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China Geothermal Energy Development Report 2018: Status and Policy Guidance

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ABSTRACT

This country report is the first public-oriented white book on China geothermal energy development status and future policy guidance. It is co-compiled by China Geological Survey, National Energy Administration, Chinese Academy of Sciences, and Development Research Center of the State Council.

With respect to resources assessment, China Geological Survey has been conducting the nation-wide survey and assessment since 2011 to 2018. The recoverable reserve of shallow geothermal resource in 336 key cities is equivalent to 0.7 billion tons of standard coals. The recoverable reserve of hydrothermal resource is equivalent to 1.865 billion tons of standard coals (under the condition of rejection), among which the medium-to-low temperature resources account for 95%. The resources amount of Hot-Dry-Rock (HDR) within the depth of 3km to 10km in mainland China is equivalent to 856 trillion tons of standard coals.

With respect to energy development, accompanying the hosting of 2008 Beijing Olympic Games, the development of shallow geothermal energy began and grows rapidly at an annual rate of 28%. By the end of 2017, the installed capacity of heat pumps in China had reached 20,000MWe, ranking the first in the world; and meet the heating and cooling demand of 0.5 billion square meters. With different ways of bathing, heating, cultivating, power generation, etc., utilization of hydrothermal energy grows continuously. By the end of 2017, the hydrothermal heating area in China had exceeded 150 million square meters, ranking the first in the world for several years. Among them, Xiong-xian county of Xiong-an New Area, Hebei province had 4.5 million square meters of the heating area which satisfied the demand from more than 95% of all urban buildings. Xiong-xian County, with Xiong-xian Model for developing hydrothermal geothermal energy in scale, has become the first no-smoke town for winter heating in China. In 1977, Yangbajing geothermal power station, the first high temperature geothermal power station in China, was successfully constructed, which made China the 8th in the world; but by the end of 2017, the installed capacity of geothermal energy power generation in China was 27.28MWe, ranking 18th in the world. HDR of 236 degree centigrade has been drilled at the depth of 3705m in Gonghe Basin of Qinghai Province in 2017.

In respect of future policy suggestions, it is an urgent need to carry out high quality geothermal resource evaluations throughout China; key techniques for the development and utilization of geothermal energy should be tackled; high-quality demonstration areas for geothermal energy development in a leading and exploratory way should be cultivated; preferential policies should be introduced to support the high-quality development of geothermal energy; the management and monitoring system of geothermal energy should be established and improved. The construction of demonstration areas for geothermal energy development, represented by Beijing's subsidiary city center, Xiong-an New Area, geothermal towns, as well as an HDR project in Gonghe Basin, Qinghai will promote and lead China's geothermal energy exploration and development to the fast lane.

1. INTRODUCTION

Geothermal energy is heat energy contained in the interior of the Earth and it is a clean, low carbon, widely distributed, largely reserved, safe and high quality renewable energy. Geothermal energy development is characteristically stable, recyclable and renewable, and can help reduce emissions of carbon dioxide while improving the environment. It plays an important role on clean energy development, and is expected to be a new direction for the energy structure adjustment. During the "12th Five-Year Plan" period, the survey and evaluation of the shallow geothermal energy in China cities at prefecture level and above was completed. As for the hydrothermal geothermal resources, exploration and evaluation which focused on typical geothermal resources has also been completed. The selection and assessment of the HDR officially started and the resource potential assessment has achieved initial results. The geothermal industry has developed, obviously.

In order to implement the important speech of the President Xi Jinping's general strategy on promoting energy production and consumption revolution, promoting clean winter heating in North China, and the spirit of the 19th National Congress Report, China has to carry forward the goals of the '13th Five-Year Plan of Geothermal Development and Utilization.' Simultaneously, they must accelerate technical progress in geothermal energy exploration and development, improve utilization levels, solve issues such as space heating in winter and haze treatment, realize people's dream of cleaner energy utilization and better living 'after got rich.' In recent years, China has entered an outburst period in development of geothermal energy.

With the "Three deep and One soil" strategy proposed by the Ministry of Natural Resources, the expansion to the deep resource space, the development of deep geothermal resources, and the development of deep geothermal detection and exploitation technologies will all be important future developments. Whether it is from the detection accuracy and depth of hydrothermal type

geothermal resources, or the high efficiency development technology of HDR, there will be a qualitative leap. The detection and development of geothermal resources is an integrated technology, requiring comprehensive uses of geophysics, geochemistry, drilling, and other means. Geothermal development involves reservoir construction, downhole heat exchange, reinjection technologies, etc.; while the utilization of geothermal resources includes materials technology, power generation technology, heat transfer technology, and other aspects.

