DEPARTMENT OF TECHNOLOGY AND BUILT ENVIRONMENT

THE DISTRICT HEATING IN CHINA

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June 2009

Master's Thesis in Energy Systems

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Preface

After several months of hard work, we finally have finished this thesis. In this period we cooperate with each other. Firstly we found some important information through the web, books, reports etc. Then we discussed with our supervisor and chose the title of the thesis. We began this task since June. By this work we gained lots of knowledge and made more experiences in this area---district heating in China.

It is really complex hard work for us; lots of people helped us to complete it well. We really appreciate that.

Alemayehu Gebremedhin our supervisor, helped us choose the title, gave us advices and comments.

Zhang yu an English teacher in Harbin Normal University in China gave us some suggestions on grammars used in the thesis.

Li xiang my classmate, who is working in Heilongjiang Development Committee gave us lots of information.

Our opponent, Zhou yun and Wang quanfeng gave us some suggestions about our presentation

Finally, we would like insure that we are responsible for any copyright issue regarding the information contained in this thesis.

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Abstract

The district heating in China started in late Qing dynasty, but it was only after the founding of P. R. China that district heating had been developing steadily. Since 1982, cities such as Beijing, Shenyang, Harbin, Lanzhou and Jilin had commenced application of heat exchange technology for the district heating. In particular, the government decided to make combined heat and power a fundamental policy for district heating. Altogether 86 cities had completed heat charging system reform till 2008.

“Three North Areas”, namely Northeast, Northwest and North China are major areas where district heating are applied. Winters are very cold in these areas. Heilongjiang province is the most active district heating region than any other provinces.

The main heat sources of district heating are CHP and hot water boiler.

During the years, district heating technology in China has developed rapidly. This thesis introduces the status of district heating in china: the developing history, the district heating areas, the cities characters etc.

Contents

1. Introduction

District heating system is an important basic infrastructure for urban economic and social development; its development level may represent the level of urban modernization. Enlarging area using district heating system has become a basic policy for Chinese urban construction.

Compared to the dispersed heating system, the district heating has some advantages:

(1) Economic benefits: The capacity of the boiler used in district heating is large with high thermal efficiency, nearly 90% [1]. The dispersed heating boiler efficiency is only about 60% [1]. Therefore, using the district heating system instead of the dispersed heating could save energy.

(2) Environmental benefits: The urban pollution mainly comes from carbon dioxide and soot which are produced by coal combustion. The capacity of boiler used in district heating is large; it has better dust control equipments. It uses efficient precipitator. Dust removal rate is about 90 - 98% or even higher [1]. Using this technology could reduce urban pollution.

(3) Social benefits: District heating is significant for people's life, saving the urban construction land; improving power shortage situation in cities.

Due to the local geographical position and temperature distribution in China, the main district heating areas are: "Three North Areas" (Northeast, Northwest, and North of China).

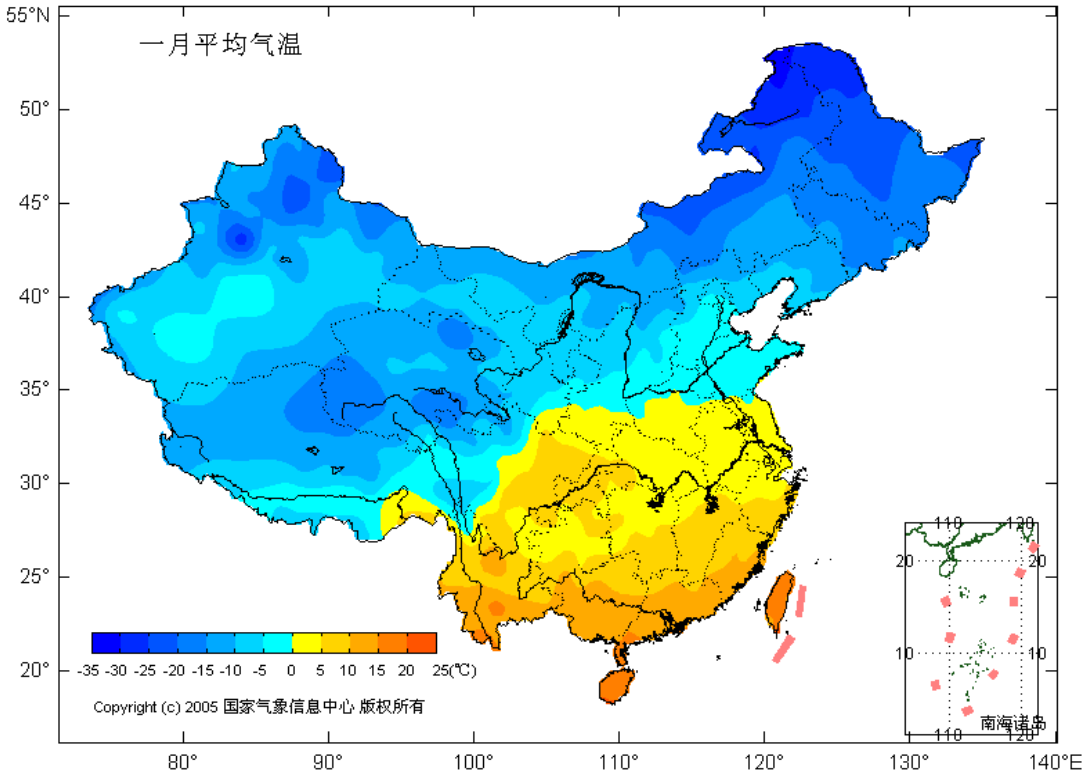

Figure1: The temperature distribution picture in Jan. of China [2]

According to Figure 1, China's average temperature in south is more than 0 º C, the average temperature in northern areas is below 0 º C. The temperature influences China's district heating situation:

Table 1: The district heating situation in China [3]

The district heating situation in China							
Area	Max Heating Ability		Heating Total		The Pipe length(km)		Heating Area (10^4m^2)
	Steam (t/hour)	Hot water (10^9W)	Steam (t)	Hot water	Steam	Hot Water	
Total	70146	80591	22169	69771	7733	30506	96774.83
Beijing	3408	4255	1715	8206	345	1855	6976.40
Tianjing	7878	3917	177	4648	269	2177	5011.49
Hebei	6155	7669	5829	4673	467	2757	8750.73
Shanxi	3519	5289	907	4452	530	1697	4645.52
Neimenggu	1222	5001	122	4132	74	1310	4335.32
Liaoning	11850	13949	3191	8390	1456	5700	17652.84
Jilin	3355	8622	426	7006	249	3424	8430.11
Heilongjiang	4696	13472	1509	12178	492	4573	12944.88
Jiangsu	2581	0	573	0	335	0	1372.18
Zhejiang	1334	0	396	0	134	0	300.60
Anhui	1915	380	484	20	107	23	196.04
Fujian	0	25	0	61	0	44	1500.00
Shandong	11640	7421	2375	6180	1842	2636	10737.50
Henan	2899	1211	914	928	445	759	3222.39
Hubei	750	12	409	24	52	1	498.00
Hunan	733	49	577	1	51	0	577.00
Shanxi	1843	543	261	292	273	174	1465.54
Gansu	2310	2531	1588	2522	193	1086	3066.81
Qinghai	0	54	0	34	0	36	60.00
Ningxia	670	2213	244	2204	142	491	1520.50
Xinjiang	1388	3978	472	3820	277	1763	3510.98

The figures show that Heilongjiang province is the most active district heating area in China, there is nearly no district heating in South. In non district heating areas, China uses some equipment to keep warm in winter such as: air conditioner, regenerative electric heating and so on.

However, the district heating is in rising trend. Table 2 shows us the heating ability and heating data.

Table 2: The district heating situation in cities of China [4]

Year	Capacity		Heating Total		Pipe length(km)		Heating Area (10^4m^2)
	Steam (t/hour)	Hot water (10^9W)	Steam	Hot water	Steam	Hot Water	
1985	1406	1360	896	52	76	954	2742
1990	20341	20128	7117	21658	157	3100	21263
1995	67601	117286	16414	75161	909	8456	64645
2000	74148	97417	23828	83321	7963	35819	110766
2003	92590	171472	59136	128950	11939	58028	188956

Types of urban heat sources in China contain: CHP, scattered boiler room, industrial waste heat, nuclear, geothermal, solar, heat pumps, household and small coal-fired (oil, gas) heaters and so on. The main heat sources are CHP and collect boiler room. Since the reform applied, the CHP has been developing rapidly.

By the end of 2001, the situation of China's combined heat and power: [5]

Total heat in 2001:1287430000GJ

The amount of heating units (6000 kW and above):1583

The total heating capacity of heating units (6000 kW and above):31,842,100 kW

The district heating energy includes coal, oil, natural gas, electricity, nuclear, geothermal, solar, etc. District heating mainly uses the coal as source of energy. In the past, district heating network normally used half-ditch installation, which is now gradually being replaced by a buried pipe. Since the first buried network had been adopted, the buried pipe network accounts for 40 %. [5]

Although the district heating system has been developed well, it faces some problems. How to lower initial investment and improve the efficiency of heating system are challenges we are facing now.

