

# Heat pump market development in China

Lingyan Yang, China

Heat pumps can effectively use clean energy for heating, so they have been widely used in China. The coal-to-electricity project is an effective measure to reduce air pollution. The Chinese government has issued a series of policies to support the project. In this article, the development of air-source and ground-source heat pump markets in China are discussed. Using heat pumps is a good way to indirectly utilize electricity for heating, and heat pumps have a bright future in China.

## Introduction

Air pollution caused by heating is a challenge for the Chinese government. As a clean energy heating measure, heat pumps have been applied rapidly. This paper will describe the changes of the heat pump market in China, driven by policies and demand.

Air source heat pumps have developed rapidly due to their convenient installation and good economy. Ground source heat pumps are mainly used in large projects, so the growth rate is gradually slowing down, although the cumulative application area is still increasing.

## Air source heat pumps

The most common heating method in China is to directly produce high-temperature water by coal-fired boilers. However, the heating efficiency is low and the combustion of coal gives rise to significant amounts of CO<sub>2</sub>. Also, the emissions of particles (such as PM2.5) and NOx

caused by coal combustion are considered to be one of the main factors leading to haze weather. During recent years, China has promoted clean energy heating, in order to reduce air pollution and energy consumption. A coal-to-electricity project is an effective measure taken by the Chinese government, based on requirements of clean energy heating in northern China, and relevant policies have been introduced gradually, such as the [Clean Energy Heating Plan for Winter in North China \(2017-2021\)](#).

Heat pumps are a good choice for heating under the support of these policies. The air source heat pump is mainly used for heating scattered residential buildings and rural buildings. The ground source heat pump is used for heating buildings with a central heating demand.

Considering the up-front investment, the economic advantages of air source heat pumps are obvious. The growth rate of air source heat pump application is high-

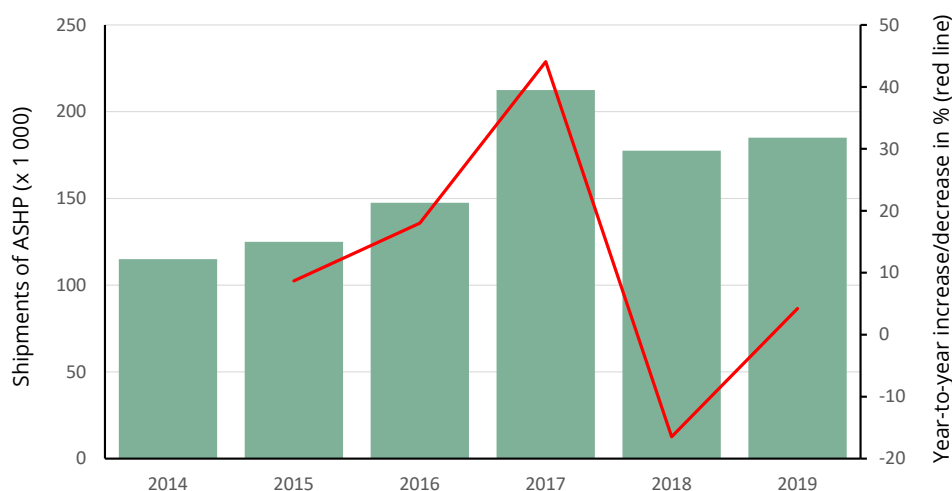


Fig. 1: Shipments of air source heat pump in China (x 1 000).

The red line shows the year-to-year increase/decrease in %, see the axis on the right. Source: Data.chinaiol.com

er than that of ground source heat pump. Fig. 1 shows the shipments of air source heat pumps in China. With the support of national policies and funds, the sales of air source heat pump increased significantly in 2017, and maintained a high sales volume during the next two years.

#### Recent policies on Air Source Heat Pumps:

##### 1. *Guidance on Promoting Electric Power Substitution*

The National Development and Reform Commission of China issued this to promote air source heat pump heating to replace coal-fired heating.

##### 2. *Work programme on air pollution prevention and control in Beijing, Tianjin, Hebei and surrounding areas in 2017*

The Ministry of Environmental Protection issued that Air-Source Heat Pumps (ASHPs) should be the main heating system for new residential buildings; coal-fired boilers should not be installed in these buildings.

Relevant financial subsidies for ASHP projects (currency conversion: 1 yuan = 0.15 USD, as of October 2020):

- » Beijing: 24,000 yuan/household (corresponds to approx. USD 3,600).
- » Tianjin: 29,000 yuan/household (corresponds to approx. USD 4,350).
- » Shanxi: 27,400 yuan/household (corresponds to approx. USD 4,100).
- » Hebei: 7,400 yuan/household (corresponds to approx. USD 1,100).
- » Shandong: 8,000 yuan/household (corresponds to approx. USD 1,200).