The underlying purpose for the compilation and release of the 'China Geothermal Energy Development Report' is to summarize the current development status, clarify the development outline, specify developing strategy and policies, while creating consensus and support for the rapid development of geothermal energy in China.

2. HISTORICAL REVIEWS

China is the earliest country in the world to use geothermal energy, but geothermal research and development in China systematically began in 1970s. According to historical records, as early as 2800 years ago, King of Zhou Dynasty used hot spring bath at Huaqing Hot Springs in Mount Li. The earliest geothermal data collection in China was the "Summary of China Hot Springs" written by Zhang Hongzhao in 1956, which recorded 927 hot springs. The history of geothermal development in China can be summarized into three stages.

2.1 Initial Stage

Geothermal research in China systematically began in the 1970s. On October 15, 1970, Li Siguang visited the geothermal development and utilization in Tianjin. He pointed out: "The earth is a large heat reservoir and it is a new source of natural energy for humans, just as discovered coal and oil can be burned." The Tianjin geothermal campaign kicked off from then on. The country has gradually entered a booming development stage of geothermal energy. In 1970s and 1980s, China completed a general survey of geothermal resources in more than 20 provinces and autonomous regions, and initially identified the distribution and characteristics of geothermal resources. Apart from that, the country also carried out research on geothermal resource exploration at some important geothermal fields, mainly focusing on Tianjin, Niutuo Town of Hebei, Zhangzhou of Fujian Province, Yangbajing and Yangyi of Tibet, etc.

2.2 Development and Utilization Stage

Since the 1990s, geothermal development entered the stage of marketization, causing disorderly development in some areas, which has affected the sustainable use of geothermal resources to some extent. During this period, a lot of achievements have been made in several respects, including geothermal fundamental research, geothermal research in mines, and geothermal research in oil and gas basins. The Chinese Academy of Sciences has published terrestrial heat flow data three times, compiled and revised the national heat flow map; the former National Commission of Mineral Reserves established a database of some hot springs, hot water wells, and geothermal fields in the country. In the study of oil and gas exploration and oil field water, the oil sector has successively discovered thermal water and hot brine resources in oil and gas basins, studied geothermal resources in the North China Oilfield and other oilfields, and gradually formed techniques and methods to restore the thermal history of a multi-period complicated evolution of sedimentary basins in China. A number of geothermal research results have also been applied to oil and gas exploration practices; the depth of mining geothermal studies has been gradually expanded, and new understandings of deep ground temperature predictions have been achieved. Since 1999, the China Geological Survey has organized and implemented the geothermal resources exploration and evaluation work in Yinchuan Plain of Ningxia, urban areas of Beijing, Guanzhong basin in Shaanxi and Lubei region, etc., which has made important contributions to the development and utilization of regional geothermal resources and the local economy.

2.3 All-round Development Stage

The systematic evaluation of geothermal resources in China has entered a period of rapid development after 2010. It was also "a second wind" of the development and utilization of geothermal energy in China. As for shallow geothermal energy, the country completed the investigation and evaluation of cities at prefecture level and above. With regards to hydrothermal type geothermal exploration, the country, at a basic level, determined the present situation of national geothermal resources development and utilization. Initial results have been achieved in key geothermal fields from high temperature in the Southwest (Western Sichuan, southern Tibet) to low temperature in the East (Pearl River Delta). In 2013, it launched a survey, evaluation, exploration and demonstration work of HDR resource. The Ministry of Science and Technology has also set up two "863" high-tech research programs, that is, "The key technology research on the development and comprehensive utilization of HDR thermal energy" and "The key technology research and demonstration of medium and low temperature geothermal power generation". The exploration and evaluation of HDR officially started. From perspective of regions, favorable target area for HDR exploration and development in China was delineated, and 4 types of HDR resources genetic models were proposed. Achievements have been made in the detection of HDR at the southeastern coast, northeast margin of the Tibetan Plateau, Wudalianchi of northeast region and other places. In respect of geothermal development and utilization technologies, major breakthroughs have been made on geothermal reinjection, geothermal reservoir chemical stimulation, downhole heat exchange and geothermal comprehensive utilization technologies, which laid the foundation for the future efficient use of geothermal energy in China.

