

# CLEAN FUEL, CENTRALIZED HEATING SYSTEM, EFFICIENT PUBLIC TRANSPORTATION, THE KEY FOR URAN AIR POLLUTION CONTROL

## ---The practice in Weihai, China

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### 1, GENERAL BACKGROUND

Weihai is a coast city, located in the eastern tip of Shandong peninsula, its area is 5436Km<sup>2</sup>, with the population of 2.45M. After China opening to the out side of the world, Weihai developed very fast. From 1987 to 2001, GDP from 2.56billion RMB grew to 62.7billion RMB, urban population from 233 thousands grew to 533.4 thousands; developed urban area from 13.1Km<sup>2</sup> grew to 43.65Km<sup>2</sup>. Though the economy, population and urban area developed rapidly, but the environmental quality remains the first class of the country. In 1990, the city got the honor of National Sanitary City, number 1 in China. In 1997, got the honor of Environmental Protection Model City, first cohort (only 6 cities) of China. In 1996 and 2000, two times got the award of The Best Example For Improving Living Environment In The World from UN Human Living Center. Now, all the three cities under its jurisdiction got the award of “ Environmental Protection Model City ”. That is the number one in China.

Like the cities in other developing countries, Weihai facing the heaven pressure for urban air pollution control. The air pollution sources mainly are: cooking, heating and vehicle emission. Through administration and economic mechanism, Weihai government encourage the residents use clean fuel for cooking, use centralized system for heating, establish a efficient public transportation system, though the developed urban area, the population and GDP grow very fast, but the air quality remain the first class in China, some parameter like TSP even getting better.

Table 1, The development and air quality

Year	GDP(bil lion yuan)	Develop ed urban area km <sup>2</sup>	Urban population (thousand)	SO <sub>2</sub>	NOx	TSP
1987	3.324	13.1	233	0.031	0.017	
1988	5.061	14.0	243	0.035	0.019	
1989	5.729	14.3	251	0.033	0.020	
1990	7.201	14.7	257	0.035	0.016	0.118
1991	8.756	16.8	265	0.014	0.018	0.129
1992	12.742	20.2	278	0.009	0.016	0.124
1993	17.617	32.7	294	0.019	0.020	0.147
1994	26.468	38.61	419	0.020	0.017	0.143
1995	32.66	38.61	438	0.018	0.019	0.156
1996	37.883	43.00	462	0.021	0.020	0.184
1997	42.865	43.27	485	0.021	0.020	0.168
1998	47.000	43.27	496	0.020	0.019	0.148
1999	50.08	43.55	508	0.019	0.021	0.115
2000	56.089	43.65	522	0.023	0.029	0.129
2001	62.71	43.65	533	0.033	0.028	0.101

### 2, Government subsidize, encourage residents use clean fuel for cooking

Because China is a developing country, eating is a very important thing. China also is rich in eating culture, the cooking method of Chinese food is very complicate. Most of the Chinese spend

more than three hours to prepare the food every day. So more than half of the energy consumed in households is for cooking.

20 years ago in Weihai, now still in most of the rural area in China, Chinese use grass, leaves and branches of tree, stem of corn and wheat for cooking. During the winter, all the things that can be used for cooking in the field and mountains were collected to home, let the bare land open to the strong wind that caused a serious depletion of the ecology system. The cooking facilities were also very poor, the efficiency was very low, only about 15%. During the cooking time, the smoke were everywhere, that caused a serious air pollution.

In Weihai, there is no oil or nature gas resources, but from the early 1980s, the government began encourage the residents use clean fuel for cooking. The government established a company, transport the liquefied petrol gas from oil refining factory to Weihai, use bottles distribute the LPG to the residents. Because the LPG is expensive, a 15 kg bottle, can be used for a month, costs 25 yuan, that means a half month salary for a worker during that time. If no subsidize, the workers is hard to support it. Weihai government decided subsidize 10 yuan from the revenue to the servant, ask the factories subsidize 10 yuan for their workers, so the residents themselves only pay 15 yuan. In this case, the residents of Weihai began to use the LPG for cooking. Along with the increase of the salary, using LPG for cooking became popular. The government gradually reduced the subsidize, totally canceled it in 1990. But use the LPG for cooking is not convenient, because the bottle is very heavy, is not easy to carry it up and down stair, especially for ladies and old people. Storage a LPG bottle in home is not safe, it looks like a bomb beside your bed.

