Low-carbon City Construction Based on Large-scale Thermoelectric Cogeneration

1. Background of the program

In recent years, with the fast development of Chinese economy, carbon emission also increased. According to data collected by the International Energy Agency, China has surpassed the US in carbon dioxide emission in 2007 and has become a country with the most emission. Underdeveloped energy utilization and increasingly growing demands of urban development for thermal and electric power are the primary causes of fast increasing carbon emission. Coal is the non-renewable energy resource most frequently used in China. In 2008, Chinese consumed about 2.8 billion tons of coal, of which around 90% was burnt directly as a fuel [1]. The situation will continue for a long time. Therefore, how to satisfy the demands of urban development for thermal and electric power as well as effectively control carbon emission have become a factual problem and an important means to cope with global climate changes.

In most areas of North China, heating is mainly dependent on small-sized coal-burning boilers and partial heating duty is taken by thermoelectric units. The energy-inefficient heating system of the small-sized coal-burning boiler, which usually causes serious environmental pollution, is the chief reason for unqualified urban ambient air quality in winter [2]. In addition, although China's thermoelectric cogeneration industry has reached a certain scale and made understanding contribution to energy conservation and environmental improvement, serious problems still exist: Firstly, the thermoelectric units are generally small. In recent years, although some 300,000kW large-sized thermoelectric units have been put into operation, the small thermoelectric units still account for a higher percentage. The small thermoelectric units have no obvious energy-saving advantages, so the centralized air pollution control facilities won't function well. Secondly, the lower thermoelectric ratio, i.e. disproportional heat load on production and heating, increases the costs of thermoelectricity and decreases energy-saving effect [3].

Therefore, based on the profound ponder over the present situation of the Chinese energy mix and urban heating system, we propose a low-carbon city construction plan for

which large-scale thermoelectric cogeneration systems are used to reduce energy consumption and carbon dioxide emission. We have carried out the preliminary practice in Yingkou, Liaoning Province. This is an energy utilization scheme in combination with the urban development planning, imbuing with forward-looking unified planning, and satisfying the demands of urban development for thermal and electric power with large-scale thermoelectric units on the basis of making full use of all industrial heating sources,. It has achieved a maximum reduction of energy consumption, reduced carbon emissions, providing an effective premise for the installation of centralized carbon-capture devices in the future.

2. Present situation and existing problems of Yingkou's heating system

Yingkou is a Municipality in Liaoning Province, located in the northeast Liaodong Peninsula. Figure 1 shows Yingkou's geographical location. The city covers an area of 5, 402 square kilometers with a total population of 2,305,000. The city governs four districts (Zhanqi, Xish, Laobian and Bayuquan) and two counties (Dashiqiao and Gaizhou). In recent years, Yingkou has had a fast economic development with an average annual GDP growth of over 20%. In 2007, the city' GDP topped CNY 56,887 billion and ranked fourth in Liaoning Province. Under the great pressure of fast economic growth, the major industrial enterprises in Yingkou consumed 6,930 million tons of coal in 2007, an increase by 23% than the year 2006. The newly-consumed coal was mainly used for the production of thermal and electric power.

By the end of 2007, there have been 592 coal-burning boilers in Yingkou city, with an average power of 9.1MW for each. These boilers have such disadvantages as low heating efficiency (below 60%), poor heating reliability, lack of air pollution control devices and serious environment polluting. Moreover, with the fast development of Yingkou's economy, large quantities of newly-built industrial enterprises doubled the city's demand for thermal power, so solving the energy supply problem that is restricting the economic development becomes urgent. If continuing to construct small-sized coal-burning boilers to meet the demand for thermal power, urban coal consumption will inevitably increase, thus resulting in more emission of carbon. Therefore, it is necessary to reform the urban energy utilization modes so as to reduce coal consumption and carbon emission.

Figure 1 Yingkou's geographic location

3. Formulation of the grogram

The core contents of the implementation of the program are the scientific prediction for future development in heat and power load, and regulation of the existing urban planning. It mainly includes the following several steps:

(1) Investigation into the heat load and available industrial afterheat heat sources. Through investigation into the comprehensive heat load of the entire region, including all heat loads that can implement the centralized heat supply method, such as the industrial heat load, the centralized heat load, the agricultural and cultivation heat load, and according to the economic development program, we can conduct a forward-looking prediction for the future load; through investigating into the potential of afterheat utilization efficiency of the existing industrial production facilities, we can put forward relevant upgrading program for the afterheat utilization of industrial facilities, so as to improve the rate of utilization of energy of industrial enterprises and lighten the load on urban main heating systems.

(2) Formulation of preliminary thermoelectric construction program. According to the prediction for demands for thermal and electric power, we can carry out the type selection of thermoelectric units, formulate the preliminary construction program, and determine the composition and relevant pollution-control program of the thermoelectric units in each

construction stage.

