

# CHINESE MARKET AND TECHNICAL DEVELOPMENT OVERVIEW

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**【Abstract】** This paper briefly introduces the general development situation of buildings, weather characteristics and the requirements of air conditioning / heating in China; And also explains development history of heat pump technology, its production and demand, application and the trend of research and development.

## 1. GENERAL SITUATION OF BUILDING SECTORS AND REQUIREMENT FOR HVAC

### (1) General situation of building sector

In China the building sector is divided into civil building and industrial building sectors. Just as its name implies that the industrial building is used for industrial process. The civil buildings are divided residential buildings and public ones. The public buildings include department store and marketplace, office building, hotel; and the buildings for cultural education, science and research, medical treatment, athletic sport and so on; and the buildings for bank, post office, communication, airport, railway station etc.

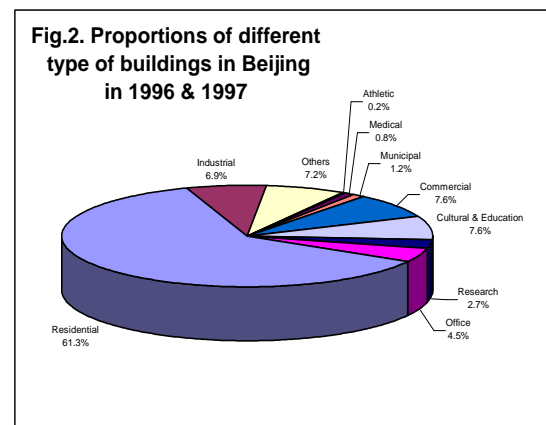
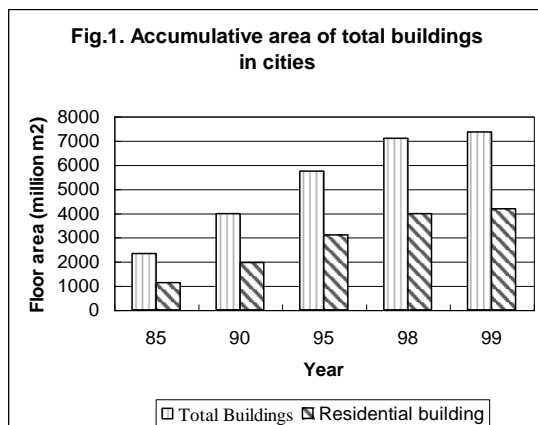
Since 1980's the construction speed of buildings are quite high. In the beginning of 1980's 700 – 800 million m<sup>2</sup> of floor area has been built for each year and in the beginning of 1990's about 1000 million m<sup>2</sup>. In recent years 1600 – 1700 million m<sup>2</sup> has been built for each year. For example, 1709 million m<sup>2</sup> has been completed in 1998, among them 477 million m<sup>2</sup> for residential building in cities, 799 million m<sup>2</sup> for residential building in countryside and other 433 million m<sup>2</sup> for public and industrial buildings (mainly in cities). General speaking, industrial building takes about 10% of the building in cities; it means that about 100 million m<sup>2</sup> of industrial building for each year. At present, the residential and public buildings in cities need to be heated and cooled. It means that about 800 million m<sup>2</sup> of residential and public buildings in cities are the potential market for HVAC.

The accumulative floor area of total buildings in cities is shown in Fig. 1. By the end of 1999 the total floor area in cities is 7350 million m<sup>2</sup>, among them 4170 million m<sup>2</sup> is for residential building. The residential building takes about 57% of the total. The proportions of different type of buildings in Beijing in 1996 and 1997 are shown in Fig.2.

General speaking, the residential building is multi-storey building and but a part of it is high-rise building. The construction of high-rise residential building in the large scale started from 1973, and developed fast since 1980's. Before 1983 the building with more than 8 storeys (including 8) was defined as high-rise building, but after 1984 the building with more than 10 storeys (including 10) was defined as high-rise one.

It is estimated (1999) that the total floor area of high-rise building has reached to 250

million  $m^2$ . Among them Beijing and Shanghai take about 20% separately. The high-rise buildings are mainly used for residential building, hotel, office, complex building and broadcasting, television and telecom buildings and hospital, university and research buildings and so on. General speaking, the floor area of high-rise residential building takes about 50% of the total high-rise building areas. And the percentage is higher than 50% in some large cities, especially in extreme large cities. For example, there are 3000 of high-rise buildings with more than 8 storeys in Shanghai until now. In Lu-Jia-Zui finance and trade zone 289 of high-rise buildings with more than 20 storeys are built by the end of 2000. The total floor area of them is 7.21 million  $m^2$  (Fan and Long 2000).