In 1990, Weihai government invested 200 million yuan, constructed a 160,000 m<sup>3</sup>/d coal gas factory and pipe net, use coal to generate gas, through pipe distribute to the households. That is convenient, the residents do not need to carry the heavy bottle, but the cost is higher than LPG, the government still needs subsidize to encourage the residents to use it. In 2001, because the price of coal grew higher, the cost of the coal gas also grew higher, reached 1.96 yuan/m<sup>3</sup>. But the government still collects 1.00 yuan/m<sup>3</sup> for the residents, 1.30 yuan/m<sup>3</sup> for commercial use. The total subsidize from the government revenue to the coal gas company is more than 10 million yuan in 2001.

In 2000, Weihai government began the feasibility study of nature gas project. There is a nature gas field in Bohai bay, the cities along the bay plan to use the nature gas. The total investment of the Weihai nature gas project is 510 millions yuan, the capacity is 154 million m<sup>3</sup>/a. The investment of the first phase is 287 millions, main content of the project is the transport pipe construction and the reform of the pipe net in urban area. It will start in 2003.

The nature gas project will follow the market economy mechanism, use foreign direct investment, establish a joint venture, according the really cost plus reasonable profit, collects the fee from the end user. The government will not subsidize it any more. Because the stable resource, the higher calorie per unit, according the calculation, the payment is almost the same for the residents. We hope that is the sustainable way for cooking fuel in Weihai.

Through the effort above, the rate of the residents using gas for cooking gradually goes higher, now almost 100%. That is the base for the air pollution control in the urban area.

### **3, Use centralized system for heating**

Heating in households and factories is also a big source of air pollution in the urban area.

In China, there is a regulation during its planning economy period, southern of Yangtze river, no heating at all; between Yangtze and Yellow river, only have heating in the office, non at home;

northern of Yellow river, have heating both at office and home. Let you heating means the government gave you the money. Weihai is located in the area between Yangtze river and Yellow river, we only have heating in the office, non at home. But the regulation does not work any more after China reform for the market economy, especially along with the improvement of the living standard, the residents do not like stayed in a cold home in the winter. They like the temperature are comfortable both in office and home. They began to heating during the winter.

At beginning, they use a very simple facility for heating, a small stove. They put the stove in room where they stay, use steel pipe connect the stove to the outside, burning coal or wood for heating. The efficiency of the stove is very low, less than 30%; its pollution is very serious. In the morning, all the stoves begin lighting, heavy smoke were everywhere, some time make you hard to breath.

In the late of 1980s, some apartment buildings work together, install a small boiler, heating its adjacent area. That is a little bit better than the stove, the efficiency of the small boiler is about 40-50%. But the dust, the noise of the blower and the SO<sub>2</sub>, still are the environmental problem.

In 1990, Weihai established the Heating & Power Company. At beginning, we innovated the No.1 Heating & Power Plant, let it not only produce electricity, but also supply steam to the nearby factories, commercial and apartment buildings for heating. In 1992, we constructed No.2 Heating & Power Plant. In 2001, the No. 3 Heating & Power Plant began to operating. Now the No.4 Heating & Power Plant is under construction. The capacity of the boilers in the Heating & Power Plant are large, their efficiency are more than 85%. We installed modern equipment to reduce the flying ash, some of them have the function to reduce the emission of SO<sub>2</sub>. The plants were constructed in an open area, a little bit far from the sensitive points like resident apartment. The Environmental Protection Agency forced the plants use the low sulphur coal, use high chimney to disperse the pollutants. Both the measures they taken above effectively reduced the pollution to the urban air.

