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The Goal of China's Geothermal Energy Industry in 2025s

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ABSTRACT

This paper summarizes the achievement of the development goals of China's geothermal energy industry from 2016 to 2020, and analyzes the existing problems. Then, this paper analyzes the environmental system of geothermal energy industry development in China from 2021 to 2025, and puts forward the idea of high-quality development of geothermal energy industry in China from 2021 to 2025. Furthermore, the paper predicts that the industry will have a 7% ~ 10% annual growth rate of the development target, and analyzes the development path of China's geothermal energy industry and the key points of development. Finally, this paper analyzes and discusses the measures for the development of geothermal industry, from the aspects of resources, technology, management mechanism, standard certification, recharge monitoring and regulations and policies.

1. AN ANALYSIS OF THE DEVELOPMENT OF CHINA'S GEOTHERMAL ENERGY INDUSTRY DURING THE 13TH FIVE-YEAR PLAN PERIOD

1.1 Geothermal heating is developing rapidly in China

During the 13th Five-Year Plan period, the use of geothermal energy for heating has been rapidly developed in the Beijing-Tianjin-Hebei air pollution transmission channel cities " 2+26 "and 11 cities on the Fenhe and Weihe Plains, while it has become an important green alternative energy for clean heating in the northern region. According to geothermal heating data of 15 key provinces and cities, by the end of 2019, the newly added area of hydrothermal geothermal heating reached 376 million square meters, and that of shallow geothermal heating (cooling) reached 273 million square meters. According to the development rate of the first four years, it is estimated that during the 13th Five-Year Plan period, the area of geothermal heating (cooling) in China can be increased by 898 million square meters, including: the area of hydrothermal geothermal heating is 480 million square meters; The area of shallow geothermal heating (cooling) increased by 418 million square meters. Geothermal heating (cooling) area has reached 1.392 billion square meters.

1.2 Sustainable development of hot spring utilization and geothermal greenhouse planting and breeding

By the end of 2019, the "Home of Hot Springs" report calculated that the scale of hot springs utilization had reached 6,608 MW, accounting for about 40 percent of the country's total hot springs utilization. It is calculated that the utilization scale of all hot springs in China is 16,520 MW, equivalent to 281 million square meters of heating area. By 2019, the use of geothermal energy for aquaculture in China has spread to 47 geothermal fields in more than 20 provinces. There are about 300 farms with 5.5 million square meters of ponds. In 2019, there was an installed capacity of 346 MW and 482 MW of geothermal energy in China's greenhouse planting and aquaculture aspects, year-on-year increases of 55.4 percent and 55 percent respectively in 2015. The annual utilization rate of geothermal energy was 4.26 million GJ and 5.02 million GJ, respectively, which will become an important way to utilize geothermal energy.

1.3 Geothermal power generation is growing steadily

In China, geothermal resources are mainly used at medium-low temperature. Due to the limited spatial distribution of high-temperature resources, they are mainly distributed in the Qinghai-Tibet Plateau. Geothermal power generation in this region has high investment cost, and there is no electricity price subsidy, making it less attractive for enterprises to invest. As a result, geothermal power generation as a whole is growing steadily. By the end of 2019, the country had added 22 MW of geothermal power capacity, and the cumulative installed capacity is expected to reach about 49 MW by the end of 2020.

1.4 Existing problems

1.4.1 Insufficient investment in resource exploration

During the 13th Five-Year Plan period (2016-2020), the proportion of national investment in geothermal resources exploration was low, and the central finance only made key investment in a few areas such as the Beijing-Tianjin-Hebei region and the dry hot rock projects in the Gonghe Basin of Qinghai Province. The input of local governments is a drop in the ocean, which cannot ensure the detailed investigation of geothermal resources and systematic exploration of geothermal fields. As a result, the exploration degree of geothermal field is low, basic data are lacking and information sharing cannot be realized, which is far from meeting the needs of the rapid development of geothermal industry.