2. Development of Chinese heating system reform

- **July 21, 2003 Heating system policies reform**

In order to accelerate the district heating system development, the government announced that great efforts shall be made to solve Chinese district heating problem for residents in the northern region.

- **November 5, 2003 Three major reform goals to be achieved**

Ministry of Construction announced that three objectives for district heating system to be achieved: [6]

First: Commercialize heating supply

Second: Change district heating method. The district heating system should be established with concept of energy conservation.

Third: The heating price should be acceptable for low-income families.

- **September 26, 2005: "Six" aspects that need to be considered in building heating system [6]**

(1) Social stability

(2) Mandatory subsidies

(3) Difficulties of enterprise workers

(4) The unit price

(5) The termination of heating transactions

(6) Social Security

• **December 18, 2005 Published "Further promote urban heating system reform" --six major achievements [6]**

⑴ Heating price formation became more scientific.

⑵ Heating subsidies with more reasonable costs.

⑶ Established better heating market.

⑷ Low-income groups are better protected.

⑸ Heating energy resources used more efficiently.

⑹ Heating market regulation is more effective.

• **February 16, 2006 Ministry of Construction announced that the heating system will be completed in two years**

Chinese vice Minister of Construction Cou Baoxing, introduced the three aspects:

- Inform the national association of building energy-saving special inspection
- Building energy saving as a main project.
- Introduced the situation of "The International conference of Green Building and building energy saving. [6]

3. Overview of district heating system in China

District heating system mainly comprises of source of heat, heat supply network and users.

3.1 Heat source

3.1.1 Main type

China's urban heat source mainly include: CHP, central boiler room, scattered boiler room, industrial waste heat, nuclear energy, geothermal, solar, heat pumps, household and small coal-fired (oil, gas) heaters and so on.

The main heat sources are CHP boiler room and concentrated boiler room. Heating energy includes: coal, oil, natural gas, electrical power, nuclear, geothermal, solar, etc.

In the future fossil fuels shall remain as main energy for human life for a long period of time. According to The International Institute for System Analysis of the forecast, by 2030, the composition of world primary energy shown in the figure below.

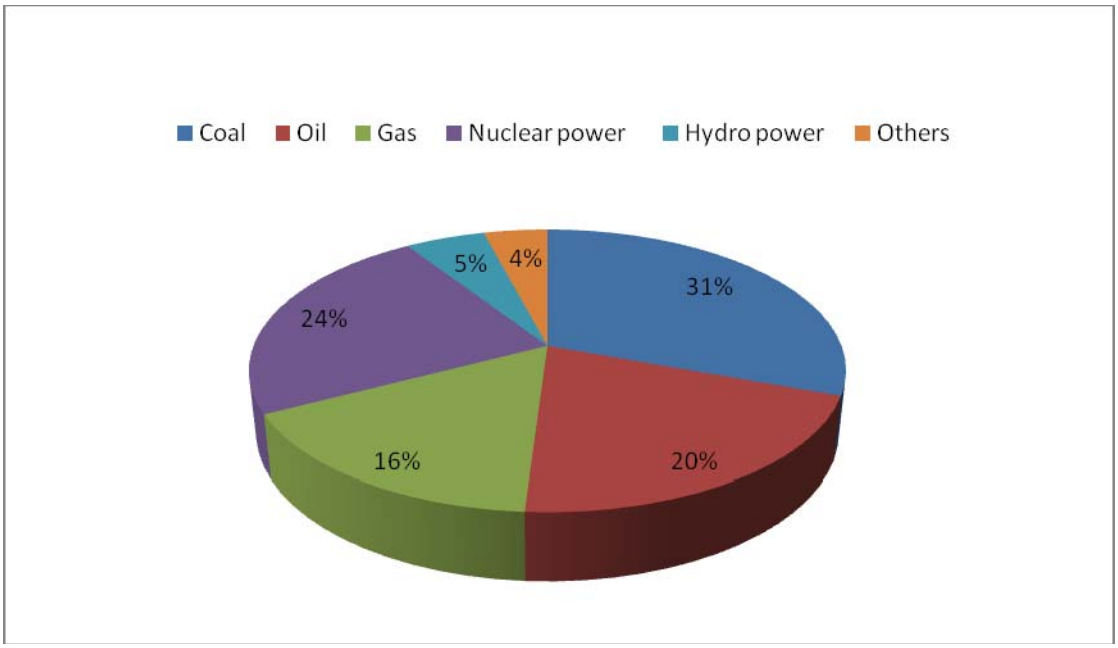

Figure 2: The composition of world primary energy in 2030 [7]

At present, the use of natural gas is increasing rapidly in the world; at least 30 countries are replacing oil with natural gas. In the future, natural gas consumption will be increased for heating system in cities. As people's living standard keep on rising, national energy policy is focusing more and more on both the principle in urban environmental protection and the energy conservation. The local urban heating industry is developing rapidly, CHP becomes a major heating method, boiler room and other ways are the supplement methods for district heating system.

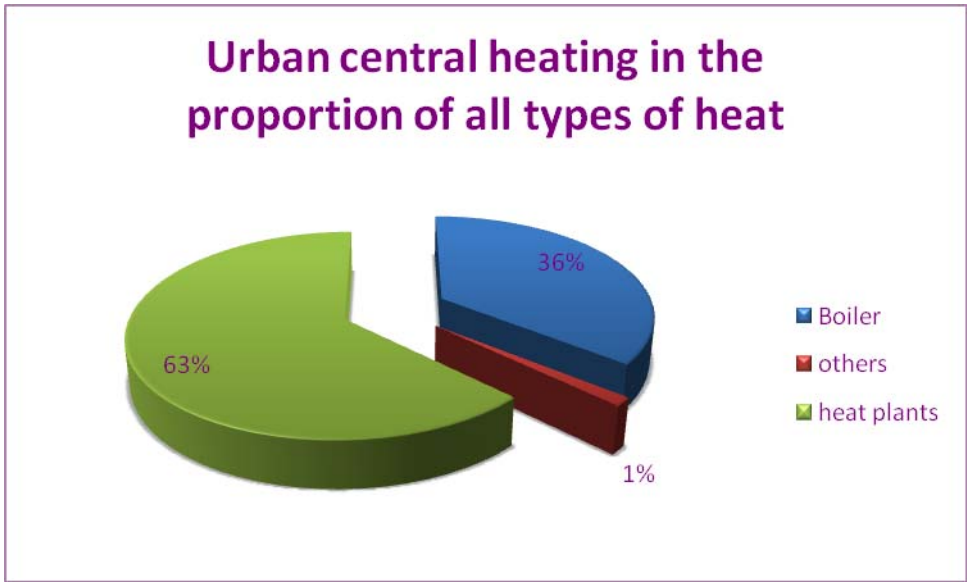

Figure 3 Heat Types Distribution for Urban District heating [8]

The civil district heating area is growing rapidly in recent years.

China's current development status of CHP

District heating system adopted the urban district heating; the first CHP was established in 1958. During 48 years it experienced a tortuous development process. In the first 10 years it had been developed rapidly. Beijing, Shenyang cities are the first ones who began to use district heating system. In 1986 the State Council published the No.22 document. It has played an important role on urban planning and implementation in "Three North" (northeast, northwest, and north) for the development of district heating. [8]

Table 3: Chinese cities development of district heating [8]

Year	District heating facilities with the number of cities	Heating area (㎡)
1980	10	200000000
1989	81	1560000000
2003	321	18900000000

In the recent 15 years district heating has been developing more rapidly. By 2003, 321 cities had established district heating facilities, heating area reached about 1890 million ㎡. Hot water pipe network was 58,000 km; steam pipe network was 11,900 km [8]. Beijing's thermal heating has been developed quickly in the past 10 years, heating area was about 167500000 ㎡in 1989, in 2004 it was 848700000 ㎡, now it has exceeded 900000000 ㎡-- 5.7 times more than that of 1989 [8] . The development of thermal heating accompanied with technological progress. In the past, because of low operational management level and lack of effective regulation, temperature couldn’t be controlled at constant level during heat transition district heating system.

In addition, a computer monitoring technology is used in the majority of heating enterprises, on transmission and distribution network. The enterprise management and heating information construction is in its infancy period.

Nowadays, energy waste problem still exists such as overheating. The thermal heating enterprises are thermal station, secondary network and user terminals, they are controlled by heat, therefore this problem is very difficult to solve.

<1> the district CHP are the main heat resources and the small CHP of enterprise are supplementary one.

<2> the construction of CHP are subject to the overall city planning and urban heat

plan. Now both the city and country side have CHP planning.

<3> as the development of power plants and urban construction, the old equipment consumes too much coal. They are no longer suitable for development of electric power generation.

<4> with the development of heating industries, the district heating had been chosen as the major heating infrastructure.