At beginning, it is not easy for the factories and residents to accept the centralized heating system. For the factories, they should remove the small boiler, pay money to the Heating & Power Plant, that is hard for the factories if their performance is not good. For the residents, they should pay 35 yuan/m<sup>3</sup> for the pipe connection and the facility reform in the room. Most of the apartments in Weihai are 70-120 m<sup>2</sup>, that means they should pay 2450-4200 yuan. That is a big money for most of them. In order to let the factories use the centralized heating system, the government set a regulation, do not approve boiler installation in the urban area anymore, reform the existed small boilers to be heating exchange stations, demolish the outdated boilers, force the factories use the centralized heating system. For the residents, the government issued a regulation, let the unit that the residents work for to pay the reform cost, subsidize 1/3 of the heating fee. Now all the factories and residents totally accepted the centralized heating system. After the housing reform in 1998, though the facility installation cost have to be paid by the house buyer themselves, but because the increasing income, they prefer to pay more to enjoy the comfortable living style.

During the last three years, we removed more than 200 small boilers in the urban area, except the buildings that out of the pipe net service, warehouse and some workshop, almost all the buildings that need heating during the winter use the centralized heating system. The rate of using centralized heating system (the area that using centralizes heating system/the total construction area in the urban) growth rapidly.

Table 2, The Heating & Power Plants

Name	Time operation to	Investment (million yuan)	Capacity	Method of flying ash control	Method of desulphur
No. 1	1990	500	75T/h*3, 220T/h	Electronic	Flowing bed
No.2	1992	320	35T/h*5, 130T/h*2	Electronic	Flowing bed
No.3	2001	340	75T/h*3	Electronic	Flowing bed
No.4	Constructing	340	75T/h*3	Electronic	Flowing bed

#### 4. Developing the public transportation system

The vehicle emission gradually became the major urban air pollution source in developed countries. Now in Weihai, we face the same challenge. In 1987, Weihai only had 22,000 vehicles, in 2002, it reached 457,200, 20.8 times compare with 1987. How to control the vehicle emission is a big task of Weihai government.

Before 1973, Weihai had no public transportation facility, all the residents go to work by bicycle. In 1974, Weihai began establish public transportation system, but only had 4 buses. Until 1987, had 23 buses. After China open to the outside of the word and economic reform, the urbanization grows very fast. The longer transport distance, the fast living pace and the low safety, make the residents do not satisfy any more with the bicycle. They are searching a fast transportation method. In most countries during this period, they experienced a motor bicycle booming period. Because the motor bicycle emission is 3 times high than car, it caused very serious air pollution and lot of traffic accidents.

As a later comer, learn from the successful practice in developed countries, Weihai put its main efforts to develop the public transportation. Though the public transportation company is an enterprise, but the government invest for most of the new buses, allocate the land for bus station, every year subsidize more than 1 million for its operation. Give some priority to the public transportation company, let them abstract the private to invest, to lease, to operate the public bus; use the bus do some advertisement, remit some of their taxation etc.

The public transportation company does their best to enhance the administration, increase the operation efficiency. They lower the price of month ticket, give half price to the students, grand the ticket to the old residents if their age is more the 70, encourage the residents to use it. In 1997, they began to use no ticket officer system, let the passengers put the money to the box by themselves or show their mouth ticket to the driver, that is the pioneer in China. In 2001, they began to use the electronic ticket system, let the passengers use the public transportation system more easily, that also is the pioneer in China.

The public transportation company pay much attention to the environmental protection, they only buy the bus that can meet the national emission standard, strictly follow the regulation to replace the outdated bus, they innovated 40 buses try to use liquefied petrol gas to reduce the pollutant emission.

Through the effort above, the public transportation system developed very fast. In 2001, the public bus reached 354, 15.4 times compare with 1987; passengers reached 83.56 million, 33.3 times compare with 1987.

In order to meet the different level service demand, Weihai government pay much attention to

develop the taxi service while develop the public bus. We wider the investment channel, relax the limitation, the taxi is booming in very few years. In 1989, the taxi just began emerge in Weihai. Only 6 years later, in 1995, it reached 1400. It is cheap, easy to catch. Some taxi owners began to claim it too hard to keep running. After that time, Weihai government do not distribute the taxi license any more, just to innovate the outdated ones. The good taxi service also has the function to limit the motor bicycle and private car booming, to control the urban air pollution.

