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Current Situation of Geothermal Energy Utilization and Development Suggestions in Henan Province

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ABSTRACT

In recent years, with the continuous promotion of carbon neutral policy, the utilization of clean energy has been accelerated. 2017, the Ministry of Environmental Protection released the "2017 Air Pollution Prevention and Control Work Plan for Beijing, Tianjin, Hebei and Surrounding Areas", which refers to the channel cities as "2+26" cities. Of the 17 prefecture-level cities in Henan Province, seven of them belong to the "2+26" cities, and the prevention of air pollution in Henan Province is imminent. The structure of Henan Province straddles two tectonic units, the southern Bohai Bay Basin and the North and South China Basins, and is mainly dominated by low and medium temperature geothermal resources. The shallow geothermal energy is distributed throughout the province, while the middle and deep geothermal energy is mainly in the eastern plain sedimentary basin and the southwestern mountainous fracture convection type resources. At present, the utilization of shallow geothermal energy in Henan Province is mainly in the form of buried pipes and water source heat pumps, and the main development area of middle and deep layers is sedimentary basin type geothermal resources.

1. PREAMBLE

At present, how to deal with climate, environmental change, energy security has been a common global concern, to ensure the rapid development of the economy, the development of low-carbon, economic society, has been more and more countries agree. China's primary energy structure of the three stages of change once for: coal-based - diversified development - non-fossil energy-based. Now, China is in the stage of diversified development, coal, oil, natural gas, renewable energy coordinated development of the energy supply system, technology and equipment level has improved significantly, the living conditions of energy use significantly improved. But China is facing energy demand energy demand is large, supply constraints are more, energy production and consumption of ecological damage is serious, the overall level of technology lags behind and other challenges. Geothermal energy mainly comes from deep in the earth's crust and is the natural thermal energy stored underground. Geothermal resources are the sum of geothermal energy, geothermal fluids and useful components with real or potential exploitation value within a certain depth of the earth's crust surface under the influence of economic, technical and geological factors at the present stage only. Geothermal energy, as a new non-polluting energy source, is a new direction of energy development and utilization, and the development and utilization of geothermal resources is an important way to implement sustainable development strategy. Since the 18th Party Congress, China has issued documents such as the "Thirteenth Five-Year Plan for Renewable Energy Development" and "Thirteenth Five-Year Plan for Geothermal Energy Development and Utilization", taking geothermal energy industry as an important direction for new energy development and putting forward the green and sustainable development principle in the medium and long-term planning of geothermal energy industry. In August 2018, in order to ensure the completion of the 2017 targets set by the Action Plan for the Prevention and Control of Air Pollution, the Ministry of Environmental Protection previously formulated the 2017 Air Pollution Prevention and Control Work Plan for Beijing, Tianjin, Hebei and surrounding areas, with a list of "2+26" cities, including including Zhengzhou, Kaifeng, Anyang, Hebi, Xinxiang, Jiaozuo, Puyang, Henan Province, a total of seven cities, clean energy development and utilization in Henan Province is imperative. The thermal storage area of geothermal resources in Henan Province accounts for up to 25.2% of the province's land area (166,758km^2 of Henan Province). 2019, Xi Jinping set the ecological protection and high-quality development of the Yellow River Basin as a major national strategy, and Henan Province, as the largest province in terms of population in the Yellow River Basin, plays a vital role in protecting the ecology of the Yellow River Basin. Henan Province follows the national policy, grasps the opportunity of "ecological protection and high-quality development of Yellow River Basin", and actively promotes the development of geothermal energy along the Yellow River area.

2. GEOTHERMAL ENERGY POTENTIAL AND UTILIZATION STATUS IN HENAN PROVINCE

Geothermal energy refers to geothermal energy with realistic or certain development potential under the influence of current economic, technical and geological factors. Geothermal energy is mainly divided into shallow geothermal energy and medium-deep geothermal energy according to depth. According to the research situation, both shallow and medium-deep geothermal energy is utilized in Henan Province.

2.1 Distribution of shallow geothermal energy resources

Shallow geothermal resources in Henan Province are distributed throughout the province. According to the geomorphology of the city, it can be divided into three types: alluvial plain city, inland valley basin city and piedmont alluvial proluvial inclined plain city. Among them, alluvial plain cities are the most abundant in groundwater, including 9 cities including Zhengzhou, Kaifeng, Xinxiang, Puyang, Xuchang, Luohe, Shangqiu, Zhoukou and Zhumadian. The underground water-rich cities of inland valley basin-type cities are second, including Luoyang City, Sanmenxia City, Nanyang City, Xinyang City, Jiyuan City and other 5 cities. Four cities, including Pingdingshan, Jiaozuo, Hebi, and Anyang, are alluvial-proluvial inclined plain cities in front of mountains. The single well water output of shallow geothermal wells in various cities varies from 1000 to 3000 m3/d, and the water-rich area of the Yellow River alluvial plain is the strongest. The depth of the constant temperature layer in various cities is 20-27m, the temperature is 15.5-

17℃, and the shallow ground temperature field within 200m can be used with a temperature of 15.9-19.33℃. According to the suitable area for groundwater source heat pump and the suitable area for buried pipe, the resources are calculated by the thermal storage method. Considering the total urban area of 8147km2 in Henan Province, the amount of recoverable geothermal resources in the suitable area for water source heat pump is calculated to be 21.11×108 GJ/a, which is equivalent to standard coal. 71 million tons/year; the annual available geothermal resources in the area suitable for buried pipes are 19.73.55×10^8GJ/a, equivalent to 67.3407 million tons of standard coal/year.