The largest CHP is the First Thermoelectric Plant in Taiyuan. The installed capacity is 1,386,000 kilowatts. [8] In Beijing, Shenyang, Jilin, Changchun, Zhengzhou, Tianjin, Handan, Qinhuangdao ,Taiyuan and some other central cities, a number of dual-use and large-scale extraction condensing units have been put into operation [8] . The CHP has been established not only in north China, but also in the frontier city of Hainan province. The Regional Power Plant development areas are spread from the city industrial zone to the township industrial development zones.

In recent years, due to the development of market economy, some private entrepreneurs are optimistic about cogeneration investment in building CHP. In terms of urban district heating companies, the largest heating company is the Beijing Heating Company with a network of 514 km [9]; heating area is 70 million square meters, supply 105 industrial users of steam at 897 tons per hour, thermal stations totaling 1223.

In the end of 2001, the district heating area was 1,463,290,00 ㎡ in China.[9] Thermal steam pipe has reached a total length of 9,183 kilometers, hot water pipe 43,926 kilometers [9]. In the northeast, north, northwest, district heating area accounted for about 80% of the total district heating area, the district heating totally employ 220,000 people. [9]

City civil district heating area is growing rapidly. The following table is the district heating area classification in china.

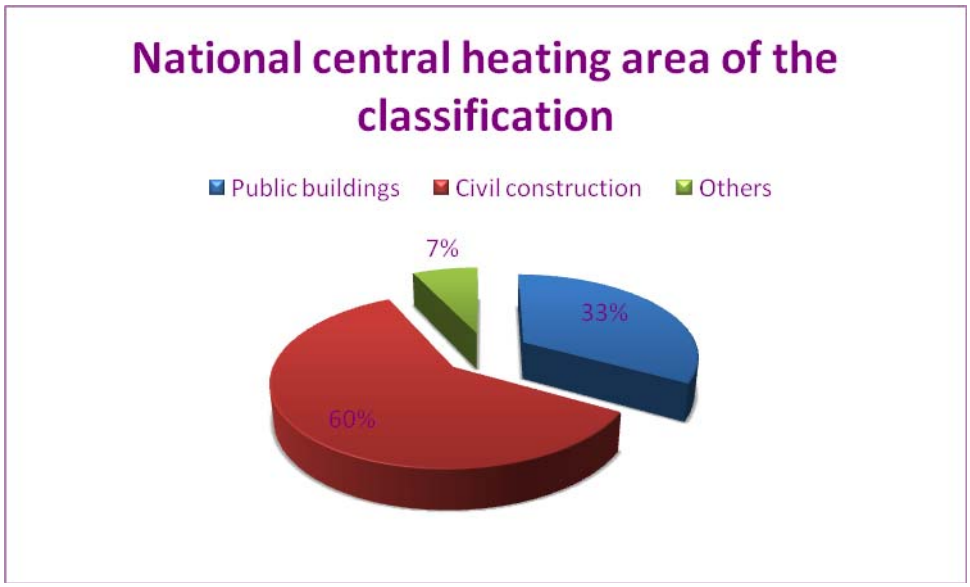

Figure 4: National district heating area classification [9]

Characteristics of public building heating solution: [9]

- Three north areas mainly use district heating for buildings, e.g., district heating for buildings account for 72.66 % in Beijing, 66.54 % in Hebei, 67.5 % in Shenyang, and 51.97 % in Shandong province.

- Urban district heating is gradually expanding to areas such as Shanghai, Jiangsu, Zhejiang, Anhui and other provinces and cities. However it is applied mainly in public buildings and factories, e.g., 61.72 % in Shanghai, 53.35 % in Jiangsu, and 39.55 % in Anhui.

Table 4: The percentage of CHP reaching energy saving standards [10]

Coal consumption efficiency	Self-reported	60 %	65%	68%	74%
coal thermal power plant consumption	12	42	34	30	21
Standard rate	22%	78%	63%	56%	39%

The development status of the boiler room:

Recalling thermal heating development process: since the building up of heating facility failed to keep pace with the rapid urban development, the development of thermal heating boilers had been spontaneous and disorderly due to lack of unified plan for heat supply, resulting in a very difficult situation of small boiler capacity, high energy consumption, serious pollution created by great number of small boiler rooms scattered in the "Three North" major areas. According to survey in 1989, in the "Three North" eight major cities, 82 % of the heat is supplied from heating boilers, heat supply from thermal power heating account for only 15 %, and others account for 3 % [11]. This shows that the heating boilers are very important.

From the founding of New China to 1975, China uses manually operated cast iron boilers, with largest single capacity of only 0.46 MW. Due to that reason that the scale of the residential quarters keeps expanding, in 1960, a heating area of 130000 m^2 needed heat supply from one single boiler room. Due to lack of large capacity boilers, 32 cast iron boilers were installed, and 100 people worked in the boilers room [11].

Fortunately, in 1975, fast loading chain turning hot water boiler with a capacity of 2.8 MW was invented in Shanghai, facilitating smoke and dust control and transformation of boiler system in north China in the mid-1970s [11].

At that time, in order to meet environmental protection standards, all manual boilers were changed to quick loading boilers or automatic boilers. In 1980's, many residential quarters are more than 1 million㎡, but there was no large-capacity hot water boiler. Between 1981 and 1987, hot water boiler with capacity of 14 MW and 29 MW was put into use firstly. By 1997, Beijing has built 100 blocks optional 14 MW and 29 MW large-scale heating boiler plants, with heating area of about 600000000 ㎡ [11].

In 2006, the government asked some heating districts such as: Chaoyang, Haidian,Fengtai and Shijingshan used 1400 coal-fired boilers whose capacity is under 14 MW .

In addition, in the past several decades because of environmental requirements continue to be increased, the coal-fired boiler desulfurization task is still in a transformation period, it still meets many problems.

<1> Scattered small heating boilers operating conditions is poor, both inside and outside of boiler room are usually full of dust, ash flying to surrounding environment which brought great harm to work environment .

<2> Dust precipitator of heating boiler has less efficiency (only about 60-70 %), It lacks effective desulphurization facilities which increase atmospheric pollution in cities.

<3> Chimney of scattered heating boilers generally is low .The dust is difficult to spread out resulting in the dust concentration of boiler room exceed national environmental protection standards.

<4> External boiler room using rate is low, thermal efficiency is less than 60 %.

3.1.2 Technical problems

⑴District heating system meet severe challenges: First, how to reduce the initial investment (including heat source, heating network, investment of thermal station); the second is how to improve heating system, strengthen enterprise management and reduce users' heating costs.

(2) Due to lack of perfect heating plan, the heating works mostly are of short-term behavior and construction projects starts soon. The capacity of boilers is too large compared to the heat used. Therefore building heating plant need pre-planning to avoid resources waste.

(3) District heating load is mainly heating and industrial load, the hot water load is little in proportion.

(4) Automation and operation management level of central boiler room needs to be raised.

(5) Sulfur dioxide pollution problems

Heating boilers are mainly small and medium-sized coal-fired ones. Because smoke stack is lower, urban air pollution is relatively serious. Reducing air pollution caused by small and medium-sized coal-fired boilers is the key to improve urban air quality. Therefore manager should seek a method like desulfurization with high efficiency and low consumption to promote the development of district heating system.

(6) The capacity of central boiler room is small which restricts heating system development. Heating system development is uneven such as the use of lots of small-capacity and low efficiency boilers and traditional technology. Manager should reduce the use of traditional technology and small capacity boilers. Manager should promote the use of high efficient circulating fluidized boilers.

3.2 Heating Pipe

3.2.1 Heating pipe trench laying problems

Over the past decades, heating pipe trench utilized laying method. Heating pipe trench lay mainly has follow problems:

(1) Commonly used insulating materials in laying pipeline equipment are: Yanmian, perlite, Kuangmian. Most of them are water absorbent material. These insulation material are soaked in hot or wet water, the insulation effect was reduced and need reparation every year. The pipe was always in heat and moisture conditions underground and this shorten the lifetime and lead to increasing heating costs.

(2) Winding package discount method is used for thermal insulation structure. It has too much joints and heat loss. According to test, in general the thermal radiation measure of joints is 5 times larger than other parts of pipe. In humid condition no. 24th lead wire bund method is used in thermal insulation structure. Lead wire is corroded easily and the insulation layer was destroyed which leads to increasing heat loss. According to survey, heat loss is up to 25 %, each 1,000 meters pipe, it's temperature decrease by 10-20℃.[14]

(3)The laying of the heating pipe trench digging, build trenches, pipe installation, pipe insulation and other construction processes are carried out at the scene. Poor working conditions of construction personnel, construction of cycle length, a great impact on urban traffic, high cost.

According to survey, about 450 million tons of dust and 240 million tons building material are needed to build heating pipe trench every year [14]. A large number of vehicles used in the project caused traffic congestion, road damage, exhaust and

noise pollution.

Therefore, to get more benefits: energy saving, lower costs, shorten the construction period, environmental protection, the traditional trench heating pipe laying methods must be reformed.

