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To cite this article: Keyan Zheng 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **249** 012013

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# Industrialized Geothermal Development in China: Past and Future

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**Abstract.** Geothermal resources development and utilization started in 1970 in China when the world's first petroleum crisis. Unfortunately it had not lasted for long time. However, along with the reform and opening-up at 1980s the decreased national input affected further growth. Up to the time of market economy many developers invested geothermal at the middle of 1990s, Chinese geothermal business became expanded and formed industrialized scale. It made Chinese geothermal high speed growth. Chinese geothermal annual energy use for direct use occupies the first place in the world since 2000. GSHP has a very rapid growth in past two decades in China. Its annual energy use had reached the first place in the world in 2015. Overall these achievements are based on industrialized development in China. It will bring China to go a more promising future.

**Keywords:** geothermal, development, industrialize, China

## 1. First Geothermal Upsurge in China in 1970s

There are over 2,000 years of history for hot spring bath with medical treatment in China. However geothermal development as energy resources started in 1970. During the first crisis of oil price national governments paid attention to look for new energy. Prof. J.S. Lee the Minister of Geology mobilized the whole nation to develop and utilize geothermal energy. China was socialist planned economy at that time. The order made nationwide response. Great upsurge of geothermal exploration, development and utilization raised rapidly. Geological teams enhanced geothermal investigation and survey. Universities and research institutes provided scientific information and research results. They joined up to carry out various tests of geothermal utilization by using hot springs or thermal wells.

Geothermal power generation test started in Fengshun county, Guangdong province. Geothermal electricity of 72 kW was produced from hot spring water of 92°C. in addition, a 50 kW power generation gained success by using ORC method from 67°C hot spring water in Yichun county, Jiangxi province. There were 7 of such medium-low temperature geothermal power plants with total capacity of 1,550 kW built in China. And high temperature geothermal power generation of 1 MW started in Yangbajain, Tibet from 1977.



Medium-low temperature geothermal water direct use is more popular. Tianjin wool manufacturing used geothermal water for washing and dyeing. Tianjin duck factory used geothermal water for slaughter, washing and incubation. Geothermal greenhouse cultivated fresh vegetables at winter. Geothermal space heating started in Beijing and Tianjin. Hot spring water of 80°C was used for cooling and leather industry in Fuzhou. Hot spring sea eel feeding for export popularized in Guangdong and Fujian provinces. Various geothermal agricultural use popularized in Hubei province. It includes soft-shelled turtle feeding and incubation, fish feeding, aquatic plant growing, and geothermal irrigation for double cropping rice.

Geothermal survey and exploration were carried out in many provinces. Beijing Hydrogeological Team established geothermal section in 1970. After geological and geophysical survey the first geothermal well drilling yielded thermal water of 39.2°C in urban area of Beijing. Subsequently the Beijing Urban geothermal field was discovered as 30 km<sup>2</sup> area. Geothermal water was used for washing, dyeing and air-conditioning in textile mills, for fish feeding in suburban area, and for bath and haircut in factories. Geothermal exploration also gained success in Guangdong, Hebei, Anhui, Jiangxi, Liaoning etc, provinces and then started utilization.

## **2. Market Economy Created Chinese Geothermal Industry**

The first geothermal upsurge lasted more than 10 years. The main participants is geological public institutions, universities and research institutes. Some enterprises owned hot spring or geothermal well. But they just took part in geothermal utilization. Geothermal is not their main products. There was no geothermal industry basically at that period. In 1980s along with the decrease of geothermal national input there was only a few geothermal projects maintained at that time. It means the geothermal upsurge had finished.

Until the reform and opening up policy implemented in 1990s, it added new vitality to Chinese geothermal development. Geothermal industry established from that time. It started growth in various regions.

Hot spring life cultivation and health preservation, and hot spring leisure and entertainment were developed at that time. It accommodated people's new demand while accompanying social economic development and upturn living standards. The first developer invested such geothermal business and gained large and fast return. It became a "force of example". The chain reaction brought latter developers to follow-up. New developers pushed out new idea and new design. Such geothermal development was continued and continued again. And it expanded from Beijing, Tianjin and coastal region to small cities and hinterland. It keeps one's flag flying for decades.