3. STATUS OF GEOTHERMAL ENERGY DEVELOPMENT

China is rich in geothermal resources. However, the ratio of explored and utilized geothermal energy is still low. Thus, the development of geothermal energy has great potential in China. In recent years, with the continuous innovation in exploration and development technologies, the equipment that is associated with developing and using geothermal energy is also improving rapidly. The utilization of shallow geothermal energy has increased remarkably, and the development of hydrothermal resources continuously increases while the exploration of HDR type geothermal energy has also started. The industry system of developing geothermal energy has been preliminarily formed. At the same time, the deeply-seated problems of inadequate and uncoordinated development need to be resolved urgently.

3.1 Great Potential of China's Geothermal Resources

During the "12th Five-Year" period, the national survey and assessment of geothermal resources was conducted by China Geological Survey, the resource amount of shallow geothermal energy, hydrothermal energy, and HDR type geothermal energy were calculated. According to the evaluation results, the recoverable reserves of shallow geothermal resources in 336 cities equals to 0.7 billion tons of standard coals, which can meet the heating and cooling demand of 32 billion square meters. Among them, the Huanghuaihai Plain and the middle and lower plains of the Yangtze River are favorable areas for developing shallow geothermal energy. The recoverable reserve of hydrothermal resource is equivalent to 1.865 billion tons of standard coals (under the condition of rejection), among which the medium-to-low temperature geothermal resource accounts for 95%. The medium-to-low temperature geothermal resources are distributed not only in plain areas (basins) such as the North China basin, Songliao basin, Subei basin, Jianghan basin, and Ordos basin, but also in hilly areas, such as the southeastern coast, Jiaodong Peninsula, and Liaodong Peninsula. The medium-to-low temperature geothermal energy is mainly used for heating, drying, tourism, cultivating, and so on. The high temperature geothermal resources are mainly distributed south of Tibet, west of Yunnan, west of Sichuan, and Taiwan Province. Annual recoverable reserves of high temperature geothermal resources in Southwest China are equivalent to 18 million tons of standard coals, and the potential of power generation capacity reaches 7,120MWe. The cascade utilization of high temperature geothermal resource in Southwest China can meet the power needs and heating demands for 50% of the population in western Sichuan and some minority in southern Tibet.

According to a preliminary estimation, the resource amount of HDR within the depth of 3km to 10km in mainland China is about 2.5×10^{25}J (equivalent to 856 trillion tons of standard coals), among which, the resource of HDR within 3km to 5.5km is about (equivalent to 106 trillion tons of standard coals). Considering the difficulty in exploring and utilization of HDR type geothermal energy, the HDR type geothermal energy buried between 3km to 5.5km represents the priority research field for the next 15 to 30 years.

3.2 China's Geothermal Energy Industry System has been Constructed

China's geothermal energy industry system has been constructed since the All-round Development Stage. China's geothermal energy was utilized in many different ways: bathing, space heating, power generation, and so on. Since the beginning of the 21st century, impelled by policy guidance and market demands, the development and utilization of geothermal energy has developed rapidly.

Shallow geothermal energy grows rapidly. The development and utilization of shallow geothermal energy began at the end of the 20th century and during the year of 2000. Then, the heating/cooling area of ground source heat pumps was merely 100,000 square meters. As people pay more attention to energy saving and climate change, the development and utilization of shallow geothermal energy grows rapidly. The heating/cooling area of ground source heat pump was 7.67 million square meters in 2004 and since 2010, the heating/cooling area of shallow geothermal energy grows at the rate of 28%. By the end of 2017, the installed capacity of China's heat pumps had reached 20,000MWe, ranking the first in the world and the development and utilization of shallow geothermal energy reduce the burning of 19 million tons of standard coals and meet the heating and cooling demand of 0.5 billion square meters, mainly in the city district of Beijing, Tianjin, Hebei, Liaoning, Shandong, Hubei, Jiangsu, Shanghai, and so on. Among them, the heating/cooling area of shallow geothermal energy ranks first in the Beijing-Tianjin-Hebei region.