3.2.2 Buried heating pipe development

To solve the defects of heating pipe trench laying method in 1930s some developed country such as: Sweden, Finland, Denmark, Germany used directly buried laying method. In Denmark, Finland, more than 90% used directly buried laying method [15].
In Sweden, Finland, Denmark, Germany, Italy and other countries all established one or several prefabricated insulation pipe factories. They used check alarm systems, improved security of directly buried laying pipes. I.C.MOLLEC Company in Denmark and ECOPIPE Company in Sweden are two large prefabricated insulation pipe factories. Their annual production of DN20 ~ DN1200 prefabricated insulating pipe are 1100 km and 800 km. Its products are exported to the United States, Europe, Africa and other countries. [15]

In 1980s heating pipe buried technology gained achievements. Some effective methods in pipe laying process such as: polyurethane foam spray insulation, wrapped the glass and silk around the pipe were used in Shenyang, Jiamusi, Beijing, Daqing, Heihe etc... Harbin, Jixi, Tianjin recommend, dozens of prefabricated insulation pipe from Denmark and Sweden. Harbin established a prefabricated insulation pipe plant.

People's Republic of China Ministry of Construction issued the industry standards of "High-density polyethylene pipe for polyurethane foam insulation of prefabricated Buried" CJ / T 114-2000 and "High-density polyethylene pipe for rigid polyurethane foam pipe insulation prefabricated buried "CJ / T 155-2001 [15].

In 1993, Harbin Building University and Shenyang Thermal Engineering Design

Institute of Construction jointly completed the "Heat pipe buried technical support" research projects and made coefficient test for three typical prefabricated insulation products of Buried Pipe Plant. In 1998, the People's Republic of industry-standard "Urban buried heating pipe engineer point of order" CJJ/T81-98 was implemented.

In 2002 Taiyuan Technology University and Taiyuan heat and Power Company made research on “Friction coefficient of Large-caliber prefabricated directly buried laying heating pipe", the length of the test heating pipes was more than 10 km. Through this research we have got the data for Directly Buried laying method. Half ditch installation is now gradually being replaced by a directly buried laying; the new network has all been adopted (accounts for 40 %). [15]

3.2.3 Advantages of Directly buried laying technology

The 10 years application experiences show that the directly buried laying technology has social and economic benefit:

1. Low project cost:
According to statistics of some project, using dual-control heating pipe, the cost can be reduced by 25% (FRP protective layer) and 10% (high-density polyethylene protective layer) see Table 5

Table 5: Buried trench and pipeline laying heating economic and technical comparison (DN200) [15]

	Heat loss	Coal consumption standards	Project Cost	Maintenance costs	Life
Buried laying	1	1	1	1	4
Trench laying	2．53	2．53	1．06	6．36	1
	Construction cycle	Difficulty	Area	Obstacles encountered	Case of water treatment
Buried laying	Short	Small	small	Less	Construction of precipitation
Trench laying	Long	Big	big	More	For waterproofing treatment

2. Small heat loss, energy saving

Manager use polyurethane foam insulation materials, compared to other normal materials, insulation effect is raised 4 to 8 times see table 6.

Table 6: Insulation material thermal conductivity [15]

	Rigid polyurethane foam	Vinyl asbestos	Foam Concrete	Slag cement Cotton	Yanmian glass wool
Thermal conductivity （W/m.℃）	0.015～0.035	0.116	0.128～0.395	0.081～0.101	0.074

According to Tianjin University research: compared to normal heat preservation material,

the heat loss of "cyanide-buried plastic heating pipe" is reduced by 40% -- 60. [15] According to the research conducted by Beijing Coal Gas Heat Power Designing Institute, using rigid polyurethane foam insulation pipe, reduce the heat loss by 25 %-40 %. [15] Compared to using asphalt cement tile insulation materials.

According to test by Taiyuan Thermal Power Company, using rigid polyurethane foam insulation tubes , the loss in temperature is 1 ~ 2 ºC in each 10 kilometers. [15]

According to statistics from Tianjin Water Supply Company, the coal consumption decreased by 40 %. In 1990s, coal cost was about 1270000000 tons, if manager can reduce 20 % cost, it could save coal 254000000 tons. [15]

3. Anti-corrosion, good insulation properties [15]

Foam is a kind of closed-connectivity pipe material with lots of small hole. It has low water absorption. Moreover, high-density polyethylene protection layer has a good anti-corrosion, insulation and mechanical properties. Therefore, pipe insulation service life is up to 30 years or even longer than the traditional trench laying.

4. Occupying less land, fast construction speed, good to environmental protection

Using directly buried laying technology will not need a construction of a huge trench, therefore it greatly reduce project area, reduce the dust used by about 50 %, reduce the civil engineering and concrete masonry by 80 % and reduce soil ditch by more than 50%. [15] At the same time, manager can reduce the work period by using this kind of technology. On the other hand manager protect the environment by reducing transport of brick, cement, gravel, soil, which could reduce the automobile exhaust emissions, the volume of dust, noise emissions. As the construction period shortens, it will reduce the impact on the human living and traffic situation.

3.3 Heat users

Status

(1) Building energy saving project had been successful:

It had been 20 years since the first energy-saving building design standards was introduced. A number of energy saving houses has been built, e.g.: In Beijing, there were 269 million square meters residential building were built by the end of 2004, of which 65% are of energy saving types. Manager should control the heat load to ensure the temperature in room is in the normal standards.

(2) Users' "energy-saving method" as a priority task achieved much benefits. "Energy-saving method" inspired enthusiasm of users which is an important element for energy saving.

4. The situation in major cities

4.1 Beijing

4.1.1 Background

Beijing is located in the northwest of North China Plain, middle-altitude zone, with the typical continental monsoon climate of semiarid and sub-humid of warm-temperature zone.

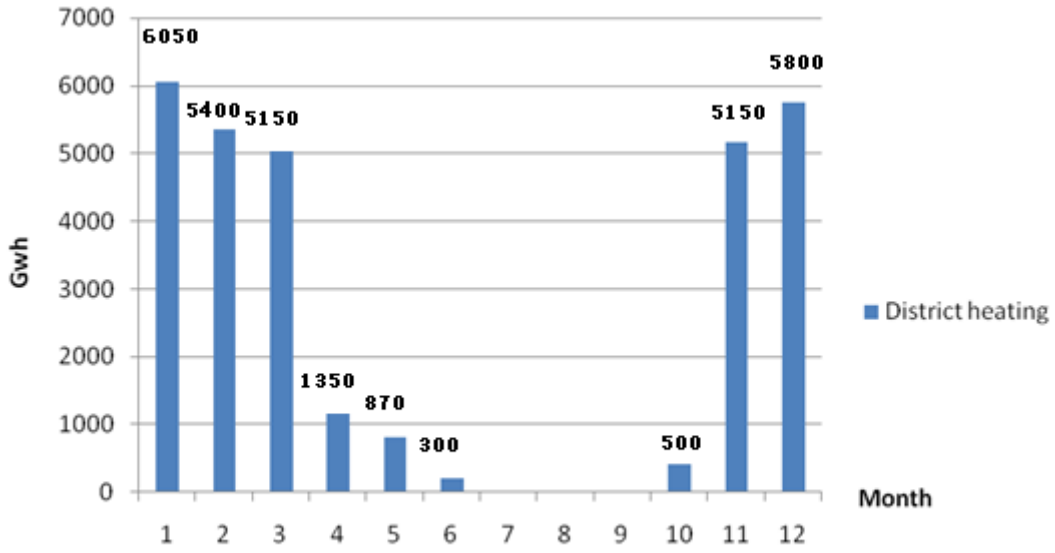

Figure 5：Heating period in Beijing [16]

Winter in Beijing is from the last ten days of October to the middle ten days of March next year. Annual average is 160 days. (National regulation states that the heating season in Beijing City is from Nov. 15th to March 15th next year.) Therefore, heating in winter has become the basic living requirement of residents in northern areas.

4.1.2 Heating status

A tremendous heating pipeline network was buried underground of Beijing, east-west direction as main line running through between 4th East Ring Road to 2nd West Ring Road. Main lines include Chang'an Street (2 lines), Ping'an Avenue, Chaoyang Road,

Chaowai Street, Guang'an Street along Liangguang Road as well as the line from Shijingshan to Chaoyang Park, etc. Branch lines are in south-north direction, shunting the hot water or steam from main lines. Branch lines extend widely with many intersections, occupying most place of pipeline distribution map of heating group.

