

Operation status and PPP mode analysis of typical geothermal central heating project

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ABSTRACT

With the rapid development of geothermal industry in China, the heating area of low temperature geothermal resources is expanding continuously. The large-scale winter geothermal heating project in North China belongs to the urban infrastructure project, which provides public service and is suitable for the PPP mode. In order to ensure the safety and stability of central heating in the North China in winter, franchised PPP mode is more suitable for geothermal projects. The key factors of a successful geothermal heating project include resource conditions, technical conditions, market conditions and policy conditions.

1. INTRODUCTION

With the continuous development of China's urbanization, the heating scale in the northern region is expanding in winter. In the area of geothermal resources enrichment, more and more geothermal projects have been built and run^[1]. In recent years, the PPP mode has been gradually introduced into the geothermal heating industry in China^[2]. As the largest geothermal heating enterprise in China, the Sinopec has developed a number of large-scale geothermal central heating projects using low temperature geothermal resources. Several typical projects from Xiongxian County of Hebei Province, Xianyang city of Shaanxi Province and Lindian County of Heilongjiang are selected to analyze their construction and operation status, summarize their success and failure. At the same time, the relationship between the geothermal central heating project and the PPP model is also discussed.

2. ANALYSIS OF TYPICAL GEOTHERMAL HEATING PROJECT

Four geothermal projects are analyzed from Xiongxian County of Hebei Province, Xianyang city of Shaanxi Province and Lindian County of Heilongjiang Province. They are referred to as projects A, B, C, and D. The location of the projects are shown in Figure 1.

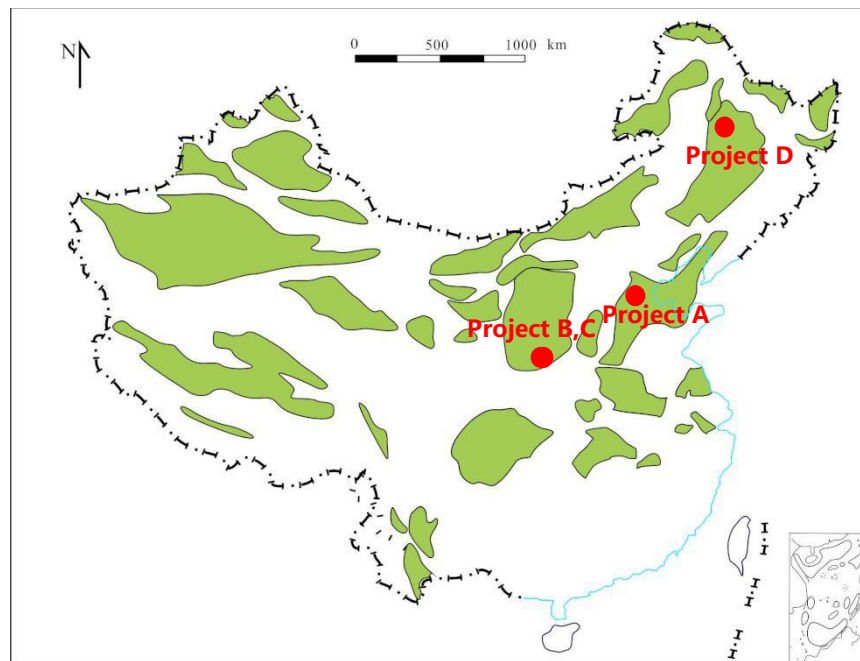


Figure 1: The location of the projects

2.1 Project A

Project A is located in the Xiongxin County of Hebei Province. The geographical position is in the middle of North China Plain. Geologically, Xiongxin is located in the Niutuozen geothermal field, Bohai Bay Basin. Geothermal reservoir is the dolomite in Wumishan formation of Middle Proterozoic. In the past, the winter in Xiongxin was mainly heated by coal, and the pollution of the environment was very serious. In some areas, small scale geothermal heating was used, but the tail water was not reinjected at all.

In August 2009, based on the consensus of "protected development resources, ecological civilization construction, green and low carbon development", the Xiongxin government and Sinopec signed the "geothermal development cooperation agreement" to jointly promote the development and utilization of geothermal resources in Xiongxin. The Sinopec built geothermal heating area of 4 million 500 thousand square meters in Xiongxin, which basically realized the full coverage of geothermal heating and became a "smoke-free" city. Geothermal resources have been effectively developed on the basis of the "taking heat without water" technology. All the geothermal water has been reinjected in the same layers.

Now, the "Xiongxin model", which is based on the experience of geothermal development in Xiongxin, has been widely recognized at different levels (The country, the industry, the public, and so on). The State Energy Bureau points out that the "Xiongxin model" is technically mature and economically feasible, and can be popularized and replicable. The success of the "Xiongxin model" has benefited from the "four unity": unified policy, unified management, unified planning and unified development.

2.2 Project B

Project A is located in the Xianyang City of Shaanxi Province. The geographical position is in the Guanzhong Plain of Shaanxi. Geologically, Xianyang is located in Fenwei Basin. The geothermal reservoir is the sandstone of Neogene. Project B was completed and put into operation in 2013. It was expected to heat 4 districts, and then adjust the investment and construction plan according to the change of the market, and provide heating for two districts with an area of 280 thousand square meters. Two new geothermal wells were drilled, and the tail water of the nearby project was used as a supplementary heat source.

When the project was designed, the expected internal rate of return after tax was 13%. After the actual operation of the project, the calculated post tax internal rate of return is 35%. The main reason for this difference is that the utilization of waste heat of the nearby geothermal tail water and reduce the construction of a heat exchange station save the related expenses. If the project does not use the heat of the nearby geothermal tail water, a geothermal well or a heat pump will be needed, and this will increase investment and increase the cost of operation and maintenance.