## (2) The requirement for heating and air conditioning

According to the national standard "Standard of Climatic Regionalization for Architecture GB50178-93", seven climate zones are divided. They are "very cold, cold, hot in summer and cold in winter, hot in summer and warm in winter and moderate zones".

The living standards of people rise as a result of continuing growth of economy, heating and air conditioning have been more and more popular especially after the middle of 90's. According to the weather characteristics the requirements for air conditioning / heating in different zones are as follows:

- 1). Very cold zone, the major requirement is heating, only the residential building with high standard needs for air conditioning.
- 2). Cold zone, primarily heating and then air conditioning are needed.
- 3). Hot in summer and cold in winter, both air conditioning and heating are needed.
- 4). Hot in summer and warm in winter, the major requirement is air conditioning, only the residential building with high standard needs for heating.
- 5). Moderate zone, in part area of the zone heating or heating / air conditioning are needed.

Of course, the application of air conditioning also depends on economic development, energy supply and environment protection.

## (3) The Energy for A/C & Heating

- 1). Energy usage

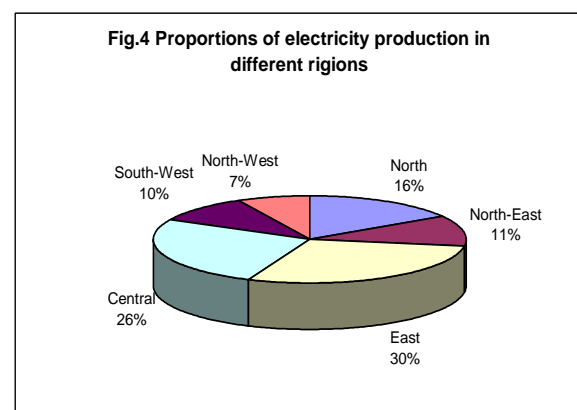
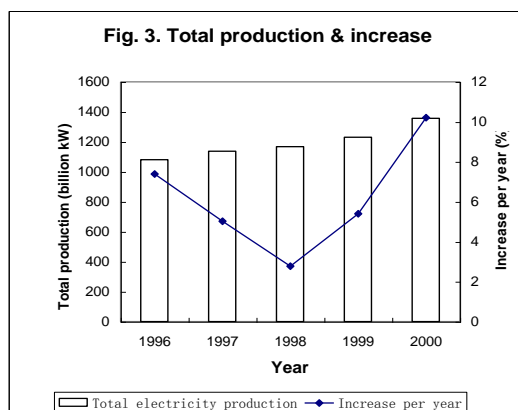
The electricity or heat is the energy to drive heat pump. The electricity load for air conditioning takes more than 20% of the total in China. In 1996 – 1997 the production of

LiBr absorption chiller driven by heat reached to the highest because electricity was shortage and also air conditioning market was enlarged rapidly in that time. Since 1998 the supply of electricity has mended, the supply and demand kept balance basically because some new power stations began to produce electricity. Since 1999 the electricity production has been more than the demand. In 2000 there is 10% of rich in electricity production. The total electricity production and increase per year in recent years are shown in Fig.3.

China has rich in natural gas reserves, but most of them distribute in the North-West region. The plan, on which the natural gas in west part of China is going to transfer into the east part, has been implemented now. It should promote the development of absorption chiller driven by gas (CRAA 2001).

## 2). Distribution of electricity resource

The distribution of electricity resource is not reasonable in China. The power stations mainly concentrate in the North, the Central and the East regions and their production takes 71.3% of the total production. The proportions of productions in different regions are shown in Fig.4 (CRAA 2001).



## 2. DEVELOPMENT AND APPLICATION OF HEAT PUMP TECHNOLOGY

### (1) Development history

The research and development of heat pump technology began from 1950's. The Institute of Thermal Energy of Tianjin University was the first research institution for developing the technology. Since 1960's the heat pump units have been applied to industry. In 1963 the former East-China Architectural Design Institute and Shanghai Air Conditioning Factory began to develop heat pump type air conditioner. In 1965 Shanghai Refrigerator Factory produced the first heat pump type window air conditioner (Type CKT3A) with 3720W heating capacity. In 1965 Tianjin University cooperated with Tianjin Air Conditioning Factory to produce the first water-cooled heat pump unit, and also with the Si-Fang Vehicle Institute of the Ministry of Railway to make the test of air to air heat pump unit for passenger car. In 1966 the Former Harbin Architectural Engineering Institute and Harbin Air Conditioning Factory developed and produced heat pump type (Type LHR—20) air conditioning unit with constant temperature and humidity.