Figure 6: Heating network in Beijing [17]

Heating pipeline network connects radiators of innumerable homes on one end, and 8 heating resources of heating group on the other. It can be divided into CHP and heating plant on the basis of heating resources. Heating pipeline network of heating group connects 4 CHP including Beijing Guohua Cogeneration Power Plant, Second Thermoelectric Plant, Jingneng Thermoelectric Plant and Huaneng Beijing Thermoelectric Plant. They are main heating resources of heating pipeline network. Heating pipeline network connects 4 Heating Plants including Zuo Jiazhuang Heating Plant, Fangzhuang Heating Plant, Shuangjing Steam Plant and Shuangyushu Heating Plant. Heating capacity is given in the table below:

Table7: Heat capacity of current state table [18]

Heat source name	Power capacity	Design heating capacity		Design hot water heating area	Heating area
	kW	Stream	Hot water		
		t/h	MW	10^4m^2	10^4m^2
Guohua Beijing Thermoelectric Plant	750000	700	930	1333	1003.5
Huaneng Beijing Thermoelectric Plant	8950000	500	1349	1933	1948.5
Zuo Jiazhuang heating plant	400000		349	500	
Fangzhuang heating plant	350000		290	417	
The second power plant	650000		698	1000	971
Shijingshan Power Plant	550000		698	1000	1625
Shuangyushu heating plant	475000		349	500	
Shuangjing steam plant	400000	120			
Total	4470000	1320	4663	6683	5548

Note: 1.heating area in the end of 2001

2.Steam heating area is 5,488,000 ㎡

At present, the heating methods in Beijing are mainly supplied by heating supply network, coal burning boiler house and fuel gas boiler house, has basically formed the new heating situation of district heating oriented together with multi-energy and multi-heating methods. By the end of 2006, there were over 3000 heating units, 5593 boiler houses, 18324 boilers in Beijing. The total heating area was 518.15 million m^2 and the total length of heating pipeline network was 17,000 km. The following table is district heating data from 2003 to 2006. [19]

Table8:2003-2006 Heating situations in Beijing [19]

Target	2003	2004	2005	2006
Steam supply capacity (t/h)	3816	1384	2297	620
Hot water supply capacity(MW)	3406	23706	30115	30546
Total heating steam (10^5GJ)	22646	1071	812	619
Hot water volume(10^5GJ)	11565	12436	15142	15189
Steam pipe length (km)	245	108	173	35
Hot water pipe length (km)	4419	5107	6272	7013
Area of district heating(10^4m^2)	25107.8	28150	31736.2	34977.1

There are 4 kinds of heating prices: RMB 24 Yuan/m^2/heating season for district heating of city pipeline network; RMB 30 Yuan/m2/heating season for heating of clean energy such as fuel gas, etc.; RMB 16.5 Yuan/m2/heating season for users directly supplied without heat exchange, RMB 19 Yuan/m^2/heating season for users indirectly supplied with heat exchange, for the prices are different according to direct supply or indirect supply of coal-burning heating.

4.1.3 Existing Problems

[1] Great imbalance between supply and demand

Beijing did not focus on new large-scale combined heat and power projects. The construction of thermal source has greatly lagged behind city construction; there appears therefore increasing imbalance between heat supply heat demands. Fuels used for heating in Beijing are mainly coal and natural gas. Due to limitation of natural gas supply, the price of energy has been increasing, so the development of urban heating is facing heavy pressures of population, resource, environment and economy.

[2] Absolute unreasonable facility layout, serious waste of heat supply resource

Management system of heating in Beijing gives priority to logistics department, Beijing has 3894 heating units and 5346 heat source, 90% of them are owned by different industries and departments, it is very hard to manage. Greatly dispersive management system resulted in decentralized management of urban heating sources, unreasonable facility layout and serious waste of resource.

[3] Low efficiency of operational management, further improvement has to be made on heating and energy saving.

For the time being, energy consumption of heating with unit building area in the city is 2 times more than that of in developed countries with similar climate; average operational efficiency of coal burning industrial boiler is 55%—60%, 20-25% lower than international advanced level; average operational efficiency of gas burning boiler is 80%, 10% lower than international advanced level. [20] The efficiency of energy utilization is far away from that of foreign countries, so there are huge potentiality of energy saving.

[4] Loose management of heating development, disorder of construction of heat source.

Because of historic limitations and dispersive gas utilization, natural gas has been enormously used for partial and dispersive heating under the direction of policy of structural adjustment of city energy and environmental protection. However, in the accreditation of newly established heating projects, the accreditation of project planning and heating management have disjointed, which caused the construction of heating facility in the city lacking unified sector planning guidance, and the construction of heating project is staying in aimless and disordered condition in a sense.

[5] Heating system reform lags behind and heating market has not taken in shape.

Current welfare system of heating and the prevailing charge mode for heating has not taken heat consumption into consideration, making heating units, heat users and construction developers not so motivated on energy-saving. So it is difficult to form the heating energy-saving system and has largely restricted the sustainable development of heating. In Beijing, heating rules and regulations have not been well established. It can be seen from those above that it is not the time for realizing Market-oriented of heating in Beijing.

4.1.4 Development

Plan for Heating Development during the period of The 11th Five-Year Plan in Beijing City has put forward guiding ideology, principle and objective of the development of heating and determined planning scheme, major task and safeguard measures of heating.

[1] Heating Plan

To set up heating area, heating mode and proportion during the 11th Five-Year Plan in Beijing City based on satisfying the demand of heating load.

Table 9: Beijing Municipal Planning heating methods and heating area tables [20]

Ways of heating	Year 2010	
	Heating area($10^4 m^2$)	%
Heat supply network	13347	22.4%
Coal-fired boiler heating	16580	27.9%
Gas-fired heating boilers	26700	44.9%
Others	2873	4.8%
Total	59500	100%

<1> Heating Plan for 8 districts in the city

8 districts in the city mainly adopts district heating by heat supply network, gas heating and district heating by large scale coal burning boiler house, supplementing with

heating by new and renewable sources of energy. It is planned to develop district heating by city heat supply network, to make the gas replacing small and medium coal burning boiler house, upgrading large scale coal burning boiler house to improve environmental protection and strengthen heating capacity to supply heat for surrounding areas;

<2> Yizhuang Economic Development Zone and Heating Plan for Towns and Counties in Outer Suburb

The plan include merging small coal burning heating boiler house, development of large-scale coal-fired boiler room, promoting the application of clean coal burning technology, upgrading the existing district heating boiler house, improving environmental protection and expanding heating capacity and in major new cities, gradually increase the proportion of clean energy supply.

In Yizhuang Economic Development Zone, government is planning citizens heating area of 198.30 million m^2.

<3> Heating Plan for Towns and Counties in the Village

During the period of The 11th Five-Year Plan, the heating in towns and counties in the village must be deeply investigated and the heating method suitable for actual circumstances in the village should be applied. The method may include heating by new energy like solar energy, methane, etc.

<4> Heating Plan for Historical Cultural Conservation

Heating in historical cultural conservation mainly adopts natural gas and district heating by city heat supply network; it can also adopt heating methods such as energy storage, heat pump, etc.

[2] Balance between supply and demand of energy

According to planned heat load, it has been estimated that the amount of coal consumption for heating by coal burning boiler house in the city in 2010 is 3.68 million

tons standard coal and the amount of gas consumption for heating by fuel gas boiler house (including wall-hung boiler) is 2.86 billion m^2. Basically, there is a balance between supply and demand of energy. [20]

[3] Major Projects

The “11th Five-Year” Plan, Solar Palace and Zhengchangzhuang Thermoelectric Plant were newly established. Large scale heat sources like Huaneng Thermoelectric Plant and Jingfeng Thermoelectric Plant are rebuilt and expanded. The Government is integrating heating resources and transforming old pipeline network. In Yizhuang, it has been given priority to implement projects of newly building and rebuilding large scale boiler house.

[4] Environment

Modifying existing heating facilities by means of some measures like resource integration, energy saving modification, application of clean coal burning technology, etc. Compared to 2004, in 2010 coal-fired boiler heating will reduce: dust emissions by 934 tons, SO_2 emissions by 2862 tons, NOx emissions by 5724 tons and 160,778 tons ash emission reductions. [20]

4.2 Heilongjiang

4.2.1 Background

Heilongjiang province is located in a severe cold district. As one of the coldest provinces in China, it is characterized by high altitude, long winter, average latitude of 48.5 degree and considerable temperature difference. The heating time often lasts for about 182 days. The annual heating time reaches a length of 6-7 months. Due to the tough nature conditions, heating is needed to satisfy the people's living and working demand for more than half of a year. Heating in city has become the citizens' focus, for it is an important issue concerning the vital interests of all citizens. Helongjiang government highly valued heating issue and adopted a series of effective measures to make the city's heating because achieving long-term development.

4.2.2 Situations of heating

All cities in Heilongjiang province have house building area 633.221 million m^2, including actual residential area 445.556 million m^2. [21] Main heat supply method is district heating (CHP, regional boiler house, and industrial waste heat), scattered heating by boiler house (all kinds of small boiler houses), unit or single household heating (fuel oil, fuel gas, electric radiator, electric thermal film, coal-fired home electric radiator, etc.). After decades of development, district heating and cogeneration in Heilongjiang province have grown by leaps and bounds, nearly 38% of cities have achieved cogeneration, over 50% of cities have achieved district heating or heating by regional boiler house.