1.4.2 Multi-head management remains unresolved

At present, the exploitation of geothermal resources is regulated by the Mineral Resources Law, the Water Law and the Renewable Energy Law. As these administrative authorities belong to different departments, the relationship between the management agencies is complicated, and the problem of multiple management remains unsolved. This has caused the burden of enterprises, especially in the process of applying for the mining rights and water drawing license of geothermal projects, the management procedures are complicated and the process between institutions is not smooth. As a result, many geothermal projects are built without government approval and illegal construction occurs. At the same time, the management efficiency is low because the law enforcement subject is

not unified. The phenomenon of overstepping the right examination and approval is serious, which affects the rational development and sustainable utilization of geothermal resources. Once environmental pollution events occur, there are treating them rigidly uniform and allowing for no flexibility, which makes geothermal projects face greater policy risks.

1.4.3 Support policies need to be strengthened

Recently, there is no special renewable energy heating support policy in China, which has been involved in the existing work of energy conservation and emission reduction, green buildings, new energy cities, green energy and so on. The central and local governments have issued fiscal and price incentive policies, which play a positive guiding role in accelerating the development and utilization of shallow geothermal energy and promoting clean heating in northern China. However, the policies are not perfect, including Fiscal and tax laws are difficult to implement, inadequate enforcement of laws, inadequate incentive measures, and support policies to be strengthened.

2. ANALYSIS ON THE ENVIRONMENT OF GEOTHERMAL ENERGY INDUSTRY DEVELOPMENT IN THE 14TH FIVE-YEAR PLAN

2.1 Abundant geothermal resources can ensure the development of geothermal industry needs

China is rich in geothermal resources, among which the total amount of hydrothermal geothermal resources is equivalent to 1.25 trillion standard coal, and its annual exploitable heat is equivalent to 1.86 billion tons of standard coal. The annual exploitable volume of shallow geothermal energy resources is equivalent to 700 million tons of standard coal in 36 cities at or above the prefecture level. The dry-hot rock resources at the depth of 3~10 kilometers in the mainland amount to 25,200 trillion GJ, equivalent to 8.56 trillion tons of standard coal. Even if only 2% of its reserves are developed, it can be equivalent to 172 trillion tons of standard coal. These geothermal resources can well support the development needs of geothermal industry.

2.2 The demand of clean energy market promotes the development of geothermal industry

2.2.1 The urgent need for clean heating in winter in northern China

During the 13th Five-Year Plan period, a series of policies have been introduced to encourage clean heating. The number of cities piloting clean heating in winter has been increasing, with 43 cities in total, including "2+26" cities, Zhangjiakou City and cities on the Fenhe and Weihe Plain, in the Beijing-Tianjin-Hebei region and its surrounding areas, covered by the two expansion. At present, the main means to achieve clean heating is through coal to electricity, coal to gas. But electric and gas heating costs more than geothermal heating. By the end of 2016, the total heating area of urban and rural buildings in northern China was about 20.6 billion square meters. Of these, 14.1 billion square meters of urban buildings and 6.5 billion square meters of rural buildings were used for heating. The "2+26" urban and rural building heating area is about 5 billion square meters. It also means that geothermal heating in northern China has a great development space.

2.2.2 Potential demand for heating and cooling in hot summer and cold winter areas in southern China

As socialism with Chinese characteristics has entered a new era, the principal contradiction facing Chinese society has become the contradiction between unbalanced and inadequate development and the people's ever-growing needs for a better life. The problem of winter heating in southern China is a typical example of this major social contradiction. In China, the areas with hot summers and cold winters are roughly south of the Qinling Mountains and Huaihe River. North of Nanling, including 16 provinces, municipalities, autonomous regions, an area of 1.8 million square kilometers, living urban and rural population of about 550 million, GDP accounting for about 48% of the country, is the most densely populated, economically and culturally developed region in China, its political and economic position is extremely important. This climate is characterized by hot summer, cold and humid winter, high air humidity, when the outdoor temperature below 5℃, such as no heating facilities, indoor temperature is low, poor comfort. In this situation, it has become an important development trend to popularize geothermal heating and cooling in hot summer and cold winter areas.

