantages of natural gas distribution system?
2. Who are company's main target customers?
3. Can the number of customers in the park meet the demand?
4. Are energy consumption fees collected in time?

5. The condition of Heating, cooling and power supply.
6. Does the company have any plans to start new business?
7. How are you encouraging customers' energy consumption?
8. How are you going to attract more customers?
9. What kind of cooperation have you accomplished with the government and other relevant social departments?