2.3 Project C

Project C is also located in Xianyang, about 6km away from the project B. Project C, like Project B, also uses the geothermal resources in the Neogene sandstone, which was also built and operated in 2013. It was expected to heat four districts, but because of the change in the market, only 140 thousand square meters of building area from two districts were heated. Three wells were drilled, only one well has been put into use.

When the project was designed, the expected internal rate of return after tax was 14%. After the actual operation of the project, the calculated post tax internal rate of return is 6%. The main reason for this difference is that the market conditions have changed. Two geothermal wells and some pipelines have been built, but they are not put into use, resulting in the deposit of funds.

2.4 Project D

Project D is located in the Lindian County of Heilongjiang Province. The geographical position is in the Songnei Plain, and it belongs to the Songliao Basin in geology. Geothermal reservoir is the sandstone of Upper Cretaceous. Lindian project was completed and put into operation in 2013. It provides heating for a residential district and an agricultural project with an area of 180 thousand square meters. Three new geothermal wells are drilled. In addition, two geothermal wells invested by government were used.

When the project was designed, the expected internal rate of return after tax was 8.8%. After the actual operation of the project, the calculated post tax internal rate of return is 4%. If the investment of government wells was included in the project, the internal rate of return after tax is only 2%. The main reasons for this difference are as follows: 1. adjusting the drilling position during the construction of the project increased the investment of the pipe network; 2. the temperature of geothermal water is lower than that of the design; 3. the government costs of heating buildings cannot be put in place on time; 4. the low occupancy rate of buildings leads to a lower fee area; 5. the actual heating price is lower than the design.

3. THE RELATIONSHIP BETWEEN PPP MODE AND GEOTHERMAL PROJECT

PPP is the acronym for Public - Private - Partnership. PPP mode refers to a partnership relationship between government and social capital, in order to cooperate in the construction of urban infrastructure projects, or to provide some public goods and services. In the PPP mode, the rights and obligations of the two parties are usually identified through signing the contract to ensure the smooth completion of the cooperation so that all partners can achieve better results than the expected action alone.

3.1 Classification of PPP mode

The generalized PPP can be divided into three categories. The outsourcing PPP project is generally invested by the government, the enterprise contracts one or more of the functions in the whole project, and realizes the income through the government payment. The

franchising PPP project requires enterprises to participate in some or all investment, and share certain project risks and share project profits with the public sector through a certain cooperation mechanism. The public sector may charge a certain franchise fee or give a certain amount of compensation to the franchisee. The private PPP project requires the enterprise to be responsible for all the investment of the project. Under the supervision of the government, the profit is realized by collecting the investment to the user. Enterprises take the most risk in such PPP projects.

3.2 PPP mode classification of geothermal heating project

The large-scale winter geothermal heating project in North China belongs to the urban infrastructure project, which provides public service and is suitable for running in the PPP mode. When geothermal projects are established, heating enterprises sign contracts with users, and often sign agreements with the government at the same time, to clarify their rights and obligations so as to ensure the smooth development of geothermal projects. If the geothermal project has signed an exclusive agreement with the government, it is a franchised PPP mode that the enterprise should plan and develop geothermal resources in a larger range. Project A belongs to this type of PPP mode. If the geothermal project does not sign an exclusive agreement with the government, it cannot avoid the competitive development of similar enterprises in the near range, which belongs to the Privatized PPP mode. Project B, C, and D belong to this type of PPP mode.

3.3 The necessity of adopting the PPP mode

Winter heating in North China is very demanding for the safe and stable operation of the project. If the high efficiency, green and large-scale geothermal development cannot be realized, the geothermal tail water discharge may cause large-scale environmental pollution. If the heating project has problems and cannot be safely and steadily heated, it may seriously affect the people's life and cause "social stability problem". In some areas with weak geothermal heating management in China, problems have occurred. If the PPP mode, especially the exclusive PPP mode is adopted, the project can run more smoothly, and the relevant parties of the project can get better results. Project A is a typical example of success. Otherwise, the effect of the geothermal heating project may vary greatly because of the possible changes in the market or policy conditions, Project B, C, and D are typical examples.

4. POINTS OF CONCERN FOR GEOTHERMAL PPP PROJECT

4.1 Key factors of a successful geothermal heating project

According to the analysis of the typical geothermal project, the main factors for the success of geothermal projects include the following conditions: resources, technology, markets and policies. Resource conditions mainly refer to high temperature and large amount of geothermal water; a clear understanding of thermal reservoir. Technical conditions are the foundation of green economic development of geothermal resources, and also the threshold of screening the enterprise. Market conditions refer to the in-depth investigation of enterprises and the reasonable guidance of the government. Policy conditions require the government to support the development of geothermal projects, the construction and operation of the project have a good human and social environment. If one of the four conditions is missing, the geothermal project will not be successful.

4.2 The necessity of adopting exclusive PPP mode

Based on the perspective of resources and technology, if there are other geothermal heating enterprises, geothermal resources cannot be unified planning, which will easily cause destructive development of geothermal resources, increase heating difficulties, and tail water drainage will also form environmental risks. Based on the perspective of market and policy, if there are multiple heating projects running in the same area at the same time, there will be unnecessary competition among the projects, which will affect the government decision-making and enterprise confidence, and will eventually affect the residents' normal heating. Adopting the exclusive PPP mode, the government can effectively control the heating effect and environmental impact. Enterprises can get stable market and reasonable profits, and residents can get good heating services.

5. CONCLUSIONS

Two conclusions are drawn as follows.

- (1) The success of a large-scale geothermal central heating project in North China depends on four key conditions: resources, technology, markets and policies.
- (2) The large-scale central heating project of is suitable for the PPP mode, especially exclusive franchised PPP mode.

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