2.2.3 The demand for renewable energy such as geothermal energy is gradually increasing

China is now the largest user of new energy in the world, and its share of renewable energy has increased from 5 % to 12%, but the share of fossil energy is still as high as 86%. With increasing pressure on environmental protection, energy conservation and emission reduction, the country's demand for renewable energy generation will gradually increase. Geothermal power generation has the characteristics of stable load and high generating hours. It can complement the advantages of wind power and photovoltaic power generation, as an important supplement to renewable energy power generation. In particular, the development of geothermal power generation in Tibet is of great significance for the development of Tibetan economy and employment of local residents.

3 DEVELOPMENT IDEAS AND OBJECTIVES OF GEOTHERMAL ENERGY INDUSTRY "14TH FIVE-YEAR PLAN"

3.1 The development idea of the 14th Five-Year Plan

Based on the new energy security strategy of "four revolutions and one cooperation" and the five development concepts of "innovation, coordination, green, openness and sharing", according to the requirements of building a clean, low-carbon, safe and efficient modern energy system, we will fully develop and utilize geothermal energy to provide green alternative energy for clean heating in northern China and heating (cooling) in southern hot summer and cold winter areas, further promote the growth of high-temperature geothermal power generation in southwest China, and strive for a breakthrough in dry-hot rock power generation.

3.2 The development goals of the 14th Five-Year Plan

According to the "Winter Clean Heating Planning in Northern China (2017-2021)", it is expected that in the early period of the "14th Five-Year Plan" in northern China, the phased task of clean heating in winter has been completed. Under the condition of the decline of financial subsidies and the lack of strong government promotion, the development speed of geothermal heating will inevitably return to the normal development level. During the "14th Five-Year Plan" period, the way of thinking of our country's economic development will be adjusted, inevitably fundamentally from the mode of high speed development to the mode of high quality development. The geothermal energy industry is also facing the same adjustment. According to the forecast of the industry experts of the major provinces and cities that use geothermal energy, the annual growth rate of geothermal energy heating during the "14th

Five-Year Plan" is about 7% ~ 10%, and the total increase rate is about 40% ~ 60%. The factors affecting the change range are mainly policy factors, and the planning target can be calculated and predicted according to the average of 50%.

(1) Hydrothermal geothermal heating

Based on the 582 million square meters of hydrothermal geothermal heating area at the end of the "13th Five-Year Plan", the increase rate during the "14th Five-Year Plan" is calculated according to 50%. By 2025, the increase will be 291 million square meters, and the cumulative amount will reach 873 million square meters.

(2) Shallow geothermal energy heating (cooling)

With the shallow geothermal heating (cooling) area of 810 million square meters at the end of the "13th Five-Year Plan" as the base, the increase rate during the "14th Five-Year Plan" is calculated in accordance with 50%, to 2025, the increase of 405 million square meters, a cumulative 1.215 billion square meters.

(3) Geothermal power generation

In the field of high-temperature geothermal power generation, Sinopec, CNNC, Zhejiang Jinjiang Group, Beijing Control and other enterprises plan to build several new geothermal power generation projects in areas rich in high-temperature geothermal resources and with favorable grid connection conditions in Tibet. In terms of power generation from dry hot rock, the State Bureau of Geological Survey of China plans to build a world-class dry hot rock exploration and development model project by 2025, and form a mature dry hot rock development technology system to achieve a breakthrough in power generation from dry hot rock. It is expected that the total installed capacity of high-temperature geothermal and dry hot rock power generation will exceed 100 MW during the 14th Five-Year Plan period.

4 THE DEVELOPMENT PATH AND FOCUS OF GEOTHERMAL ENERGY INDUSTRY "14TH FIVE-YEAR PLAN"

During the "14th Five-Year Plan" period, by implementing the development path of "one point, two zones, three zones, internationalization", our country will drive the high quality development of geothermal energy industry. "One point" is to create a model for the high-quality development of the geothermal industry in Xiong'an New Area, so that it can occupy the commanding heights of the global industry; The "Two Zones" is a demonstration zone for the development of geothermal energy industry in two river basins, centering on the ecological protection and high-quality development strategy of the Yellow River basin and the development strategy of the Yangtze River Economic Belt. The "three regions" focus on the development of clean heating in winter in northern China, heating (refrigeration) in hot summer and cold winter areas in southern China, and geothermal power generation in the Qinghai-Tibet Plateau. "Internationalization" is to cooperate with the national "One Belt and One Road" strategy, strengthen the introduction, digestion and absorption of foreign advanced technologies through international exchanges and cooperation, promote the layout and promotion of geothermal industry in the regions along the "One Belt and One Road", and achieve the goal of going global.