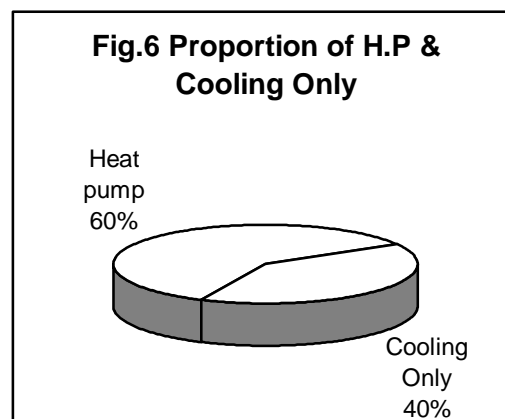
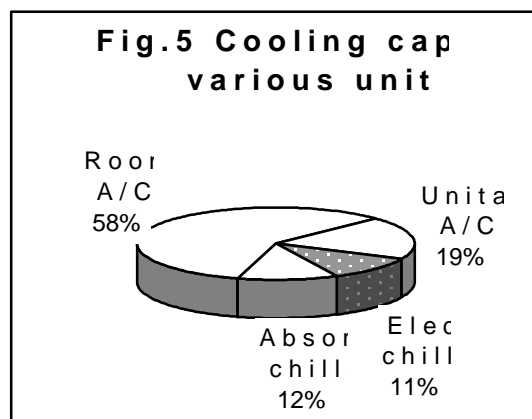
After 1980's the research and development of heat pump technology have been paid more and more attention. The air-cooled heat pump unit has been quickly and widely applied in the

Middle of China, especially in the middle- and downstream basin of Yangtze River because the weather characteristic and booming economic in that region. The earliest application of water source heat pump units was in the beginning of 1980's, which were installed in the foreign investment enterprises. In the late of 1990's there are more than 50 buildings were installed closed loop water source heat pump units. In 1999 the domestic water source heat pump unit was developed and its water source is mainly from well. In the meantime heat pump --- this kind of heating and cooling mode began to apply to residential building from public building. Because the water resource is restricted by region and protection from contamination, the geothermal heat pump has been put the order of the day. The test and research of heat transfer of underground-buried tube has been doing and done by some universities and institutions and also applied in the demonstration projects (Yin Ping 2001).

## (2) Production and demand of heat pump

### 1). Cooling capacity of air conditioning unit

According to the statistics data of domestic air conditioning unit in 1996 the total cooling capacity was 20 million kW. The proportions of various units are shown in Fig.5, and 6. They are shown that the cooling capacity for room air conditioner takes near 60% of the total (Fig.5) and for heat pump also takes about 60% (Fig.6). It is indicated that the room air conditioner and heat pump have been widely used. According to the investigation data of all of air conditioning units including from abroad the total cooling capacity reached to 45 million kW in 1999. It is estimated that the above two 60% is still accepted (Yan Qisen 1997).



### 2). Demand of room air conditioner has been increasing

After 1980's the living standards of people rise as a result of continuing growth of economy, the room air conditioner (especially split type) began to be more and more widely installed in residential building. In hot-summer and cold-winter zone the residents prefer heat pump type. In cold zone the outdoor temperature is lower in winter and it is not suitable to use air-cooled heat pump type room air conditioner for heating. But the residents still would like to use it only in the beginning and the end of the heating season where the central heating system is installed. The room air conditioner is also applied to some public buildings (especially office buildings) with lower standard because easy to install and convenient to operate. In recent years multi-indoor unit air conditioner with variable refrigerant volume has been applied to residential and public buildings.