(3) Design of site selection program for the thermoelectric project and amendment of overall urban planning layout. This is for the purpose of determining the ideal position for the thermal power plant, minimizing the comprehensive thermal losses in transmission, to maximizing the energy-saving benefit. At the same time, we should regulate the urban planning layout, optimizes layout of the newly-built heat-consuming projects to further reduce energy lost in transmission and coal consumption.

(4) Formulation of the final thermoelectric construction program on the base of the previous work in combination with other special planning for urban development.

4. Main contents of the program

According to the fore-mentioned construction steps, two 320MW condensing generating units from Huaneng (Yingkou) Power Plant in Bayuquan district and the production facilities of Wukuang Yingkou Medium-sized Plate Factory in Laobian district have the heating-updating potential. The former can provide 500MW thermal power after heating updating, and the latter can provide 81MW thermal power, thus the demands of both Bayuquan and Laobian districts for heating can be basically satisfied. Therefore, no thermoelectric units will be constructed in these two districts and the urban heating will mainly depend on the updating of the original heat sources. Correspondingly, new-built thermoelectric programs include six 300,000kW thermoelectric units which will be constructed during three construction stages in Yingkou Coastal Industrial Base, and three 300,000 kW thermoelectric units which will be constructed during two construction stages in Dashiqiao and Gaizhou districts respectively. The construction plan of thermoelectric is as shown in Figure 1. Figure 2 shows the construction sites and heating service areas. Moreover, the plan also includes related clean energy substitution plan and auxiliary policies for the implementation of low-carbon urban construction. The low-carbon urban construction plan in Yingkou city may provide sufficient and effective thermoelectric supply for the city as well as effectively reduce the urban energy consumption and carbon emission. These newly-built thermal power plants will take full advantage of environmental protection technologies such as plasma igniter, totally sealed coal bin, effective wet desulfurizing unit, low nitrogen burner, and mixed denitrification installment to control the emission of air pollutants. Moreover, these thermal

power plants will also reserve space for the installation of centralized carbon capture devices to make preparation for further reducing carbon dioxide emission.