4.1 Promote high-quality geothermal development in xiong'an new area, build a global model and occupy the commanding heights of the world

According to the requirements of "global vision, international standards, distinctive Chinese features, and future-oriented goals", the country will use high standards and high quality services in the construction of Xiong'an New Area. The state will further study a series of technologies for efficient exploration, development and utilization of geothermal resources suitable for the geological characteristics of Xiong'an New Area, and then use a first-class standard system to regulate the market, so as to achieve the purpose of leading the high-quality development of the region. We will build a geothermal energy monitoring system and a smart geothermal energy supply system. At the same time, geothermal energy will also be used in clean heating, high-end agricultural planting and breeding, industrial energy demonstration projects, tourism and leisure, cultural industry and other fields in Xiong'an New Area, and finally make the geothermal energy industry one of the characteristic industries of Xiong'an New Area. This will upgrade the "Xiongxian model" of large-scale development to the "Xiongan model" of high-quality development. This model will become a model for the development of the global geothermal industry and occupy the commanding heights of the world's geothermal industry.

4.2 Serves the ecological conservation and high-quality development of the Yellow River Basin and provide clean geothermal energy

Focusing on the ecological conservation and high-quality development strategy of the Yellow River Basin put forward by the state, we will help the energy transformation needs of key areas and provide clean geothermal energy.

Middle reaches of the Yellow River: Shanxi Province relies on the geothermal resources in Guanzhong Basin to promote geothermal clean heating and help the energy transformation in Xixian New District. Shanxi Province will continue to take Taiyuan as the leader to develop the geothermal resources in the tropical Fen and Wei Graben, give full play to the leading role of the provincial capital, and promote transformation and development to be the leader of the energy revolution.

Lower reaches of the Yellow River: Relying on abundant geothermal resources, we will vigorously develop clean heating projects in Zhengzhou, Kaifeng, Puyang, Henan Province, Liaocheng, Jinan, Zibo, Dongying, Shandong Province and other key cities along the Yellow River, and build geothermal central heating demonstration projects, so as to improve people's living standards while reducing air pollution, achieve zero emission, protect the ecological environment of the Yellow River basin and promote ecological protection and high-quality development.

4.3 Serve the development strategy of the Yangtze River Economic Belt, focusing on the large-scale application of urban river water sources

During the 14th Five-Year Plan period, according to the strategic pattern of urbanization dominated by high-end urban agglomerations, our country has utilized the location advantage of the Yangtze River economic belt, which spans the three sectors of East and West as well as the abundant water resource advantage. Relying on a series of large-scale river water heating (cooling) projects such as the Shanghai World Expo Axis, Nanjing Jiangbei New Area and Wuhan Binjiang Business District, we have promoted the construction of centralized geothermal energy development and utilization projects in Chongqing, Nanjing, Hangzhou, Chengdu and other large coastal cities along the Yangtze River, and created a pearl chain of high-level geothermal industry along the Yangtze River Economic Belt with a high starting point. We will help it become a geothermal industrial cluster that runs from east to west, radiates from north to south, connects rivers to the sea, and achieves high-quality development that gives priority to ecology and is green and low-carbon.

4.4 The development of geothermal instead of coal for clean heating in winter in northern China helps prevent and control air pollution

At present, the three elements of geothermal resources, heating demand and policy incentives in the northern winter clean heating areas have been fully prepared, and there is a good environment for the development of geothermal heating. In order to achieve clean heating in northern China and win the " Blue Sky Protection Campaign" , we will focus on developing geothermal coal heating instead of coal in the pilot cities of clean heating in winter in northern China, including the "2+26" cities in the Beijing-Tianjin-Hebei region and its surrounding areas as well as the cities in Zhangjiakou and Fenhe and Weihe plains. During the "14th Five-Year Plan" period, in North China, we should focus on the development of hydrothermal geothermal energy in areas rich in hydrothermal resources, and focus on the development of shallow geothermal energy in rural areas.