Table10:2003-2006 Heating situations in Heilongjiang [21]

Target	2003	2004	2005	2006
Steam supply capacity (t/h)	5993	5690	5937	4365
Hot water supply capacity(MW)	2524	22646	23952	23805
Total heating steam (10^5GJ)	20493	2479	2496	2010
Hot water volume(10^5GJ)	20814	24082	24076	24576
Steam pipe length(km)	532	519	603	405
Hot water pipe length(km)	7451	9923	10064	10442
Area of district heating(10^4m^2)	19944.3	22707.3	24397.4	26056.9

From 2003 to 2007 the area of district heating increased over 95 million m^2. Heating area of scattered boiler house occupied 56% of urban heating area in the province. Unit or single household heating by fuel oil, fuel gas and electricity accounted for 3%, [21] coal-fired home electric radiator accounted for 3%. Heilongjiang is a major province in producing coal, its energy mainly consists of coal-fired structure, so coal will still be key energy for heating in our province for a long time.

4.2.3 Heat Price

Since July 2005, heat price has been successively adjusted in 8 cities including Harbin, Qiqiha'er, Jiamusi, Jixi, Shuangyashan, Hegang, Qitaihe and Suihua in Heilongjiang province, in which the highest adjustment range appeared in Suihua with the increase by 42.35%. Average increase in 8 cities was 25.75%, increased RMB 7.42 Yuan/m^2 based on utilization area.

Table11:13 Heilongjiang urban heating prices case [22]

City	According to the construction area of charges(Yuan/m2)	By the use of space(Yuan/m2)
Jiagedaqi	30	46.14
Daqin	26	39.99
Qiqiha'er	26	39.99
Shuangyashan	25.5	39.22
Heihe	25	38.45
Jiamusi	24.8	38.14
Suihua	24.2	37.22
Jixi	24	36.91
Hegang	23	35.37
Yichun		35
Harbin		35.55
Mudanjiang		34.26
Qitaihe		33.53

Residential heating price in town and county-level city is totally charged at personal expense with the fee collecting rate above 95%, so there is no difficulty in collecting fee and supplying heating. Residential heating price in above prefecture-level city is

mainly charged at the company's expense, personal charge only account for 10—30% of total heat price. Difficulties in collecting fee and supplying heating mainly happened in cities above prefecture-level. Especially Harbin, as a megalopolis city influenced by many factors, has quite a lot of problems in urban heating.

First, collecting heating fee is difficult; it has been the prominent problem at present. As a result of arrears, heating enterprises have been deeply in debt, unable to pay for raw materials such as coal, water, electricity, etc. Lots of old heating facilities with overload cannot be upgraded in time, hard to operate normally, so heating quality and security were difficult to be guaranteed;

Second, the heat price and payment system are not suitable for the requirement of market economy. Citizen’s salary income in Heilongjiang province is lower than other provinces, but heat price accounts for 10—20% of their income, especially the lay-off workers from some closed or bankrupt enterprises are more unlikely to pay expensive heat price.

Third, the speed of reform in heating enterprises is slow with low efficiency, lacking competitive awareness;

Fourth, heating method lags behind; fifth, the strength of administrative management of government is not strong enough, Unbar Heating Regulations in Heilongjiang Province and relevant provisions have not been completely implemented.

4.2.3 Developments

The reform of heating subsidy "Turning Invisible Subsidy to Open Subsidy" have been totally completed in Heilongjiang province by the end of 2008 and kept on improving heating metering, heating insurance and heating quality. At present, reform of heating subsidy "Turning Invisible Subsidy to Open Subsidy" has been completed in 10 cities including Qiqiha'er, Jiamusi, etc, the reform is accelerating in Harbin, Mudanjiang and

Jixi and will be completed at the end of this year.

Plan for Project "Three Supplies and Two Governance" in Heilongjiang province suggested that newly increased heating area 100 million m^2, The urban district heating realized 70% of the goal, as well as vigorous expansion of district heating in small and medium cities, plan for district heating project .

In 2008, in the face of rising coal prices, Helongjiang province positively took measures to ensure stable heating. Integrating heating resources vigorously develop cogeneration, adopting merger, buying shares to help heating enterprises.

Government has set up service enterprises specialized in heating business in each city. They vigorously strengthen district heating, speeding up the rebuilding construction of district heating pipeline network, improving the security, technology and management of heating facilities to ensure heating security.

Since 2008, all new heating buildings must be equipped with heat measurement and indoor temperature regulator. Heat source, heating power station and pipeline network of all new heating projects must be equipped with metering equipment and control equipment like hydraulic equilibrium, climate compensation, frequency conversion, etc.

Transforming heating system of existing non-energy saving buildings and completing transforming area 4 million m^2, government agencies and other public office should take the lead in the completion of the construction transformation heat metering.

Strengthening heating security system to ensure heating for low-income families; ensuring right appropriation of financial special funds in the cities with urban heating security system.

4.3 Tianjin

4.3.1 Background

As a coastal open city, Tianjin is moving to the international metropolis gradually, which is an ancient and young city. Winter heating is started from November 15, every year in Tianjin. Moreover, Tianjin government insists on paying great attention to "Improve public facilities and increase supply of water, gas, electricity, heat as one of the 10 tasks of improving urban life" every year unremittingly. The city heat supply has got considerable progress in Tianjin, since Tanggu Dalian Road heating station was built in 1981.

4.3.2 Situations of heating

Table12. Heating situations in Tianjin [23]

Target	2003	2004	2005	2006
Steam supply capacity (t/h)	3234	3407	3294	3325
Hot water supply capacity(MW)	1486	10111	10563	11753
Total heating steam (10^5GJ)	9390	1764	1966	1728
Hot water volume(10^5GJ)	6191	6530	7572	8220
Steam pipe length(km)	439	402	415	346
Hot water pipe length(km)	6948	7636	14040.9	9057
Area of district heating(10^4m^2)	10786.9	11441	3294	15140.6

The heating rate was 47.7% in 2003; the district heating area of the city increased to 151406000 m^2 in 2006 and heating rate has reached 90% by the end of October, 2006. Tianjin determined heating goal of this year in 2008, the heating area will reach 185.6 million m^2, and 12 million m^2 is added compared with that of 2007. The rate of district heating will reach 92.5% in Tianjin at the end of this year, which is at the national leading level. [23]

[1] Existing heating boiler [24]

There are 437 boiler houses with total capacity of 6674 MW, more than 850 heating boiler, 480 chimneys in central urban area of Tianjin currently. In addition, there are 212 boiler houses, 434 boilers for industrial production in Tianjin, the total capacity is 1 087.7 MW.

Table13: Central urban area of Tianjin existing heating boiler [24]

Target	Boiler Number	The number of Boiler Room	Total capacity(MW)
7 MW and below	84	286	1 458．8
7～10．5 MW	178	78	1 375．5
14 MW and above	188	70	3 840．2

[2] Existing CHP

At present, there are 3 CHP as the heat source of district heating in Tianjin including Tianjin First Thermoelectric Plant, Chentang Village Power Plant, and Yangliuqing Thermal Plant:

Tianjin First Thermoelectric Plant: is located in center of Tianjin and close to Hai River. It was founded in 1937, converted to CHP in 1986; it is the earliest plant that achieved cogeneration district heating in Tianjin. The total capacity is: 1.3 MPa Industrial steam, including 189 MW for heating and 151 MW hot water heating. The total heating area is about 5000000 m^2. Annual heat supply capacity is 5 780 614 GJ and annual steam supply capacity is 1 512 331 t. [24]

Chentang Village Power Plant: is located in the south of Industrial Zone, Chentang Village, Hexi District, and Tianjin City and within the Outer Ring of Tianjin. The first

phase of construction of power plant was completed and put into operation in 1996. The plant has industrial steam heat supply capacity of 1.3 MPa, heating heat supply capacity of 203 MW and heat supply area of about 3000000 m^2. The annual heat supply capacity is 2 148 252 GJ and the annual steam supply capacity is 414 000 t. [24]

Yangliuqing Power Plant: is located in the east of Yangliuqing Town, Xiqing District, Tianjin City and outside the Outer Ring of Tianjin, it is far from Tianjin downtown about 6.5 km and Tianjin West railway station about 10 km. The heating unit of power plant was completed and put into operation in 1998, which adopts hot water heating with heat supply capacity of 2 × 349 MW. Yangliuqing Power Plant is mainly in charge of district heating of Nankai District, Hongqiao District and Heping District, its heat supply range reaches Ziya River on the north, Nanjing Road and Duolun Road on the south, Hai River on the east, Outer Ring on the west.

In the end of 2003, the length of the district heating pipeline has reached 7, 387 km. The main heat distribution network and the status is shown below.