The application range of air source heat pumps is also extended from the Yangtze River basin to Northern China, even in areas with lower temperature in winter. The national standards for the application of air source heat pumps at low ambient temperatures have also been further improved. Air source heat pumps are required to be used at lower ambient temperature ( $-25^{\circ}\text{C}$ ) than before ( $-20^{\circ}\text{C}$ ). The national standard also requires that

the primary energy utilization rate of air source heat pump heating is higher than that of coal heating when the outdoor temperature is higher than  $-12^{\circ}\text{C}$ . In this way, it is ensured that ASHP is used more than coal combustion. This is advantageous, since the energy efficiency of ASHP is higher (and the greenhouse gas emissions are lower) than that of coal combustion.

#### Ground source heat pumps

Ground source heat pumps have been used in China for more than 20 years, and their cumulative application area change is shown in Fig. 2. By 2019, the cumulative application area of ground source heat pumps had exceeded 0.5 billion square meters, of which 70% were in borehole exchanger heat pump systems.

China's research on heat pump technology has undergone four main stages during which numerous technological and engineering breakthroughs have been reached:

1. 1980 to 2000: In this starting stage, the heat pump concept began to spread in the HVAC field and producers had only few and incomplete accessories. As a result, the application scale increased slowly.

2. 2000 to 2004: Turning into the promotion stage, heat pump application had increased to about 80 heat pump unit producers and system integration manufacturers. Still, heat pump technology was not well considered, due to the low technical level of installers and breakdowns caused by engineering inexperience.

3. 2005 to 2013: This is the rapid development stage, under the strong policy support which firmly emphasized energy conservation and carbon emission reduction. This laid a solid foundation for heat pump technology in renewable energy applications. Heat pump technology and facilities emerged across the country. By the end of 2012, there were 4000 heat pump unit producers and system integration manufacturers, with a total areas of 0.24 billion square meters. At the end of 2013, the

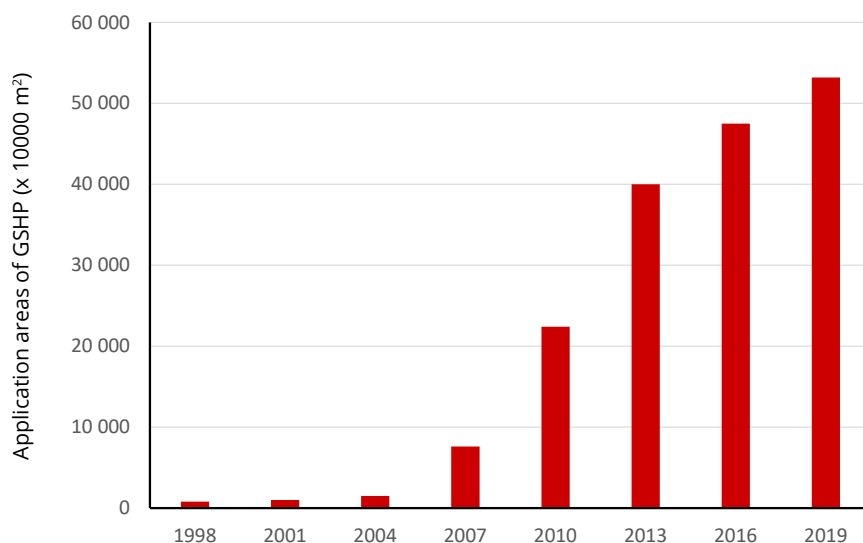


Fig. 2: Application areas of ground source heat pumps in China (x 10,000 m²).

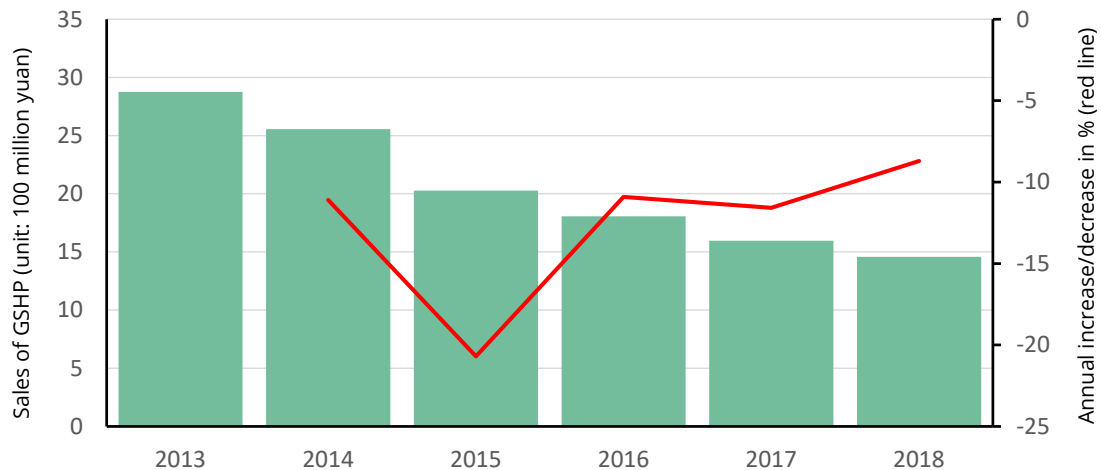


Fig. 3: Sales of ground source heat pumps in China (unit: 100 million yuan).