4.5 Shallow geothermal energy should be developed to meet the demand of combined heat and cold supply in the south where the summer is hot and the winter is cold

During the "14th Five-Year Plan" period, there is a huge demand for heating and cooling in the south where the summer is hot and the winter is cold, which needs to be solved through the market mechanism. We should vigorously develop and utilize the shallow geothermal energy in southern China in the way of "adapting to local conditions, intensive development, strengthening supervision and paying attention to environmental protection". According to the occurrence conditions of shallow geothermal resources in the south, we should give priority to the development of surface water (river, lake, sea, etc.) water source heat pump, actively develop the buried pipe ground source heat pump, and moderately develop the ground source heat pump. In large, medium and small cities and towns, the distributed shallow geothermal energy development and utilization system has been fully built, which can meet the heating and cooling needs of various buildings. Shallow geothermal energy is being harnessed on a large scale, and it could help green and low-carbon urban development.

4.6 Breakthrough in developing high-temperature geothermal power generation and realizing dry-hot rock power generation in Qinghai-Tibet Plateau

The construction of China's key hydro-thermal geothermal power generation projects has been promoted by taking into account the local power demand and overall consideration of geothermal resources and engineering construction conditions. On the basis of the construction of Yangbajing and Yangyi power stations, we have made detailed exploration and exploration of geothermal resources. In the Qinghai-Tibet Plateau and its marginal areas, where medium-high temperature geothermal resources are abundant, we focus on "one Belt, two routes", focusing on the development and promotion of geothermal power generation projects in the eastern tropical section of the Mediterranean-Himalayan mountains, along the Qinghai-Tibet Railway and along the Sichuan-Tibet Railway. The use of geothermal power and industrialization is interactive with the local economy.

China has been steadily carrying out the construction of deep dry hot rock exploration and power generation demonstration projects, especially the dry hot rock geothermal power generation project in Qinghai. By establishing one or two demonstration bases for geothermal power generation, the key technologies of deep dry hot rock resource exploration and dry hot rock power generation have been developed, which will lead the development and utilization of domestic dry hot rock resources.

4.7 Strengthen international cooperation and cooperate with "the Belt and Road" to achieve the goal of going global

The internationalization strategy is in line with the national "the Belt and Road" strategy. Through international exchanges and cooperation, the focus of geothermal project development gradually changed from geothermal engineering construction contracting during the 13th Five-Year Plan period to industrial cooperative development during the 14th Five-Year Plan period. It has built the "Overland geothermal Silk Road" and the "Maritime geothermal Silk Road". On the premise of geothermal resource endowment and market demand, we will focus on geothermal heating (cooling) projects in Central Asia and Eastern Europe along the "overland Silk Road". In the "Maritime Silk Road", geothermal power generation projects will be developed in countries along the western tropical rim of the Pacific Ocean, the Red Sea, the Gulf of Aden and the East African Rift Valley, which will help China's geothermal industry go overseas successfully.

5 DISCUSSION ON SAFEGUARD MEASURES

5.1 Increase investment in exploration and promote detailed investigation and evaluation of geothermal resources

It is suggested to increase financial input at all levels, let enterprise capital actively participate, and then carry out detailed investigation and fine evaluation of geothermal resources in key areas. The resource investigation and evaluation study is firstly carried out in the northern clean heating area, and then the detailed resource survey is carried out in Xiong'an New Area, "2+26" city and 11 cities of Fenhe and Weihe Plain as the key areas. The geological conditions, heat storage characteristics and quality and quantity of geothermal energy resources of the hydrothermal geothermal field are identified as soon as possible, and the technical and economic conditions of exploitation are evaluated to provide a basis for rational development and utilization. We will accelerate research on dry hot rock exploration and evaluation technology, select a number of dry hot rock target areas, and prepare for the verification of dry hot rock geothermal energy development and utilization project.