Table14: The existing heating network case [24]

	Power plant	pipe network pressure(MPa)	Temperature
Steam pipe system	Tianjin First Thermal Power	1.3	300 °C.
	Chen Tang zhuang power plan	1.3	300 °C.
Hot water pipe network	Tianjin First Thermal Power	1.3	120 °C.
	Thermoelectric Plant Chen Tang Zhuang	1.3	120 °C.
	Liu Qing power plants	1.4	130 °C

4.3.3 Problem

[1] Structure of heat source and power source is unreasonable

The city development and construction is fast, but cogeneration project has long construction period and large investment, so coal-fired boiler rooms become the main

heating source in Tianjin currently. Tianjin city heat and energy supply structure is shown in figure 7.

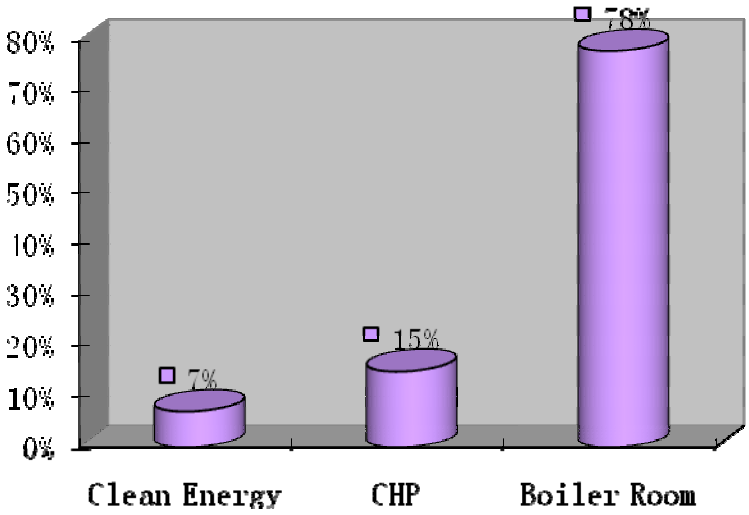

Figure 7: Heat (energy) structure [24]

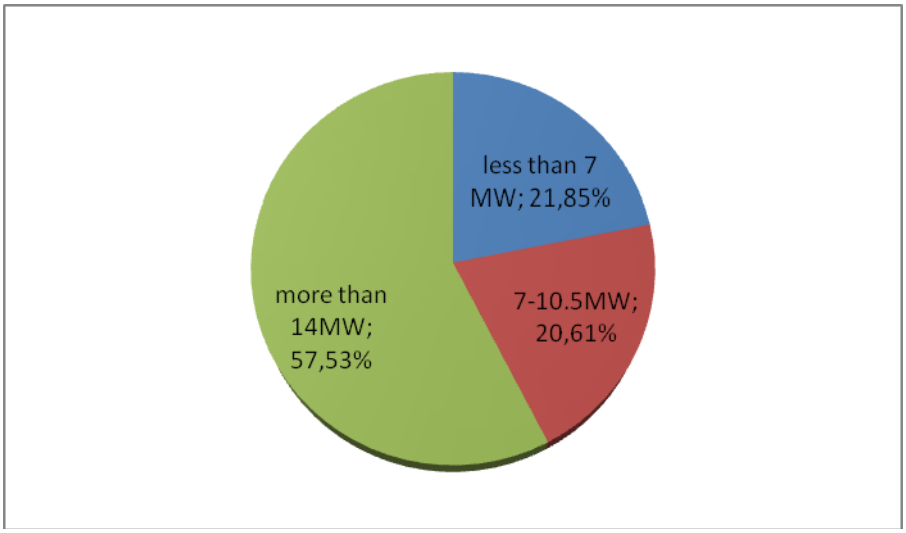

Figure 8: Existing boiler capacity and their share of the total [24]

Small boiler has features of small scale heating, large coal consumption, energy waste, high operation cost and difficult environmental protection control.

[2] Layout of heat source and heating network is unreasonable.

Because urban heating planning is delayed, the demands of urban district heating

cannot be met adequately. There are 437 boiler houses, over 850 heating boilers in Tianjin central urban area, including 484 boilers with capacity of 7 MW and below, 286 boiler houses. These heat sources are scattered in the central urban area and belong to different enterprises and management departments, and the heating scope is cross. The layout of heat source is small and disorderly, so the unreasonable layout of heat source leads to the irrational layout of heating network inevitably.

[3] Low efficiency of operational management and operant level

At present, the staff of Tianjin heating station has low average educational qualifications and irrelevant major; moreover, most actual operators do not have the relevant expertise, which is not only a serious issue, but also one of the major reasons caused to occur other relevant issues.

[4] Aging heating facility and inadequate maintenance

Heating facilities are in need of urgent replacement because of aging, especially the heating equipment and its accessories; moreover, these facilities do not get good maintenance usually, which cause many problems such as damaging insulation layer of pipeline, reducing heating performance, rusting valves of pipeline and other accessories seriously, etc. So the damage caused by various factors shortens the service life of heating facilities greatly.

[5] Serious environmental pollution

There is a certain gap between atmospheric environment quality of Tianjin central urban area and Grade 2 of "Ambient Air Quality Standards" which should be met, and the extent of pollution during the heating period is higher than that of non-heating period.

In 2004, the annual average of SO_2 mass concentration in Tianjin (central urban area)

was 0.069 mg/m^3, which exceeded 15% of the national annual average Grade 2 Standard; it was 0.126 mg/m^3 in heating season and 0. 029 mg/m^3 in non-heating season, [24] the pollution was very serious.

Moreover, statistical data of 2005 and 2006 indicated that SO_2 pollution index of Tianjin has been declined gradually in past several years, but there was a rebound in the last two years, it was serious in every winter especially.

SO_2 pollution index in heating period is higher, which is caused by running many coal-fired boilers in winter without desulphurization facilities or unqualified daily desulfurization.

4.3.4 Prospect

The Tianjin government has decided to finish the projects of heating measurement and energy-saving reform for existing residence buildings of 13 million m^2 in two years. This "Program" required to achieve the goals of heating with saving of coal by 30 % and summer air-conditioning with saving energy by 30% by implementing energy-saving reform of heating system, reform of heating measurement system, improving heating efficiency and reducing heating load.

In Tianjin, there are 381 small heating boilers with low capacity. In order to safeguard atmospheric environment, all of small boilers will be dismantled in this year and next year. To achieve this goal, the urban heating office make many efforts to reduce pollution and improve efficiency, such as strengthening inspection and check heating units and enterprises, formulating incentive system and check system, encouraging to update equipment. Heating office will focus on supporting some heating enterprises as well as perfect measures of energy-saving and emission-reducing, merger and treat small boilers to reduce and remove small boilers.

5. Discussion and Suggestions

Heating system consists of heat source, network, users and several components. It is a complex system. In order to make heat production, transmission, we need to look at the entire system to save energy and improve efficiency. So we want to talk about energy saving ways of boiler room, heating network, users, and other aspects.

5.1 Boiler room and heat transfer station

Industrial boiler is the main equipment in district heating system; it cost too much energy, especially coal consumption about 40%. The efficiency is about 60%. The boiler aid equipments consume much electrical power, but we could save energy.

5.1.1 Selection of boiler equipment design

The selection of the boiler room design and the type of boiler equipment is a core part. When user select the types of the boiler, energy saving is the main element. The following parts are some suggestions [28]:

- Determine the boiler equipment capacity through a rational calculation and render the load curve analysis.

- Choose boilers according to coal. If the type of the boiler does not match the burning coal, there will be incomplete combustion, causing serious shortage of boiler output, low thermal efficiency, and energy waste.

- Determine the boiler models and number; make the boiler running efficiently as far as possible.

When Producer selects auxiliary or electrical equipments, they need to choose the new energy-saving equipment firstly, then the boiler operating conditions according to their

fans and pumps, in order to avoid resources wastage.

5.1.2 Improving the technological operation and enhancing the technological management

- Improving combustion efficiency and stability

- Maintain the heating surface clean, raise heat distribution efficiency, and strengthen water management.

- Adjustment the circulating pump operation numbers:

The heating system includes primary water system and secondary water system. The water systems commonly use large flow and small temperature difference operating modes. The actual temperature of supply running water is 10 ~ 20 degree lower than the plan temperature, the recycle water increased 20 - 50 %. On this situation, the circulating pump electricity cost is increasing fast, the transport capacity of network is declining, and the heat exchange equipments of heat transfer station are increased. Therefore, Managers should improve the management method in heating system.

- Adopting new technologies

<1> Frequency Control technology

When producer selects type of boiler, they must base on the rated load of the boilers, because fans and pumps are the major electrical consuming equipments. The Air volume often changed when blower are operating. So Producer use Frequency Control technology to adjust the electrical power, it could achieve energy-saving; The Grate Motors use the Frequency Control devices, it could control the speed of grate motors, and achieve the best burning conditions, by this method they can improve the thermal efficiency of the boilers. With the growing implementation of the household metering policy, the network traffic system will also change. So installed water pumps on

frequency device is also very necessary. The use of the technology, fans and pumps save the energy by 30% - 40 %.