The red line shows the annual increase/decrease in %, see the axis on the right. Source: Data.chinaiol.com

total application areas of ground source heat pump had reached 0.4 billion square meters. 78% of the whole application projects were gathered in North China and the Southern region of North-East China, in Beijing, Tianjin, Hebe, Liaoning, Shandong, and Jiangsu, etc.

4. 2014 up to now: ground source heat pumps have entered into a steady developing stage. This is due to several factors, such as the great urgency of renewable energy application, high-efficiency clean heating, and the rigorous regulations of under-ground water usage. This current stage is characterized by a new focus and interests in shallow geothermal energy application in heat pumps, system design, controlling and optimization.

The development characteristics of ground source heat pumps (GSHPs) in China are as follows.

1. As a result of market surveys, GSHPs have been installed in residential buildings and public buildings. According to the summary data, almost all types of buildings can use ground source heat pump system for cooling and heating. There is a high proportion of borehole exchanger heat pump systems in public building projects, and boreholes make it is relatively easy to control the balance of heat absorption and discharge. Therefore, the proportion of GSHPs applied in public buildings is higher than that in other types of buildings.

2. There are various types of low-temperature heat sources of GSHPs, and the projects develop on a large scale. Soil, groundwater, surface water and so on can be used as low-temperature heat sources of GSHPs. In recent years, GSHP projects have been developed on a large scale, and a number of national, provincial and municipal key projects have been applied in large scale. The new office buildings of Beijing Municipal Government are heated and cooled by GSHP systems. The energy supply area reaches 3 million square meters.

3. The research and application of middle and deep borehole exchanger heat pump systems are very active. This is a new geothermal energy utilization technology. Because the rock and soil have the characteristics of gradually increasing downward temperature, this technology is suitable for one-way heat extraction for building heating. In recent years, there have been a number of demonstration projects in China, mainly using coaxial tube heat exchangers. The technology is also constantly improving, making it a hot spot of GSHP research in China.

China's ground source heat pump application area has been in the forefront of the world, but in recent years, due to a variety of factors, the growth rate has slowed down. According to Fig. 3, the sales of ground source heat pump units in China has decreased year by year after 2013.

The main reasons for the decline are as follows:

1. The application of groundwater source heat pumps has been greatly reduced

During the rapid development stage, ground water source heat pumps accounted for a large proportion of the application of ground water source heat pump. Due to the problems in design, construction, installation and operation of some of the projects, some problems have been gradually exposed. This includes the difficulty to recharge groundwater, which may cause water pollution, etc. As a consequence, a number of provinces and cities have recently issued policies to restrict the use of groundwater source heat pumps. Instead, borehole systems now dominate.

2. Impact of construction market

Ground source heat pump systems are widely used in buildings with both cooling and heating load requirements. They are widely used in public buildings. After 2013, the number of public construction projects de-

creased, and thus the amount of new ground source heat pumps also decreased.

### 3. Technology risk-affected user confidence

Some projects had many problems. For instance, the heat transfer capacity of ground source heat pumps may be insufficient due to improper construction, or the heat and cold accumulation caused by nonstandard design calculation results in the attenuation of heat exchange capacity of the system, affecting the energy efficiency of the system. It not only causes the loss of the project itself, but also leads to lower confidence in the ground source heat pump technology, leading to a decline in the number of new ground source heat pumps.

Policies regarding Ground Source Heat Pumps:

#### 1. *13th Five-Year Plan for GSHP Energy Development and Utilization*

Established according to the 13<sup>th</sup> Five-Year Plan for Renewable Energy Development, this policy elaborates the guidance, goal, key tasks, major layout and operation measures of GSHP energy development and application which is the basic foundation for geothermal energy development.

#### 2. *Accelerating the Development and Utilization of Shallow Geothermal Energy to Promote Coal-Reducing Substitution in the Northern Heating Area*

This will promote the use of clean and efficient energy, for regional heating and cooling, in order to improve air quality.

Relevant financial subsidies for GSHP projects

- » Beijing: 30% of the initial investment in compensation engineering.
- » Jilin: 60 yuan/m<sup>2</sup> in accordance with the energy supply area.
- » Chongqing: 30-40 yuan/m<sup>2</sup> in accordance with the energy supply area.
- » Nanjing: Compensation for energy supply area is 35-70 yuan/m<sup>2</sup>.

## Conclusions

Heat pumps are an effective way to utilize renewable energy. Heat pumps have bright prospects in China in the future. With the continuous support of policies and funds, the application of heat pumps will continue to increase.

It was expected that the Chinese air source heat pump market would maintain a steady growth at an annual rate of more than 10%. However, this is not currently the case. The problem is how to improve the operation performance of the ASHP, so that it can be effectively used in coal power engineering.

Under the influence of many factors, such as changes in the construction market, the ground source heat pump market will be further affected, and the application growth rate is expected to decline for a period. However the decline rate will be further slowed down, and the accumulated application area will still be further increased.

LINGYAN YANG

China Academy of Building Research, CABR

[yly8111@163.com](mailto:yly8111@163.com)