2.2 Distribution of geothermal energy resources in the middle and deep layers

The average terrestrial heat flow value in Henan Province is 57mw/m^2, which is generally high in the east and low in the west. The geothermal gradient of the Mesozoic sedimentary strata is slightly higher, generally 3-5.1℃/100m. The west is mainly fault convection type, and the east is sedimentary basin type. The geothermal field of the fault structure type in the bedrock mountainous area is affected by the thermal conductivity of groundwater and rocks, resulting in a slightly lower geothermal gradient, generally between 0.2-1.7°C/100m. There are two main types of thermal storage in the province—sandstone pore-type thermal storage and karst-type thermal storage. The Cambrian-Ordovician karst thermal storage is the most favorable in the convex area, and the Neogene and Paleogene sandstone thermal storage in the depression area. Best for development. Among them, the Neihuang uplift in northeastern Henan, the Taikang uplift in central Henan, the Changshan uplift in southern Henan, and the high part of the Sanmenxia Basin are favorable for the development of tropical karst thermal storage; Dongpu depression in northeastern Henan, Kaifeng depression in central Henan, The Zhoukou Depression and the Nanxiang Basin in southern Henan have well-developed tropical sandstone thermal reserves. In general, the top surface of Neogene sandstone thermal storage in the province is buried at a depth of 800-1500m, and the temperature of geothermal water is 30-85℃; °C. The thermal storage volume method estimates the recoverable amount of geothermal resources of shallow sedimentary basin-type geothermal resources above 4000 m in Henan Province to be 110.8×10^8GJ.

According to the estimation of the recoverable resources of mid-deep geothermal under the condition of recharge in Henan Province, according to the utilization rate of 20%, the Mesozoic thermal storage can replace 2554.8×10^4t of standard coal and reduce carbon dioxide emissions by 63.6911 million tons. The annual thermal storage can replace 1196.97×10^4t of standard coal, and can reduce carbon dioxide emissions by 29.8404 million tons. Among them, Kaifeng, Xinxiang, Puyang, Zhoukou and other cities have the most favorable resource conditions.

Table 1: Types of heat storage for mid-deep geothermal energy utilization in Henan Province.

Area	Thermal storage type	Buried depth of top surface of thermal storage/(m)	Water temperature/(℃)
Zhengzhou City	Neogene Sandstone	800	40-50
Kaifeng City	Neogene Sandstone	1500	70-85
	Ordovician system	2000	65-75
Puyang City	Neogene Sandstone	1400	45-52
	Ordovician system	1600	52-60
Xuchang City	Ordovician system	500	30-35
Luoyang City	Paleoproterozoic sandstone	1000	45-50
Jiaozuo City	Neoproterozoic-Paleoproterozoic sandstone	1000	45-50
Luohe City	Neogene Sandstone	1000	50
Sanmenxia City	Neoproterozoic-Paleoproterozoic sandstone	1000	45-55
	Ordovician system	1200	45-50
Shangqiu City	Neogene Sandstone	1000	30-40
Xinxiang City	Neoproterozoic-Paleoproterozoic sandstone	800-1500	40-70
Zhoukou City	Neogene Sandstone	1000	45-55
Nanyang City	Neoproterozoic-Paleoproterozoic sandstone	800-1200	45-55
	Metasedimentary karst thermal storage	600	35-40

2.3 Geothermal Energy Utilization Form and Current Situation

During the "13th Five-Year Plan" period, under the background of national clean heating and the promotion of relevant policies in Henan Province, the utilization of geothermal energy for heating in Henan Province has developed very rapidly. By the end of 2019, the geothermal heating area in Henan Province exceeded 100 million square meters, of which nearly 30 million square meters were heated by shallow geothermal energy and more than 80 million square meters by medium-deep geothermal energy. The current shallow geothermal energy utilization in Henan Province mainly includes underground water source heat pump systems and buried pipe heat pump systems, which are more mature in technology and are mainly utilized for heating and cooling of commercial and public buildings, mainly concentrated in Zhengzhou, Luoyang, Nanyang and other cities. In the utilization of deep geothermal energy in Henan Province, the western uplift area is dominated by fracture convection type geothermal resources, suitable for bathing development; the eastern part straddles the Bohai Bay and the two basins of South China and North China, with the development of sedimentary basin type geothermal resources, which can carry out geothermal heating and industrial utilization.