<2> Use stratified coal plant

Use stratified coal plant device to pick out the coal before it comes into the boiler. When the coal comes into the boiler, the big blocks stay in the lower part, the small blocks stay in the middle part, and the upper be the end of the reasonable distribution of coal. This equipment improves the boiler combustion conditions significantly and it reduces the amount of carbon leakage and the grate of coal, which can increase the burning efficiency more than 8 %.

<3> Promoting the Sulfide Bed Technology

The main characteristics of the circulation sulfide bed boiler is: burning the fuel and desulfurization agent in the furnace several times, during the cycle of repeated low-temperature combustion and a desulfurization reaction furnace turbulent campaign strongly, so that the fuel can reach the burning rate over 97%. Moreover, circulating fluidized bed boilers have the advantages of wide applicability, load regulation performance, and comprehensive utilization of ash.

<4> Boilers' Self-Control

Computer Monitoring System not only can complete the conventional instrumentation functions, but also can automatically track outdoor temperature changes, adjust operation load, monitor combustion system and to maintain the furnace pressure, regulating water supply system. In that way, the boiler can be operated more securely and at high efficiency.

Installing the water flow control equipment at the entrance of heat transfer station, will solve the hydraulic imbalance problem in water system. Uses of advanced heating units according to outdoor temperature regulate the supply water's temperature and heat to reduce waste of energy.

5.2 Heat network systems

Heat network system is the bridge between the source (boiler room) and the users. People should use some method to save energy.

- Use Regulation Balance Technology

The heat network system connects many heat users. Although people use some method like: adjust pipe diameter and control valves to make hydraulic balance calculation, it is still difficult to meet the requirements of pressure balance standards. The final balance is achieved through the pressure of the redistribution flows of users.

- Promoting the Directly buried laying and reducing the basis investment and operation costs

Directly buried laying is better than trench laying. Because it not only saves the land for construction, maintenance and investment projects, and it can also reduce the workload. Because of the use of a very small thermal conductivity of the rigid polyurethane foam insulation materials, heat loss is significantly less than trench laying.

China should make use of new insulation materials for directly buried laying. This technology can reduce the cost for heating pipes, flanges, valves and accessories; it can also reduce the heat loss in heating pipe network.

- Preventing too much polluted water of heating system.

Heating system is a closed cycle system. In the normal operation system, there will be a small amount of water leakage; water loss .The loss of water should generally be less than 1 % in water cycle.

However there are some problems in operation: there is too much polluted water and

a large amount of water and energy was wasted. So we should step up publicity, education and management and use some method like: leak-proof, leak investigation, plugging etc. to reduce the water wasted.

5.3 Heat users

Heat users are an important part of heat thermal system. The heat users not only should use necessary wall insulation, roof insulation and energy-saving windows and doors, but also try their best to improve heating efficiency.

- Establishing a concept that heat is commodity.

In the long terms, in most parts of China the government implemented the welfare heating system, so that the users' energy-saving initiative is not high.

Government should use some equipment: heat measuring instrument and heat distribution measuring instrument, etc. establish and improve user fee system. This policy will save 20 - 30 % energy. People must obey the economical laws and take heat as commodity. It should be controlled by the user. By this way the users could save energy.

- Promoting two-household system actively and creating the conditions for charging:

With the installation of heat to each user, and the beginning of metering and charging, One-pipe systems does not enable installation of the temperature control equipment and can not carry out heat metering so it is no longer used in the heating system.

When the use of temperature radiator, Twin-tube system is easy to be adjusted and control the household. So government should promote using Twin-tube system.

6. Development Perspectives and Plan

China's district heating technology development prospects:

During the past 20 years, district heating system has been improving rapidly. 268 cities had built district heating facilities. The district heating area has reached 865.4 million square meters. [26] Accompanied with expansion, new technologies, new materials, new equipment and new technology had been continuously applied.

In the technological innovation period, China should speed up the transformation and applications of scientific and technological achievements. Improve heating technology, equipments, construction and technical management level.

To achieve heating and technological progress, there are two important aspects:
First, establish perfect technology development system;
Second, promote new energy-saving heating technology.

6.1 Technological innovation system construction

- Our country should build a technological innovation system according to their characteristics and conditions of heating enterprises. China should set up regional heating technology development center; learn the new heating technology from other countries.

- The government should promote the cooperation between different institutes: Open up new technology and attract best scientific and technological personnel working in heating enterprises.

- Increased technological development investment, our government should come up with more than 5 % funding for scientific research and development in enterprises.

- The government decided to change Thermal Design Institute to scientific and technological enterprises.

The government will form fund foundation for urban heating technology development, give special support to encourage enterprises to set up heating technology development center, promote the technological exploitation and achievements conversion. Moreover, the government will form two or three Research Institutions to promote the development of heating technology.

- The government will publish policies to encourage technological innovation.

According to Chinese actual conditions, our government should develop technological innovation policies and regulations as soon as possible, including: technical innovations, assets evaluation, technology management, provide a reliable legal protection for technology innovation.

- China should carry out popular science education; encourage workers get scientific and technical knowledge, scientific methods and scientific thinking.

6.2 District Heating Technology Development Outlook

The district heating companies will transform their management from extensive management to their products' qualities in ten years. The improvement of the district heating efficiency depends on the development of innovation and promotion, specifically in the following areas:

(1) The Improvement of The Self-control Heating System

The government will use the self-control boiler system, automatic control heat transfer stations and unmanned automatic system widely. The use of automation will not only guarantee the reliability of the heating, but also improve the heating efficiency.

⑵ The proportion of heating units becomes more important

Because some cities did not meet heat load increase problem, they are building more than 100 MW capacity stand-alone heating units. At the same time, heating units more than 200 MW are being built in Taiyuan, Beijing, Shenyang and other cities. The proportion of large-scale heating units will be increasing.

⑶ The development of the cities' heat, electricity and cold units

With the development of cities' construction, China need build buildings with both heating and cooling system. Some cities use thermoelectric plant to CCHP. In summer, heating load increases, so it can improve the efficiency of CHP.

⑷ The implement of household measurement

Household metering

When the council publishes the "People's Republic of China energy conservation law", All of us are beginning to realize that reducing energy consumption is important.

⑸ Promoting the circulating fluidized bed boiler

Circulating fluidized bed boiler has some benefits: high thermal efficiency, coal wide adaptability, low-temperature combustion chamber and generating less nitrogen oxides. Because it has so many advantages, the government had spread the CHP and district heating boiler room widely. At present, nearly 200 circulating fluidized bed boilers are in operation.

(6) Promote boiler energy-saving technology

The use of boiler automatic control, combustion control, frequency control of water pumps and fans, efficient economizer etc. will reduce energy consumption and other indicators.

(7) Use clean energy

As people's living standard is improving and the environmental awareness is enhanced, oil, gas, coal slurry and other cleaner fuels are replacing coal. The engineer began to develop gas - steam combined cycle power generation in some cities. CHP had reached our goal: high efficiency, energy saving, reducing pollution.

(8) Heating energy development is rising

Utilize geothermal, nuclear, heat pumps, waste incineration, biomass etc. The utilization of heating energy structure adjustment, environmental and economic benefits are obvious.

<1> Geothermal

The earth is an enormous energy storehouse and it contains a large amount of heat. Geothermal stores about 170 million times heat than coal combustion. [27] People don’t need to burn any fuel, even save a huge complex transport and fuel combustion system by using geothermal. Moreover using geothermal energy helps to avoid environmental pollution. It is a clean and cheap energy. There is a large number of geothermal resources in some provinces such as: Shandong Peninsula andLiaodong. Using geothermal energy could improve heating energy structure and reduce pollution. [27]

<2> Waste burning

Thermal energy generated by waste incineration can be used to heating or power generation. Municipal solid waste as a new energy is conducive to the protection of the environment, and get better value for money.

<3> Nuclear:

Nuclear energy is a new energy, fuel calorific value and the coal calorific value is 2700000:1. The reactor heat is more safely; it can be close to the city and heat users. Significantly lower investment costs. [27]

<4> Heat pump technology.

Heat pump converts low-grade heat in water, air, soil into high grade energy andsavecoal. During nearly a century development, heat pump technology is almost perfect. Heat pump unit has entered to homes, public buildings, plant to meet air-conditioning, heating, and hot water demand. Heat pumps technology had been used in Shanghai, Guangzhou and other southern cities. [27]

7. Conclusion

Although our government had gotten some achievement, but the district heating development is still a long period hard project. Establish and improve district heating systems, strengthen management method, applying right policies are basic demand. Our country need to achieve high efficiency, low consumption heating system construction.

At the same time, power plants should use advanced technology and equipments to ensure high efficiency and low costs in producing process. Avoid new energy waste and strengthen operation training, improve staff‘s education and operational level.

Energy-saving and environmental protection is two important elements to achieve sustainable district heating system development. Our government use energy-saving method in district heating system to reduce energy consumption and environmental pollution.

Hence, exploitation renewable energy using in district heating system not only could improve efficiency but also protect the environment. How to reduce energy consumption and keep the heat balance are still problems, both the government and district heating institute will pay more attention to these problems, and improve district heating level in China.

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