Hydrothermal energy grows continuously. During the past ten years, the average annual increase rate of hydrothermal energy was 10%, and the amount hydrothermal energy utilization ranked the first in the world for many years. Geothermal energy is primarily used for space heating, then used for bathing, cultivating, and so on. In the year of 1990, hydrothermal energy heating area was merely 19 million square meters, and increased to 11 million square meters in 2000, and at the end of 2015 the number had reached 102 million square meters. Among them, geothermal energy heating area in Tiaiyin was 21 million square meters, ranking the first in China cities and accounting for 6 percent of total hydrothermal energy heating area. In Xiongxian county of Hebei province, the hydrothermal heating area was 4.5 million square meters, which had satisfied more than 95% heating demand of whole urban area. The developing of geothermal energy in Xiongxian county made it become the first no-smoke town in China and the "Xiongxian Model" was proposed to develop hydrothermal geothermal energy at scale. According to incomplete statistics, by the end of 2017, the hydrothermal heating area in China had exceeded 150 million square meters; among them, Shandong, Hebei and Henan province grow well. China's geothermal energy power generation began at 1970s. The first middle-to-low temperature geothermal power station was established on December 1970 in Dengwo Village of Fengshun County, Guangdong province and successfully generated power. On September of 1977, the first high temperature geothermal power station-Yangbajing power station was successfully constructed with IMWe installed capacity, which made China became the 8th country to own geothermal energy power generation technology. In 1991, the installed capacity of Yangbajing geothermal power generation of Tibet reached 25.18MWe, and the generated electricity accounting 40-60 percent of total electricity in Lhasa city at that time. By the end of 2017, the installed capacity of geothermal energy power generation in China was 27.28MWe, ranking 18th in the world.

The development and utilization of HDR type geothermal energy is still at the early stage. The development and utilization of HDR type geothermal energy is the future of geothermal energy. After 20 to 40 years of research, countries like US, German, France and Japan have made significant accomplishments and accumulated valuable experience in the exploitation of HDR type geothermal energy, reservoir reconstruction, and power testing. Comparably, China's researches on the HDR type geothermal energy were relatively late. It began from the National High-tech Research and Development Program (863 Program) which was conducted by the Ministry of Science and Technology. Since 2013, China Geological Survey and Qinghai Province have been collaboratively propelling the exploitation of HDR type geothermal energy in key areas in Qinghai province. In 2017, 236T；HDR was drilled at the depth of 3,705m in Gonghe Basin of Qinghai Province and this was the first time to find such high temperature HDR type geothermal energy in contemporary non-volcanic activity regions. Through deep research, in the future, the development and utilization technologies for HDR type geothermal energy will make great breakthroughs to promote the rapid development of China's geothermal energy power generation and cascading utilization industries.

The technologies for geothermal energy utilization have improved steadily. With the development of heat pump technology, China has the ability to recreate large-scale heat pump systems, high temperature heat pump systems, and multifunctional heat pump systems which are feasible in China's markets. Major technologies and facilities have been basically localized.

Tail water reinjection technology has improved. The technology of tail water reinjection in confined space in karstic reservoirs is relatively mature. After numerous scientifically experiments, the technology of economic reinjection in sand reservoirs has made significant progress, however, to promote it to a large scale still need more experiments and researches.

The cascade utilization of geothermal energy has been positively studied in China and some demonstration projects have been constructed in Beijing-Tianjin-Hebei region and southeastern coastal areas where developing geothermal energy for power generation, space heating, and so on.

3.3 Continuous Technical Innovation for Geothermal Energy Exploration, Dvelopment and Utilization in China

The technology system for geothermal energy exploitation has continuously improved. Since the 1970s, China has made significant achievements in geology, geophysics, geochemistry, drilling, and so on.

The first one is geological study on geothermal system. China has made great progress in geothermal flow distribution, origin of geothermal energy, distribution patterns, geothermal resource evaluations, and so on. Currently, China is positively investigating the origin of deep geothermal energy, three-dimensional geological modelling of geothermal field, fine description of the structure of heat reservoirs, and the evaluation of resource amounts under the condition of rejection. All of these studies will provide theoretical guidance for the exploration and development of geothermal energy.

The second one is the study on geophysical methods. A variety of comprehensive geophysical prospecting techniques, from gravity, magnetoelectric survey to detailed seismic prospecting, have been preliminarily formed. In recent years, with the technology of comprehensive interpretation of seismic data and fine descriptive technology for 3D seismic geological model, the accuracy and efficiency of target selection and borehole location for hydrothermal energy and HDR type geothermal energy has been greatly improved.