5.2 Technology research and development has been intensified to achieve key breakthroughs in key technologies

The 14th Five-Year Plan period is an important stage for China's economy to change from a high-speed development mode to a high-quality development mode. At present, many geothermal projects have been listed in the National Key Research and Development Program of China, and three key projects related to geothermal energy have been set up in the key project of Renewable Energy and Hydrogen Energy Technology: Research on Key Scientific Problems of Energy Acquisition and Utilization of Dry-hot Rock, Comprehensive Evaluation Technology of Enhancing Production and Utilization of Deep Carbonate Thermal Reservoir, Technology and Equipment for Increasing Efficiency of Exploitation and Irrigation of Sandstone Thermal Reservoir. "Deep Geothermal Resources Exploration and Development" has set up two key projects related to geothermal resources: Demonstration of Deep Geothermal Resources Exploration and Evaluation Technology in Xiong'an new area and Research on Key Technologies of Deep Geothermal Resources Exploration and Evaluation. During the "14th Five-Year Plan" period, with the deepening of research, key technologies such as exploration and evaluation of geothermal resources, enhanced production and utilization of deep carbonate reservoirs, economic reinjection of sandstone, development and utilization of dry-hot rocks, etc. will be broken through, providing reliable technical guarantee for the development of geothermal industry.

5.3 Improve the system of policies and regulations and create a good development environment

5.3.1 Straighten out the management mechanism and guide the geothermal development planning

(1) Define the responsibilities of management department

The energy management department is responsible for coordinating the development and reform, planning and natural resources, water conservancy, housing construction, finance and other relevant departments to promote the planning, price and fiscal policy formulation of geothermal energy industry; The competent department of natural resources is responsible for the examination and approval of geothermal exploration rights and mining rights (hereinafter referred to as mining rights); The water administrative department is responsible for the examination and approval of geothermal water intake right. It is suggested that the inter-departmental examination and approval channel should be opened, and the competent department of natural resources should jointly demonstrate and approve with the competent department of water administration when granting geothermal mining rights. At the same time, the water intake permit and mining permit should be handled, so as to simplify the procedures and improve the handling efficiency of geothermal mining rights.

(2) Make a good plan for geothermal resources protection and development and utilization

Geothermal planning is a guiding document for the exploration, development, utilization and protection of geothermal resources, and an important basis for the examination, approval, supervision and management of the exploration, development and utilization activities of geothermal resources according to law. We need to draw up plans for the protection, development and utilization of geothermal resources and incorporate them into special plans for local urban infrastructure.

5.3.2 Establish a monitoring, evaluation and certification system to lead the high-quality development of the industry

(1) Optimize and improve industry standards

During the "14th Five-Year Plan" period, it is necessary to strengthen the research and formulation of core standards, gradually optimize and improve industry technical standards in all links, and build a perfect technical standard system covering the whole industrial chain. On the basis of the international standards, including the four industry standards of "Evaluation method of geothermal energy based on sustainable development and utilization", "Technical requirements for geothermal reinjection", "Technical requirement of preparing geothermal reservoir development plan" and "Standard for geothermal resources dynamic monitoring", we have jointly formulated the international standard of "Recommended Practices for Geothermal Heating" with the International Geothermal Association. We will strive for the international voice of the geothermal industry and seize the commanding heights of the international geothermal technical standards.

(2) Strong implementation of geothermal recharge

The industrial standard "Technical requirements for geothermal reinjection" (NB/T 10099-2018) will be strictly implemented in the newly developed geothermal development and utilization projects for heating and power generation, and the mining owners should make a recharge plan. The irrigation plan shall be examined and approved by the department in charge of natural resources and submitted to the department in charge of water administration for the record. The mining owner must design, construct and put into use the Wells, facilities and water intake facilities at the same time according to the irrigation scheme.

(3) Strengthen the dynamic monitoring of geothermal resources

Dynamic monitoring of geothermal resources is the scientific basis for realizing sustainable development of geothermal resources and also an important basis for evaluating the impact of geothermal resources exploitation and environment. Competent government departments should take the lead in establishing a dynamic monitoring system for geothermal resources, and conduct comprehensive physical dynamic monitoring of the pressure, temperature, flow rate and turbidity of geothermal water. Monitoring instruments with various means such as water pressure, water level, hydrology, seismic measurement and strain should be placed at the wellhead where conditions permit, so as to conduct comprehensive monitoring of the geothermal water system. To master the dynamic changes of geothermal water within a certain time and space, and strictly supervise important monitoring matters related to environmental issues, so as to promote the high-quality development and utilization of geothermal resources.