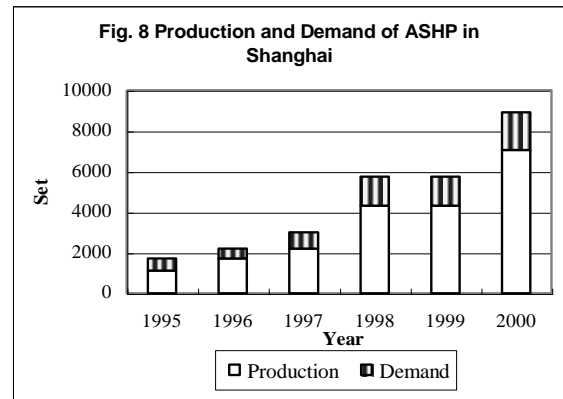
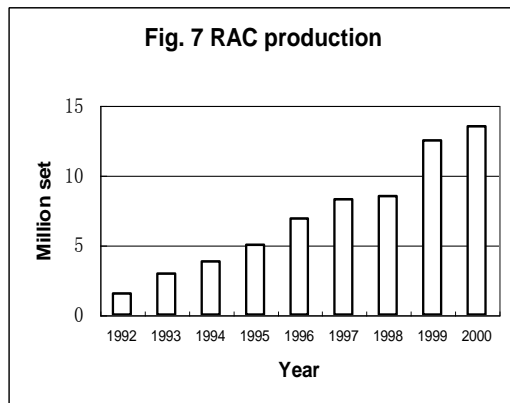


Fig.7 shows the production of room air conditioner (especially split air conditioner) has been increasing year by year.

### 3). Demand of air source heat pump has been increasing

Air source heat pump unit has been more and more widely used in the middle of China, because the heat pump system is simple, doesn't need to have cooling water system and to install boiler plant or other heat source. Some air source heat pump units with large capacity, for example more than 100 RT, have been installed in public buildings as heating and cooling sources. These units with reciprocation and screw compressors can be operated normally in the Yangtze River area and Shanghai. According to the investigation data of high-rise buildings in Shanghai, the trend of application of large capacity air source heat pump unit has moved up. For example the investigation of 200 high-rise buildings in 1996 – 1997, in 30% of the buildings the air source heat pumps are installed, and the investigation of 50 high-rise buildings in 1998, in 37% of the buildings they are installed. At least more than 1000 sets of air source heat pump units operate in Shanghai now. The proportion of domestic units has increased in recent years. The production and demand are shown in Fig.8 (Fan and Long 2000).

### 4). Water source heat pump

Air source heat pump has several advantages, but mainly has two disadvantages. One is frost problem when outdoor (environmental) temperature is lower than about 4°C. It will decrease the heating capacity; another is the capacity and COP will decrease with the demand increases, so when the environmental temperature is lower than the balancing temperature the back-up heater is needed. When air-cooled unit is used for very cold region and for moist region in winter the disadvantage is very serious. Water source heat pump uses water as a heat source and sink. The source can be the water from river, lake and underground water, wastewater etc., and also the underground soil. Compared with air-cooled heat pump it has higher COP and without its disadvantage mentioned above.

In recent years the research and development of water source heat pump have been paid more attention because both of heating and cooling are needed in some buildings especially in the north of China and the requirement of environment protection becomes more strict. Since 1999 the domestic water source heat pump (water to water type) has been developed and produced and also applied in the North-East of China and Beijing city. It is estimated that

the area applied reaches to several hundred thousand m<sup>2</sup>. It is not only for using public building and also for applying in apartment. The water source is from underground water (well), surface water and also closed water loop. The geothermal heat pump has been just tested and applied.

### **3. TREND OF RESEARCH AND DEVELOPMENT**

#### **(1) Air source heat pump**

- 1). Under low temperature the operation should be high efficiency, stability and reliability.

Many research efforts have done for extending region applied air source heat pump to the north direction, it means that the region is from Yangtze River area to Yellow River area. It is indicated by recent research that the new type air source heat pump can be operated with higher heating capacity and supply temperature under - 10°C ~ - 15°C of environment temperature. In other words it can satisfy the heating need in winter in the north of China, for example in Beijing.

- 2). The defrost technology under high relative humidity.

Four zones – low temperature frost zone, light frost zone, heavy frost zone and general frost zone – are divided according to the weather characteristics. Some countermeasures are put forward.

#### **(2) Water source heat pump**

- 1). When using the water from well, the fill back technology should be researched and improved. In the same time the underground water resource should be protected and no polluted.
- 2). To make continuously efforts about underground heat exchanger performance of geothermal heat pump.
- 3). To improve system design information.
- 4). To research and develop the unit and components in the system which are suitable for our country.

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