The third one is the study on geochemistry. China has gradually built a technology system for geochemistry exploitation. After several decades' development, based on isotope and chemical characteristics of gas, water and rock, Chinese institutes have basically employed/created a set of geochemical methods which can be used in judging abnormal areas of geothermal energy, evaluating heat reservoirs' temperatures, inferring the origins of geothermal water, predicting scaling and eroding, and so on.

Fourthly, there is a great improvement in geothermal energy drilling. Since the end of 1990s, China has attempted to combine the technology of oil drilling and completion with developing geothermal energy which greatly improved the efficiency of drilling, shortening the period of drilling. China has successfully completed many high-temperature drilling projects (above 300℃) in Yangbajing of Tibet, Kenya, Turkey and some other regions.

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4. SUGGESTIONS ON PROMOTING HIGH-QUALITY DEVELOPMENT OF GEOTHERMAL ENERGY

4.1 To Carry Out the High-Quality Geothermal Resource Evaluations Through China as soon as Possible is an Urgent Issue

Some actions need to be taken to facilitate the development of China's geothermal resources evaluation, such as increasing financial investment, encouraging active participation of all kinds of social capital, and carrying out investigations and evaluations of national geothermal resources. Focusing on North China, Songliao, Jianghan, Ordos, Subei and other basins (plains), China should accelerate efforts to ascertain geological conditions, reservoir characteristics, quality and quantity of both hydrothermal type and HDR type geothermal areas (fields), and evaluate the technical and economic conditions for its development. Besides the aforementioned suggestions, China should also speed up the exploration and development of deep geothermal resources, and prepare for the large-scale and commercialized development of HDR type geothermal energy.

China should not only establish the system of data collection, sharing and service for the government-led whole industrial chain in geothermal energy exploration, development and utilization, but also form a national data platform for geothermal energy development and utilization which includes basic data of geothermal resources, dynamic and efficiency monitoring data of geothermal development and utilization, and industrial network information management system aimed at improving support for geothermal energy investigation, evaluation, scientific development, and utilization.

4.2 Key Techniques for the Development and Utilization of Geothermal Energy Should be Tackled Fast

The central finance and local finance should set up the major specialized funds for geothermal resources survey and for scientific and technological innovation, increase the investment in the research and development of key technologies for geothermal energy

exploration and development, and strengthen the research and development of special equipment and special technology for geothermal energy.

The first is to develop comprehensive geophysical and geochemical techniques that can directly detect the underground temperature field, so as to realize three-dimensional fine characterization of the underground temperature field. The second is to strengthen the research and development in directional drilling technology and equipment, at high temperatures. This requires breaking through the key technical bottlenecks of high temperature degradation and low cost drilling, achievable through the upgrading of core equipment. The third is to tackle technical problems in the economical recharge technology of sandstone reservoirs, to improve the well completion technology of recharge wells, and to optimize the layout of the production and recharge system. The fourth is to make technical breakthroughs in HDR exploration and development, and to break through the key technologies of reservoir construction, reconstruction and efficient heat exchange. The fifth is to explore a multistep, comprehensive, and efficient model of utilizing technology system and business mode, and to tackle key technologies in power generation, heating, cooling, commercial application, and other related areas.

4.3 High-Quality Demonstration Areas for Geothermal Energy Development in a Leading and Exploratory Way Should Be Cultivated

The first is to establish a demonstration area for efficient development and utilization of geothermal energy in Xiong'an New Area. To make the “Xiong'an Model” of geothermal energy utilization into a global model in accordance with the goal and requirement of the “Xiong'an Quality” in the planning and construction of Xiong'an New Area. In terms of planning concept, geothermal planning will be carried out first instead of the previous geothermal development following urban agglomeration. For the source of energy supply, the original hydrothermal-focused type will be reformed as the geothermal, hydrothermal, and HDR integrated type. For the way of energy supply, a single heating supply will be replaced by multiple supplies of electricity, heating and cooling supplies. The way of energy consumption will be transformed from a single geothermal consumption into multi-energy consumption. The energy-consumption cycle will be changed from one heating season to four seasons. The industrial chain will be transformed from the single energy industry into an integrated industrial cluster of upper, middle and lower streams of geothermal energy.