(4) Establish geothermal industry evaluation and certification system

The standardization demonstration project of geothermal energy development and utilization was selected, with the management of the whole life cycle of geothermal energy projects as the starting point and the current standards as the selection rules, and the

demonstration project was used to drive the high-quality development of the whole industry. We have established an industry inspection and certification center to carry out geothermal recharge technology evaluation and certification based on industry standards, making it an important starting point and basis for the quality improvement of geothermal energy development and utilization projects. We will promote the certification of geothermal recharge, eliminate the existing geothermal development projects that only mining without irrigation, tail water discharge and environmental pollution, so as to strengthen the protection of geothermal resources, and ensure that the development and utilization of geothermal energy belongs to the category of renewable energy.

5.3.3 Formulate and implement active policies to support the development of geothermal industry

The development and utilization of renewable energy is still new technology, new industry in our country, with high cost. It is lack of competition compared with traditional heating from fossil energy. Moreover, the environmental and ecological benefits of the exploitation and utilization of geothermal energy are not enough in the return on investment. It is urgent to formulate and implement more active fiscal and tax pricing policies for renewable energy. Only through the policy support and guidance of price, subsidy, investment and financing, can the construction and operation costs of geothermal heating projects be effectively reduced.

(1) Establish a price mechanism specifically for geothermal industry, improve the economy of the project, and strengthen the capital attraction of geothermal industry

The competent government departments should establish the pricing mechanism and compensation mechanism of geothermal heating as soon as possible, which should be determined according to the application level and conditions of various technologies. It should verify the guiding price (or subsidy standard) of geothermal energy for heating, especially the hydrothermal geothermal that has already been applied on a large scale. The heating price should give full consideration to the characteristics of low operating cost but high construction cost of geothermal heating. At the same time, measures should also be considered, such as including the construction and renovation costs of geothermal heating pipe network into the urban basic equipment fees, and charging according to the standard of conventional energy heating pipe network construction. On the basis of fully guaranteeing the normal operation and reasonable profit space of geothermal enterprises, we can adopt a detailed and executable pricing mechanism and compensation mechanism, so as to enhance the enthusiasm of enterprises to invest in geothermal, so as to promote the rapid development of geothermal industry.

(2) Increase financial support from finance and taxation, and form a complete fiscal and taxation subsidy policy from top to bottom

At present, the local governments of various provinces and cities have introduced some preferential policies, but the preferential policies are not enough, and these policies are issued according to the current situation of local finance, the consistency of the policies cannot be guaranteed. Therefore, it is necessary to strengthen the policy research and formulation of geothermal industry at the national level, and form a complete system of preferential fiscal and tax policies for geothermal energy. Due to the characteristics of high initial investment and low returns of geothermal heating projects, it is difficult for enterprises to recover funds quickly in a short time. If enterprises want to develop sustainably, they need more support from the government in such areas as tax cuts and exemptions, investment subsidies, accelerated depreciation, and coordination among financial institutions to issue low-interest loans. Geothermal power generation is mainly concentrated in Tibet, Qinghai and other regions, with a large investment scale. It is suggested that in the early stage of the development of the geothermal power industry, a reasonable on-grid electricity price and subsidized electricity price should be formulated by referring to the national comprehensive support policies of wind energy, photovoltaic and other renewable energy sources in the early stage of development, so as to promote the development of the geothermal power industry.

(3) Give full play to the role of the market and improve the professional level of geothermal industry

The state will further relax the market access conditions of the urban heating industry, encourage private capital to enter the field of geothermal heating construction and operation of geothermal heating projects, and make full use of the public-private partnership (PPP) model. These measures can guarantee the return on investment of enterprises and fully mobilize the enthusiasm of private capital to participate in the construction of geothermal heating projects. At the same time, the state will support specialized and branded geothermal heating enterprises to merge small, loose and weak geothermal heating enterprises through mergers, acquisitions and reorganizations, so as to improve the professional level of the geothermal heating industry.

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