In the context of the national level, which attaches great importance to clean heating in the north, medium and deep geothermal energy is receiving more and more attention because of its cleanliness, economy and flexibility. The development of medium and deep geothermal heating in Henan Province is very rapid, and heating enterprises have promoted geothermal heating projects in Puyang City, Kaifeng City, Zhengzhou City, Zhoukou City and other areas in Henan Province through the technology of "taking heat without water" and "recharge at the same layer", and realized the geothermal heating projects in Puyang area, Zhoukou area and Kaifeng area. Puyang, Zhoukou, Kaifeng and other areas, effectively contributing to energy saving and emission reduction in the region.

3. SUGGESTIONS FOR GEOTHERMAL ENERGY DEVELOPMENT IN HENAN PROVINCE

3.1 Constraints on the development of geothermal energy in Henan Province

(1) The awareness of geothermal resources in the province still needs to be deepened, and the degree of sharing of information on resource investigation and evaluation is insufficient.

(2) The competent department for geothermal development and utilization is not clear, and the phenomenon of multiple management exists.

(3) The implementation of geothermal resource tax will make enterprises unprofitable and seriously affect their investment enthusiasm.

(4) The certification and recharge monitoring system for geothermal development and recharge has not been established, and the supervision is insufficient.

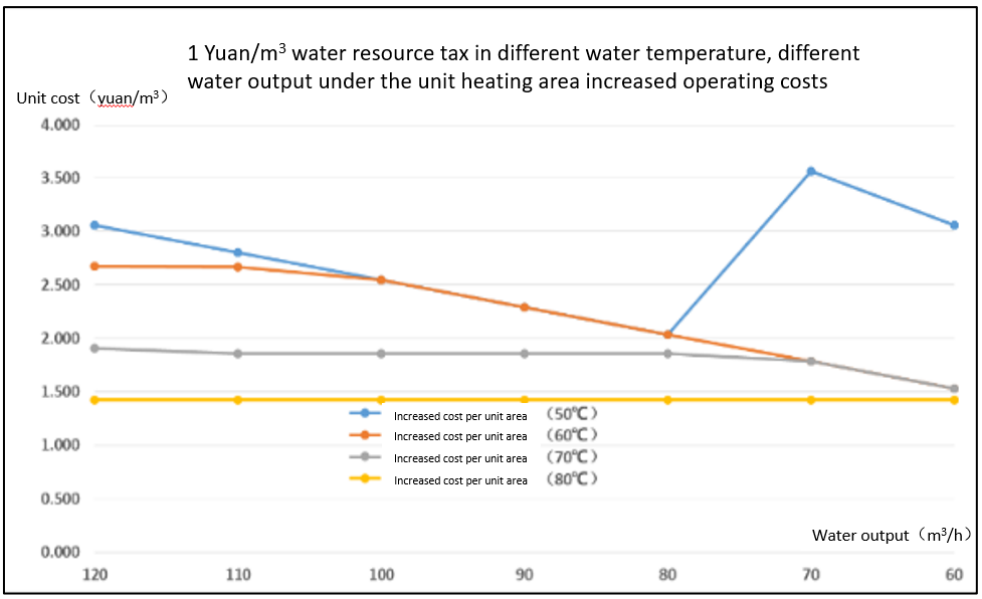

Figure 2: 1 Yuan/m³ water resource tax in different water temperature, different water output under the unit heating area increased operating costs.

3.2 Suggestions for Geothermal Energy Development in Henan Province

From the perspective of the overall geothermal energy utilization volume and utilization ratio, Henan Province still has a large potential for geothermal energy. For the next step of development and utilization, the following suggestions are made: (1) Henan Province is at the junction of the north and south, and the number of days for building cooling and heating is roughly equal, so it is very suitable for promoting shallow geothermal energy utilization projects, which can give full play to the role of underground energy storage to realize building heating in winter and cooling in summer, and effectively relieve the energy pressure during the peak electricity consumption period (2) Henan Province has already achieved large-scale development of medium- and deep-level geothermal energy in Puyang and other regions, and can rely on the existing development base, supported by the most advanced geothermal development technology, to create a centralized continuous area for the development of medium- and deep-level geothermal energy in northern and central Henan, so as to realize coal-fired substitution in mandatory heating areas and help energy transformation; (3) in areas with very favorable geothermal resources such as Kaifeng depression, the basic energy advantages of geothermal energy can be given full play, and under the Under the guidance of scientific planning, a new mode of utilization of

"geothermal +" gas and electric energy can be formed, and the industrialized utilization of geothermal energy can be gradually explored; (4) water resources tax can be exempted for geothermal heating projects with complete recharge; for geothermal planting and breeding projects, the amount of direct utilization of geothermal water can be considered for appropriate taxation; (5) the exploration of high-temperature geothermal resources and dry heat rocks and explore geothermal power generation based on resources to lead the development of the industry; rely on geothermal energy resources to carry out high-end flower cultivation and aquaculture projects to help improve the rural economy.

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