The developers invested geothermal business under market economy made an everlasting power for growth of Chinese geothermal development. They constituted Chinese geothermal industry. It achieved evolution of Chinese geothermal development. Since 2000 Chinese geothermal direct use had reached the number one in the world. This record has been keeping so far.

## **3. GSHP Brought up Expand of Industrialization**

Worldwide ground source heat pump (GSHP) rapid expansion brought a new road to China. Depending on advantage function of GSHP, under the situation of energy conservation and emission reduction national and local governments gave many of preferential policy. Plus lower technical

threshold of GSHP installation and application, Chinese GSHP development gained vast space. During past 2 decades Chinese GSHP growth had exceeded the world's increase speed. It made also a great expanding of enterprise troops of Chinese GSHP industry. Enterprise is entity and foundation of economic development. A combination involving production, teaching and research formed totality strength of the industry.

GSHP was recommended in China in 1990s. It is 20 more years growth in China so far. GSHP grow out of nothing at the first half. There was high increase rate but limited total energy use in that period. In the second half GSHP reduced the increase rate but there was huge quantity of increase (Table 3). In 2000 Chinese GSHP was ranked in later half among 26 countries. In 2005 Chinese GSHP was raised the 6<sup>th</sup> position among 32 countries. In 2010 Chinese GSHP became the second place among 43 countries. In 2015 Chinese GSHP was reached the first place for annual energy use among 48 countries. The growth of Chinese GSHP has exceeded world's speed. It is the contribution of Chinese GSHP enterprises. There are over 4,000 enterprises of GSHP manufacture, installation and supplier in China. Some quoted companies have been appeared. Chinese geothermal industry never showed such glorious achievements.

**Table 1.** Statistics of growth of annual energy use of GSHP in China

Year	1995	2000	2005	2010	2015
Annual energy use, TJ/yr	7	83	6,569	29,035	100,311
GSHP ratio in direct use, %	0.04	0.26	14.4	38.5	57.3
Increased rate than 5 years ago		11.9 times	79.1 times	4.4 times	3.5 times
Cumulative annual increase rate, %		64	140	35	28

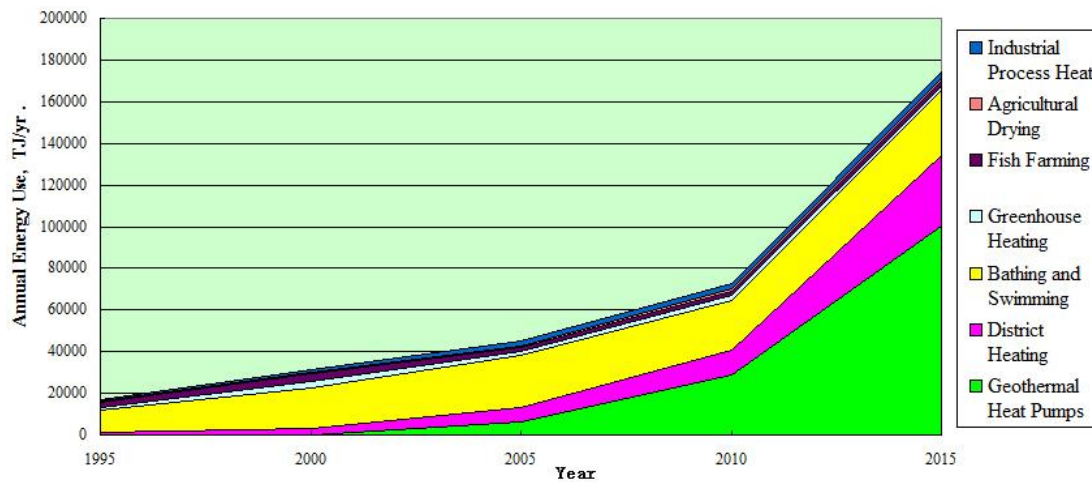


**Fig. 1.** Comparison of growth of GSHP, geothermal direct use and power generation in China

#### 4. Meet the Second Geothermal Upsurge in China

Review past 48 year's development history, there was positivity of mass movement under planned economy period. But it had support of industrial foundation. So it was short of stamina. However developers created investment-profit model under market economy. It established industrial troops and settled the fundament of growth. Plus combination involving production, teaching and research it built