The second is to establish a demonstration area for shallow geothermal energy utilization in Beijing's subsidiary administrative center. With the coordinated planning and construction of underground and aboveground space, build a distributed and complementary large-scale energy station system for shallow geothermal energy development and utilization, form a demonstration area of cluster utilization, meeting the needs of heating and cooling of large building aggregates in Beijing's subsidiary administrative center, and assist the construction of green low carbon city.

The third is to establish a pilot site for hot-dry rock exploration and development in the Gonghe Basin. Facing the future development needs for geothermal energy and aiming at the technology frontier of HDR, we will carry out pilot tests to tackle difficulties in strategic science and technology in the Gonghe basin of Qinghai. There we will vigorously promote the development of theory, technology, engineering ,and equipment for the exploration and development of dry-hot-rock type geothermal resources. All the while, we will strive to achieve a major breakthrough in the exploration and development of the HDR type geothermal resources, as soon as possible.

The fourth is to build a demonstration town featuring geothermal energy. Taking the Xiaoyangkou of Jiangsu Rudong as a demonstration area, to build a town based on geothermal energy and featured in the cascade, highly efficient development and utilization of clean energy. Following the comprehensive and high efficiency utilization concept, it will form a clean energy industry cluster for heating, cooling, electricity generation, bath therapy, hot spring leisure, old-age services, efficient modern fishery, agriculture, flower drying, and so on. It will provide a demonstration for the acceleration and development of green industry systems supported by clean energy.

4.4 Preferential Policies Should Be Introduced to Support the High-Quality Development of Geothermal Energy

At the early stage of geothermal energy industrial development, support policies of finance, tax and finance for wind power, photovoltaic and other renewable energy can be referenced, so as to give great support to the exploration and utilization of hydrothermal and HDR type geothermal energy. The geothermal development and utilization should be included into the subsidy range of the renewable energy fund, and should be issued with green certificate quotas in accordance with the green certificate system of renewable energy. Relevant preferential policies of value-added tax, property tax and urban land use tax should be implemented for enterprises of hydrothermal and HDR energy development and utilization as well as other related equipment and materials manufacturing enterprises. Financial subsidy policies for geothermal energy to replace fossil energy for heating, cooling and power generation should be studied and formulated, based on the amount of heating (cooling) and electricity per unit.

Carrying out pilot promotions of the franchise right in another preferential policy consideration. In order to attract social forces and financial capital to participate in geothermal exploration and evaluation, and to promote the scale development and standard development of geothermal energy industry, pilot promotions of the franchise right for geothermal development will be carried out. Enterprises participating in the exploration of basic public welfare using geothermal energy, while integrating the survey and evaluation data if the national geothermal energy data management platform, will be granted the priority of obtaining the franchise qualification of geothermal resources (mining rights).

4.5 The management and monitoring system of geothermal energy should be established and improved

The first is to make a proper special planning for geothermal energy. The special planning of geothermal energy utilization will be included in the national spatial planning system, and the overall objectives and basic ideas of the geothermal energy development and utilization will be clearly defined. The geothermal energy heating (cooling) will be included in the special planning of local infrastructure construction, so as to realize the scientific layout and efficient development of geothermal energy.

The second is to improve the management system of geothermal energy. In accordance with the principle of “One department is responsible for one thing”, the management measures for geothermal energy development and utilization will be formulated in line with *the renewable energy law of the People's Republic of China* as soon as possible. The boundaries and standards for utilizing water resources, geothermal resources, and for both water and heat intakes will be clearly defined. The market access regulations of geothermal energy exploration and development, the bid, auction, listing and selling of mining rights, and third-party services will be perfected. The reinjection system of geothermal tail water will be perfected, effective implementations will be made, and the geothermal resources and environmental protections will be strengthened. The strengthened supervision, standardized market order, and increased penalties for illegal enterprises will be targeted. Finally, a statistical report system for geothermal energy exploration, development and utilization will be established.

The third is to establish an evaluation system for geothermal energy development and utilization. In areas of the northern region and the Yangtze River economic belt that meet the requirements, there should be a transformation of their energy system into comprehensive application demonstration projects(areas). The utilization of geothermal energy should be included in the assessment system of regional ecological civilization construction, and act as an additional part of the assessment criteria for energy conservation and emission reductions.

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