Now most of the residents in Weihai feel the public transportation system is convenient, cheap, safe and comfortable, they prefer take the public service to travel. In the street, you can see there are more people traveling, but the number of bicycle has been reduced, the number of motor bicycle almost keeps the same, the air quality affected by the vehicle emission keeps in low level.

Table 3, some parameters of the urban air pollution control

year	Rate of using gas for cooking (%)	Rate of using centralized heating system (%)	The number of public transport bus	The number of passengers and times using public transportation (thousand)
1987	62.1		23	2510
1988	66.7		27	3180
1989	81.0		29	4520
1990	81.8		59	5090
1991	82.1		37	6780
1992	85.3		41	8360
1993	93.8		53	11560
1994	94.0	26.9	72	13030
1995	95.0	30.2	145	18330
1996	97.77	31.3	187	25570
1997	97.77	37.99	274	43240
1998	97.85	45.49	287	55030
1999	97.97	52.16	318	57700
2000	98.1	65.88	341	71040
2001	98.3	78.63	354	83560

## 5, Improving the monitoring system, open the information to the public

Weihai began to monitor the air quality in 1982, the method and equipment have been innovated several time.

At beginning, we only monitor SO<sub>2</sub> and NO<sub>x</sub>, four seasons a year, three days a season, three times a day, 20 minutes a time. Collect the samples in the field, analysis them in the lab. In 1988, we plus TSP, began use continuous sampling equipment, 5 days a season, 24 hours a day. In 1994, monitor 15 days a season. In 1998, monitor 15 days a month. In 2000, we invested more than 4 million yuan, imported the equipment form USA, established continuous automatic monitoring system, monitor the air quality all the time, change the TSP to PM<sub>10</sub>.

We began to publish the environmental quality in 1995, once a year. In 2000, after the establishment of the automatic monitoring system, we publish the air quality daily through the newspaper, TV and radio. In 2001, we began to predict the air quality for the next day, publish the data through the same way as the air quality.

Open the air quality information to the public has very good affection. First, the environmental awareness of the public has been increased very much. Through the media, the pubic can know what the air quality is, what is the main pollutant, how it affects the health. If they find a pollutant

source nearby, they will claim it to the environmental protection agency immediately. Second, the city government pays much more attention to the environment. Because the air quality information open to the public, everybody knows the situation of the environment, know the efficiency of the government, that gives much pressure to the mayor. The government, especially the Environmental Protection Agency must work harder.

## **6, The challenges we are facing**

Though we have done a lot of work on urban air pollution control, keep the quality to meet the national standard while with the rapid development of the population, urban area and economy, but we still facing some severe challenges.

One is the high coal consumption. In China, more than 70% of the energy comes from coal, most of the coal its sulphur content is higher, so the SO<sub>2</sub>, dust and NO<sub>x</sub> are always the main issue of the air pollution control. These years, we encouraged the people to use clean fuel, but the total coal consumption still growth rapidly. We constructed a Power Station and 4 Heating & Power Plants, the total coal consumption from 0.69 million tones in 1987 to 3.27 million tones in 2001, 4.7 times higher. Now in China, we have policies and regulation to force, to encourage the factories especially the power station to use the low sulphur coal, like collect sulphur emission fee, total sulphur emission control, large power station must has desulphur facility etc. but it does not work well. It is hard to find an available technology that can meet the situation in China. So the total SO<sub>2</sub> emission slowly goes high. This situation is hard to be changed in near future.

Another is the vehicle emission. These years the private car grows very fast. In Beijing, 12% of the families have car. In some cities in southern China, 20-30 % of the families have car. In Weihai, from 1987 to 2001, the annul growth rate of the vehicle is 21.7%. In China, the main problem of the vehicle emission is not only the number of vehicle, but also the poor vehicle condition. Though the emission standard is not as strict as west countries, but most of the vehicle still can not meet it. Some of the car outdated already, but still running in the road, that caused more traffic accident, also polluted the air very seriously. For this issue, China is just starting, still has a long way to go.