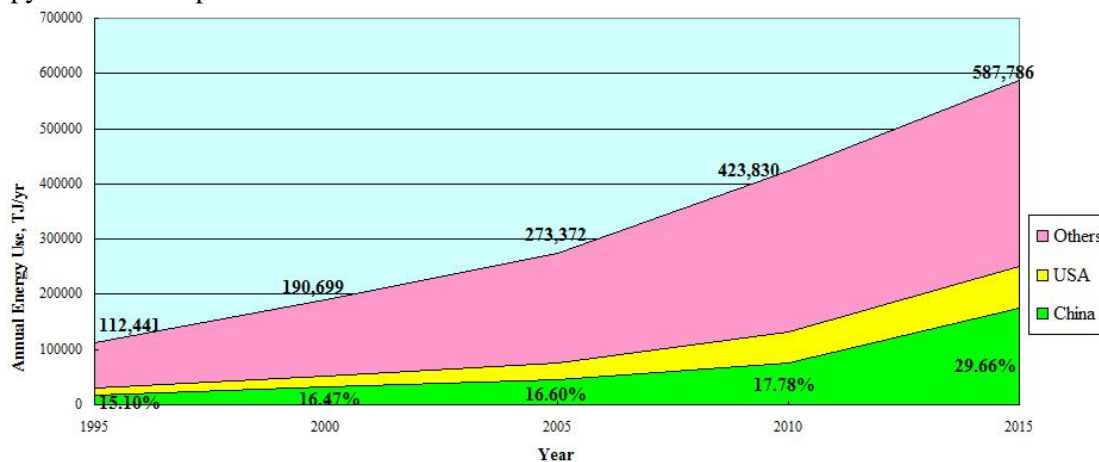
the sustainable development model which featured by industrialization.



**Fig. 2.** Process of geothermal development in past 2 decades in China

Figure 2 shows clearly that the growth of Chinese geothermal development is mainly in past twenty more years. This achievement was brought by geothermal industrialization in China.

We can see further the figure 3 showed the world geothermal development history with a contribution by China and United States therein. Chinese geothermal has exceeded in United States to occupy the absolute predominance.



**Fig. 3.** History of geothermal annual energy use in the world, China and USA

In January of 2017 China issued “The 13<sup>th</sup> five-year plan of geothermal energy development and utilization”. This is the first time for geothermal five-year plan in China.

Chinese geothermal workers jubilate with the new target. It will bring Chinese geothermal development to step up a new horizon.

## 5. Make Persistent Efforts We Need Keep Punching

Chinese geothermal development experienced long historical process. How about the next step? An aphorism from a benchmarking enterprise said “Although the road is far away, it will be reach by our walking”. We have to make persistent. We need keep punching. By finding the problem and finding out gap, we will create new glory.

The geothermal five-year planning has issued for one year. However the geothermal progress was

less than satisfactory in 2017. Geothermal power generation has a target of 500 MW of new installation in 2020. But the new installation was 4 small units of total 1.4 MW only in 2017 by two private companies. One of them installed 3 units of 400 kW each in Ruili county, Yunnan province. Another one installed 1 units of 200 kW in Kangding county, Sichuan province. After 20 more years hesitancy Chinese geothermal power generation started a 32 MW new construction in Yangyi, Tibet during the 12<sup>th</sup> five-year plan. We appealed to support by creating national demonstration project and giving preferential subsidy of electricity price. Unfortunately, nothing progressed. This project has not completed yet so far.

National President XI Jinping proposed to carry forward cleaning winter space heating in northern China. Ordinarily geothermal space heating owns obvious advantage. Especially GSHP is universal relevance for urban or rural areas. Unfortunately, such implementation got following result in Beijing: geothermal of 0%, GSHP of 1%, solar heating of 1%, electric heating of 19%, air source heat pump of 67% and natural gas heating of 12%. We don't know why high function GSHP wasn't trusted while used air source heat pump of lower function?

Perhaps there was insufficient broadcast by our geothermal and GSHP industry so that decision maker had deficiency of understanding. Some corresponding policies are still not in place. We need solve such barrier in order to win more success.

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