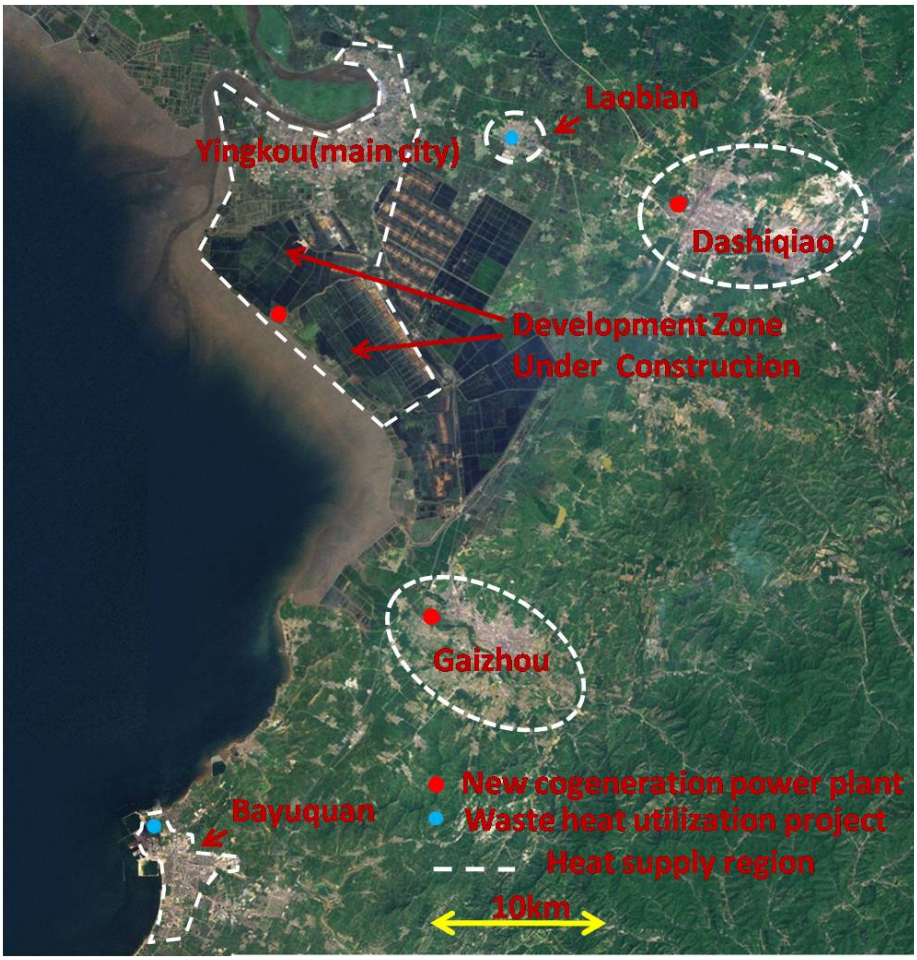

Fig2 Project location and heating service areas

Location	2010			2015			2020		
	Installed capacity（MW）	Heating capacity（MW）	Steam supply capacity（t/h）	Installed capacity（MW）	Heating capacity（MW）	Steam supply capacity（t/h）	Installed capacity (MW)	Heating capacity（MW）	Steam supply capacity（t/h）
Dashiqiao	——	——	——	330×2	580	160	330×3	870	160
Gaizhou	——	——	——	330×2	580	160	330×3	870	240
City proper	330×2	580	160	330×4	1160	320	330×6	1740	480

Table 1 Thermoelectric construction program

5. Benefits from carbon emission reduction

If we don't carry out the construction of low-carbon cities, i.e. maintaining the

independent development of the thermal and electric power supply system, the thermoelectric production of Yingkou city will consume 12,62 million tons of coal by 2020. On the contrary, if we implement the low-carbon city construction plan, only 9,02 million tons of coal will be consumed by 2020, saving 3,6 million tons compared with conventional thermal and electric supply system, reduce 6,84 million tons of carbon dioxide emission. To realize a real low-carbon development, we can provide auxiliary centralized carbon capture devices in the future to further reduce carbon dioxide emission.

6. Progress of the program

At present, the main contents of the program have been adopted by relevant institutions of Yingkou city and used for revising and formulating corresponding planning for urban and thermoelectric development. Part of the major projects programmed have been completed or under construction. So far, the technological upgrading of heating system and laying work of part of heating pipe network for the two 300,000kw units of Phase Ⅰ Huaneng (Yingkou) Power Plant have already been completed, and the two units were able to provide heating service for Bayuquan district Since the heating period of 2008,. Figure 3 shows the first heat exchange station for the heating updating project located in Huaneng (Yingkou) Power Plant.

*Figure 3 **F**irst heat exchange station for the heating system updating project located in Huaneng (Yingkou) Power Plant.*

Funded by Huaneng Group, the City Proper Thermal Power Plant started to be constructed in July, 2008. According to the plan, two 200,000kW thermoelectric units and their affiliated heat networks will be constructed in the phase Ⅰ project. Due to vigorous support from Yingkou Municipal Government, the first unit is estimated to be completed and put into operation by the end of 2009. It is estimated that the 17-month construction period will probably create the national shortest construction record in building large-scale thermoelectric units of over 300,000kW. Figure 4 shows the power house of Yingkou City Proper Thermal Power under construction.

Figure 4 Power house of Yingkou City Proper Thermal Power under construction**.**

The afterheat utilization project of Wukuang medium-sized plate factory in Yingkou Laobian district has been completed in October, 2008, and began to supply heat for some residents in Laobian district since the heating period of 2008. This helps bring the enterprises more benefits. Figure 5 shows the filtration pumping station of the afterheat utilization project in Wukuang medium-sized Plate Factory. Moreover, it has been determined that Dashiqiao Thermal Power Plan will also be invested by Huaneng Group and the project is in preparation.

Figure 5 Filtration pumping station of the afterheat utilization project in Wukuang Medium-sized Plate Factory

7. Significance of the program

In the foreseeable future, the human society will be faced with more serious environment and energy crisis. It is a practical problem to face the challenge and deal with the crisis. Considering China's present situations, it is hard to change China's energy mix that is centered on coal in a long period of time. So how to make good use of coal and reduce its harm to the environment when using is the key to a faster and better development of the economy. By taking improving the utilization efficiency of energy as the cut-in point, starting with changing the independent and dispersed means of energy utilization, the low-carbon city construction program proposed herein satisfied the demand of social development for energy by such two mean as thermal and electric power through establishing the centralized energy generation and distribution system. Particularly, the centralized large-scale combustion devices planned in this study have laid a good foundation for the future installation of centralized carbon trapping devices. So this program is not only an adventurous attempt at building low-carbon cities with Chinese characteristics, but also offers a valuable reference for developing countries in reducing carbon emission.

[1] 2008 China *National Statistical Bulletin on National Economy and Social Development*, 2008

[2] Niu Chengjia, Niu Daming, *Probe into Air Pollution Prevention in Small Cities*[J], North Environment, 30, 1

[3]Wang Zhenming, Yu Gang. *Status quo, Prospects, and Suggestions of China Thermoelectric Cogeneration*[J], China Electric Power, 36,9

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